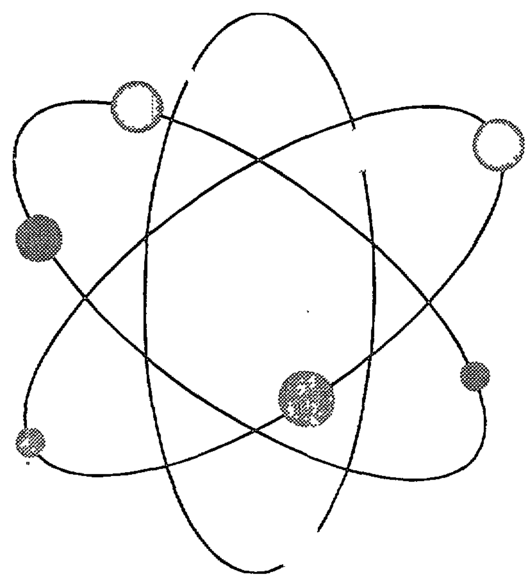
NATIONAL CENTER FOR EDUCATION STATISTICS

Statistical Analysis Report February 1996

National Education Longitudinal Study of 1988

High School Seniors' Instructional Experiences in Science and Mathematics



U.S. Department of Education
Office of Educational Research and Improvement NCES 95-278

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Statistical Analysis Report February 1996

National Education Longitudinal Study of 1988

High School Seniors' Instructional Experiences in Science and Mathematics

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Summary of Major Findings

This study examines the instructional experiences of a national sample of 1992 high school seniors in the subjects of science and mathematics. The study analyzes data from the National Education Longitudinal Study of 1988 (NELS:88). The information on instruction comes from the NELS:88 1992 survey of teachers, which collected questionnaires from the science and mathematics teachers of 9,853 sampled seniors enrolled in public and private high schools across the United States. Two general questions are addressed: To what extent are high school seniors' instructional experiences affected by their social backgrounds and by the schools they attend? To answer these questions, multiple regression analysis is used to sort out the influences of social background and schooling variables on instructional variables and achievement score differences.

Factors Affecting Instruction

We focused on three sets of explanatory variables, organized under the rubrics of student background, intra-school organizational factors, and between-school factors to answer the question of why students' instructional experiences differ. Before examining the instructional variables, it is important to take stock of who takes senior-year science and math. Many seniors do not take science or mathematics, and thus we examined the relationship of these factors with enrollment.

- Overall, 66 percent of the seniors were enrolled in mathematics courses, and 48 percent were enrolled in science courses. Most of the students enrolled in science and mathematics classes were in relatively higher-level courses, but about one-third were taking low-level or basic courses. About 27 percent of math enrollees were in first-year algebra or lower courses, while 33 percent of the science students were in biology 1 or lower.

- Overall, students taking senior science courses and students taking senior mathematics courses tend to come from more affluent families. Males are slightly more likely to take senior-year mathematics. Among those taking senior-year mathematics, females are more likely than males to be enrolled in the higher-level mathematics classes. Enrollment rates of whites, blacks, and Hispanics do not differ significantly; however, Asians are significantly more likely to take both subjects. Asians are also much more likely to be enrolled in advanced placement (AP) and other higher-level classes within science and math.

- Students in Catholic high schools and National Association of Independent Schools institutions are more likely to take senior-year science and mathematics. The school policy variables that are most strongly related to senior enrollments are the numbers of math and science courses students are required to complete for graduation.

The instruction variables we examined included the teacher's emphases on various learning objectives, the allocation of instructional time, and the methods of instruction. The learning objectives measured were higher-order thinking skills, mechanical operations, and everyday applications. The time allocation measures included the extent to which whole-group instruction was used, the amount of time devoted to maintaining order in the class, the amount of homework ordinarily assigned, and—in science—the amount of time devoted to laboratory sessions, the frequency of computer use, and student oral presentations. Instructional methods were measured by responses to questions about the relative roles of lectures, discussions, small group work, and individualization.

- Student background variables are associated with instructional differences, but these associations mostly reflect the correlation of student background variables with the achievement level of the class. The most powerful predictor of instructional differences is the achievement level of the class, which overshadows the influences of social background and school characteristics.

- Some effects of background persist even after the impact of class achievement level is factored out. Students from higher socioeconomic status (SES) families tend to have mathematics teachers who assign more homework and place greater emphasis on higher-order skills. In science, higher SES is associated with more laboratory opportunities.

- Teachers of higher-level students are more likely to have undergraduate and graduate specializations in their respective field (mathematics or science). However, differences in educational credentials of teachers of students at the same class achievement levels are generally not associated with instructional differences.

- School policy variables are related to several aspects of instruction. School demographic factors such as location and SES composition generally have weak and inconsistent relationships with classroom instruction. Policy variables which do make a difference relate to work conditions of teachers. Higher-order thinking skills are emphasized more by teachers who report more discussions with colleagues.

Effects of Instructional Variables on Achievement

Efforts to link the measures of students' instructional experiences to their achievement outcomes are unavoidably tentative because of the NELS:88 study design. Achievement was measured at the end of 10th grade and the end of 12th grade, but instructional experiences were only measured for 12th grade. As a result, we may not have very good measures of the instruction which students received in the period spanned by the achievement test scores. Measurement error of this sort has the effect of making relationships seem weaker that they actually are. Since the lack of grade 11 instructional measures is likely to bias the estimated effects of 12th grade instruction in the direction of insignificance, our strategy has been to look for strong relationships and to discount the weak ones. Nonetheless, all the regression analyses of 12th grade achievement included controls for 10th grade achievement, social background, and school characteristics.

The strongest effects that emerge from this analysis are those associated with the students' class compositions, which we have referred to as their class achievement levels. Here we find that students in higher-level classes learn much more over the two year period than otherwise comparable students in lower-level classes. The results are strongest in mathematics but are present in science as well. The effects of class achievement-level are only partially explained by the instructional variables measured here, and we can only speculate on the additional mechanisms that produce the remaining learning differentials.

Some of the instructional measures we examined for mathematics show significant associations with learning.

- Controlling for sophomore achievement level, social background, school characteristics, achievement level of the class, and teacher credentials, we still find that students whose teachers place greater emphasis on higher-order skills and lower emphasis on the relevance of mathematics score higher.

- Students lose when their teachers have to spend more time maintaining order in the class. The losses from spending more time maintaining order are not confined to lower-achieving students in the lower-level classes. When high-achievers are in classes where order is problematic, their achievement is also lower.

The results from our analysis of science are not nearly as strong as for math. While class achievement-level effects are again evident, the instructional variables measured in the NELS:88 survey do not show much connection with the variability in sophomore-to-senior achievement growth. The weakness of the results in science may be due to either the content of the test not matching the students' actual learning, or the content of the instructional measures not matching the actual instruction that occurred.

Acknowledgments

The topic of this report was originally conceived by Larry Suter of the National Science Foundation. The NSF supported the 1992 survey of mathematics and science teachers in the National Education Longitudinal Study of 1988 (NELS:88), from which the data are drawn. After the teacher data were collected, NSF contracted with NCES and the National Opinion Research Center (NORC) to produce a report illustrating the use of these data, and particularly how they might be combined with other aspects of the NELS:88 data base to inform current policy debates. Larry helped work out the details of the study design, and provided helpful comments at several stages of the analysis and report writing. While the original conception and primary support for this study are attributable to NSF, the review process was organized by NCES. The authors are grateful for the help and encouragement of Peggy Quinn and Jeffrey Owings at NCES, who also contributed constructive criticisms at several points.

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Chapter I
Introduction

As American education moves into the 21st century, public interest in improving student learning is increasing. Some of the more prominent reform proposals have focused on the roles of accountability systems, school choice, teacher professionalism, and family responsibilities. Compelling arguments for the seminal importance of each of these mechanisms have been made, but are often made without acknowledging a very simple fact. This is that the focus of efforts to improve outcomes must ultimately fall upon the classroom and, even more specifically, upon the organization and delivery of instruction. Teachers teach and students learn in classrooms. While state, district, and school policies can have large effects on outcomes, their ultimate effects on student learning are largely mediated by classroom processes.

Despite the centrality of the classroom, systematic research on it using large-scale surveys is still in its infancy. The U.S. Department of Education national longitudinal surveys collected virtually no information on classroom instruction in the National Longitudinal Study of 1972 or the 1980 High School and Beyond study. The analytic thrust of those studies was much more in the direction of explaining differences among individuals in terms of social background, social-psychological, curriculum program, and school organizational variables. New ground was broken by the Second International Science and Mathematics Studies (SISS and SIMS), conducted from 1980 to 1986. These studies collected extensive information about content coverage in the early and late secondary school grades. While their findings continue to stimulate research and policy debates (McKnight, et al., 1987; Westbury, 1992 and 1993; Baker, 1993; Stedman, 1994), the surveys had several shortcomings with respect to sampling adequacy and measurement of processes, outcomes, and organizational contexts. Many of these problems have been overcome by the National Education Longitudinal Study of 1988, or NELS:88. NELS:88 collected data from teachers about how they conduct their classrooms so that the data could be linked back to the individual students in those classes as well as to a wealth of information about the schools in which they worked. These data were collected during the spring terms of 1988, 1990, and 1992, when the sampled students were mostly in grades 8, 10, and 12.

This report draws on the NELS:88 second follow-up (1992) survey of science and mathematics teachers to shed light on the instructional experiences of high school seniors in those subjects. The main objectives here are to describe the types and variability of science and mathematics instruction, and to assess the extent to which differences are associated with ability grouping, student social background, and school characteristics. Beyond that, we provide some preliminary analyses of the relationships between students' instructional experiences and their academic growth over the last two years of high school.

In the sections which follow, we set forth the conceptual framework of the study and describe the sample and measures we use. With these in place, we present univariate statistics describing the NELS:88 variables used throughout the remaining chapters.

Background Perspectives: Policy Issues and School Effects Research

The specific instructional variables and relationships among variables examined in this report were selected because of policy and theoretical interests. This section provides some background on the nature of these interests, and thus gives the context for the report as a whole.

Policy Issues. Current interest in research on classroom processes reflects a convergence of policy and theoretical concerns. On the side of policy, questions about the nature and quality of secondary-grade instruction in science and mathematics have attracted considerable attention over the past decade, due in large part to the mediocre showings of U.S. students in international comparisons of science and especially mathematics. The main response of the federal government has been to establish general goals for the nation's schools, and to support efforts by state and local governments and teacher professional associations to develop standards of what should be taught and how learning should be assessed.

Thus far, the states have relied mainly on the leadership of various national organizations to work out the details of the content standards in mathematics and science. To a much greater extent than their counterparts in the humanities, history, and social science, the national professional associations of secondary science and mathematics teachers are pursuing reform programs that include recommendations for classroom practice. In both fields, the associations are calling for a shift away from disseminating information to having students formulate questions, propose methods for answering them, and then try to arrive at some sort of answer. These proposals often fly under the banners of "inquiry learning" in science, and "constructivism" in mathematics (National Council of Teachers of Mathematics, 1989; National Science Teachers Association, 1992).

The reform proposals arise from widespread perceptions that (a) student achievement levels in science and mathematics are unacceptably low, (b) most teachers rely mainly on lecture and recitation methods and emphasize memorization and mechanical operations (Mullis, Dossey, Owen, and Phillips, 1991, pp. 64-66); and (c) students are typically not engaged by the subject matter. The goal is to have more students achieving at higher levels; the means are to increase student engagement through enlivened yet demanding instruction.

In both science and mathematics, the reform initiatives are more advanced in the areas of general principles, curriculum design, and assessment of student progress than in the area of instructional practice. One does not find mention in the documents of the professional associations specifics on, say, the optimal balance between problem-solving exercises and routine drill, or between lectures and small-group work. What one does find are recommendations about orienting principles of instruction and, to a lesser extent, the relative emphasis teachers should give to different types of skills and the relative time allocations to different methods. With these caveats, the following recommendations follow from the reform proposals of the science and mathematics teacher associations:

- Teachers should emphasize problem-solving and scientific reasoning in all mathematics and science classes, not just classes enrolling the most advanced students. Corrolaries include:
    - Mathematics teachers should minimize the practices teaching specific operations and then assigning students mechanical drill exercises to learn those skills.
        - Science teachers should minimize the practice of having students memorize vocabulary and definitions.
        - Science teachers should minimize the use of lecture-recitation format in favor of greater use of naturalistic observation and laboratory experimentation.

- Both science and math teachers should make regular use of group discussions formats for "thinking out loud" about how to define and solve problems.

- Teachers should emphasize the connections between mathematics and science and problems of everyday life, rather than teaching the subjects as specializations that are pursued for their own sakes.

- Teachers should incorporate the technologies of calculators in mathematics and computer-based data analysis in science, emphasizing the utility of these tools for solving problems.

The aim of these recommendations is to improve the learning outcomes of students in science and mathematics classes by making the subjects more engaging and challenging. While the present report cannot address the value judgments involved in these recommendations, it can address the empirical questions of how widely and under which conditions the recommendations are being pursued, and whether students whose teachers claim to follow the recommendations are actually achieving at higher levels than students whose teachers claim to do otherwise.

While the reform platforms emphasize the importance of improving classroom instruction, advocates in both subject areas also stress the importance of larger systemic reforms to that effort. Two areas that are key to the reforms are curriculum design and teacher professional development. The proposed curriculum changes in both fields represent sharp breaks from the past. One side of curriculum reform is the redesign of thematic content and sequences across all grade levels. This has coincided with formulation of standards as to what should be taught and what students need to know. Another important side is the assignment of teachers and students to classes. The traditional practices of ability grouping and ability-correlated curriculum differentiation are seen by many as impediments to student engagement because it is believed that students in lower groups invest less effort and are held to lower expectations by teachers.

As might be expected, the teacher professional associations want these changes to come mainly from the ranks of the teachers themselves. Thus, alongside curriculum and instructional reform, they also advocate expanded inservice-training opportunities, increased preparation time, and greater opportunities for teachers to develop and coordinate their lessons with other teachers in their schools and professional communities (NCTM, 1991; NSTA, 1992).

A possible problem with these reform proposals concerns the role of incentives and sanctions. The professional associations view teachers' behavior as guided by their knowledge base and the time and resources available to them to learn more. The associations believe that given the opportunity, teachers will develop better instruction and student performance will concomitantly improve. These critical opportunities, however, will probably cost more money because of the increased teaching staff needed to allow more planning and problem-solving sessions. In other words, the incentive to improve is there; what is lacking are the means. Critics of the proposals tend to believe that efforts to reform will accomplish little unless the goals have teeth and good work is rewarded (Hanushek, 1994). Unless schools and students are held accountable and rewarded for achieving specific objectives, reform will be half-hearted and often misdirected. Some claim that the costs of building strong incentive systems can be met by reallocating existing funds, rather than increasing expenditures (Hanushek, 1994).

A related policy issue concerns the means of assessing student and school performance. Many fear that when performance is only assessed by multiple-choice test items, the incentives shift away from "teaching for understanding" to coverage of what is tested and repetitive drill (Newmann, 1992). This may discourage teachers from trying new instructional methods which promise to increase student engagement and which may promote deeper thinking and understanding (Sizer, 1984). This problem confronts the entire curriculum, for advanced students are subject to standards set by the SAT and ACT tests, while slower students are often subject to minimum competency tests.

It is important to recognize that many teachers may in fact prefer "teaching to the test" and the concomitant drill, even when external accountability pressures are not present. The mathematics curriculum developed by John Saxon, for example, is used in many schools and has its share of strong supporters (Diegmueller, 1995). The argument can be made that student engagement increases with mastery, and that mastery is more accessible when tasks are highly structured and feedback unambiguous.

Research on the Effects of Schools and Schooling. The theoretical interest stems from work over the past several decades on factors related to student achievement differences. Initial large-scale research proceeded from the hypothesis that *differences among schools* in the kinds and levels of resources they made available could account for a large share of the differences among students. The Coleman study of 1966 (Coleman, et al., 1966) showed, however, that about 80 percent of the overall variability in student test scores was among students enrolled in the same schools. Furthermore, if one factored out the impact of students' family background differences on the 20 percent of the variance that lies among schools, it turns out that only around 10 percent of overall test-score variance can be attributed to differences in what schools as units actually do. Essentially the same pattern that Coleman discovered has been found in other national surveys spanning the last 30 years (Jencks & Brown, 1975; Hauser, Sewell, & Alwin, 1976; Hotchkiss, 1984).

While differences among schools are thus relatively small compared to the overall variability in test scores, this does not mean that schools do not have much effect on student learning. Studies that have examined the effects of whether and how long students are enrolled in school show that students learn very little when they are not attending school over the summer (Heyns, 1978; Entwisle & Alexander, 1992) or if they drop out of school (Gamoran, 1987). Furthermore—and more to the point of the present study, there is substantial evidence that differences in students' schooling experiences have a large impact on their achievement outcomes. The research on the effects of ability grouping and curriculum tracking (Alexander & McDill, 1976; Gamoran & Mare, 1989; Hoffer, 1992) is one body of evidence here, while another is the research on classroom effects. While the teacher and classroom data have thus far been largely limited to smaller-scale, local samples, the evidence suggests that large differences in learning are found among classes (Hanushek, 1972; Murnane, 1975; Pauly, 1991).

The mechanisms producing the observed achievement level and classroom differences, however, have not been clearly identified. Oakes (1985) documents that the instructional goals, methods, and quality of classes varies by class achievement level, but does not attempt to relate these differences to the achievement gaps. Hoffer and Gamoran (1994) find some support for Oakes' hypotheses, but show that large portions of ability group differences in eighth-grade mathematics and science achievement remain unexplained. There is thus a need to extend this research in order to gain a better understanding of why achievement differences arise and how outcomes for lower-achievers can be improved.

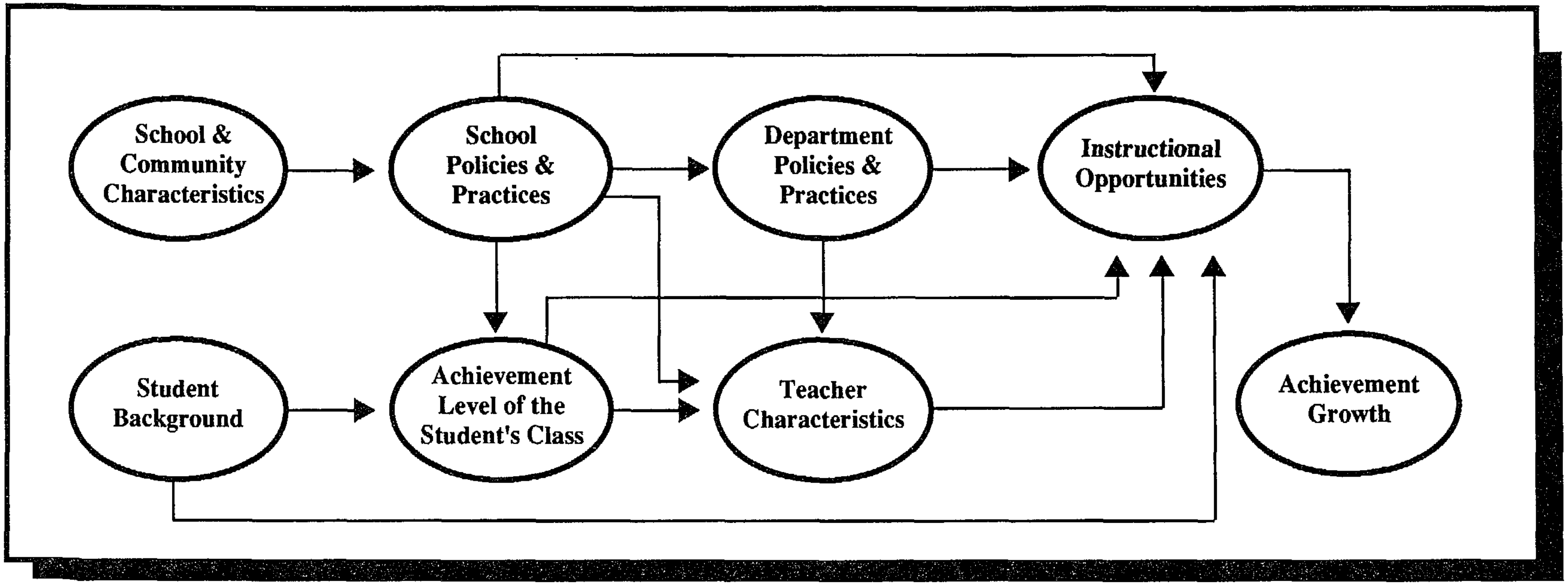
Which Aspects of Instruction are Important, and Why?

A schematic representation of the conceptual model guiding this study is shown in Figure 1.1. This diagram is essentially a rough answer to the question, "Why do students differ in how much they learn over the course of high school?" The ovals represent the main sets of variables drawn upon in this report. The connecting lines indicate paths of influence or causation. Our main interest is in understanding the role of instructional differences among classes in generating achievement differences among students.

What is meant by "achievement" is of course important to clarify. As used here, achievement refers to mastery of content and skills that are generally recognized as important goals of the secondary school science and mathematics curricula. These are operationalized in the NELS:88 survey in terms of multiple-choice items, but these items cluster into sets which measure both simple recall and more complex reasoning. This is important because some of the instructional and school policy factors we consider may lead to positive results on recall items but negative effects on problem-solving. In the analysis presented in Chapter V, we thus examine the effects of the instructional variables on the different types of achievement outcomes in both subject areas.

The diagram shows that student learning is most directly affected by instructional opportunities. Instructional variables are themselves affected by various factors included under the rubric of teacher characteristics, and also by school and subject-department policies and practices, and the ability group of the class. School policies and practices are shaped by community characteristics such as commitment to education and financial support for schools. Individual student background differences are shown here as having an impact on their ability group placements. Background includes parental education and socioeconomic status, as well as actual involvement of the parents in their child's education. While the path is not shown in the diagram, individual background can also be considered to influence the kinds of communities in which students live, in the sense that family income, parental occupation, and educational preferences affect where families reside. Conversely, communities can also affect some aspects of individual background, as when community institutions facilitate greater parental involvement (Coleman and Hoffer, 1987). Also potentially important but not shown here are direct paths from family and community background to achievement outcomes. While we suspect that most of what students learn of mathematics and science during high school is learned in high school classrooms, students certainly can learn from parents, outside readings, museums, and television.

Figure 1.1:
Schematic Diagram of Factors Hypothesized to Affect High School Students' Achievement Score Gains



Instructional opportunities. Instructional variables include the substantive content of the course, the quantity of time devoted to instruction, and the methods used to teach the content. The conception of course content used here refers to the general kinds of skills that the teacher aims to instill, rather than the specific skills such as algebraically solving for an unknown or balancing a chemical equation. Theoretically, the main distinction in the general skill objectives of mathematics and science classes is between reasoning and recall. Many observers have claimed that American high schools tend to emphasize recall and routine application of skills to solve typical problems, at the expense of an emphasis on original thinking and devising and applying problem-solving strategies (Goodlad, 1984; Sizer, 1984; Powell, Farrar, and Cohen, 1985). If the critics are correct, students should perform better on tests requiring reasoning and problem solving when their teachers emphasize thinking over recall. On the other hand, students whose teachers emphasize recall may perform better on tests of factual knowledge and simple operations.

A second general skill dimension along which we anticipate class content will differ is the emphasis teachers place on practical applications and the importance of math and science in everyday life. The science and mathematics teachers associations are both recommending that teachers present these subjects as practical activities rather than as abstract pursuits with little relevance to life outside the classroom. The rationale for this is that it will improve student engagement in the subject matter. We thus expect to find that, other things being equal, teachers who emphasize practical applications will realize better achievement outcomes among their students. In practice, however, other things may be difficult to keep equal, because teachers who allocate time to emphasize practical applications may be taking time away from covering material or working on problem-solving skills.

The quantity of instruction simply refers to the amount of time devoted to instruction. One of the more influential hypotheses of educational research over the past 30 years has been Carroll's (1963) idea that learning differences are affected by the amounts of time devoted to coverage of materials. Research has operationalized "time on task" in various ways, some ways being more error-prone (e.g., the length of the school year) than others (e.g., measures derived from detailed classroom observations of how time is actually spent). Predictably, the more fine-grained studies have found strong associations between time devoted to instructional tasks and students' learning of the content in question (Fisher, et al., 1978).

The third aspect of classroom instruction, the methods of instruction, is the most difficult for which to formulate grounded hypotheses. Are lectures more effective than discussions? Is dividing the class into small work teams that work out solutions to problems more effective than teacher-centered whole class methods? Any answer to these questions seems to depend on many conditions. A thoughtfully-articulated lecture from a well-educated adult is likely to be more informative than even the most earnest discussion among 17-year olds. But a careless lecture may be much less effective than a good discussion. And even the best lecture may fail to stimulate reflection among many students, while the discussion forum may carry some compulsion for the same students to use their intellects.

Factors affecting instruction. Why might classes vary in the kinds of instruction provided to students? Teachers traditionally have had considerable control over how to teach their classes, and some control over the content, as well (Lortie, 1975). The personal preferences of teachers are thus allowed some expression, and instructional differences may be quite unsystematic. Systematic variations may still arise, however, from both direct and indirect mechanisms.

One influence may be the educational background of the teacher. Teachers with undergraduate and graduate specializations in science and mathematics should have better understandings of their subjects and thus should be able to explain ideas more intelligently. Little evidence of positive effects of teacher credentials on student achievement exists (Hanushek, 1989; Hedges, Laine, & Greenwald, 1994), but the expectation of positive effects is sufficiently strong to warrant the further analysis we undertake here. Teachers also differ in their years of experience. More experience should lead to greater effectiveness in classroom management as well as a deeper understanding of the substantive material. On the negative side, more experience may result in the teacher's knowledge base and methods of classroom management being more outdated. A mix of positive and negative effects would be consistent with the evidence from past research, for the effects of experience are usually found to be positive but inconsistent and small (Hanushek, 1989)

Instructional opportunities are also likely to be affected by the composition of the class, particularly the achievement or ability level of the students. Some observers have claimed that the most effective teachers are often assigned to the highest ability levels (Oakes, 1990). This path is indicated in Figure 1.1 by the arrow from ability group to teacher characteristics. A large literature also suggests that ability group placement affects the instructional goals and methods of all teachers, regardless of the teachers' professional backgrounds and personal preferences (Raudenbush, Rowan, & Cheong, 1993; see Gamoran and Berends, 1987 for a review). Students in higher-ability groups are more attentive to teachers and engaged in school, and their teachers are thus able to use whole-class instructional methods more frequently and to assign more homework. Higher-group teachers may also be able to adapt more easily the open-ended inquiry methods recommended by the professional associations.

Although most high school teachers are members of subject-area departments, research on the roles departments play and their influence over their members is only beginning to appear (Bidwell & Bryk, 1994; Little & McLaughlin, 1993). Exploratory research by Talbert and McLaughlin (1994a, 1994b) on a sample of 16 high schools shows that departmental policies and practices affecting teacher professional orientation vary significantly from school to school. Some of the variability is likely to depend on how much autonomy departments have. In some schools, departments choose textbooks and supporting materials. Departments may also set guidelines on what their members should cover and even how it should be covered. Less formal exchanges of information and opinions are also likely to be important functions of departments.

School policies allocate students and teachers to classes, and thus can affect instruction through those mechanisms. Students' time on task may vary because of differences in school and district policies regarding the length of the school year and class periods (Wiley, 1976) and the number of courses students must pass to graduate (Wilson & Rossman, 1993). Time on task differences may also result from different amounts of time needed to discharge administrative duties and to administer tests required by the school.

School policies can also directly affect the definition of instructional goals and the methods used. This can happen through informal channels, as when teachers are influenced by unwritten norms about what to teach and how (Kilgore, 1993). As noted above, one important path of technical and normative information is the teacher's discussions with other teachers in the school, particularly within the same subject-area department. School policies affecting the professional collegiality have not received much research attention, but we speculate that schools which delegate curricular responsibilities to subject-area departments and allocate time to fulfill those responsibilities will have greater collegial involvement in instructional issues. We also suspect that school policies which directly address student learning goals will have an impact on teachers' instructional decisions. Some schools evaluate principals and teachers partly on the basis of measured achievement levels, and there thus can be a strong incentive to find and implement more effective goals and methods (Schneider, Plank, and Wang, 1994).

Effects of student and school background characteristics. The final (left) tier of variables in Figure 1.1 is hypothesized to affect school policy and practice. Numerous studies have shown that student background variables of gender, race-ethnicity, and parental socioeconomic status are associated with instructional experiences in science and mathematics. Transcript studies show that females complete about the same numbers of math and science courses during high school, but are still less likely to take the most advanced courses, particularly in science. These lower rates of participation hold even when males and females at the same achievement levels are compared. Instructional inequalities associated with student SES and race-ethnicity can arise both from segregation between classes within schools as well as segregation between schools. Within schools, lower-SES and minority students are usually found to be disproportionately enrolled in lower-level classes. Between schools, Oakes (1990) showed that schools where lower-SES and minority youth are concentrated tend to offer classes which have less-well-educated teachers than their more affluent counterparts.

School background characteristics include geographic location, type of control (whether the school is public, Catholic, or other private), school size (which could also be viewed as a policy variable), and average socioeconomic status (also affected by policy). Traditionally, students in the Midwest and Northeast states have scored better on standardized achievement tests than students in the South and West (NSF, 1993, p. 26). Similarly, students in suburban high schools usually score higher on average than urban and rural students.

School control type is also associated with outcome differences, and the effects are not completely accounted for by sector differences in the students' backgrounds (Coleman and Hoffer, 1987). Whether by virtue of selectivity (Murnane, 1984), market-driven competition (Chubb and Moe, 1990), or closer student-faculty ties (Bryk, Lee, and Holland, 1993), Catholic schools tend to place greater academic demands on their students.

School enrollment size has long been considered an important influence on school organization and climate. The trend throughout most of this century has been toward consolidating smaller schools into larger units which could realize various economies of scale and provide a greater range and depth of courses. However, larger schools are usually considered to be more impersonal and less able to exert informal social control over students. As far as instruction is concerned, this could lead to less use of methods which require independent work by students, such as small group projects and homework. Because of the challenges larger size schools encounter in their control over students, research suggests they tend to be more formalized and less demanding (Lee, Bryk, & Smith, 1993).

School SES composition is also associated with average school achievement, but once individual SES is taken into account, the research record does not generally indicate large independent effects on individual student learning (Gamoran, 1987; Mayer & Jencks, 1989). In other words, low-SES and high-SES students do about the same whether they are in high-SES or low-SES schools. Nonetheless, some studies have found that instructional resources and practices are better in higher-SES schools (Oakes, 1990; Horn, Hafner, and Owings, 1992). From the standpoint of equality of opportunity, it is thus useful to examine instructional differences among high- and low-SES schools.

Research Questions

The conceptual framework diagrammed in Figure 1.1 shows how we have organized our ideas about the causes and consequences of instructional differences. Each of the paths represents a hypothesis or set of hypotheses that we will address in various ways throughout this report. Our focus, however, will be a relatively small set of questions that can be formulated as follows:

(1) How equal are instructional opportunities, and what are the sources of inequalities? Since our main concern is with the allocation of opportunities to classrooms rather than individuals, inequalities must be conceptualized as generated through the processes which allocate students, teachers, and other resources to classes. This implies that we should first examine how instruction varies among types of classes, and then turn to the question of whether relationships can be found between students' social background and the kinds of instruction they receive in high school. Three subquestions can thus be identified:

(a) What are the main dimensions along which learning opportunities vary within high schools? Some research suggests that the main source of differences is ability grouping: Students in the higher ability, more accelerated classes are allocated the most resources and receive the best instruction. Other researchers have emphasized the importance of differences among teachers in background preparation, motivation, and pedagogical skill.

(b) To what extent do instructional opportunities vary from school to school? Some research suggests that most of the variability is found within, rather than between, schools, but this has not been systematically tested with large-scale survey data. Insofar as differences are found, we will try to identify particular aspects of the schools which may account for them.

(c) What sorts of relationships can be found between students' social background and the kinds of instruction they receive in high school? A number of previous studies have argued that low-SES and minority youth receive poorer instruction. In addressing this question, we make an effort to place whatever inequalities we may find among students in the contexts of the types of classes and schools in which the students are enrolled.

(2) Are there any indications that differences in students' instructional experiences are related to differences in achievement? While the NELS:88 design does not allow a definitive answer to this question, we may find some positive support for certain practices. We will address this question in two steps:

(a) What are the overall effects of instructional differences on achievement growth over the last two years of high school?

(b) Are the effects essentially the same for all students, or are they different for students with different backgrounds? To what extent can good instruction compensate for a disadvantaged background?

Limitations of the Present Study

For several reasons, the present study is best regarded as heuristic and partial with respect to the larger issues of improving student achievement. First, the NELS:88 survey is the first national study to collect detailed information on the goals and conduct of high school classes. We thus lack comparable data from High School and Beyond, and therefore cannot make inferences about trends in high school science and mathematics instruction. Second, the NELS:88 survey design limits the effort to estimate the effects of classroom differences on student outcomes. The NELS:88 data do not allow a direct link of instructional variables to achievement growth, since the instructional variables refer to particular one-year or even one-semester classes, while achievement was only measured every two years. We thus do not have a complete account of the instruction students have received over the learning period, and causal inferences about the effects of instruction on learning must be tentative. Third, the focus on 12th graders enrolled in science and mathematics implies that the inferences we draw apply to a somewhat select group of students. While enrollments in these subjects among seniors has increased significantly in recent years, only 48 percent of seniors took science, and only 66 percent took mathematics. As we shall see, though, these students come from a wide variety of academic and social backgrounds, and were enrolled in courses ranging from the most basic to the most advanced.

Despite these limitations, careful examination of the NELS:88 data are warranted because current discussions about reducing inequalities in students' "opportunities to learn" are often based on anecdotal information about how classrooms are organized and function. The NELS:88 files contain the best available nationally-representative information on high school instructional practices in science and mathematics and should prove useful in refining the focus of current policy pursuits. And although our ability to estimate the effects of the instructional variables on student learning is limited, it is still possible to gain some important clues about the relative significance of different instructional factors for learning over the last two years of high school.

1992 Seniors: The NELS:88 Second Follow-Up Sample

The data analyzed in this report are drawn primarily from the NELS:88 second (1992) follow-up surveys of students and their teachers. NELS:88 began in 1988 with a national sample of about 24,000 eighth-graders selected from 1,052 public and private schools. The study collected questionnaire and cognitive achievement data from the students in 1988, 1990, and 1992, and followed the student beyond high school with mail questionnaires and phone interviews in 1994. While the students were in middle and high school, data were also collected from their teachers, principals, and parents. The high school transcripts of the students were also collected after the 1991-1992 school year. Participants who dropped out of high school were followed up in 1990 and 1992. In 1992, 12 percent of the 1988 eighth-grade cohort were classified as dropouts in the NELS:88 survey (McMillan, Kaufman, & Whitener, 1994, Table 18).

About 15,100 of the original sampled students were enrolled as seniors in high schools where NELS:88 surveyed the science and mathematics teachers in 1992. Ninety percent of the targeted teachers completed questionnaires, providing data for 9,634 of the 10,603 NELS:88 seniors enrolled in math and science (see Appendix B.1 for a detailed description of the study design).

It is important to keep in mind at all points of this study that (a) many 12th graders do not take science and math, and (b) the 12th graders who do take these subjects are on average higher achievers and thus not a representative sample of the larger grade or age cohorts. Nonetheless, it is not the case that only the most advanced students take science and mathematics during their senior years. As will soon be evident, students from a wide range of ability levels and social backgrounds take these courses.

The result of the NELS:88 second follow-up design is that the sample of students, properly weighted, is representative of 1991-1992 school year seniors.[1] Further, the subsamples with teacher-supplied information on science and mathematics courses are representative of seniors who took those courses. However, because the study included only one set of teacher data per eligible student, the proportions of students who have science or mathematics teacher data are substantially lower than the proportions who actually took science or mathematics as seniors. To obtain an estimate of the latter, one must turn to the transcript data. Transcripts were collected for 13,862 of the 15,105 seniors (92 percent). These students are used in the analyses of senior-year enrollments presented in the next section of this chapter and in Chapters III and IV.

Twelfth Grade Mathematics and Science Course Enrollment Patterns

Drawing on the transcript data, we constructed indicators of whether the student took courses in science and mathematics during the 1991-92 school year, and, if so, the number and types of courses. The weighted percentages of students taking each of the main mathematics and science subjects in 12th grade are shown in Table 1.1. These estimates are derived from the transcript data.[2] Two-thirds (66 percent) of the 1992 seniors completed a mathematics course. The mathematics courses with the highest enrollment of seniors (25 percent) are those classified here as "advanced." These are mostly trigonometry courses, but also include analytic geometry, pre-calculus, and statistics. At the top of the mathematics course-taking hierarchy, 10 percent of the seniors completed a course in calculus. While 12th grade mathematics enrollments are heavily tilted toward the more advanced levels, substantial numbers of students are enrolled in geometry (5 percent), algebra 2 (10 percent), algebra 1 (3 percent), and applied or basic (13 percent combined) courses.

[1] The design of the NELS:88 sample includes clusters of students within schools. This means that the sample as a whole is not as comprehensive with respect to the population being represented as a simple random sample of the same size would be. Most statistical packages base their estimates of standard errors on the assumption of simple random sampling, but these underestimate the standard errors and thus exaggerate the statistical significance of results. To correct for the NELS:88 departures from simple random sampling, we used the SUDAAN package to estimate all standard errors reported and used for statistical significance tests.

[2] We used the course-level data in the NELS:88 transcript files to construct these indicators. We used the subsample of courses completed during the 1991-92 school year. Math and science courses were identified by the standard Classification of Secondary School Courses (CSSC) codes. Since many senior-year science and math courses are single-semester courses, many students had more than one course listed in one or both subjects. Moreover, a small number of students take two science courses or two math courses concurrently. In order to characterize the students' levels of course-work in such cases, we ranked the courses in the order listed in Table 1.1 and assigned the highest level taken to each student.

Table 1.1. Percentage of Seniors Enrolled in Different Types of Mathematics and Science Courses, 1991-1992 School Year.

Type of Course	Percent Enrolled
Mathematics:	
No math course	34
Basic, general, & pre-algebra	4
Applied math	9
Algebra 1	3
Geometry	5
Algebra 2	10
Advanced: Trigonometry, Analysis, Pre-calculus, & Statistics	25
Calculus	10
Total	100
Sample Size	13,862
Science:	
No science course	52
Basic (survey, biology, chemistry, or physics)	11
Biology - regular level	5
Chemistry - regular level	5
Physics - regular level	10
Specialized (survey, biology, chemistry, or physics)	9
Advanced (biology, chemistry, or physics)	8
Total	100
Sample Size	13,862

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), 1992 High School Transcripts file.

A majority of seniors (52 percent) took no science at all. As was true in mathematics, the most popular 12th grade science courses were the more advanced subjects. First-year physics enrolled 10 percent of seniors, followed by specialized topics (9 percent), and second year or AP biology, chemistry, and physics (8 percent). At the same time, a substantial number of seniors were enrolled in low-level introductory classes: 11 percent were in designated basic courses, and another 5 percent took a regular biology course.

Measures of Instruction: Course Content

Course content differences are not confined to the subject matter areas summarized in Table 1.1. Nominally identical courses may vary considerably in terms of the subjects covered as well as the cognitive goals pursued through those subjects. The NELS:88 second follow-up teacher survey included several questions about subject matter and learning objectives. The subject-matter questions are shown in Tables 1.2 to 1.5. These data are primarily useful as an alternative, or possibly an adjunct, to the transcript data as a means of identifying the classes within the conventional schema of mathematics and science courses. The teachers were asked "Have you taught or reviewed the following topics in this (math, biology, chemistry, physics) class this year?" and were given five response options:

1= Yes, I taught it as new content.
2= Yes, but I reviewed it only.
3= No, but it was taught previously.
4= No, but I will teach or review it later this school year.
5= No, topic is beyond the scope of this course.

For present purposes, we collapsed responses 1-4 into a single category indicating whether the student has been or will be exposed to the topic, either in the present class or in one taken in a previous term. From Table 1.2, it is clear that the great majority of students who took senior-year mathematics will graduate with some exposure to basic algebra (linear equations and polynomials) and geometry (patterns and functions, properties of geometric figures, and coordinate geometry). Proofs are somewhat less widely taught than other traditional geometric topics, suggesting that some of the geometry classes are adopting an informal approach.

Table 1.2. Percentage of Twelfth-Grade Mathematics Students Whose Teachers Report Different Topics Covered: 1991-1992 School Year.

Have you taught or reviewed the following topics in this math class during this year?		
Taught, reviewed, or assumed prior knowledge of:	**Percent**	**Sample Size**
Integers	95	5,658
Patterns and functions	90	5,640
Linear equations	92	5,653
Polynomials	88	5,645
Properties of geometric figures	88	5,644
Coordinate geometry	85	5,647
Proofs	78	5,632
Trigonometry	68	5,643
Statistics	48	5,625
Probability	55	5,632
Calculus	29	5,632

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

The questions about topical coverage in science differed, depending on whether the course was in biology, chemistry, or physics. Because of this screening mechanism, the percentages of students with exposure to the topics tend to be higher than in mathematics, and indeed exceed 90 percent in most cases. Exceptions are human biology, ecology, and evolution in the biology classes; organic, nuclear, life process, and environmental chemistry; and molecular or nuclear physics.

Table 1.3. Percentage of Twelfth-Grade Biology Students Whose Teachers Report Different Topics Covered: 1991-1992 School Year.

Have you taught or reviewed the following topics in this biology class during this year?		
Taught, reviewed, or assumed prior knowledge of:	**Percent**	**Sample Size**
Cell structure and function	95	994
Genetics	94	989
Diversity of life	91	994
Metabolism and regulation of the organism	93	991
Behavior of the organism	90	992
Reproduction and development of the organism	96	991
Human biology	83	992
Evolution	87	990
Ecology	87	992

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table 1.4. Percentage of Twelfth-Grade Chemistry Students Whose Teachers Report Different Topics Covered: 1991-1992 School Year.

Have you taught or reviewed the following topics in this chemistry class during this year?		
Taught, reviewed, or assumed prior knowledge of:	**Percent**	**Sample Size**
Atomic and molecular structure	97	871
Properties and changes in matter	98	871
The periodic system	96	859
Energy relationships	93	861
Reactions	96	858
Inorganic chemistry	94	857
Organic chemistry	72	858
Environmental chemistry	70	853
Chemistry of life processes	56	852
Nuclear chemistry	68	858

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table 1.5. Percentage of Twelfth-Grade Physics Students Whose Teachers Report Different Topics Covered: 1991-1992 School Year.

Have you taught or reviewed the following topics in this physics class during this year?		
Taught, reviewed, or assumed prior knowledge of:	**Percent**	**Sample Size**
Forms and sources of energy	98	1,500
Forces, time, motion	96	1,504
Molecular/nuclear physics	72	1,503
Energy/matter transformations	90	1,503
Sound and vibrations	92	1,510
Light	93	1,501
Electricity and magnetism	91	1,509
Solids/fluids/gases	90	1,504

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Instructional emphases. Course content also includes the sorts of skills teachers try to develop among their charges. NELS:88 asked teachers to indicate the relative emphasis (with response options "none," "minor," "moderate," and "major") they placed on a number of different skills that cut across subject areas and are widely considered to be important.

As Table 1.6 makes clear, most seniors are in math classes with at least moderate emphases on each of the objectives included in the NELS:88 questionnaire. Consistent with the recommendations of the National Council of Teachers of Mathematics (NCTM), a large majority of students have teachers who emphasize representing problems in multiple ways (86 percent "moderate" or "major"), integrating different branches of mathematics (81 percent), conceiving multiple approaches to problems (84 percent), and raising questions and formulating conjectures (81 percent).

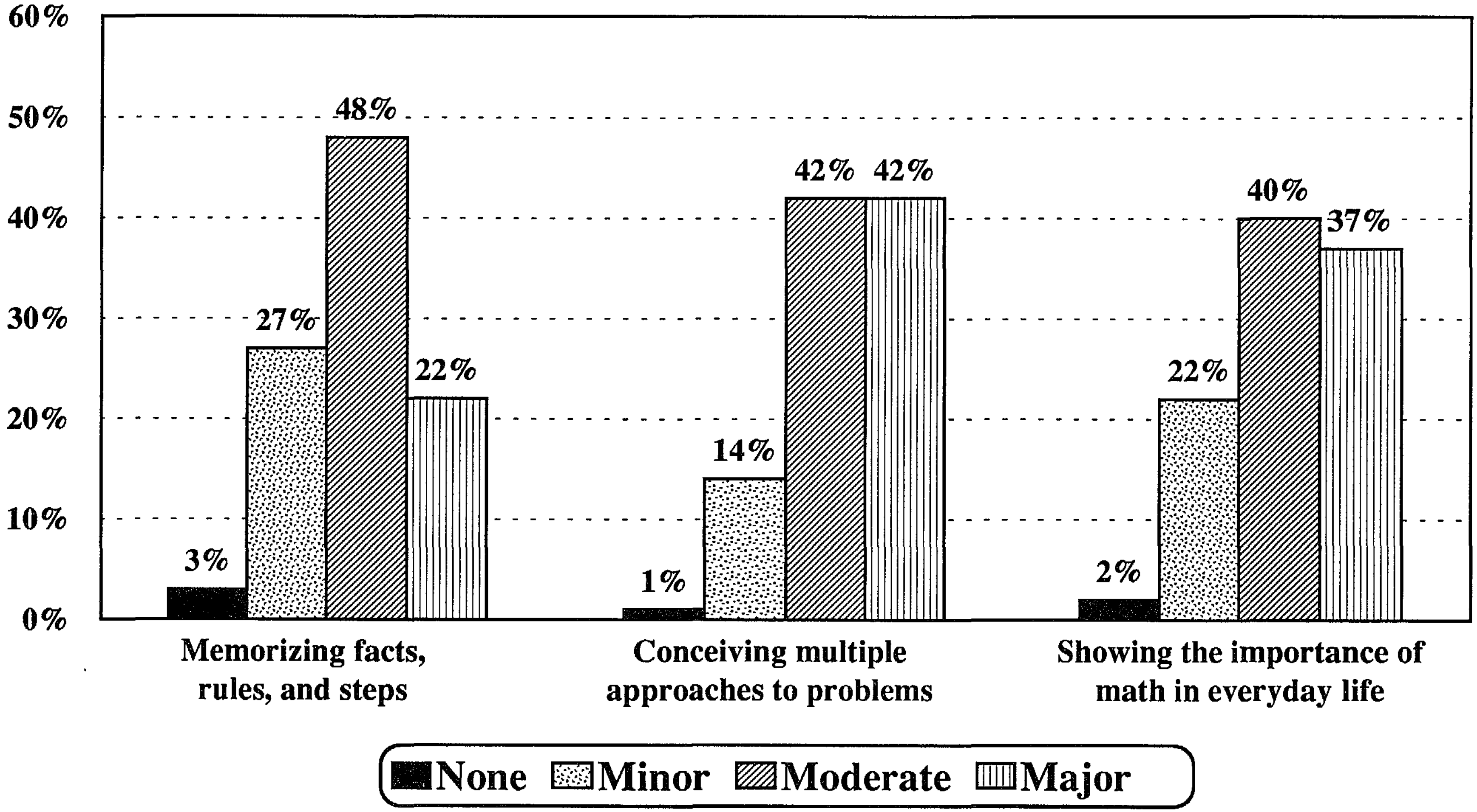
Table 1.6. Percentage of Twelfth-Grade Mathematics Takers Whose Teachers Report Various Emphases: 1991-1992 School Year

In this math class, how much emphasis do you give to the following objectives:	None	Minor	Moderate	Major	Sample Size
Understanding the nature of proofs	25	39	25	10	5,657
Memorizing facts, rules, and steps	3	27	48	22	5,658
Representing problems in multiple ways	2	11	38	48	5,659
Integrating different branches of math	5	14	34	47	5,647
Conceiving multiple approaches to problems	1	14	42	42	5,653
Performing calculations with speed and accuracy	5	27	41	27	5,643
Showing the importance of math in everyday life	2	22	40	37	5,657
Solving equations	2	14	35	49	5,636
Raising questions and formulating conjectures	2	17	47	34	5,645
Increasing students' interest in math/science	0	8	46	46	5,643

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

The distributions of three items which tap key dimensions of the mathematics reform proposals are shown in Figure 1.2. The first variable is a practice which reformers are trying to de-emphasize: having students memorize facts, rules, and steps. Despite the reform proposals, 22 percent of the seniors are in classes where the teacher reports a major emphasis on this objective, and another 48 percent are in classes where the teacher reports a moderate emphasis on memorization. The middle chart shows that a much higher percentage, 42 percent, of the seniors are in classes where the teachers emphasizes conceiving multiple approaches to problems. Also consistent with the NCTM recommendations, a large percentage (37 percent) of students are also in classes where the teacher emphasizes the importance of mathematics in everyday life. These charts indicate that while the objectives advocated by the reform proposals are given greater emphasis than memorization, substantial numbers of seniors are still in classes where memorization is a major objective.

Figure 1.2.
Percentage of 12th-Grade Mathematics Students Whose Teachers Report Various Emphases: 1992



Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

Some of these items shown in Table 1.6 appear to measure common dimensions. To see whether a smaller number of underlying factors could be identified, we estimated a factor model. Three factors emerged: (1) an emphasis on "higher-order" thinking skills, (2) an emphasis on "relevance," and (3) an emphasis on mechanical operations. To simplify the presentation of results, we combined the grouped items into three scales, giving each item an equal weight (see Appendix B.3 for details on the items included in the scales). In the rest of this report, the composite variables are used in place of the individual items presented in Table 1.6.

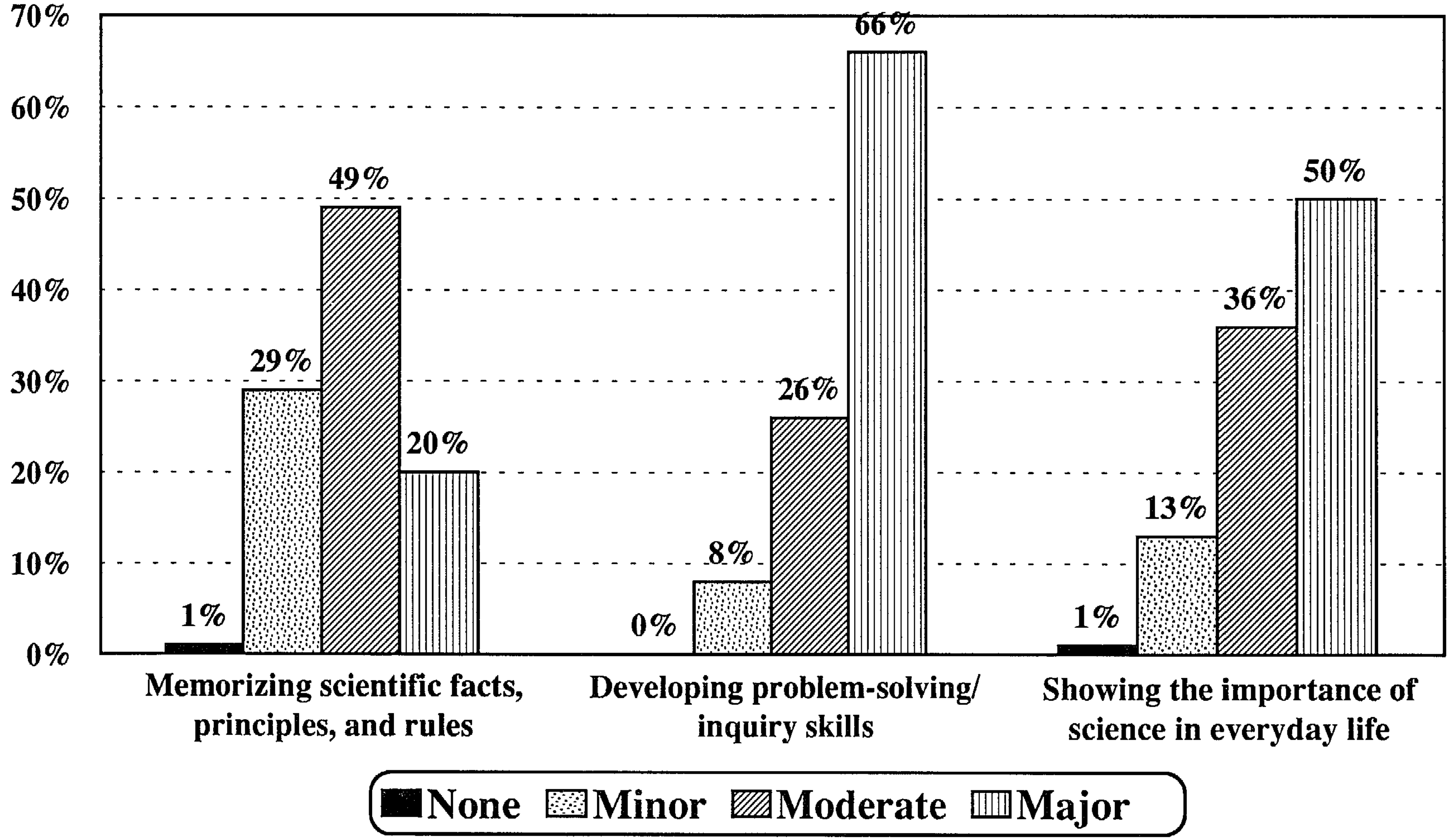
The science class emphases also tend to be strongly skewed toward the moderate-to-major end of the scale. The full set of items is included in Table 1.7; Figure 1.3 shows the distributions of three items which seem especially germane to current reform discussions. The objectives with the highest emphases are "increasing students' interest in science" (96 percent "moderate" or "major") and "developing problem-solving/inquiry skills" (92 percent). Objectives with the lowest emphases are "learning about applications of science to environmental issues" (64 percent "moderate" or "major") and "memorizing facts, principles, and rules" (69 percent). The strong emphasis on problem-solving and inquiry skills and the lower emphasis on memorization are consistent with recent reform recommendations from the National Science Teachers Association.

Table 1.7. Percentage of Twelfth-Grade Science Takers Whose Teachers Report Various Emphases: 1991-1992 School Year.

In this science class, how much emphasis do you give to the following objectives:	None	Minor	Moderate	Major	Sample Size
Increasing students' interest in science	0	4	36	60	3,615
Memorizing scientific facts, principles, and rules	1	29	49	20	3,602
Learning scientific methods	0	14	46	39	3,593
Preparing students for further study in science	1	10	34	55	3,598
Developing problem-solving/ inquiry skills	0	8	26	66	3,603
Developing skills in lab techniques	6	16	43	34	3,596
Learning about applications of science to environmental issues	3	32	36	28	3,598
Showing the importance of science in everyday life	1	13	36	50	3,596

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Figure 1.3.
Percentage of 12th-Grade Science Students Whose Teachers Report Various Emphases: 1992



Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

Factor analysis of these items shows two underlying factors: an emphasis on the importance of science in everyday life, and an emphasis on higher-order thinking or "inquiry" skills. The item asking about memorization of facts, principles, and rules did not group with any other items and is used as a single-item indicator in subsequent analyses. The other items are combined as equally-weighted components of their respective scales; these scales are used in the rest of this report in place of the individual items.

Measures of Instruction: Quantity of Instruction

Quantity of instruction refers simply to students' exposure to instruction in whatever qualitative form it might assume. The measures available in the NELS:88 second follow-up include the length of the school year (from the school survey), the number of minutes the class meets each week, and the teacher's estimate of how much time is devoted to instruction as opposed to maintaining order, administrative duties, and testing. The amount of homework a student completes can also be considered under this rubric.

The average 12th grade math student is in class for 235 minutes per week, or about 45 minutes per day. The science teachers were asked to separate lab periods from their time reports, and their average class time is slightly lower, at 222 minutes per week. In addition to this allocation, the average 12th grade science student spends 56 minutes per week in labs. While the variability around these means is not great, the class times of the 12th grade students do differ.

Average daily homework assignments reported by the teachers are slightly higher in mathematics than in science, with 34 versus 31 minutes (Table 1.8). Considerable variability in the amounts assigned are found in both subjects. About 14 percent of the math students are in classes where the teacher assigns 50 minutes or more each day, while 27 percent have less that 30 minutes a day. Science students are assigned less homework than math students. About 12 percent of the science students are assigned 50 minutes or more daily, and 39 percent are assigned less than 30 minutes.

Table 1.8. Percentage of 12th Grade Math and Science Students with Different Average Amounts of Daily Homework Assigned: 1991-92 School Year.

Minutes per Day of Homework	Mathematics	Science
None	3.5	2.9
10-19	7.8	15.1
20-29	15.7	21.4
30-39	38.9	33.5
40-49	20.0	15.0
50-59	1.6	1.7
60-69	10.6	7.6
70+	1.9	2.8
Total	100	100
Mean	34.	31
Sample Size	5,698	3,758

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Quantity of instruction was also measured with a set of questions asking the teachers to estimate the percent of class time they spent on various activities (Table 1.9). About 56 percent of the senior math-takers were in classes which devoted at least half of their time to whole-class instruction. Work in small groups and individualized instruction are relatively rare in both mathematics and science.

Table 1.9. Percentage of 12th Grade Math Students Whose Teachers Report Spending Different Amounts of Time on Various Activities: 1991-1992 School Year.

What percent of class time is spent in a typical week doing each of the following with this class?	Percent of class time						
	0	1-10%	10-24%	25-49%	50-74%	75-100%	unw. N
Providing instruction to the class as a whole	0.5	2	11	31	43	12	5,264
Providing instruction to small groups of students	11	42	31	13	3	0.5	5,178
Providing instruction to individual students	4	41	37	12	4	2	5,224
Maintaining order/ disciplining students	37	53	5	2	1	2	5,205
Administering tests or quizzes	1	35	58	4	1	0.5	5,260
Performing routine administrative tasks	9	87	3	0	0	0	5,227

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table 1.10. Percentage of 12th Grade Science Students Whose Teachers Report Spending Different Amounts of Time on Various Activities: 1991-1992 School Year.

What percent of class time is spent in a typical week doing each of the following with this class?	Percent of class time						
	0	1-10%	10-24%	25-49%	50-74%	75-100%	unw. N
Providing instruction to the class as a whole	1	3	11	27	41	17	3,472
Providing instruction to small groups of students	8	38	38	10	4	1	3,406
Providing instruction to individual students	6	56	30	4	2	2	3,411
Maintaining order/ disciplining students	38	52	6	2	1	1	3,446
Administering tests or quizzes	1	43	51	4	0	0	3,460
Performing routine administrative tasks	10	84	5	0.5	0	0	3,456
Conducting lab periods	8	11	50	24	6	1	3,424

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Measures of Instruction: Quality of Instruction

Quality of instruction refers to how the material is presented and is measured mainly by the teachers' reports of their instructional methods. The methods are listed in Table 1.11 along with the percentages of students whose teachers reported using them at each level of frequency. Lectures and recitation (i.e., "students respond orally to questions on subject matter") are the most common ways of using class time and are presented in Figures 1.4 and 1.5. In mathematics, fully 85 percent of the students were in classes which had daily or almost daily lectures, and 85 percent were in classes which used recitation on a daily or almost daily basis.

Table 1.11. Percentage of seniors with mathematics or science teachers reporting different frequencies of using various instructional methods: 1992

How often do you use the following teaching methods or media?		Never	1-2 times/ mth	1-2 times/ week	Almost Daily	Daily	unw. N
Lecture	math	3	3	9	64	21	5,268
	science	3	5	33	52	6	3,482
Students respond orally to questions on subject matter	math	1	3	12	51	34	5,278
	science	3	7	24	48	19	3,502
Teacher-led whole group discussions	math	19	16	23	34	8	5,223
	science	14	23	36	24	4	3,484
Student-led whole-group discussions	math	61	21	12	4	2	5,233
	science	57.	27	12	4	0	3,468
Students work together in cooperative groups	math	11	29	32	23	5	5,274
	science	6	22	52	16	3	3,505
Students complete individual written assignments or worksheets in class	math	14	20	28	26	12	5,277
	science	16	24	42	15	3	3,511
Students give oral reports	math	83	13	2	2	0	5,251
	science	72	25	2	0.5	0	3,490
Computers	math	69	19	7	3	2	5,238
	science	65	24	8	2	0	3,445
Audio-visual material	math	41	24	14	16	6	5,207
	science	10	40	33	14	3	3,487

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Figure 1.4
Percentage of Seniors With Mathematics Teachers Reporting Different Frequencies of Using Various Instructional Methods: 1992

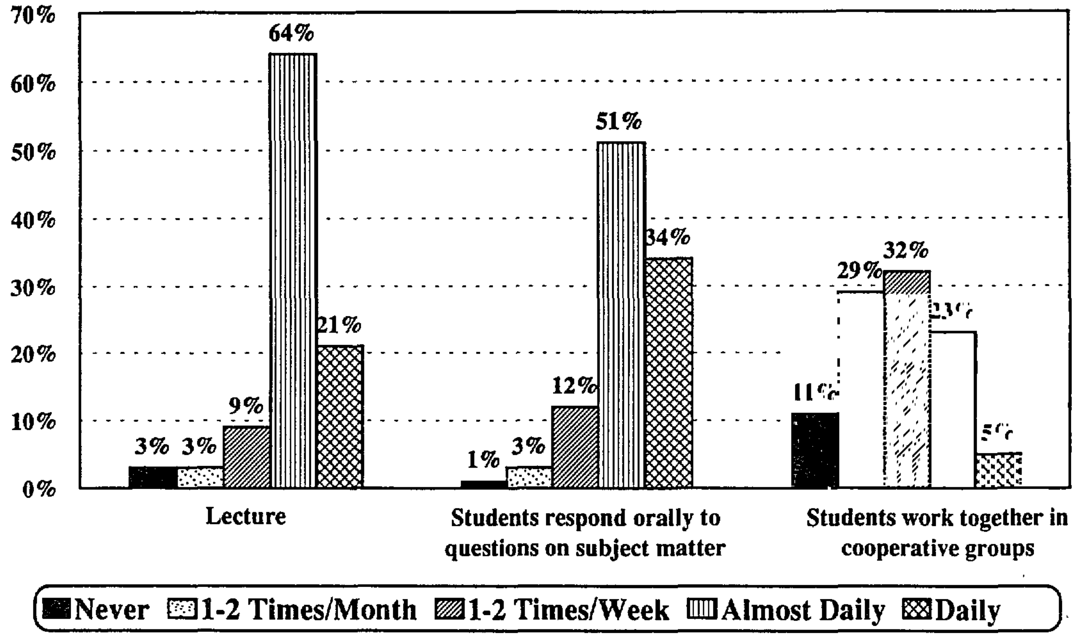
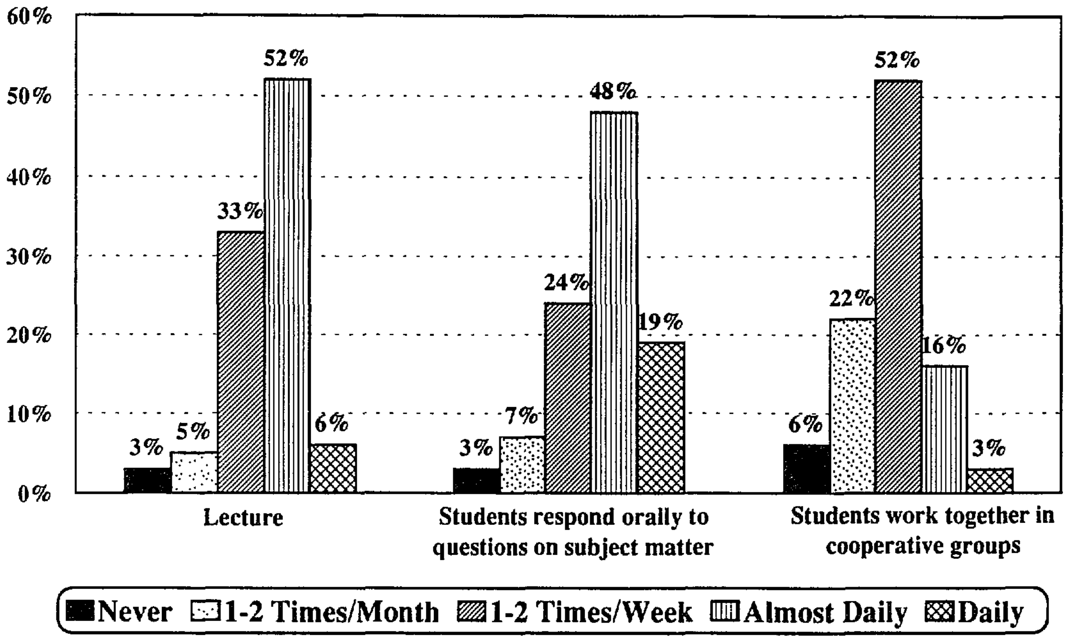


Figure 1.5
Percentage of Seniors With Science Teachers Reporting Different Frequencies of Using Various Instructional Methods: 1992



SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

The reliance on lectures and recitation has been widely criticized in recent years, and many reform proposals advocate greater use of cooperative learning and "authentic" discussions. Authentic discussion refers to situations where participants are trying to define or solve a novel problem; that is, a problem to which the answer is not known in advance. While "teacher-led whole-group discussions" and "student-led whole-group discussions" are not necessarily authentic discussions, the numbers in Table 1.11 can be taken as upper bounds on the prevalence of authentic discussions. Teacher-led discussions were fairly common, with about two-thirds of the students in classes which used them at least once a week. Student-led discussions were much less frequently used. Most students were in classes which never used them, and less than 20 percent in either subject had them once a week or more. Oral reports by students are even rarer: 83 percent of the mathematics students and 72 percent for the science students were in classes that never used them.

Over 60 percent of the students were in math and science classes which used cooperative methods at least once a week, and only 11 percent in math and 6 percent in science had teachers who never had the students work in cooperative groups. Work in cooperative groups is actually reported to about as common as "seatwork," the practice of having students complete individual written assignments or worksheets in class.

Despite calls for a greater role of computers in the classroom, Table 1.11 shows their use to be relatively rare in senior-year math and science. Sixty-nine percent of the math students and 65 percent of the science students never use computers. It should be noted that many math educators believe that wider introduction of hand calculators is even more important than use of computers. Unfortunately, the NELS:88 teacher survey did not include any questions asking whether calculators were used in the classes, and we thus do not pursue this topic.[3]

Data Quality Issues

How reliable and valid are the variables introduced in this chapter as measures of classroom instruction? We have noted ambiguity around some of the items, but there is a general question here about how well any of the items measure specific orientations and practices of teachers and their classes. Perhaps the best way to answer the validity question would be to compare questionnaire data with observational reports from teacher classrooms. Unfortunately, observational data were not collected in the NELS:88 study, and we thus cannot clearly gauge the validity of these questionnaire items. Nor have there been any other systematic studies of the issue that can be drawn upon for guidance.

The reliability issue refers to the extent to which the questions would elicit the same responses from the teachers if asked again some short time later. Again, we cannot address this question directly, because the teachers were not resurveyed. For some of the constructs, however, the teachers were asked a number of similar questions. This redundancy can be measured and, if present, utilized to build composite measures. We ran factor analyses on all of the emphasis, time allocation, teaching methods, and science class activity variables described in this chapter and in Appendix B.3. There is some redundancy in the items, and composite measures are justified in many cases. The drawback of using composites which cut across the batteries is that the metric of the composites are not interpretable in terms of any concrete time referents. The emphasis items range from 1=none to 4=major, and thus have no concrete referent in the first place. We therefore used composites for the emphasis items which factored

[3] The 1992 student questionnaire did, however, ask the extent to which calculators were used in the students most recent math course.

together, after introducing the individual items in Chapter 1. However, we did not combine the time and strategy variables until we did the regression analyses, and did so there only in science. The additional science instruction composite variables we constructed measure the extents to which computers and student presentations are used.

Summary

This chapter has set forth the principal research problems addressed in the pages that follow. While our larger objective is to identify instructional variables which contribute to positive outcomes for students, most of our efforts in this study are directed toward identifying factors related to differences in the 1992 seniors' mathematics and science instructional experiences. The next three chapters address this problem from three different angles: the impact of curriculum differentiation, the role of family background, and the role of schools as larger organizations. The final chapter returns to the issue of instructional effects on outcomes, examining the impact of selected instructional variables on student academic achievement and attitudes toward science and mathematics.

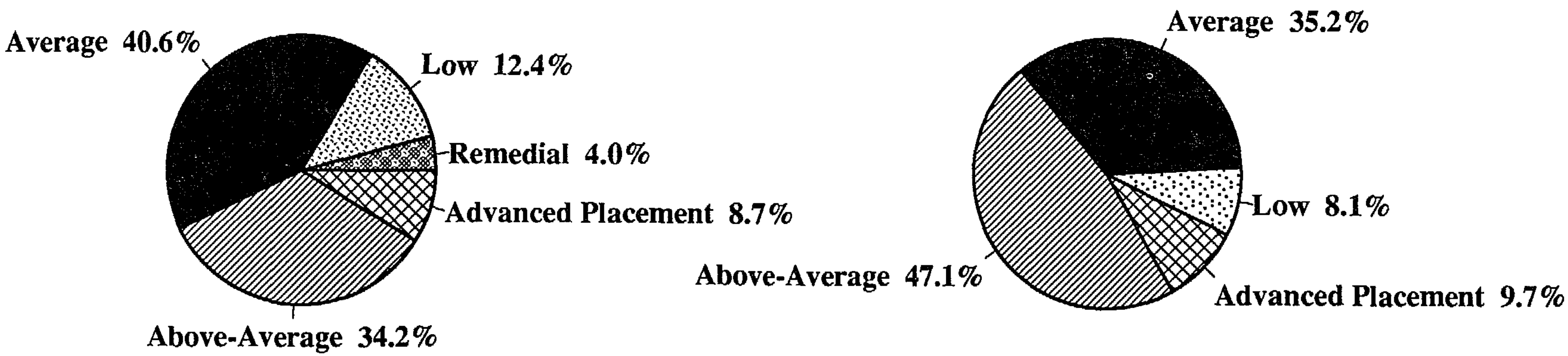
Chapter II
Types of Courses and Instruction

The conceptual framework set forth in Chapter 1 indicates that students' instructional experiences are likely to differ partly as a result of the type of courses in which they are enrolled. Figure 1.1 shows that the average student ability or achievement level of a course is hypothesized to be associated with instructional differences in a direct way, and also indirectly, because of the tendency of at least some schools to assign teachers with higher background qualifications to the higher-achievement-level courses.

Different types of courses within the science or mathematics curriculum are likely to vary in several aspects of instruction. One reason for this is that the students in different courses typically have different levels of interest in the subject and prior achievement. Teachers might thus be expected to adapt instruction to students' different needs and interests. Some critics of curriculum differentiation have argued that student diversity does not in itself call forth instructional differences; what it does call forth are different teacher expectations. That issue aside, another reason instruction may vary is the subject matter itself: some subjects call for different objectives and methods, even when students are comparable (Stodolsky & Grossman, 1995). There are thus two dimensions of courses that we suspect are important to instruction: the ability level of the students and the content. Unfortunately, the information on course content cannot be linked to the information collected from the teachers for about 20 percent of the students. We thus rely on teacher reports on the achievement level of the classes in order to assess instructional differences (see Appendix C for a full discussion of the procedures used to categorize the classes).

The distribution of students across the different class-achievement levels is shown in Figure 2.1. Most of the twelfth graders are in average-level or higher classes in both subjects. Twelfth-grade science appears to be somewhat more selective than mathematics. About 57 percent of the science students were in classes which their teachers classified as "advanced placement" or "above-average," compared to 43 percent of the mathematics students.

Figure 2.1.
Percentage of Grade 12 Mathematics and Science Students Enrolled in Classes at Each Class Achievement Level: 1992



Mathematics

Science

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

Class Achievement Levels and Instructional Emphases

The achievement level of the students' classes is associated with the emphases their teachers place on different objectives. Using the composite measures of instructional emphases described in Chapter I and Appendix B.3, Figures 2.2 and 2.3 show that the average emphasis on "higher-order" skills increases as the average achievement level of the class increases (see Appendix tables A2.2 and A2.3 for the numbers upon which these figures are based and the standard errors of the estimates). Conversely, emphases on the everyday relevance of math and science decrease as the achievement levels rise. While these trends are evident, it is also important to note that the absolute differences among the different types of classes are not great. The scale of the items used in these tables is 1=none, 2=minor, 3=moderate, and 4=major. Classes with the lowest average emphasis (levels of 2.8 and 2.9) thus still have "moderate" emphases on the skills in question. Moreover, the standard deviations on these variables are not very large, indicating that the variability around the means is not great. Virtually all students, then, are in classes where these objectives receive at least some attention.

Figure 2.2
Average Emphasis Math Teachers of 12th-Grade Students Place on Different Objective, by Achievement Level of the Class: 1992

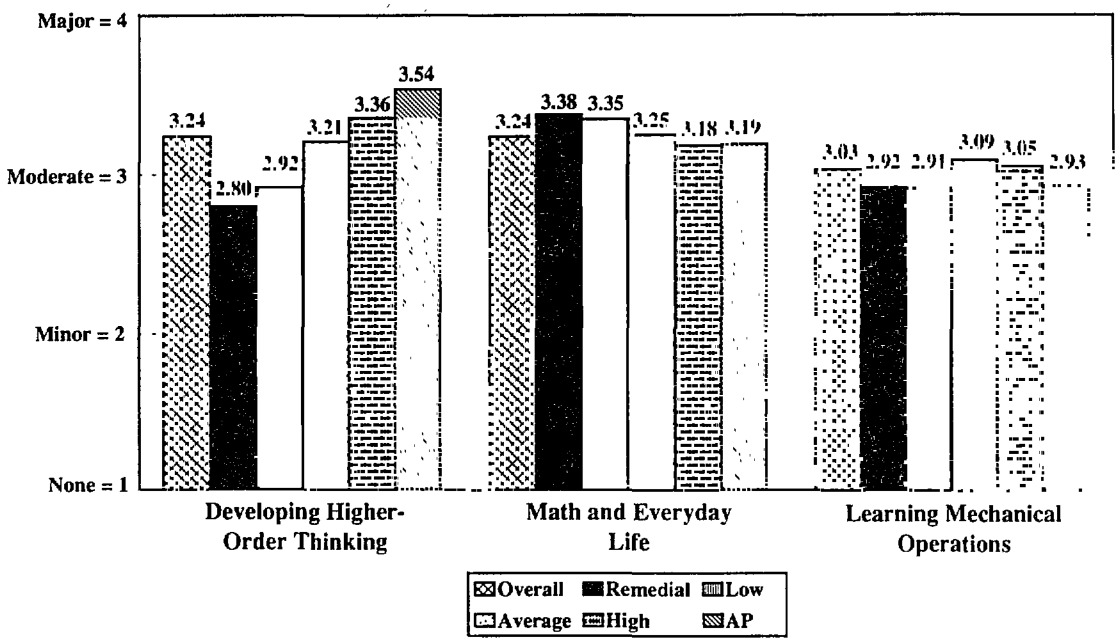
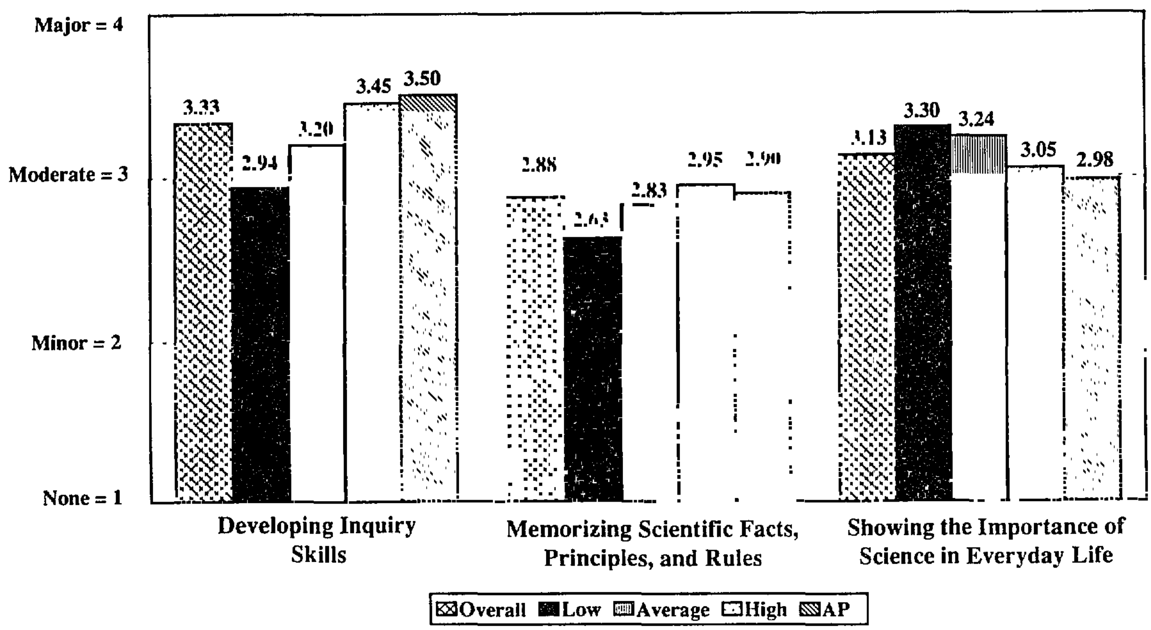


Figure 2.3
Average Emphasis Science Teachers of 12th-Grade Students Place on Different Objective, by Achievement Level of the Class: 1992

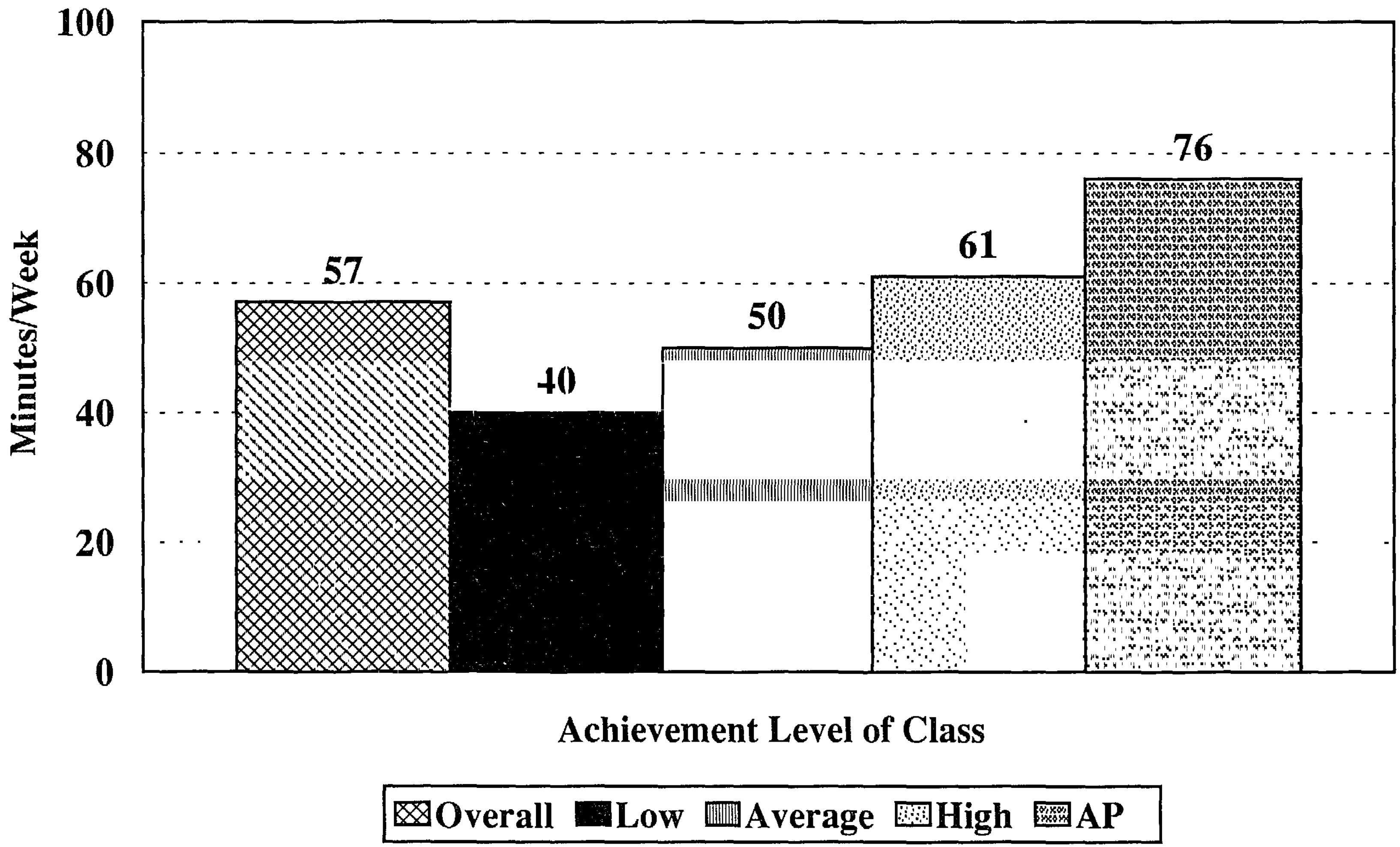


SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

Class Achievement Levels and Instructional Time

Students in the different achievement levels show some large differences in the ways their teachers allocate class time. While the total amount of time the students spend in class does not differ across class achievement levels (not tabulated here), the way the time is used and the amount of additional time demanded in the form of homework differ significantly. The time devoted to science labs is greater in the higher classes (Figure 2.4). AP students spend 76 minutes in lab on average compared to 50 for average and 40 for low group students.

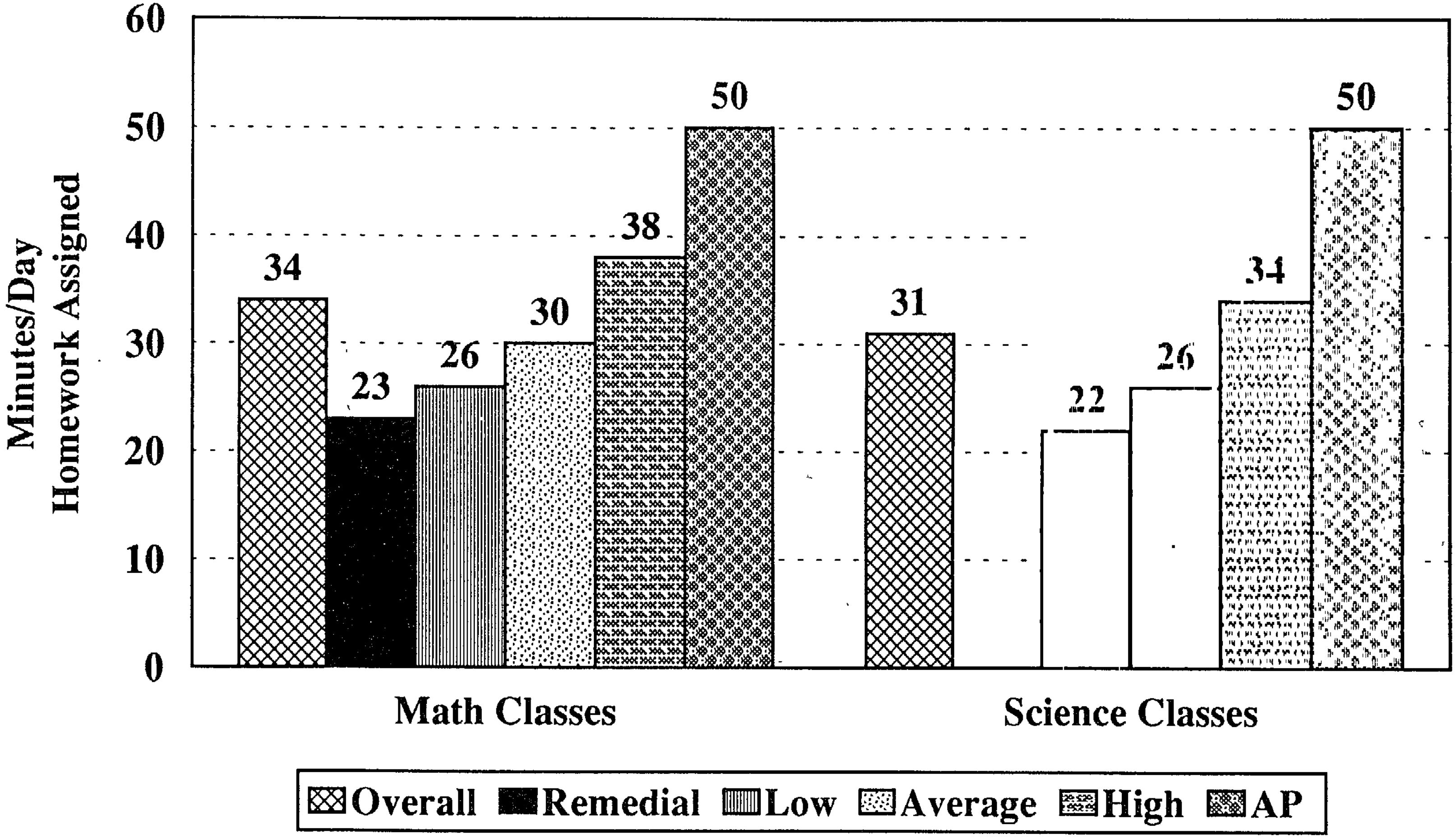
Figure 2.4.
Average Minutes Per Week Allocated for Science Labs, by Achievement Level of Student's Class: 1992



Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

The amount of homework assigned by teachers is strongly related to the level of the classes (Figure 2.5). Remedial math students are assigned 23 minutes per day on average, rising to 50 minutes per day for AP pupils. The low group-AP difference works out to over 2 hours of homework per week and 85 hours for a 38 week school year. The high group - AP difference is less than half of that but is still a full hour per week. Comparable inequalities are apparent for science.

Figure 2.5.
Average Minutes Per Day of Homework Assigned by Teachers of 12th Grade Math and Science Students by Achievement Level of the Class: 1992

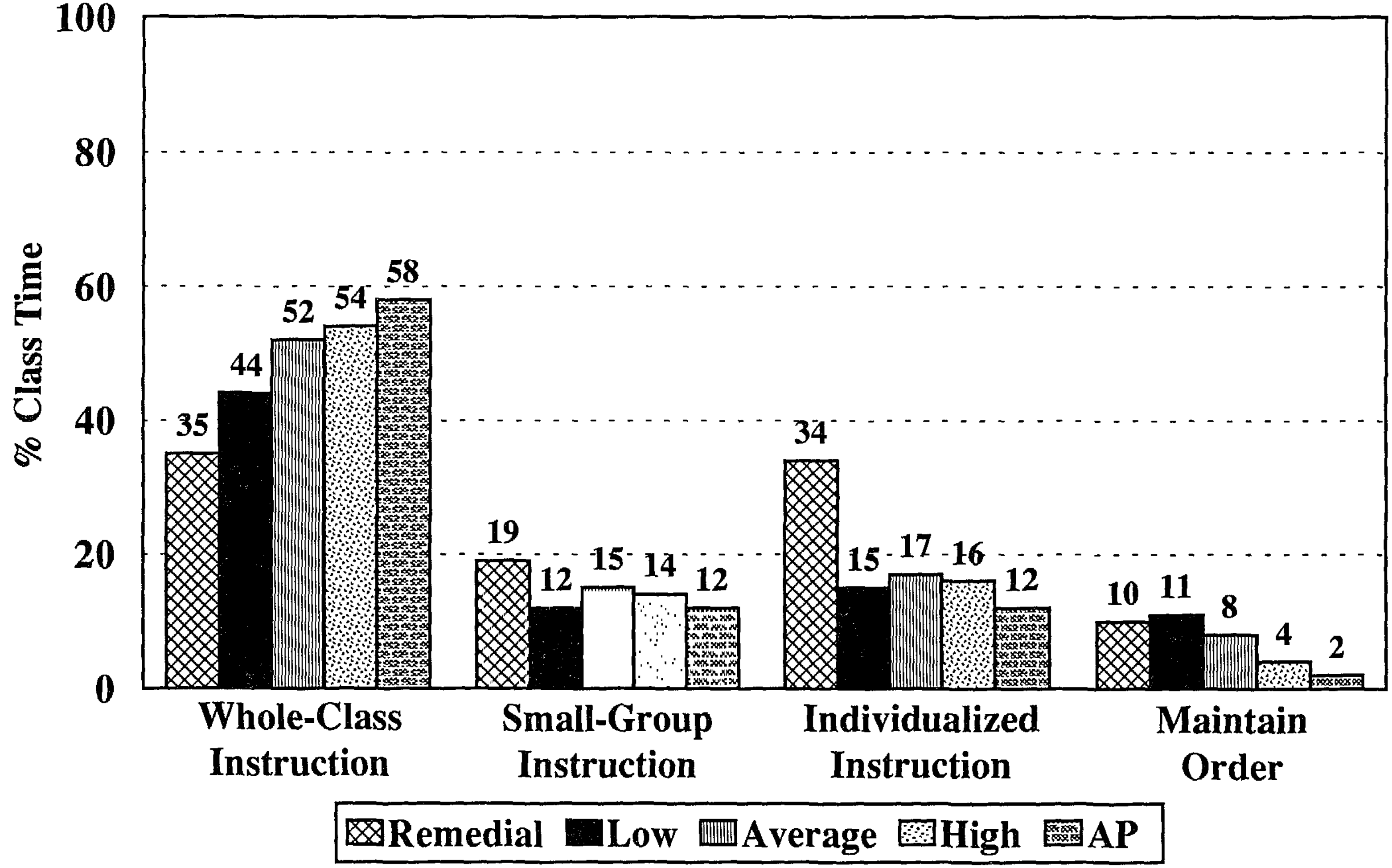


Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

The way class time is used varies with the achievement level of the class. The teachers' responses to the questions about the percentages of time they spend on different forms of instruction as well as maintaining order are shown in Figures 2.6 and 2.7 (see Appendix Tables A2.4 and A2.5 for the supporting numbers).[4] In both subjects, the achievement level of the class is related to two activities: use of whole-class instruction and time spent on discipline. In mathematics, AP and remedial classes differ by 23 percentage points on the portions of class time devoted to whole-class instruction. For a 50 minute period, this translates into about 18 minutes of whole-class instruction in remedial classes versus 29 minutes in the average AP class. The differences are much smaller between average, above average, and AP classes.

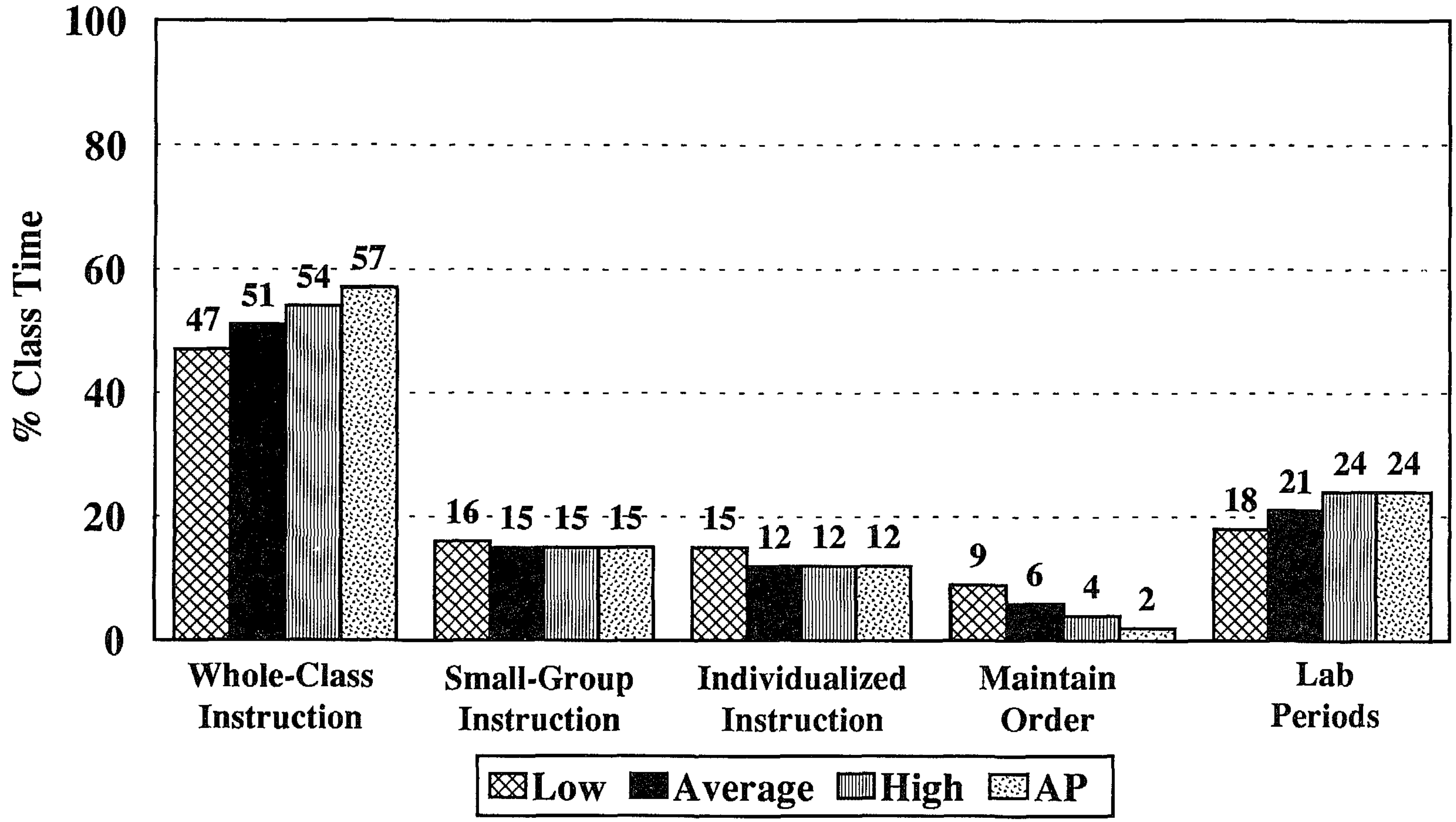
[4] The questionnaire response options for the questions asking about the percentages of time devoted to various practices are the percentile ranges described in Appendix B.3. The mean percentages reported here and in subsequent figures and tables were derived by coding the ranges to their respective percentage-scale midpoints.

Figure 2.6.
Average Percentage of Class Time Spent on Various Activities, As Reported by Teachers of 12th Grade Math Students, by Achievement Level of the Class: 1992



Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

Figure 2.7.
Average Percentage of Science Class Time Spent on Various Activities, As Reported by Teachers of 12th Grade Science Students, by Achievement Level of the Class: 1992



Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

In terms of discipline, remedial and low math students have about 10 percent of their class time spent on maintaining order, compared to only 1 or 2 percent of the time in AP classes. Comparable differentials are apparent among students in the different science classes.

Across all types of classes, Figures 2.6 and 2.7 show that most of the time not used for whole-group instruction is devoted to small-group work, individualized study, administering tests and quizzes, and, in science, laboratory work. As might be expected, remedial math classes use much more individualized study than other types of classes. Students in AP and above average-level science classes have slightly more time devoted to laboratories than low-level science students. Otherwise, without exception, the time devoted to these activities is nearly equal for students at the different levels.

Class Achievement Level and Instructional Methods

Despite the differences among classes in the percentage of time devoted to different activities, the kinds of activities pursued in the different classes turn out to differ very little. To summarize the relationships, we calculated gamma coefficients between the class achievement variables and the teacher reports of the extents to which they use various instructional methods. The gamma coefficient was developed to measure direct association between two ordinal variables, and ranges from a minimum of -1.0 to +1.0. Table 2.1 shows the correlations between the class achievement level and the teachers' use of lectures, discussions, computers, cooperative groups, and other methods. The variable showing the strongest association with the level of the student's class is the frequency of having students complete written assignments in class ("seatwork"). This is used less often the higher the achievement level of the class. Other significant associations are found between the achievement level of the class and the use of lectures and recitation in science, and the use of computers in both subjects.

Table 2.1. Correlations[a] between the teacher's report of the achievement level of the student's class and the teacher-reported frequency of using various instructional methods (standard errors in parentheses): 1992

Instructional method[b]	Mathematics	Science
Lecture	.069	.169*
	(.040)	(.048)
Students respond orally to questions on subject matter	-.046	.117*
	(.036)	(.044)
Teacher-led whole group discussions	.003	-.008
	(.032)	(.042)
Student-led whole group discussions	.041	.065
	(.038)	(.050)
Students work together in cooperative groups	.036	.063
	(.032)	(.048)
Students complete individual written assignments or worksheets in class	-.203*	-.267*
	(.030)	(.042)
Students give oral reports	-.039	-.059
	(.054)	(.060)
Use computers	.160*	.206*
	(.042)	(.054)
Use audio-visual material	.010	-.053
	(.032)	(.044)

* $p(\gamma=0) < .05$.

[a] Correlation is measured by the gamma (γ) coefficient, which is used for ordinal variables. Values can range from -1.0 (perfect negative correlation) to 1.0 (perfect positive correlation). The standard errors of the gamma coefficients are adjusted for an assumed design effect of 2.0, by doubling the simple random sample standard errors calculated by the statistical program used for this table.

[b] Instructional methods are measured ordinally. Values range from 1=never or rarely, 2=1-2 times a month, 3=1-2 times a week, 4=almost every day, 5=every day.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

One reason for the disparities in the use of seatwork may be the greater difficulty of getting students in lower-level classes to complete homework. Most would agree that individual efforts to solve problems are necessary to learning. If obtaining that effort through homework is difficult, then the teacher would reasonably set aside more time in class. Another explanation may be the greater difficulty of maintaining order in lower-level classes. Seatwork is a relatively easy way to control a class and may be given more as busywork than as a genuine pedagogical tool. Deciding which of these alternative explanations is more valid is difficult with survey data. Much depends on the quality of the work assigned in the class and how the teacher conducts class while the students are working on their assignments. These were not measured in the NELS:88 study, and thus we cannot draw any clear conclusions from these differences.

Teacher Credentials and Instructional Practice

The ability level of the class is one reason why instruction varies from class to class; another reason may be the orientation of the teacher. Of the many factors that shape one's professional decisions, one's educational background is likely to loom large. To assess the impact of teacher educational background on the instructional variables, we classified the students according to their teacher's highest specialization and then compared the distribution of instructional differences across the degree categories. The typology of educational degrees we constructed has five categories defined by the cross-classification of undergraduate and graduate specialization fields:

1. Undergraduate <u>and</u> graduate major in field
2. Undergraduate <u>or</u> graduate major in field, <u>and</u> graduate or undergraduate minor in field.
3. Undergraduate <u>or</u> graduate major in field, but no minor.
4. Undergraduate <u>and/or</u> graduate minor in field.
5. No major or minor at either the undergraduate or graduate level.

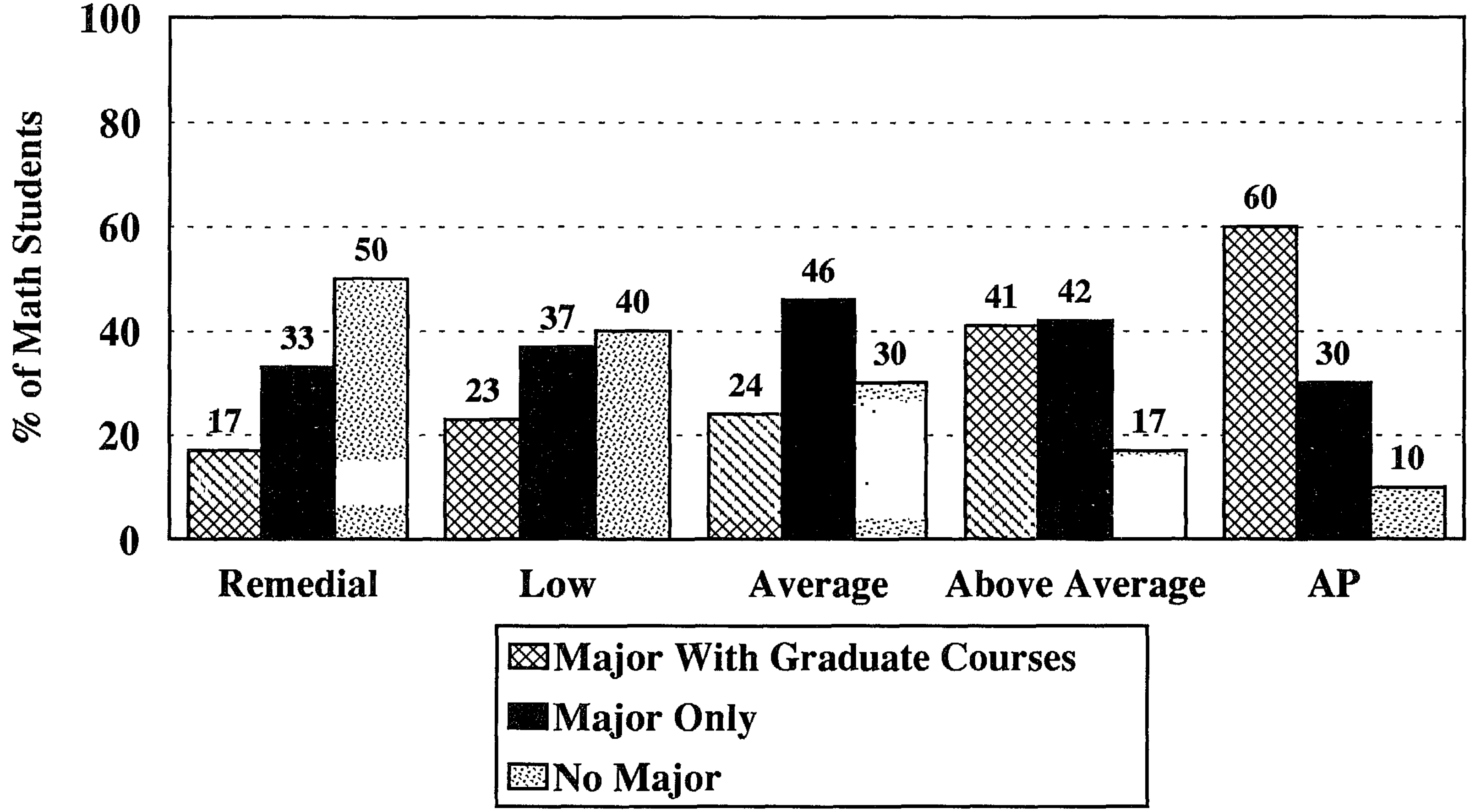
The students for whom we have 12th grade teacher data showed the following distributions:

Teacher degree category:	Mathematics	Science
1 (major/major)	20.2	28.8
2 (major/minor)	11.5	11.6
3 (major/none)	42.2	36.4
4 (minor)	16.3	13.4
5 (none/none)	9.8	9.8
	100%	100%

Credentials are somewhat higher on average among the 12th graders' science teachers, but large majorities of the students in both subjects have teachers with a field specialty at either the undergraduate or graduate level. At the low end, about 10 percent of the math and science students have teachers without either a major or minor in their respective subjects.

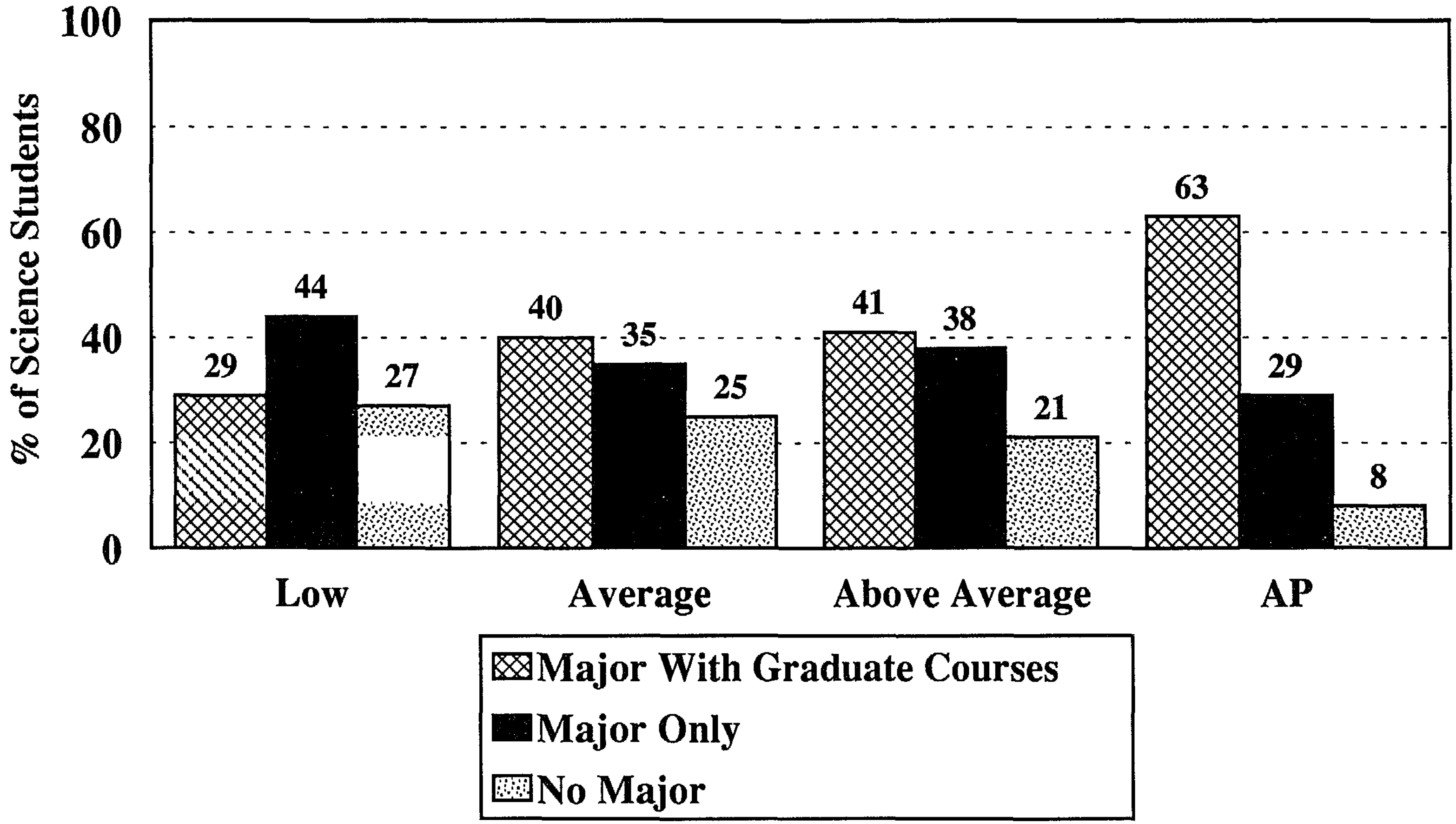
For present purposes, we collapsed the highest two degree categories and the lowest two to make a three-level indicator. This is cross-classified by the achievement level of the students' classes in Figures 2.8 and 2.9. As one might expect, the students in the higher ability groups are assigned the teachers with the highest credentials. For example, 63 percent of the students in AP science had teachers in the highest category (a major with graduate coursework), compared to 29 percent of the students in low-level science, 40 percent of the students in average-level science, and 41 percent of the students in higher-level science.

Figure 2.8.
Percent of 12th Grade Math Students Whose Teachers Had Different Levels of Educational Credentials, by Achievement Level of the Class: 1992



Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

Figure 2.9.
Percent of 12th Grade Science Students Whose Teachers Had Different Levels of Educational Credentials, by Achievement Level of the Class: 1992



Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

The association between achievement level of the class and teacher credentials suggests that credentials are also associated with the instructional variables, because instructional differences are also associated with achievement level of the class. The question, then, is whether teachers with different educational backgrounds do different things with students at comparable ability levels. To answer this question, we used the technique of ordinary least squares linear regression to calculate the unique associations of teacher educational background and the achievement level of the class with selected instructional variables.

The regression model specifies that the students' values on the instructional variables depend on their teachers' educational background and the achievement level of the class. As the conceptual model represented in Figure 1.1 suggests, the regression model is probably an oversimplification, for it ignores the role of student background and school variables.[5] However, the model does give a compact summary of the relationships at issue, even while one must be careful not to draw causal conclusions on this basis.

The main message of these regressions is that the instruction students receive along these selected dimensions depends much on the achievement level of their class and relatively little on their teachers' educational credentials. Despite the relative weakness of teacher credentials, several significant relationships with instruction are shown in Table 2.2. In mathematics, there is some indication that teachers with higher credentials place more emphasis on higher-order thinking skills, devote more time to whole-class instruction, and devote less time to maintaining order. It should be emphasized that these statistical associations are adjusted for the correlations between the achievement level of the class, teacher education level, and the dependent instruction variable.

[5] We have simplified the model even further, for teacher educational background and class achievement level are treated as continuous variables with no interactions with one another. The benefit of these simplifications is that they result in single summary coefficients of the relationships between the independent and dependent variables. Those benefits are illusory, of course, if the simplications result in misrepresentations of the actual relationships. We are confident that the results in Table 2.2 are appropriate representations, because results of less restrictive analyses essentially corroborated the findings. Specifically, we estimated two-way analysis of variance models which specified the independent variables as categorical and which included interactions between the independent variables. These models fit the data only slightly better, and showed that the ordinal class achievement variable can indeed be properly treated as a continuous variable. The effects of teacher education on instruction are not as consistent, and would probably be better treated as a categorical variable with respect to some aspects of instruction. In these cases, what seems significant is simply whether the teacher has at least a minor in his or her field. Since none of the exceptions proved substantively very large, we opted for the models presented in Table 2.2.

Table 2.2. Multiple regression estimates of the relationships of teacher education level and the achievement level of the class with selected instructional variables (t-values in parentheses): 1992.

Dependent Instructional Variables	Effect of class achievement level	Effect of teacher education level	Model R^2	Sample size
Mathematics				
Emphasis on higher-order thinking	.28 (10.02)	.10 (4.12)	.11	5,246
Homework assigned (minutes/day)	.38 (13.47)	.02 (1.11)	.15	5,234
% Class time in whole-group instruction	.20 (6.16)	.06 (2.20)	.05	5,185
% Class time maintaining order	-.18 (-10.00)	-.09 (-3.39)	.10	5,130
Science				
Emphasis on inquiry	.32 (8.22)	.02 (0.01)	.08	3,478
Homework assigned (minutes/day)	.38 (11.17)	.08 (2.62)	.16	3,409
% Class time in whole-group instruction	.09 (2.70)	.05 (1.11)	.01	3,433
% Class time maintaining order	-.16 (-8.05)	-.04 (-2.27)	.08	3,407
Time in labs (minutes/week)	.18 (4.64)	.12 (3.29)	.05	3,430
Use of computers	.10 (3.10)	.02 (0.21)	.01	3,497
Use of student presentations	.03 (1.01)	.01 (0.03)	.01	3,502

NOTE: The coefficients are standardized betas. The ordinal measures of teacher education level and achievement level of the class are treated here as continuous independent variables. The coefficients reported in the table thus indicate proportions of a standard deviation unit on the dependent variable that are associated with a change of one standard deviation unit on the independent variable, holding constant the other independent variable. See Appendix Tables A1.2 and A1.3 for descriptive statistics on the variables used in these regressions.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

The regressions of the science instructional variables also show that teachers' educational level is generally less strongly associated with the instructional variables than is the achievement level of the class. As with mathematics, teacher education is significantly related to some aspects of instruction. Teachers with higher credentials tend to assign more homework and devote more time to laboratories, and devote less time to maintaining order.

Summary

This chapter has shown that the instruction seniors receive in their science and mathematics classes is strongly associated with the average achievement level of their classes. Students in the higher classes experience a greater emphasis on developing higher-order thinking skills. Their science lab experiences, as measured by the time variable, are also much greater, as are the homework demands of their teachers. Finally, teachers manage their classes differently depending on the achievement level of the class. Students in lower-level classes receive less whole-class instruction and have a greater share of their class time consumed by efforts to maintain order.

Another aspect of classes that correlates with instructional differences is the educational level of the teacher. The pattern of associations is generally consistent with the ability-level differences in instruction. However, when instructional differences between teacher degree levels are compared within ability groups, the associations between teacher credentials and instruction largely disappear. Exceptions to this in science are found in higher amounts of homework assigned and the greater use of laboratories associated with higher-credential teachers. In mathematics, the exceptions are that teachers with higher credentials place more emphasis on higher-order thinking, devote higher proportions of class time to whole-group instruction, and spend less time on discipline. Even these differences should be treated cautiously, for the students we have grouped into our achievement-level tracks are often quite heterogeneous. It could be the case, for example, that teachers with higher credentials tend to be concentrated in higher-SES schools. These schools may require or encourage teachers to devote more time to laboratories for their lower-achieving classes. Higher-SES students may also be more tractable, and this could account for the lower amounts of time which more-educated teachers report devoting to discipline. In order to address these competing explanations, it is necessary to take account of the role of student background differences in the instructional differences we have observed thus far.

Chapter III
Instruction and Student Background

The previous chapter showed that the achievement level of the seniors' math and science classes is associated with the types of instruction they receive. What other factors might affect instructional experiences? As the research review in Chapter I (schematized in Figure 1.1) noted, student background is likely to be associated with instructional experiences for several reasons. One is that student background variables are almost always found to be strongly related to the achievement level of the class in which one is enrolled. Family background may also make a difference even among students at the same class level. This would occur, for example, if teachers held lower expectations for classes composed mainly of lower-SES pupils. Expectations, in turn, could be lower either because of prejudicial biases or because of a reasoned adaptation to reality.

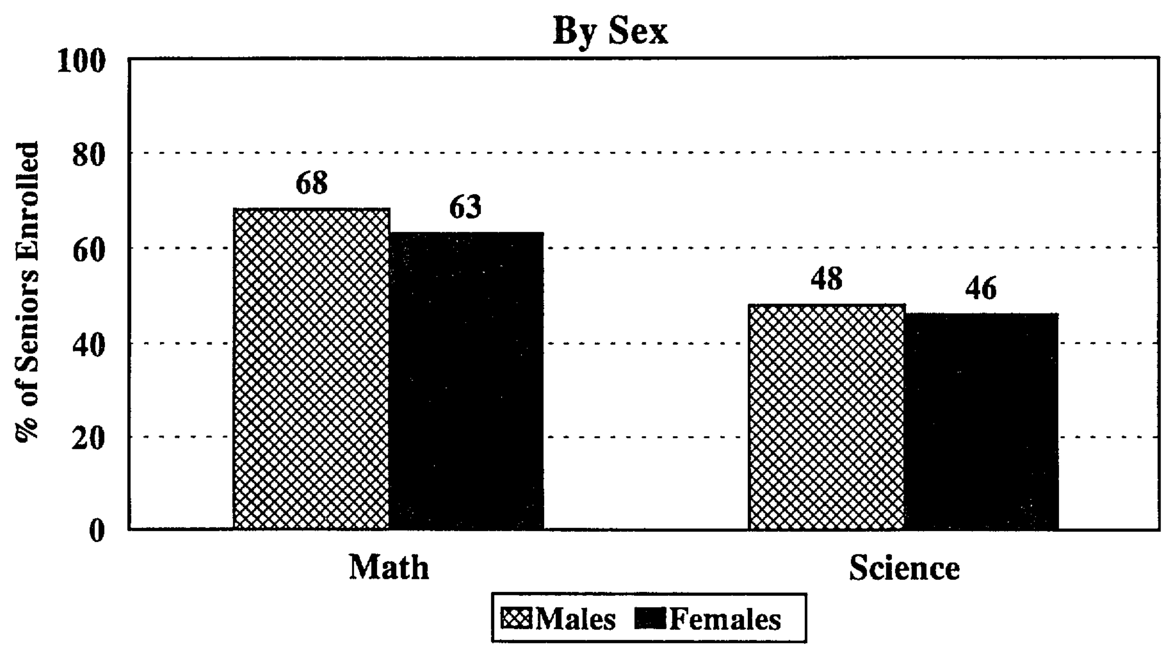
This chapter examines the relationship of student background with instructional experiences (research question #1c on p. 10). As used here, background includes parental SES, race-ethnicity, gender, and students' prior achievement levels (as measured in 1990, when most were sophomores).[6] We examine bivariate relationships of the instructional variables with student background variables, and then move on to assess the relationships within the curriculum levels examined in the last chapter.

Student Background and Course Enrollment

The bivariate relationships of student background and enrollment in science and mathematics courses are shown in Figure 3.1. The information on courses used here comes from the transcript data, and the samples thus include all of the students who were enrolled, whether or not data from their teachers were collected. Looking first at simply whether or not students are enrolled in a 12th grade course, males are more likely than females to take mathematics in 12th grade. Asians are more likely than whites and Hispanics to take mathematics, and more likely to take science than whites, blacks, and Hispanics. None of the apparent differences among whites, blacks, and Hispanics are statistically significant. Coming from an above-average-SES household is associated with higher rates of course-taking. The last chart in Figure 3.1 shows that academic achievement has a strong association with course-taking. Students in the highest achievement quartiles of the 1990 (sophomore year) NELS:88 mathematics and science test score distributions were, respectively, 29 percent and 30 percentage points more likely than students in the lowest quartiles to take mathematics and science in 12th grade.

[6] The sample of students used for the cross-classifications of senior coursework and instructional experiences by 1990 achievement scores excludes the 264 seniors who were added to the study in 1992 in order to make the NELS:88 sample representative of 1992 seniors across the U.S. This means that this subsample is not exactly representative of seniors nationally, but this is probably a minor deviation.

Figure 3.1
Percentage of 12th-Graders Taking Mathematics and Science Courses, by Student Background Characteristics: 1992



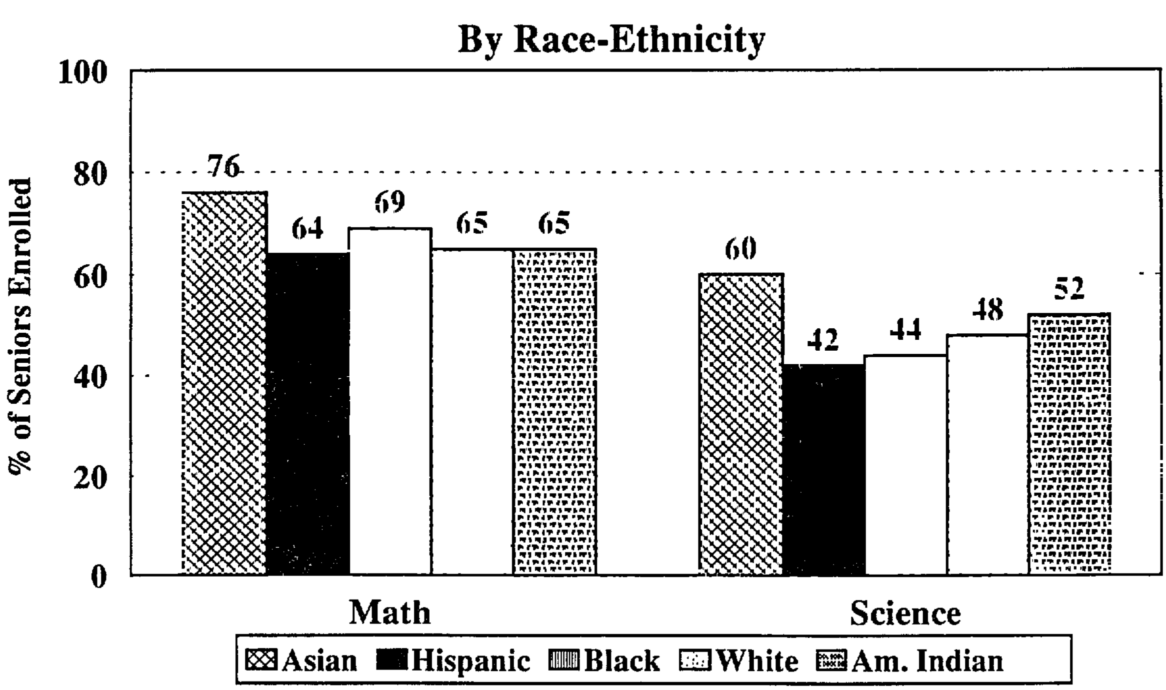
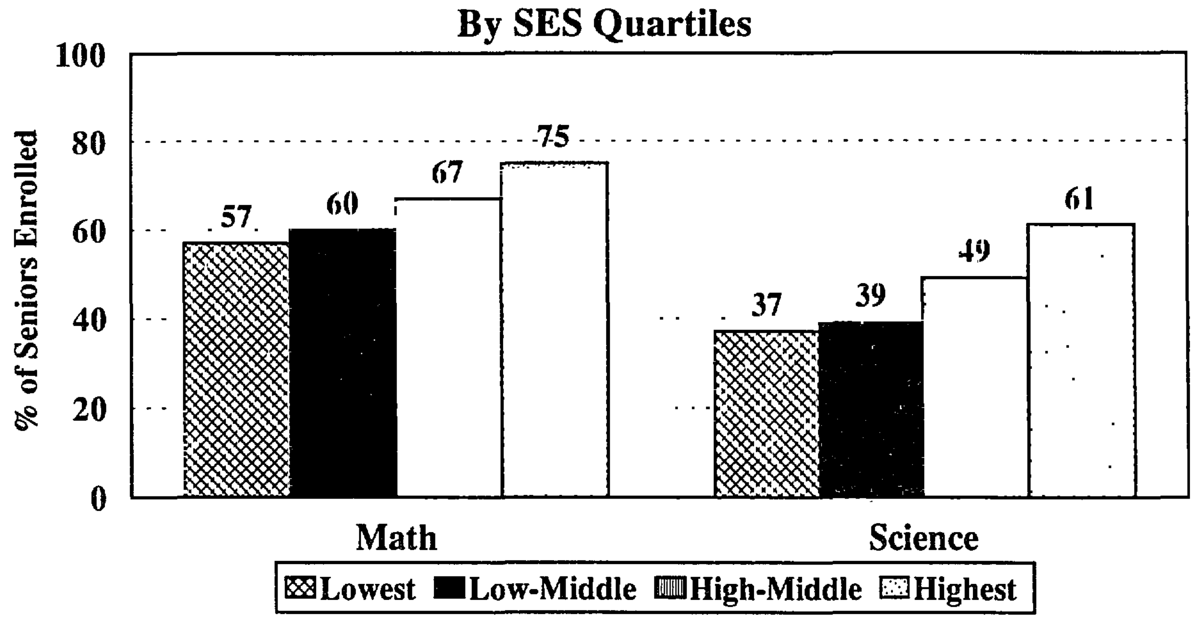
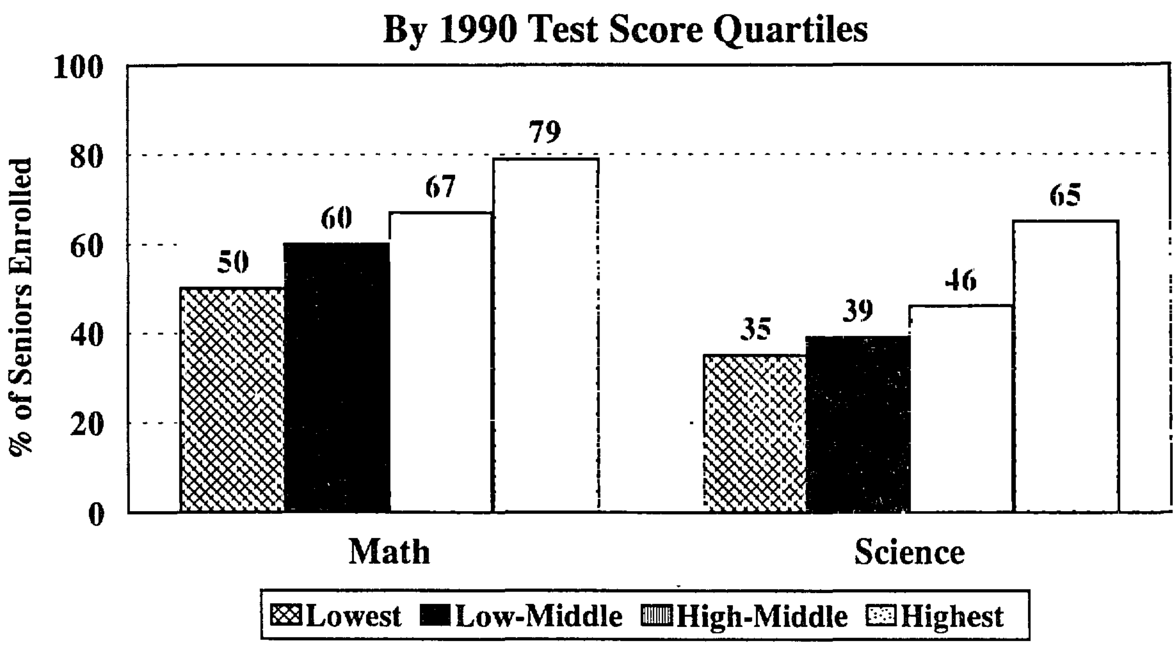


Figure 3.1
Percentage of 12th-Graders Taking Mathematics and Science Courses, by Student Background Characteristics: 1992
(Continued)

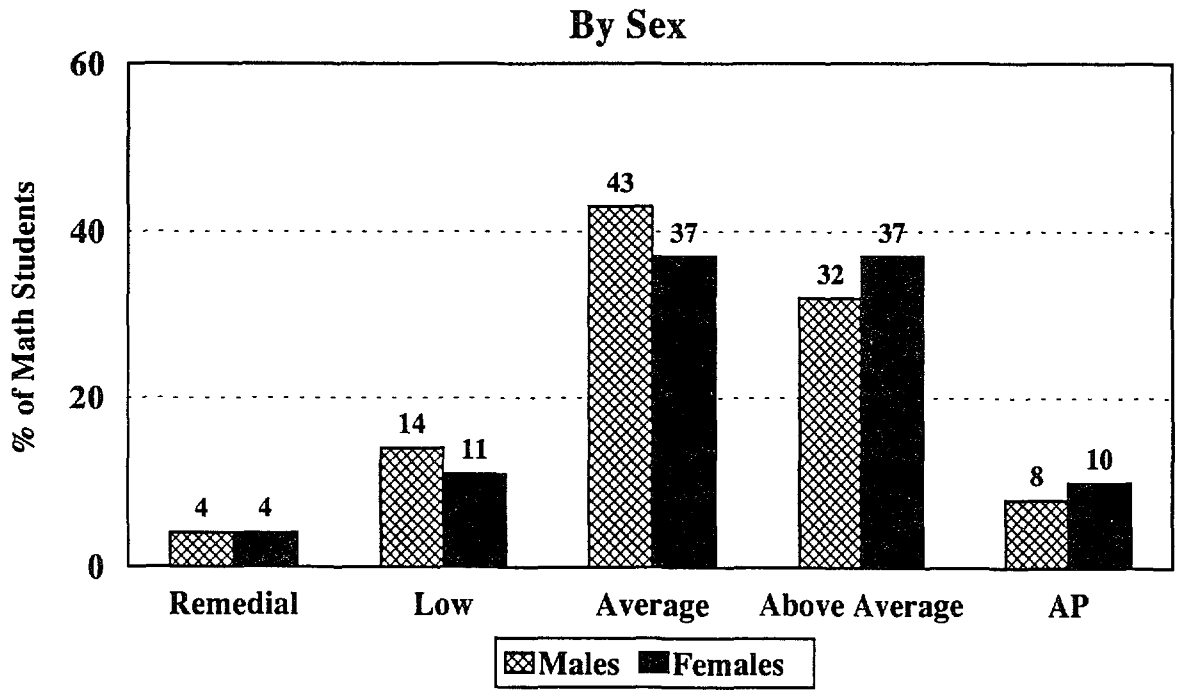




SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

Among the students enrolled in 12th grade math and science, the demographic compositions of the classes in which the seniors were enrolled vary significantly by the teacher's rating of the class's average achievement level. Restricting the sample back to the students for whom teacher data were collected, Figures 3.2 and 3.3 show these distributions. Gender differences tend to be insignificant at all levels of coursework. However, racial-ethnic differences are more pronounced. Black students are underrepresented at the AP level. Asians, in contrast, are much more likely than any other group to be enrolled in the AP math and science courses. The largest differentials in Figures 3.2 and 3.3 are found among the SES and 10th grade achievement quartile groups.

Figure 3.2
Percentage of 12th-Graders Mathematics Students Enrolled in Classes With Different Achievement Levels, by Student Background Characteristics: 1992



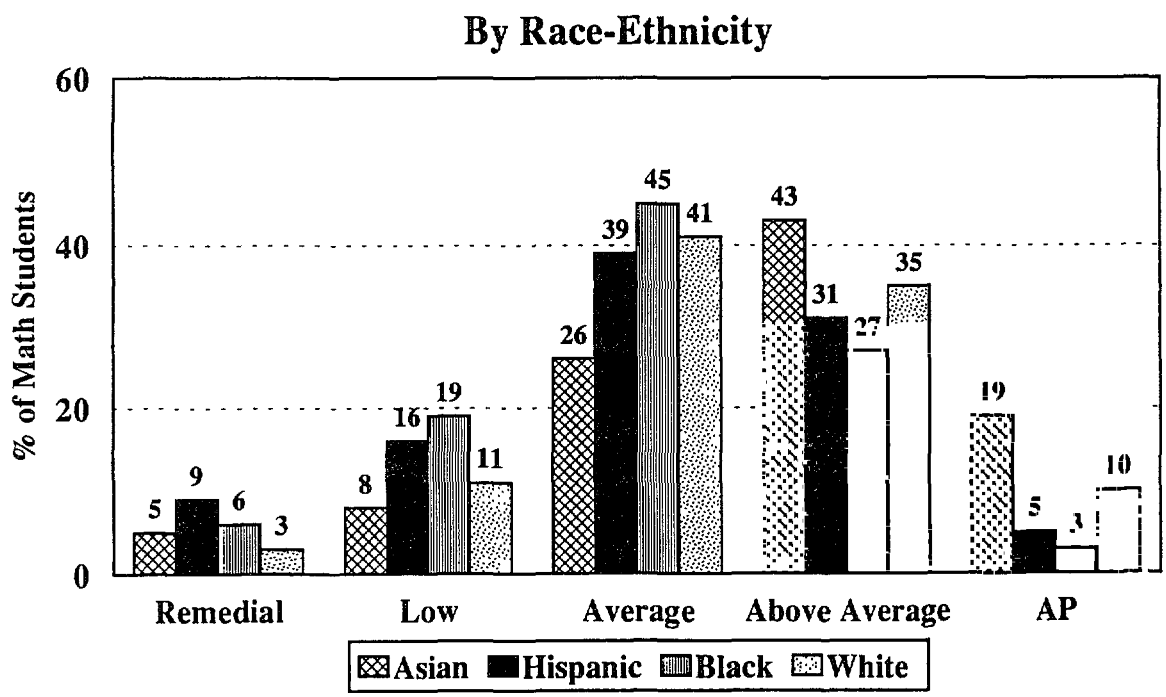
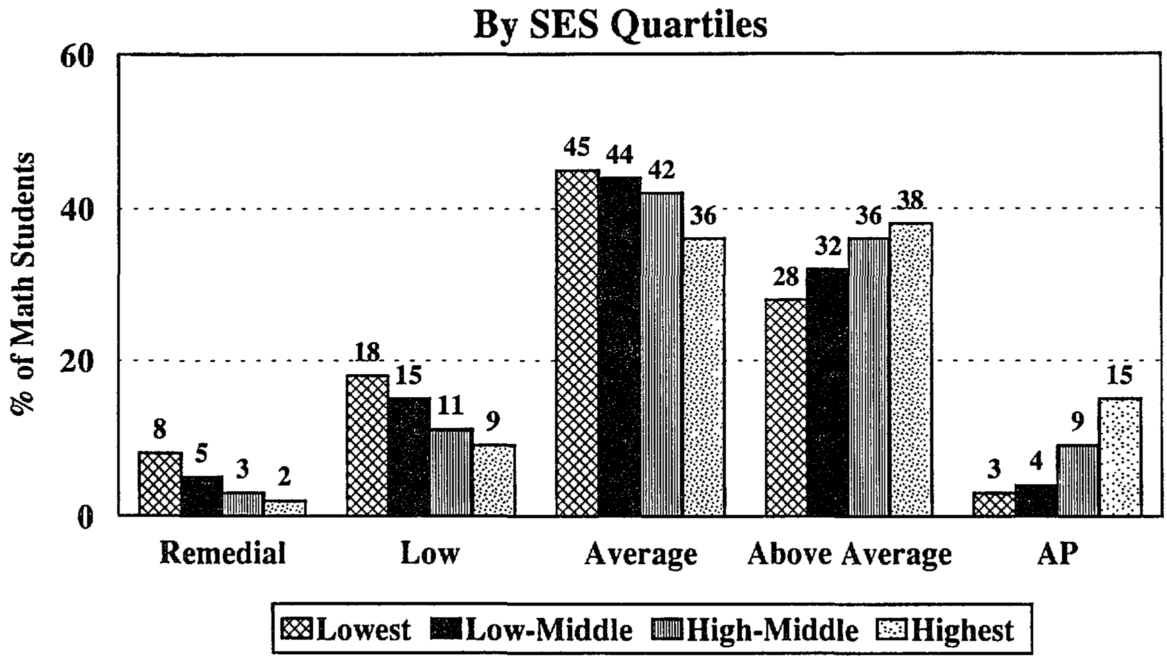
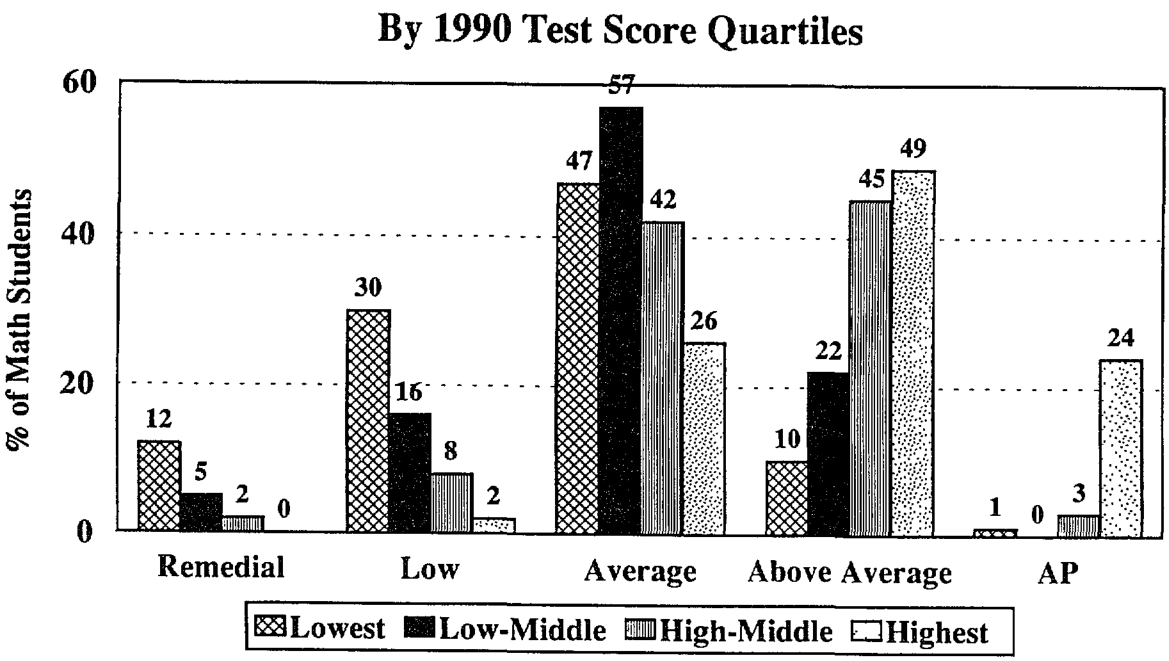


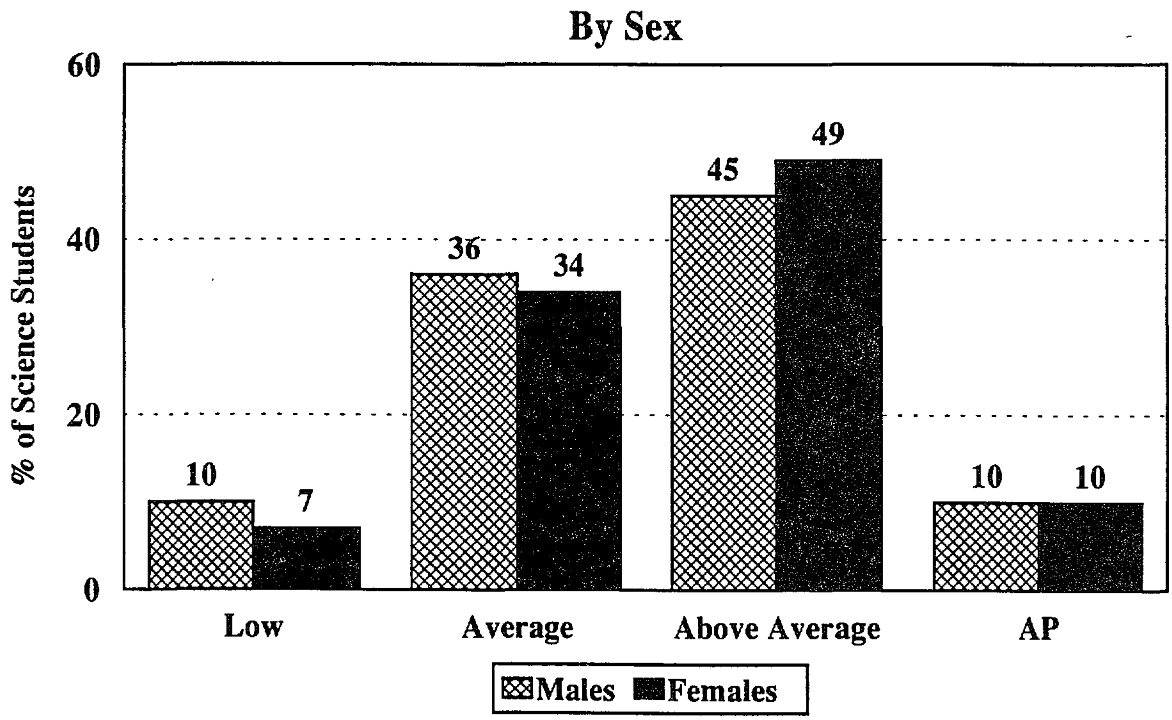
Figure 3.2
Percentage of 12th-Graders Mathematics Students Enrolled in Classes With Different Achievement Levels, by Student Background Characteristics: 1992 (Continued)





SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

Figure 3.3
Percentage of 12th-Graders Science Students Enrolled in Classes With Different Achievement Levels, by Student Background Characteristics: 1992



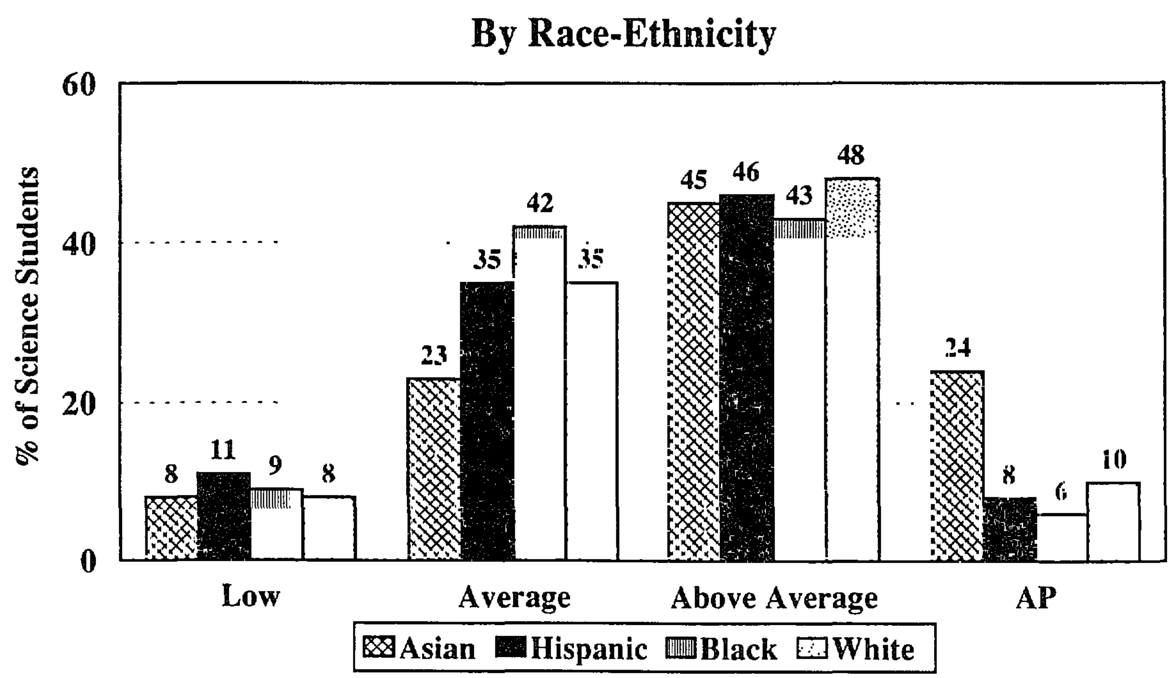
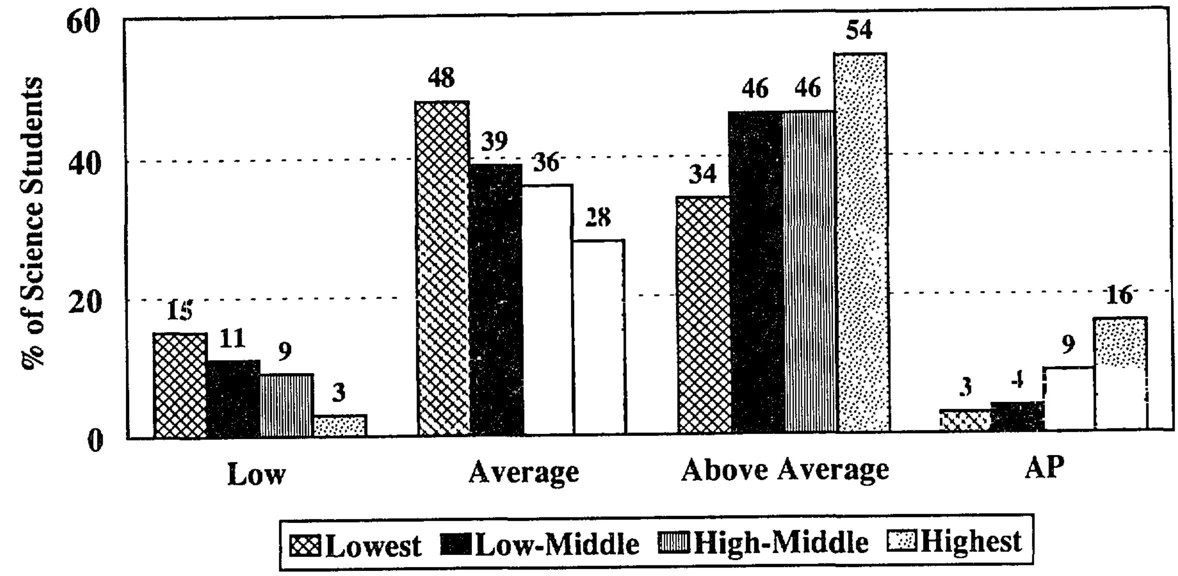
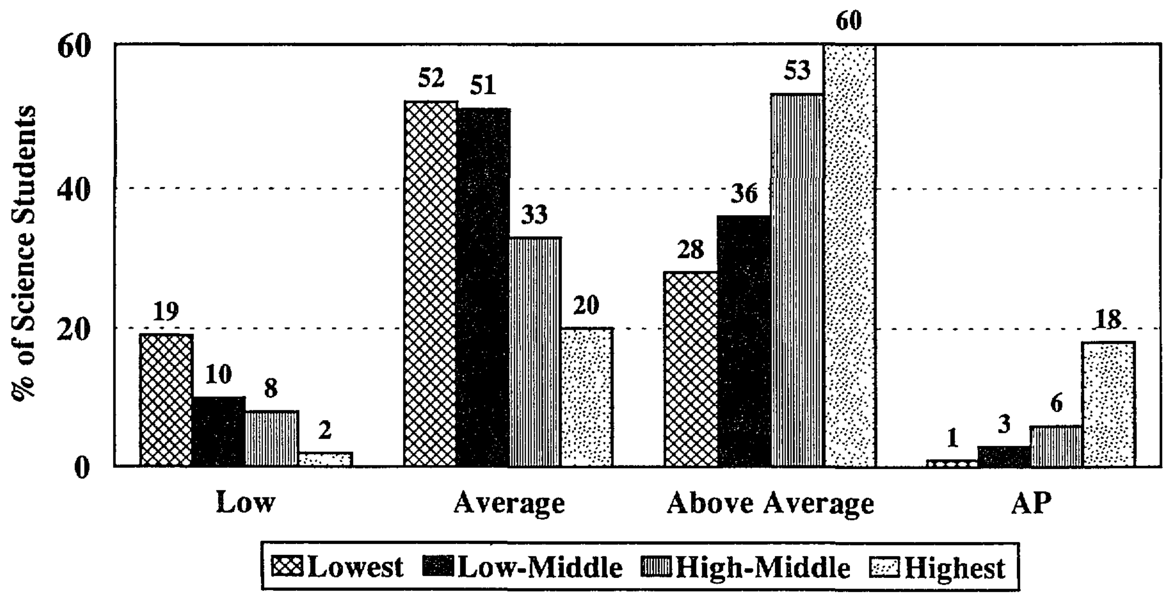


Figure 3.3
Percentage of 12th-Graders Science Students Enrolled in Classes With Different Achievement Levels, by Student Background Characteristics: 1992 (Continued)

By SES Quartiles



By 1990 Test Score Quartiles



SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up Survey.

Background and Instruction

The relationships between the background and instructional variables are shown in Tables 3.1 and 3.2. The subpopulation differences evident in these tables are consistent with what one would expect from the relationships between background and group placement (Figures 3.2 and 3.3), and group placement and instruction (Chapter II). Gender differences in the instruction students receive are negligible in both subjects. SES and race-ethnicity differences in instruction are evident at several points. SES differences in mathematics are found in the time-allocation variables: high SES students have less class time devoted to small-group and individualized instruction and to maintaining order than low SES students. Race and ethnicity differences in math instruction are evident on two variables. Black seniors have more of their class time devoted to maintaining order than Asians. Further, blacks and whites have less homework assigned to them than Asians, and blacks have less than Hispanics.

In science, high-SES students are assigned more homework than low-SES students. There are no significant SES differences in the number of minutes per week devoted to additional lab sessions or the teacher responses to the question asking them to estimate the percentage of time devoted to laboratories. Black and Hispanic youth have about the same amounts of laboratory experience as non-Hispanic whites by either method of reckoning, and are assigned about the same amounts of homework.

Table 3.1. **Means of math instructional variables reported by the teachers of 12th-grade math students, by student background characteristics: 1991-92 School year.**

Variable	Gender		Socio-Economic Quartile				Race/Ethnicity			
	Males	Females	Low	Mid-low	Mid-high	High	Asian	Hispanic	Black	White
Instructing whole class (% class time)	51.4	51.4	48.1	52.8	50.9	52.5	51.7	48.8	53.6	51.4
Instructing small groups (% class time)	14.9	13.5	17.1	14.1	14.6	12.5	12.0	15.8	14.7	14.1
Instructing individuals (% class time)	16.8	16.5	20.2	18.3	15.7	14.2	14.4	21.8	16.3	16.0
Maintaining order (% class time)	6.6	5.9	8.1	6.2	7.4	4.3	3.9	7.5	10.4	5.5
Administering tests (% class time)	14.6	13.7	13.9	14.9	14.0	14.1	12.9	14.0	15.8	14.1
Administrative tasks (% class time)	5.5	5.3	5.6	5.6	5.7	4.9	5.5	6.5	6.2	5.1
Conducting lab periods (% class time)	1.7	1.1	2.9	1.0	1.4	1.0	1.3	1.5	0.7	1.6
Lecture (use: 1=never/rarely to 5=every day)	3.96	3.99	3.95	3.99	3.99	3.98	3.95	3.98	3.98	3.98
Use computers (use)	1.50	1.51	1.60	1.46	1.49	1.52	1.56	1.57	1.38	1.52
Use audio-visual materials (use)	2.19	2.24	2.41	2.27	2.19	2.10	2.29	2.13	2.34	2.20
Use teacher-led discussion (use)	2.94	3.02	2.96	2.88	2.95	3.08	3.04	3.02	3.06	2.95
Recitation (use)	4.13	4.14	4.15	4.12	4.12	4.15	4.12	4.04	4.27	4.12
Use student-led discussion (use)	1.61	1.70	1.61	1.59	1.65	1.71	1.59	1.69	1.78	1.63
Cooperative groups (use)	2.79	2.84	2.94	2.72	2.78	2.85	2.66	3.11	2.79	2.79
Seatwork (use)	2.98	3.08	3.34	3.14	2.94	2.83	2.88	3.23	3.26	2.96
Student oral reports (use)	1.23	1.22	1.27	1.19	1.15	1.30	1.17	1.34	1.25	1.21
Homework (minutes/day)	32.8	35.3	31.5	30.9	34.4	37.3	37.7	36.8	31.7	33.7
Emphasis: Problem-solving (1=none to 4=major)	3.21	3.26	3.10	3.19	3.25	3.34	3.28	3.19	3.26	3.24
Emphasis: Applications (1=none to 4=major)	3.22	3.26	3.34	3.22	3.24	3.19	3.13	3.30	3.38	3.21
Emphasis: Mechanics (1=none to 4=major)	3.04	3.02	3.03	3.05	3.05	3.00	2.97	3.01	3.14	3.02

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table 3.2. **Means of science instructional variables reported by the teachers of 12th-grade science students, by student background characteristics: 1991-92 School year.**

Variable	Gender		Socio-Economic Quartile				Race/Ethnicity			
	Male	Female	Low	Mid-low	Mid-high	High	Asian	Hispanic	Black	White
Instructing whole class (% class time)	51.5	53.3	51.7	51.6	51.4	53.7	51.2	50.9	53.4	53.0
Instructing small groups (% class time)	15.4	15.3	18.5	13.9	16.2	14.2	12.5	22.6	15.0	14.9
Instructing individuals (% class time)	12.0	11.8	12.9	11.2	12.2	11.7	13.0	13.4	10.5	11.2
Maintaining order (% class time)	5.1	5.4	7.2	5.5	5.2	4.5	4.2	6.4	7.4	4.6
Administering tests (% class time)	12.2	13.1	12.9	12.1	11.9	13.3	12.6	12.2	12.6	12.5
Administrative tasks (% class time)	5.5	5.6	6.0	5.8	5.7	5.2	5.4	6.4	5.6	5.5
Conducting lab periods (% class time)	21.5	23.0	19.1	21.3	23.0	23.6	22.5	21.2	20.9	22.7
Lecture (use: 1=never to 5=every day)	3.55	3.52	3.46	3.57	3.46	3.59	3.45	3.54	3.50	3.56
Use computers (use)	1.49	1.47	1.40	1.43	1.56	1.48	1.52	1.43	1.79	1.45
Use audio-visual materials (use)	2.56	2.64	2.68	2.44	2.61	2.64	2.68	2.70	2.53	2.60
Use teacher-led discussion (use)	2.83	2.80	2.89	2.79	2.88	2.75	2.84	2.95	2.95	2.79
Recitation (use)	3.69	3.77	3.63	3.76	3.63	3.81	3.63	3.59	3.67	3.75
Use student-led discussion (use)	1.62	1.63	1.59	1.57	1.70	1.62	1.51	1.63	1.90	1.59
Cooperative groups (use)	2.89	2.85	2.81	2.90	2.88	2.87	2.71	2.89	2.79	2.89
Seatwork (use)	2.72	2.62	2.91	2.80	2.68	2.50	2.56	2.76	2.70	2.66
Student oral reports (use)	1.30	1.34	1.34	1.27	1.34	1.32	1.31	1.34	1.42	1.31
Homework (minutes/day)	31.2	31.6	27.6	29.8	30.3	34.1	38.0	34.8	31.9	30.3
Laboratory (minutes/week)	56.2	57.4	54.3	55.1	56.5	59.2	63.1	57.4	60.0	56.1
Emphasis: Inquiry (1=none to 4= major)	3.33	3.33	3.17	3.34	3.36	3.35	3.32	3.28	3.34	3.33
Emphasis: Science & Society (1=none to 4=major)	3.11	3.15	3.20	3.14	3.21	3.04	2.96	3.22	3.23	3.11
Emphasis: Memorizing Facts (1=none to 4=major)	2.88	2.87	2.90	2.85	2.84	2.91	2.81	2.96	2.90	2.87
Composite frequency of computer use (1=never to 5=every day)	1.40	1.37	1.29	1.35	1.43	1.40	1.42	1.30	1.52	1.38
Composite frequency of student presentations (1=never to 5=every day)	1.40	1.42	1.40	1.36	1.44	1.41	1.36	1.45	1.53	1.39

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

The background variable that is most consistently associated with instructional differences thus appears to be socioeconomic status. One explanation for this is that SES is related to the achievement level of the students' classes, and Figures 3.2 and 3.3 indeed show that socioeconomic background differences are strongly associated with the class achievement level. But it is also possible that SES is associated with instructional differences even among students at the same achievement level. To assess this possibility, we confined our attention to the instructional variables which showed SES differentials in Tables 3.1 and 3.2; these were also found in the last chapter to be associated with the class achievement levels. These instructional variables included the shares of class time devoted to whole-class instruction and discipline, the amount of homework assigned, the amount of lab time (in science), and the teacher's emphasis on developing higher-order thinking skills. In science, we added to this set the frequency of computer use and student presentations.

The relationships can be efficiently summarized using ordinary least squares (OLS) regression techniques. Regressing each of the instructional variables on the individual background indicators gives estimates of the independent effects of background on instruction. Adding measures of the achievement level of the class to the model shows the extent to which the overall effects are mediated by class achievement level.

Since this is not an experimental study, many of the explanatory variables we examine are intercorrelated. Multivariate statistical methods are thus needed to identify the independent associations, or "effects," of the variables on the outcomes of interest. Effects imply "other things equal," and it is important to emphasize that this always must be interpreted in terms of the specific set of variables included in the model. As initial formulations, the regression equations included in this report are simplifications, and almost certainly leave out some variables that affect the outcomes. Further research is needed to pursue alternative specifications and to assess the extent to which those modifications alter the results reported here. The inferences drawn here should thus be viewed as preliminary statements, rather than definitive distillations from extensive model-building efforts. The occasional use of causal imagery in this report should be understood in this light. And, as is always the case in social science, causation even under the best of circumstances is a probabilistic rather than a deterministic notion.

With these caveats in mind, Table 3.3 shows the coefficients from regressions of the math instruction variables on background and class achievement level. The full regression model estimates are included in Appendix D. The right-most column of the table shows the R^2 statistics for the models. These are proportions of the total variance in the dependent variables that are explained by the models. The statistics are "adjusted" for the sample sizes. The first point to make about these regressions is that the student background variables alone (Model 1) account for very little of the variability among students on any of the dependent instructional variables. While a number of the coefficients are significant, it is important to recognize that even when the achievement level of the class is added (Model 2), the variance explained ranges from a high of .174 (homework assignments) to a low of .053 (time on discipline). Most of the variability in the instructional variables is thus accounted for by factors not included in these simple models. The results for mathematics indicate significantly more minutes of homework assigned and greater teacher's emphasis on developing higher-order thinking skills for females. When the controls for the achievement level of the class are added to the model, these gender differences diminish, and neither is statistically significant.

Table 3.3. Regression coefficients for selected student background variables from regressions of mathematics instructional variables: 1992.

		Gender	Race-Ethnicity			SES Composite	R^2
Dependent Variable:	**Model**	**Female**	**Asian**	**Hispanic**	**Black**		
% class time for whole-class instruction	1	0.025	0.600	-1.054	3.191	1.783	.006
	2	-0.654	-0.259	0.010	4.470**	0.724	.060
% class time for discipline	1	-0.752	-1.676*	1.051	4.203*	-1.238**	.021
	2	-0.271	-0.901	0.872	3.680	-0.697**	.053
Homework minutes/day	1	2.671**	4.196**	5.620**	-0.199	3.696**	.038
	2	1.567	1.770	6.219**	1.387	2.095**	.174
Higher-order skills	1	0.059*	0.060	0.038	0.078	0.124**	.027
	2	0.032	0.020	0.065	0.127**	0.085**	.110

Key: Model 1: student background variables only.
Model 2: student background variables plus achievement level of the class.
*: $p \leq 0.05$; **: $p \leq 0.01$

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Significant racial and ethnic differences are apparent in time spent on discipline, where Asians are in classes with less time spent maintaining order, and blacks tend to be in classes where more time is spent on classroom control. In terms of homework, Asians and Hispanics have teachers who report higher homework loads. The greater proportion of time spent on discipline in the classes of black youth decreases to insignificance with the addition of the class achievement level. The greater homework load for Hispanics actually increases when class achievement level is added, while the Asian-white difference diminishes to insignificance. The elevation of the Hispanic effect occurs because Hispanics tend to be underrepresented in the higher-achievement-level classes, whose teachers generally tend to assign more homework. For the same reason, the teachers' emphasis on higher-order skills becomes significantly greater for blacks when the class achievement level is added.

Socioeconomic differences among students are significant in the areas of homework assignments, class time spent on discipline, and the teacher's emphasis on higher-order thinking. These effects diminish with the additional controls, but still remain strongly significant.

The coefficients from the regressions of the science instruction variables on background and class achievement level are shown in Table 3.4. The variance-explained statistic, R^2, is also small for each of these models. The Model 1 equations uniformly account for less than 5 percent of the variance, and the Model 2 elaborations only reach 10 percent for the homework assignments and inquiry-skill emphasis variables. Again, the point to note is that the social background variables used here and the class-achievement level variable account for only a small part of the overall variability among seniors in their instructional experiences. Gender differences are not apparent on any of the science class variables.

Table 3.4. Regression coefficients for selected student background variables from regressions of science instructional variables: 1992.

		Gender	Race-Ethnicity			SES Composit e	R^2
Dependent Variable:	**Model**	**Female**	**Asian**	**Hispanic**	**Black**		
% class time for whole-class instruction	1	2.288	-1.646	-2.401	1.012	0.978	.022
	2	1.955	-2.606	-2.616	0.736	-0.056	.031
% class time for discipline	1	0.019	-0.330	0.871	2.105	-1.186**	.049
	2	0.252	0.175	1.042	2.216	-0.572*	.071
Homework minutes/day	1	0.814	7.440**	6.177*	3.771*	3.868**	.038
	2	0.115	4.186*	4.856*	3.423	1.062	.181
Lab minutes/week	1	1.402	6.847	5.315	5.755	3.298*	.004
	2	1.137	3.088	0.306	4.853	-0.310	.040
Emphasis on inquiry skills	1	0.001	-0.011	0.005	0.049	0.071**	.010
	2	-0.026	-0.043	-0.022	0.040	0.017	.109
Use of computers	1	-0.026	0.034	-0.017	0.175*	0.068**	.014
	2	-0.029	0.025	-0.018	0.178*	0.051*	.021
Use of student presentations	1	0.019	-0.031	0.061	0.160**	0.027	.010
	2	0.020	-0.045	0.061	0.160**	0.021	.013

Key: Model 1: student background variables only.
Model 2: student background variables plus achievement level of the class.
*: $p \leq 0.05$; **: $p \leq 0.01$

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Racial-ethnic differences are significant in the amount of homework assigned, the extent of computer use, and the frequency of student presentations. Asian, Hispanic, and black students have teachers who report assigning larger amounts of homework than the teachers of white students. With the addition of the controls for the achievement level of the class, the larger homework loads for Asians and Hispanics are diminished but are still significant. The science teachers of black youth are significantly more likely than the science teachers of white youth to use computers and student presentations. This tendency is not explained by class-achievement level differences, because the racial gap remains unchanged and is still significant with the additional controls.

Finally, socioeconomic differences among students are significant in several areas: higher SES students tend to be in classes where less time is spent on discipline, more homework is assigned, more lab time is allotted, more emphasis is placed on developing inquiry skills, and computers are used more frequently. However, with the addition of the controls, the SES effect remains significant only for the amount of time spent maintaining order and for the use of computers.

Summary

Social background differences among the 1992 seniors are associated with the types of science and math classes they take and thus affect their instructional experiences. But we have also found aspects of instruction which differ along the lines of student background even after taking account of the ability levels of the classes.

Gender differences are very small both in rates and types of course enrollments and in the teacher reports of instructional practices. Race and ethnic differences are evident but mainly reflect socioeconomic differences among the groups. Even after taking account of the ability level of the classes, the mathematics teachers of higher-SES students assign more homework, spend less time on discipline, and place a greater emphasis on higher-order thinking skills. In science, higher-SES students have teachers who report less class time spent on maintaining order and more frequent use of computers for research purposes than their lower-SES peers of equal ability.

Chapter IV
Instruction and School Characteristics

Thus far we have seen that seniors' instructional experiences are related to the level of their course and, at least indirectly, to their social backgrounds. Course enrollment patterns and student background both vary from school to school, and thus which school one attends is associated with the kind of instruction one receives. But schools are complex entities that differ from one another in hundreds of ways—a large proportion of which were measured by the NELS:88 surveys of principals, teachers, and students. Which aspects of schools influence the content and form of classroom instruction? A large body of research conducted over the past 15 years offers many suggestions, but few clear answers.

While by no means exhaustive of the possibilities, the school variables we examine here do include indicators used by many previous studies. Two measures refer to school geographic location, and are included for simple comparative purposes rather than for any particular theoretical reasons. Of greater interest are the variables which in various ways reflect policy decisions, including the school's social class composition, enrollment size, whether the school is under public or private control, and the school's organizational characteristics. This chapter assesses whether instruction systematically varies between schools along each of these dimensions. To begin with, we return to the question of who takes senior year mathematics and science courses. Beyond that, we will try to determine the extent to which these school differences are associated with the instructional variables, and whether those aspects of schools which do correlate with instructional differences maintain any association once student background variables are controlled.[7]

School Characteristics and Course Enrollments

For a number of reasons, course enrollments in senior-year science and math are likely to vary among states, local districts, and schools within districts. First, enrollments vary because of socioeconomic-related differences in individual demand for the courses, because average socioeconomic status differs among states, districts, and schools. Individual differences are not the whole story, though, for policy differences that cut across socioeconomic lines are also found. Most to the point, policies on graduation requirements differ to some extent between states, and local districts and schools are usually able to enact policies more stringent than those of their state. Less directly, state and local university systems differ in their entrance requirements, and one would expect high school enrollment patterns also to respond to these variations.

[7] The multilevel nature of the NELS:88 data, where students are nested within schools, suggests that mixed or hierarchical models would be appropriate for estimating the relationships of interest here (see Bryk and Raudenbush, 1992 for an exposition of this methodology). Using these models is impractical with the NELS:88 second follow-up data, because school sample weights are not available. If weights were available, mixed models would be primarily useful for improving estimates of the standard errors. However, proper estimation of standard errors does not require mixed model methodology, but is instead solvable with use of the Taylor series approximation method as implemented in SUDAAN (Shah, et al., 1992) and other software packages. The large degree of dispersion of the original 8th grade sample as the students moved into high school means that the students are not likely to be accurate representative samples of the students in their particular high schools. The mixed model methodology would thus not be useful for estimating between- and within-school variance components, or for estimating cross-level interactions as random effects. Anticipating these problems, NELS:88 augmented the within-school samples of a subset of about 230 high schools and surveyed and tested these students and their teachers in 1990 and 1992. These data, referred to as the High School Effects Study, will be available in 1995.

To assess the contributions of these different factors, we rely on logistic regression techniques. This method gives results that are analogous to ordinary regression, and it is appropriate for multivariate models when the dependent variable is dichotomous. In the present case, the dependent variables are whether the student was enrolled in mathematics and science courses during the senior year. Controlling for individual background differences in SES, gender, and race-ethnicity, the logistic regression equation estimates the effects of a unit change in each of the measures of school characteristics on the likelihood of course enrollment. For present purposes, the effects are presented as ratios of the odds of course enrollment for students who differ by one unit on the school variables. If the odds are equal, the odds ratio equals one. If the comparison group is less likely to be enrolled than the reference group, the odds ratio is less than one; if more likely, then the ratio exceeds one.

We estimated two logistic models for each subject-area enrollment outcome. The first (Model 1) includes variables which are usually outside the control of local school policy makers, such as the school's geographic location, SES enrollment, and sector (public versus private). The second model (Model 2) adds a number of variables which, in contrast, tend to be subject to some local influence. These include the number of students enrolled in the school, the importance of test scores in how the principal is evaluated, whether the school has minimum competency requirements in math or science for graduation, and the number of math or science courses students are required to complete for graduation.

The odds ratios shown in Model 1 of Table 4.1 indicate that whether a school is urban, rural, or suburban is not related to mathematics or science enrollments. A few significant regional differences exist (the reference of these comparisons are students in the Northeast): students in the West are less likely to take math, and students in the Midwest and South are less likely to take science. The South-Northeast difference is reduced somewhat but is not explained away when the additional variables included in Model 2 are added. One possibility is that colleges in the Northeast tend to require more coursework in science and math. Another is that the economic bases of the regions differ so that even students not planning on college are encouraged to take more courses in these areas.

The measure of the socioeconomic composition of the students' schools used here is the principal's report of the percentage of students eligible for the free and reduced price federal lunch program. Controlling for individual SES, the results for Model 1 show that students in schools where 21 to 50 percent of the students are poor are more likely to take senior science than students in schools where 0 to 5 percent are poor, but no significant effects are found for any of the other levels of poverty enrollments. When the policy variables are added, in Model 2, that effect is no longer significant, but a significant effect emerges in mathematics. Generally, though, the effects of school-level SES appear to be minimal. Individual SES, in contrast, is the single strongest predictor of senior-year enrollment in science and math (see Appendix Table A4.1).

Table 4.1. Adjusted odds ratios[a] of students taking mathematics and science in 1991-1992 school year, by school characteristics

Variable	Mathematics		Science	
	(Model 1)	(Model 2)	(Model 1)	(Model 2)
Urbanicity				
urban vs. suburban	1.090	1.110	1.234	1.010
rural vs. suburban	1.005	1.030	0.997	0.932
Region of U.S.				
midwest vs. northeast	0.853	0.957	0.743**	0.791
south vs northeast	0.941	0.962	0.564**	0.591**
west vs. northeast	0.666**	0.738*	0.828	0.913
Percent students eligible for subsidized lunch				
6-20% vs. 0-5%	0.940	0.847	1.067	1.105
21-50% vs. 0-5%	0.860	0.719**	1.251*	1.239
51%+ vs. 0-5%	1.052	0.865	1.337	1.175
School control type				
Catholic vs public	1.581*	1.262	1.510*	1.485
NAIS vs. public	3.512**	2.502*	4.538**	2.833**
Other private vs. public	1.078	0.571	1.057	0.677

Table 4.1. **Adjusted odds ratios[a] of students taking mathematics and science in 1991-1992 school year, by school characteristics (Continued)**

Variable	Mathematics (Model 1)	Mathematics (Model 2)	Science (Model 1)	Science (Model 2)
School organizational variables				
12th grade enrollment size (natural log)	--	1.051	--	1.061
Importance of test scores in evaluation of principal	--	1.037	--	1.011
School rewarded for high achievement vs. not	--	0.949	--	0.997
School has min. competency requirement for math/science vs. not	--	0.894	--	0.751**
Years of math/science required for graduation	--	1.237**	--	1.246**

[a] Odds ratios are estimated from logistic regressions of whether the students took math or science on the variables listed in the table plus controls for SES, gender, and race-ethnicity. See Appendix for full regression equations.

-- Not included in Model 1.

NOTE: * indicates the effect of the variable on the odds of taking the indicated course is statistically significant at the .05 level; ** indicates significance at the .01 level.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988

As one would expect from the results of the High School and Beyond analyses of sector differences (Coleman and Hoffer, 1987), students in Catholic schools are more likely than their public school counterparts to take mathematics and science in their final year of high school. The unadjusted proportions enrolled in mathematics are 79 percent in Catholic schools versus 64 percent in the public schools; in science, 63 percent of the Catholic school seniors are enrolled versus 46 percent of the public school seniors. In contrast to HS&B, NELS:88 distinguishes non-Catholic private schools into two categories: schools that are members of the National Association of Independent Schools (NAIS) and others. NAIS private schools tend to be the most exclusive in terms of tuition costs and academic entrance requirements, and come the closest to the stereotype of the elite private school. Ninety-two percent of the NAIS school seniors take mathematics while 88 percent take science.

Non-public high schools tend to enroll students from more advantaged socioeconomic backgrounds, however, and it is likely that some if not all of the unadjusted differences are due to the different student backgrounds. When background differences among students are taken into account, Table 4.1 shows that the Catholic-public and NAIS-public enrollment differences are still significant. The Catholic advantages are not significant in Model 2, but students in the NAIS schools are still much more likely to take senior-year math and science than public school students. Other private school seniors, in contrast, do not significantly differ from public school seniors in either Model 1 or Model 2.

Larger high schools might be expected to maintain higher enrollments because of their ability to offer more classes. Working against this is the possibility that larger schools tend to have weaker control over their students, and it may be easier for their students to avoid pressures to enroll in more demanding courses. In any case, the results in Table 4.1 show that size is not related to course-taking. Further work might usefully examine whether there is a lower threshold level below which enrollment falls due to insufficient numbers of students to make classes, and perhaps an upper threshold over which enrollment also drops due to weaker social control.

The remaining school variables in Table 4.1 refer to specific organizational practices and policies. The rationale for including these measures is that all of them index policies that are designed to increase student achievement levels, and which may be expected to raise rates of participation in grade 12 mathematics and science courses as a means to that end. Two of the questions ask whether the school is accountable (the principal's report of how much influence the performance of the school's students on standardized tests has on how the principal is evaluated by his or her superiors) or somehow rewarded for higher academic achievement (the principal's report of whether or not the state or local district offers a financial award or recognition to schools for raising student achievement levels). Neither of these measures proves to be associated with senior year course enrollments. One reason for this may be that the principals are judged on the basis of test results from grade levels other than grade 12, and thus do not try to change grade 12 course enrollments. Another possible explanation is that the principals try other methods to raise achievement than increasing senior enrollments in math and science.

The other two questions address whether the school has standards which the students are obliged to maintain, specifically in the areas of science and mathematics. The first of these asks whether the school has minimum competency requirements for math and science in order for students to graduate. This proves to have a negative impact on 12th grade enrollments in science. This result is counterintuitive, but may be explained by a tendency of students who have passed the exams (often first offered in the freshman year) to become more complacent about their skill levels. Alternatively, the mechanism may be organizational if, for example, schools with minimum competency requirements tend to discourage further participation of some students once they have passed the requirements.

The organizational policy which has a clear positive effect on enrollments is the number of courses required for graduation. Whether students learn much from the courses is an interesting question for further research. Other studies have shown that high school achievement growth is strongly related to the numbers and types of courses students take (Rock and Pollack, 1995; Hoffer, Rasinski, and Moore, 1995), but additional research could usefully examine whether that general pattern holds when the additional courses are required versus voluntary.

School Characteristics and Classroom Instruction

In order to estimate the independent effects of school characteristics on classroom instruction variables, we relied on OLS regressions. For each of the instruction variables analyzed in the last two chapters, we estimated the effects of the school variables controlling for the individual student's SES, gender, and race-ethnicity. Controls for the achievement levels of the classes are not included in this analysis, because our interest here is in the total effects of the school variables rather than the effects that are not mediated by the achievement level of the student's class. As Figure 1.1 illustrated, school variables can affect a student's chances of being in a higher versus a lower ability group. For example, students in Catholic schools may be more likely to be enrolled in above-average classes, and that could account for the greater proportion of time their teachers spend on whole-class instruction. Controlling for the achievement level of the student's class, it would then look like Catholic school attendance has no effect on how much whole-class instruction one receives. But this would be an incorrect inference, because Catholic schools do have an effect, albeit one mediated by the effect of Catholic school attendance on the achievement level of the student's class. We suspect that some part of the total effects of the school variables presented here are so mediated, but tracing out those paths of influence is beyond the scope of this analysis.

In addition to the school variables included in Table 4.1, the following analysis includes several measures derived from the NELS:88 1992 survey of mathematics and science teachers. Prior research on differences among effective and ineffective schools suggests that instruction is affected by the professional culture of the school. Lee, Bryk, and Smith (1993) argue that the extent to which teachers assume responsibility for student outcomes is particularly important. Responsibility is not something that is easily mandated, because standardized methods for achieving results are largely unavailable. What schools can do instead is to identify problems and facilitate problem-solving initiatives among teachers. If teachers have influence over instructional decisions and opportunities to discuss issues with one another, then ideas about what works and what does not will be refined and practice will improve. To begin to assess these ideas, we included measures of (a) the principal's leadership in setting goals and obtaining resources, (b) the extent to which teachers have influence over instructional methods, (c) the extent of teacher influence over instructional content, (d) the extent to which teachers coordinate the content of their courses, and (e) the extent to which teachers discuss instructional content issues with other teachers. These five measures are scales constructed from multiple items which we grouped together on the basis of common factor analysis. The items used to construct these scales are described in Appendix B.3.

The regression results for mathematics are shown in Table 4.2. Although several statistically significant coefficients are evident in this table, the R^2 values indicate that the school variables coupled with the controls for individual background explain relatively little of the overall variability in any of the instruction variables. The geographic location variables show some significant effects, but no clear patterns are evident across the different outcomes, and there is little consistency between the results for mathematics and those for science. Among the students taking mathematics, students in the Northeast (the reference category) have significantly lower amounts of homework assigned and have significantly more time devoted to whole-class instruction. Neither set of results holds in science, though.

Table 4.2. Estimated effects of school variables on mathematics instruction variables, from OLS regressions: 1992

Independent Variables	Higher-order thinking	Emphasis: practical applictns	Emphasis: mechanical operations	Minutes/ day of homework assigned	Time devoted to whole-class	Time devoted to discipline
Urbanicity (vs. Suburb)						
Urban	0.08	0.03	-0.02	1.44	-2.95	2.65
Rural	-0.04	-0.01	-0.04	-1.73	-1.72	-0.11
Region (vs. Northwest)						
Midwest	0.02	-0.06	-0.00	4.83**	-6.87**	-0.58
South	0.07	0.12*	0.15**	2.74	-5.40*	0.54
West	-0.08	-0.00	-0.02	4.48**	-11.78**	1.79
Sector (vs. Public)						
Catholic	-0.03	-0.23*	-0.07	-0.07	14.67**	-1.92
NAIS	-0.12	-0.10	-0.27*	4.20	16.91**	-2.31
Other Private	-0.02	-0.20	-0.10	4.36	15.77**	1.71
% Students Receiving Federal Lunch (vs. 0-5%)						
6-20%	-0.02	0.01	0.04	-1.18	3.84*	0.37
21-50%	0.00	0.10	0.13**	-1.64	6.10**	0.40
51% +	0.14	-0.07	0.12	-0.54	10.17**	5.65
Number 12th Graders Enrolled in the School						
Ln(size)	-0.02	-0.09**	-0.03	-1.12	3.28**	0.04
Accountability of Principals for Achievement Outcomes						
Principal evaluated by test scores	0.04	0.02	0.00	0.93	-0.83	-1.37
Effective schools recognized (0-1)	-0.10*	-0.02	-0.00	1.37	0.26	1.14
Graduation Requirement						
Must pass math min. competency (0-1)	0.04	0.00	0.00	-0.38	4.53**	1.11
Years of math required	0.02	0.00	-0.00	-0.74	-2.77**	-0.45

Table 4.2. Estimated effects of school variables on mathematics instruction variables, from OLS regressions: 1992 (Continued)

Independent Variables	Higher-order thinking	Emphasis: practical applictns	Emphasis: mechanical operations	Minutes/ day of homework assigned	Time devoted to whole-class	Time devoted to discipline
School Organization Characteristics						
Principal's leadership	-0.07	0.02	0.02	0.79	-0.44	0.53
Teachers influence: methods	0.03	0.06	0.02	0.16	2.16	-1.13**
Teachers influence: curriculum	0.04**	0.03*	-0.00	0.49	0.68	-0.22
Teachers coordinate content	0.16**	0.10**	0.03	0.81	0.11	-0.65
Teachers discuss content	0.28**	0.24**	0.09*	2.46	0.05	0.20
R^2	.144	0.10	.049	.083	.076	.060
Sample Size	3,823	3,823	3,825	3,807	3,807	3,760

* p <= .05; ** p <= .01.

NOTE: All models include controls for individual student SES, race/ethnicity, and gender. See Appendix for full regression equations.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Research from the High School and Beyond survey found several indications of instructional differences between public and Catholic schools (Bryk, Lee, and Holland, 1993; Coleman and Hoffer, 1987). The general characterization that emerged was that Catholic high schools placed higher academic and disciplinary demands upon their students than public schools. Academic demands were measured by the numbers of academic courses the students completed and the amount of homework the students reported completing. Disciplinary demands were mainly measured by student reports of their own misbehavior, and teacher reports of the discipline climate in their schools. Neither set of measures thus referred to characteristics of specific courses or classes. What sorts of sector differences might one expect to find from the teacher-class reports in the NELS:88 data? Students in private schools can be expected to have teachers who assign more homework and spend less time on discipline. Emphasis on problem-solving and inquiry skills are also likely to be greater, reflecting the importance placed on academic rigor. The strong college-preparatory orientation of private schools may lead to lower emphases on practical applications. That orientation could also lead to more time devoted to whole-class instruction and less time on discussions and student presentations. The results in Table 4.2 give only limited support to these expectations, at least when one controls for student background and school organizational differences. Other things equal, students in the different types of private schools do not attend classes with greater emphasis on higher-order thinking skills, and are not assigned significantly more homework. School sector differences in mathematics instruction are found in the lower emphasis on practical applications in Catholic schools, and in the lower emphasis on mechanical skills in the NAIS schools. Students in all types of nonpublic schools receive more whole-class instruction in mathematics than students in public schools.

For a variety of reasons, one would expect schools that enroll larger numbers of low-income students to confront special instructional challenges and to show instructional differences from more advantaged schools. However, Table 4.2 shows that school SES composition as measured here (the principal's report of the percentage of students receiving reduced-price lunch) generally has little effect on seniors' mathematics instructional experiences. The main exception to this is that students in schools with the greatest concentrations of poor students have teachers who use whole-class instruction more.

School enrollment size, like school SES, has long been considered an important factor in school organization and climate. As discussed earlier, larger schools are usually considered to be more impersonal and less able to exert informal social control over students. As far as instruction is concerned, this could lead to less use of methods which require independent work by students, such as small group projects and homework. The results in Table 4.2 show that school size has no effect on homework, time devoted to maintaining discipline, or higher-order skills emphasis in math, but is negatively associated with emphases on practical applications. As might be predicted, students in larger schools receive relatively more whole-class instruction. These results thus give some support to the conception of larger schools as more formalized, but not to the view that they are also less demanding and more unruly.

The school organizational variables have several significant effects on the mathematics instruction variables. One notable exception is that the instructional experiences of math students whose teachers see the principal as a strong leader do not differ from math students whose teachers give the principal lower ratings.

The teacher influence over class content, the extent of coordination, and the extent of collegial discussions tend to be the strongest factors in predicting instructional differences in mathematics. All of these factors are positively associated with both an emphasis on higher-order thinking and on practical applications. In both cases, the strongest effect is from the extent of teacher discussions with colleagues about curriculum content issues. Greater collegial discussions also are associated with greater emphasis on computational skills.

The results of comparable regressions for the science instruction variables are shown in Table 4.3. The instructional experiences of urban, rural, and suburban (the reference) students significantly differ only on the teachers' emphasis on the role of science in society, which is greater in urban schools. Regional differences in science instruction show a few sizable differences on some instructional variables, but no clear pattern of advantage or disadvantage overall. Students in the Midwest and South experience a greater emphasis on learning facts and principles. Students in the West have teachers who make less use of computers as scientific research tools. Students in the South have teachers who make greater use of student presentations.

Table 4.3. Estimated effects of school variables on science instruction, from OLS regressions: 1992.

Independent Variables	Emphasis: inquiry learning	Emphasis: practical applictns	Emphasis: facts & principles	Minutes/day of homework assigned	Emphasis on lab work	Time devoted to whole-class	Time devoted to discipline	Frequency of using computers	Frequency of student oral reports
Urbanicity (vs. Suburban)									
Urban	0.07	0.21**	-0.01	1.34	-0.02	2.85	-1.14	-0.04	0.05
Rural	0.06	0.01	0.07	-0.27	0.03	-3.05	-0.48	-0.08	-0.02
Region (vs. Northeast)									
Midwest	-0.01	-0.05	0.27**	-1.96	-0.02	2.48	0.05	0.01	-0.04
South	0.11	0.10	0.23**	0.88	-0.05	4.10	0.33	-0.06	0.13*
West	-0.05	-0.03	0.03	0.01	-0.09	-2.58	0.03	-0.16*	0.08
Sector (vs. Public)									
Catholic	0.10	-0.13	0.17	-1.53	0.06	3.11	1.09	-0.12	-0.16
NAIS	0.24*	-0.36*	0.13	9.08	0.39**	5.02	-0.70	0.19	-0.12
Other private	0.10	-0.10	0.05	-1.74	-0.15	4.00	1.78	-0.25*	0.02
% Federal lunch (vs. 0-5%)									
6-20%	0.17**	0.13	0.08	-1.17	0.20**	-3.67	-0.39	0.07	0.00
21-50%	0.17**	0.18*	-0.01	-0.53	0.22*	-2.42	0.21	0.08	-0.06
51%+	0.17	0.08	-0.02	1.96	0.05	3.78	-0.98	0.06	-0.07
N. 12th Grade Students									
Ln(enrollment)	0.01	-0.05	0.03	-1.05	0.08*	-0.20	0.16	0.04	-0.05
School Accountability									
Evaluated by test scores	0.08*	-0.04	0.05	0.95	0.12**	-1.86	0.31	0.02	-0.05*
School recognition	-0.02	0.04	0.04	-2.25	0.00	1.64	0.93	-0.07	-0.10*
Grad Requirements									
Science min. competency	-0.02	0.09	0.07	2.06	-0.13	3.35	2.74*	-0.03	0.07
Science course units	-0.09**	0.01	0.06	-2.27**	-0.09*	0.19	0.66	-0.01	-0.01

Table 4.3. Estimated effects of school variables on science instruction, from OLS regressions: 1992. (Continued)

Independent Variables	Emphasis: inquiry learning	Emphasis: practical applictns	Emphasis: facts & principles	Minutes/day of homework assigned	Emphasis on lab work	Time devoted to whole-class	Time devoted to discipline	Frequency of using computers	Frequency of student oral reports
School Organization									
Principal's leadership	-0.08*	-0.10	-0.04	-2.32	-0.08	-2.38	-0.22	-0.04	0.01
Teacher influence: methods	0.06*	0.11*	0.01	0.83	0.02	3.38*	-0.94*	0.00	0.02
Teacher influence: curriculum	0.02	-0.00	0.01	0.52	0.04*	-0.10	0.74**	0.06**	0.00
Teacher coordination	0.04	0.15**	0.09	1.90	0.02	0.18	0.58	0.02	0.06
Teachers discuss content	0.17**	0.27**	-0.12	0.37	0.22**	-4.62*	-0.54	0.17**	0.22**
R^2	.102	.094	.044	.063	.094	.052	.055	.072	.074
Sample size	2,493	2,492	2,491	2,463	2,518	2,475	2,446	2,516	2,520

* p <= .05; ** p <= .01.

NOTE: All models include controls for individual student SES, race/ethnicity, and gender. See Appendix for full regression equations.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

NAIS school students tend to receive a greater emphasis on inquiry skills than public school students, and less emphasis on the role of science in everyday life. Catholic school students do not significantly differ from public school students on any of the science instructional measures. Other private students differ from public school students only in their lower use of computers.

The consequences of school SES differences (measured by the principal's report of the percentage of students receiving reduced-price lunches) for science instruction do not conform to what one might expect. Attending a poorer school does not appear to have a negative impact on instructional experiences as measured here, other things equal. The significant effects in Table 4.3, in fact, tend to show advantages for students in schools serving moderate (6 to 50%) percentages of poverty-level youth. The emphases on inquiry learning and lab work tend to be greater in schools with 6 to 50 percent of the students receiving federal lunch. The effects of SES on instruction that we saw in Chapter III appear to be largely differences among students within schools, rather than reflections of school-to-school differences arising from social class segregation.

School enrollment size has a significant effect only on the use of lab work, which may reflect an economy of scale, in that larger schools are able to provide laboratory space and resources for more classes because of the larger absolute numbers of students they enroll in senior-year science.

The school organizational variables also show mixed results in most cases. Students in schools where accountability mechanisms are tied to test performance might be expected to emphasize learning facts and principles, and downplay problem-solving and inquiry skills; spend more time in whole-class instructional settings; and have less time devoted to oral presentations. The reason for these predictions is that the tests typically used for accountability purposes tend to assess factual knowledge and routine applications rather than complex thinking and presentational skills (Madaus, et al., 1992; Glaser & Silver, 1994).

The results in Table 4.3 give mixed support for these predictions. Students in the schools where the principal is evaluated in part on student test scores actually experience greater emphasis on inquiry skills and had more time devoted to laboratories. However, these students also have fewer opportunities to give oral presentations in class.

One might also predict that higher graduation requirements for students would also lead teachers away from inquiry learning and labs, toward more routinized instruction, because they may be likely to confront students who are less interested in science, who are taking the classes in order to graduate. As shown in Table 4.1, senior-year science enrollments are strongly affected by school policy on the number of courses required for graduation, but not by the presence of minimum competency requirements. As predicted, students in schools with higher science graduation requirements do receive a lower emphasis on inquiry learning and lab work and have less homework assigned. Students in minimum competency schools significantly differ from nonminimum competency schools only in that students in the former have teachers who report spending more time on maintaining order. While these effects are not encouraging to advocates of these policies, it must be kept in mind that the net effects of the requirements may still be positive. Higher graduation requirements, for example, may lead to higher achievement because the positive effects of greater exposure to science offset the negative effects of lower instructional quality. The negative effects in Table 4.2 may be explained by students who would not otherwise take science as seniors being enrolled in lower-level classes. Further, what looks to some like "lower instructional quality" may prove more effective in raising scores on standardized tests than the methods recommended by progressive advocates.

The principal leadership measure is negatively associated with use of inquiry methods. The measure of teacher influence over instructional methods is positively related to the use of inquiry methods, emphasis on practical applications, and time devoted to whole-class instruction, and is negatively associated with the amount of time spent on discipline. These findings are complemented by the positive effect of greater teacher influence over instructional content on use of labs and computers, and the negative effect on time spent on discipline. This indicates that when teachers are free to implement what they judge best, they tend to adopt at least some practices that are consistent with reform recommendations. Weighing against this tendency is the lack of association of teacher influence and the use of student presentations.

Students whose teachers report more content-related discussions with other teachers tend to align more closely with reform recommendations. The strongest effects on science instruction tend to be associated with greater collegial discussions: the students whose teachers talk more with other teachers receive greater emphases on inquiry skill development, the role of science in society, and lab work. While their emphasis on facts and principles is not significantly lower, they spend less time in whole-class instructional settings and make much greater use of computers and student presentations.

Summary

This chapter has presented evidence of school effects both on the likelihood of taking mathematics and science and on the levels of the instructional variables in the NELS:88 data. School characteristics associated with higher probabilities that students take senior year mathematics and science include Catholic and NAIS affiliation and the number of years of science and math course-work required for graduation.

School characteristics are also consequential when one examines the instructional experiences of the students who enrolled in these courses. Some differences among urban, suburban, and rural schools and among schools from different regions are found for the instructional variables. These are curious, but further information on the underlying organizational differences which produce these results is needed before one should hazard interpreting them. The proportion of low-income students in the school is not clearly associated with instructional disadvantages along the lines examined here.

We found little evidence of instructional differences between students in public and Catholic high schools, but the analysis conducted here is not quite appropriate for estimating sector effects. This is because school sector may affect the school policy variables which were also included in the regression equations. Further work that separated the analyses (as was done in Table 4.1) is thus needed to see whether sector effects on these aspects of instruction are present.

The school characteristics that have the greatest effects on instruction are the organizational variables of teacher influence, coordination, and informational exchange. In both subjects, the evidence presented here indicates that stronger professional cultures lead to instruction that is closer to the ideals of the current reform movements in mathematics and science. These findings support the contentions of the professional associations that workplace conditions in the schools are key factors in the implementation of reform proposals (NCTM, 1991).

Chapter V
Instruction and Student Achievement

Thus far we have seen that instruction differences are related to student background, school characteristics, and the achievement levels of the classes. The backdrop for all of these analyses, however, was an assumption that differences in instructional experiences make a difference in students' educational outcomes. Most important of these from a public policy standpoint is the academic achievement of the seniors. This chapter returns to our original question, presenting an analysis of the relationships of instructional variables with standardized measures of student achievement in science and mathematics.

The NELS:88 Achievement Tests

During the base year, first follow-up, and second follow-up surveys, the NELS:88 study administered achievement tests in science, mathematics, reading comprehension, and social studies (history, civics, and geography). The students' responses were scored to create overall achievement scales in each subject, as well as a set of proficiency measures. The latter were defined in terms of classes of skills ranging from simple recall of definitions to complex problem-solving and deductive inference. The analyses presented in this chapter use both the overall, or "composite," measures and the proficiency measures for mathematics and science.

The NELS:88 project followed a strategy of adaptive testing in order to produce achievement scores that would satisfy two objectives: (a) measuring student cognitive growth over the 1988-to-1992 time span, and (b) minimizing "floor" and "ceiling" effects in the tests (see Rock & Pollack, 1995, for a comprehensive description of the NELS:88 testing program). In mathematics, this involved administering tests with three levels of difficulty during the 1990 and 1992 follow-up. Students were assigned to one of the three levels based on their level of performance on the previous cycle test. In science, NELS:88 used only grade-level adaptive testing, varying the items from cycle to cycle but not using multiple forms within years. By adapting the tests in this way, NELS:88 was able to obtain more accurate assessments of the students' achievement levels and growth curves than if a single form had been used.

The composite measures of mathematics and science achievement were constructed with Item Response Theory (IRT) methods. This methodology allows one to combine information from multiple forms, when the different forms contain subsets of common items. While the metric of the scores could be defined in several different ways, NELS:88 settled on the use of an "estimated number of items correct" scale for the composite scores. The scores on this metric represent IRT-derived estimates of how many of the total number of items NELS:88 administered across all three cycles that each student would have answered correctly, had he or she taken all the items at each cycle. This number must be estimated because the adaptive testing program involved having the students take at each time point only a subset of all the items used in the project.

The proficiency subscales were developed to allow researchers to focus on more specific skills within the larger domains of mathematics, science, and reading comprehension. The subscales in mathematics and science are described in the NELS:88 codebook (Ingels, et al., 1994, p. H-34) as follows:

Math Level 1: Simple arithmetical operations on whole numbers; essentially single step operations which rely on rote memory.

Math Level 2: Simple operations with decimals, fractions, powers, and roots.

Math Level 3: Simple problem solving, requiring the understanding of low level mathematical concepts.

Math Level 4: Understanding of intermediate level mathematical concepts and/or having the ability to formulate multi-step solutions to word problems.

Math Level 5: Proficiency in solving complex multi-step word problems and/or the ability to demonstrate knowledge of mathematics material found in advanced mathematics courses.

Science Level 1: Understanding of everyday science concepts; "common knowledge" that can be acquired in everyday life.

Science Level 2: Understanding of fundamental science concepts upon which more complex science knowledge can be built.

Science Level 3: Understanding of relatively complex scientific concepts; typically requiring an additional problem solving step.

The math and science test items were grouped into sets corresponding to each level, and proficiency scores were calculated based on the response patterns. The proficiency measures we use are probabilities of mastery of each of these levels. It turns out that there was virtually no change from 10th to 12th grade on the proficiency at level 1, where nearly all students had attained proficiency by 10th grade, and at level 5, where virtually none were proficient as sophomores or seniors.

Proficiency scores are available in two metrics. One is a dichotomous indicator of whether or not the student crossed the proficiency threshold, where the threshold is defined as correctly answering 75 percent or better of the skill-area items. The other metric is a continuous "probability of proficiency" which ranges from zero to one and indicates how likely the student was to attain the proficiency threshold for the skill area in question. The regression analyses presented in Tables 5.5 and 5.6 use the probabilities of proficiency as the dependent variables.

Research Questions and Analytic Strategy

The strategy we follow involves three different analyses. The first analysis estimates the effects of the instructional variables on the composite achievement scores for all students. This gives a picture of the average impact of the instructional variables, but does not assess whether the effects are the same for all students. Returning to the research questions set forth in Chapter I, it is important to assess whether particular kinds of instruction are especially helpful for some students but not for others. In the second analysis, we address this issue by estimating separate equations for students who had attained different levels of mastery in the 10th grade. The third analysis also assesses whether the relationships of instructional variables with achievement differ, but extends the inquiry by asking whether the effects also depend on the level of the achievement outcomes.

The method we use for these analyses is again ordinary least squares regression analysis. The regression equations include measures of student background and school characteristics that are associated with instructional variables and achievement, and thus help rule out some alternative explanations of whatever associations between instruction and learning we might discover. The regressions also control for the student's 1990 level of achievement. This means that the dependent variable is really the amount of change in achievement from 1990 to 1992, and that the coefficients for the independent variables should be interpreted as the amount of change in achievement over the two year span that is associated with a unit change on the respective independent variable.

These analyses have limitations which should be noted from the outset. The main problem we face in drawing conclusions about the effects of the instructional variables is that the time span covered by the change in NELS:88 achievement test scores is two years (from sophomore to senior year), while the time span covered by the instructional variables is only the senior year. Since we do not know what instructional experiences, if any, the students had in 11th grade science and mathematics, we are measuring the students' instructional experiences with some error, the magnitude of which is unknown. In general, though, measurement error of this type results in underestimates of the effects of the error-prone variables.

In this light, the best strategy is to downplay the importance of statistically insignificant results and look instead for any large (positive or negative) effects. With the proper statistical controls for differences among students' social and academic backgrounds, we can have more confidence in the validity of significant effects than of insignificant ones.

Instruction and Overall Achievement Growth

To assess the overall effects of the instruction variables on achievement growth, we estimated three OLS regressions for the composite measures of achievement in math and science. The first model regresses the 12th grade achievement score on the comparable tenth-grade achievement score plus the measures of social background, school demographic characteristics, and the achievement level of the student's senior year class. The second model adds the teacher education indicators to the set used in Model 1. The results indicate the extent to which differences in teacher background mediate the effects of ability group placement and independently contribute to learning differences within ability groups. The third model adds the instruction variables, giving estimates of the independent effects of instructional differences on achievement growth.[8]

The regression results for the overall mathematics scores are presented in Table 5.1. The estimates for Model 1 indicate strong effects of the achievement level of the students' classes on their growth from 10th to 12th grade. Controlling for social background, school characteristics, and 10th grade level of achievement, students in AP classes learned the equivalent of about 2.7 test items more than their average group counterparts. Remedial-level students, in contrast, learned about 3.1 items less. How large are these differences? One widely-used standard is to express the effects as fractions of the test's standard deviation; this is referred to as an "effect size" (e.s.) metric. Researchers typically consider "treatment" (i.e., exposure versus nonexposure to some influence) effect sizes of .10 or greater to be substantively important. The standard deviation of the composite math test in the 1992 NELS:88 administration is 13.4,

[8] The sample used in the regressions presented in this chapter consist of students with complete data on all of the variables used in the analysis. Since the seniors that were added to the NELS:88 study in 1992 (the 264 "freshened" cases referred to in Appendix B) do not have 1990 test scores, they are excluded from the analysis. This technically means that the sample is not fully representative of the 1992 seniors. As a practical matter, though, the loss of these cases is a relatively small proportion of the total attrition from missing data. Of the nearly 5,700 math students with 1992 teacher data, some 4,100 have complete data and are included in the analysis. In science, about 2,600 of the 3,850 science students with 1992 teacher data have complete data on all the variables in the analysis. See Appendix Table A1.2 and A1.3 for descriptive statistics on variables used in the analyses of this chapter.

and the effect sizes thus range from -.23 for the remedial versus average contrast to .09 for the above-average versus average group comparison.

Table 5.1. **Effects of Class Achievement Level, Teacher Education, and Instructional Variables on Sophomore-to-Senior Achievement Growth in Mathematics, from OLS Regressions: 1992.**

Independent Variables	Model 1		Model 2		Model 3	
	b	s.e.	b	s.e.	b	s.e.
Class Achievement Level (vs. average)						
AP	2.718**	0.607	2.739**	0.630	2.438**	0.733
Above Average	1.161**	0.344	1.148**	0.364	0.934**	0.377
Low	-1.656**	0.428	-1.569**	0.441	-1.157**	0.469
Remedial	-3.129**	0.708	-3.018**	0.750	-2.509**	0.776
Teacher Education (vs. major in field)						
College & graduate major			0.156	0.357	0.121	0.356
Major and minor			-0.514	0.390	-0.611	0.405
Minor only			-0.461	0.375	-0.435	0.376
No major or minor			-1.528**	0.457	-1.155**	0.439
Instructional Variables						
% class time spent in whole group instruction					0.125	0.170
% class time spent maintaining order					-0.405**	0.157
Minutes/day of homework assigned					0.013	0.010
Emphasis on higher-order thinking skills					0.732**	0.248
Emphasis on practical skills					-0.594*	0.272
Emphasis on mechanical skills					0.041	0.259
R^2	0.86		0.86		0.86	

* p <= .05; ** p <= .01

NOTE: All models include controls for individual and school SES, race/ethnicity, gender, sophomore math achievement, school urbanicity, region of the country, and school sector. See Appendix D for full regression equations.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

The effects of class group placement are not much reduced when the indicators of teacher education are introduced in Model 2. The only significant teacher education effect is for students who had teachers with neither a major nor a minor in mathematics. These students learned substantially less (b=-1.53, e.s.=-.12) than the reference group, whose teachers had a major but no additional major or minor specializations in math.

Measures of instructional variables are added to the regression equation in Model 3. The explanatory power of the model (indexed by R^2) does not perceptibly improve with the addition of these variables, though several show significant effects on achievement growth. Three of the variables—the percent of class time devoted to whole-group instruction, the amount of homework assigned each day, and the amount of emphasis the teacher gives to developing mechanical skills—have no effects on achievement growth. The effects of the other variables are in the expected directions. To gain a sense of the relative strength of these effects, one can multiply the coefficients by the standard deviation of the variable, and divide the product by the standard deviation of the 12th grade math test; this gives standardized effect size estimates. The largest effects of this set are the positive effect of emphasizing higher-order thinking skills (e.s.=.05) and the negative effects of maintaining order (e.s.=-.03) and emphasizing the importance of mathematics in everyday life (e.s.=-.04). None of these effects is large, but it must be remembered that the errors of measurement associated with using only the senior year instruction variables for the two-year growth analysis are likely to result in a downward bias. The true effects may be larger than these estimates.

Table 5.2 summarizes the regressions of overall science achievement. The results for Model 1 show large effects of the class-achievement level. As the standard deviation of the 1992 science test is 6.1 items, the regression coefficients represent effect sizes of .18 for the AP, .15 for above-average, and -.13 for below-average groups. The addition of the teacher education indicators in Model 2 does not significantly reduce the effects of class-achievement level, and none of the teacher education indicators has a significant effect on achievement growth in science.

Table 5.2. Estimated Effects of Class Achievement Level, Teacher Education, and Instructional Variables on Sophomore-to-Senior Achievement Growth in Science, from OLS Regressions: 1992.

Independent Variables	Model 1		Model 2		Model 3	
	b	s.e.	b	s.e.	b	s.e.
Class Achievement Level (vs. average)						
AP	1.092**	0.347	.993**	0.378	.770*	0.423
Above Average	.917**	0.211	.900**	0.220	.913**	0.221
Low	-.813*	0.377	-.749*	0.393	-0.524	0.419
Teacher Education (vs. major in field)						
College & graduate major			0.484	0.304	0.371	0.268
Major and minor			0.122	0.296	0.239	0.300
Minor only			0.032	0.267	0.006	0.259
No major minor			-0.092	0.272	-0.064	0.313
Instructional Variables						
% class time spent in whole group instruction					0.054	0.095
% class time spent maintaining order					-0.009	0.152
Minutes/day of homework assigned					0.002	0.007
Emphasis on lab use					-0.020	0.175
Emphasis on inquiry skills					0.246	0.221
Emphasis on practical skills					-0.351**	0.146
Emphasis on scientific facts					0.063	0.135
R^2		0.67		0.67		0.68

* p <= .05; ** p <= .01

NOTE: All models include controls for individual and school SES, race/ethnicity, gender, sophomore science achievement, school urbanicity, region of the country, and school sector. See Appendix D for full regression equations.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

The addition of the instruction variables adds virtually no explanatory power to the science achievement model. The only variable with a significant effect is the teacher-reported emphasis on the role of science in everyday life. At face value, this suggests that students whose teachers opt for greater emphasis in this area are learning less of what the NELS:88 tests measure.

Effects of Instructional Variables for High- and Low-Achieving Students

The effects of the instructional variables on learning may not be the same for all students. As we have noted at various points in this report, teachers may use different methods for different classes because they believe the effectiveness of a particular method depends on the level of the class. For example, an emphasis on higher-order thinking may work well among college-oriented, highly motivated students, but may fail with students mainly interested in completing a graduation requirement.

To assess whether the instructional variables have variable effects on the composite achievement scores, we re-estimated the regressions presented in Tables 5.1 and 5.2 separately for three groups of students: those who scored in the lowest quartile as sophomores, those in the middle two quartiles, and those in the highest quartile. One could divide up the sample in other ways; for example, by the achievement level of the class, or student SES levels, race-ethnicity, or gender. We selected the grade 10 achievement levels because the theoretical rationales for varying curriculum according to the students' initial achievement levels are the most compelling. Many teachers and parents believe that instructional approaches are appropriately varied by the achievement level of the students; few would argue that instruction should be modified on the basis of SES, racial-ethnic, or gender differences among classes.

The results of this analysis are presented in Tables 5.3 and 5.4. While the statistical significance of the estimates is lower due to the smaller sample sizes, the pattern of effects tends to be consistent with the overall patterns seen in Tables 5.1 and 5.2. In mathematics, significant positive effects are found in all three groups for being in an above-average or AP-level class. A significant positive effect of the emphasis on developing higher-order thinking skills is only found for students in the middle two quartiles, but the signs and magnitudes of the coefficients in the other quartiles are consistent with the overall estimates. Significant negative effects are found for the time devoted to maintaining order in all but the highest quartile and a greater emphasis on showing the relevance of mathematics in the lowest quartile.

Table 5.3. Estimated effects of class-achievement level, teacher, and instruction variables on grade 12 composite mathematics achievement, by grade 10 composite science achievement quartile, from OLS regressions: 1992.

Subsample:	grade 10 achievement quartile 1 (lowest)		grade 10 ach. quartile 2 & 3 (middle)		grade 10 achievement quartile 4 (highest)	
	Coef	SE	Coef	SE	Coef	SE
Achievement Level (vs. average)						
AP	3.387**	1.288	5.713*	2.416	3.568**	0.641
Above Average	2.128**	0.803	1.007*	0.491	1.221**	0.438
Low	-0.761	0.552	-0.930	0.626	-0.129	1.010
Remedial	-1.392	0.832	-2.346	1.250	-3.648**	1.148
Teacher Education (vs. major in field)						
College & graduate major	0.559	0.924	0.242	0.508	-0.022	0.406
Major and minor	0.559	0.983	-0.696	0.570	-0.591	0.418
Minor only	-0.534	0.646	-0.322	0.450	-0.475	0.572
No major or minor	-0.277	0.653	-1.511**	0.586	-0.820	0.604
Instructional Variables						
% class time spent in whole group instruction	0.098	0.245	0.254	0.255	0.008	0.162
% class time spent maintaining order	-0.442*	0.206	-0.504*	0.200	-0.084	0.197
Minutes/day of homework assigned	0.028	.017	.018	.014	-0.000	0.010
Emphasis on higher-order thinking skills	0.409	0.429	0.737*	0.325	0.703	0.389
Emphasis on practical skills	-1.006*	0.514	-0.548	0.347	-0.330	0.270
Emphasis on mechanical skills	-0.069	0.469	-0.089	0.361	0.034	0.302
R^2	.39		.58		.47	
Sample Size	536		2,009		1,565	

* p <= .05; ** p <= .01

NOTE: All models include controls for individual and school SES, race/ethnicity, gender, sophomore math achievement, school urbanicity, region of the country, and school sector. See Appendix D for full regression equations.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table 5.4. Estimated effects of achievement level, teacher, and instruction variables on composite grade 12 science achievement, by grade 10 composite science achievement quartile, from OLS regressions: 1992.

Subsample:	grade 10 achievement quartile 1 (lowest)		grade 10 ach. quartiles 2 & 3 (middle)		grade 10 achievement quartile 4 (highest)	
	Coef	SE	Coef	SE	Coef	SE
Class Achievement Level (vs. average)						
AP	0.431	1.267	1.075*	0.513	0.867	0.537
Above Average	0.998	0.646	0.983**	0.302	0.622*	0.315
Low	0.696	0.840	-0.660	0.400	-1.986**	0.761
Teacher Education (vs. major in field)						
College & graduate major	0.196	0.701	0.772**	0.311	0.190	0.375
Major and minor	2.243**	0.775	-0.084	0.421	0.413	0.352
Minor only	0.147	0.713	-0.367	0.325	0.664	0.385
No major or minor	0.285	0.755	0.047	0.440	0.272	0.546
Instructional Variables						
% class time spent in whole group instruction	0.124	0.226	-0.095	0.131	0.134	0.115
% class time spent maintaining order	-0.345	0.300	0.004	0.173	0.217	0.217
Minutes/day of homework assigned	0.037**	0.012	0.004	0.008	-0.005	0.010
Minutes/week of lab	-0.003	0.362	-0.157	0.231	-0.029	0.258
Emphasis on inquiry skills	0.608	0.558	-0.117	0.335	0.485	0.306
Emphasis on practical skills	-0.391	0.444	-0.510**	0.192	-0.078	0.185
Emphasis on learning & memorizing facts, principals, & rules	0.566	0.342	-0.025	0.180	0.020	0.181
Frequency of computer use	-0.373	0.298	0.107	0.224	0.425	0.244
Frequency of student presentations	0.035	0.447	0.355	0.239	-0.312	0.236
R^2	.34		.44		.23	
Sample Size	309		1,224		1,086	

* $p <= .05$; ** $p <= .01$

NOTE: All models include controls for individual and school SES, race/ethnicity, gender, sophomore science achievement, school urbanicity, region of the country, and school sector. See Appendix for full regression equations.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

The effects of the instructional variables on science achievement gains shown in Table 5.4 are again weaker, but are also consistent with the findings of the full-sample analysis. Significant positive effects of AP and above-average class placements are apparent for the middle and upper quartile students, and students who scored high as sophomores but who enroll in low-level senior science courses learn significantly less than students enrolled in average-level classes.

One variable which shows a significant effect in Table 5.4 but not in Table 5.2 is the amount of homework assigned. In Table 5.4, students who scored in the lowest quartile as sophomores score higher as seniors if they are assigned (and presumably do) more homework.

Analysis of Proficiency Gains by Sophomore Achievement Levels

The overall mathematics and science achievement scores summarize a number of different performances and are analogous to combined scores in sports like figure skating. Some of the items on the NELS:88 tests measure students' abilities to recall facts or perform simple calculations, while other items require relatively complex reasoning to answer correctly. It stands to reason that the different instructional experiences we have examined may have different effects depending on which type of performance one assesses.[9]

A problem in following this reasoning, however, is that some students had already mastered one or more of the NELS:88 proficiency levels by the time they were sophomores. It would not be very informative to estimate the effects of instruction on skills that were already mastered. This implies that the samples should be restricted to students for whom the different proficiency scales are appropriate. How to decide what is appropriate? One strategy is to match the tests with class-achievement levels in some fashion. We might, for example, restrict the analysis of level 2 proficiency to remedial and below-average level students. A problem with this method is that the matching is necessarily based on certain normative criteria, since it in effect assumes what are appropriate goals for different groups. Some lower-level classes may pursue higher-level goals, and vice versa, but these would be arbitrarily excluded from that analysis. A strength of the method, though, is that the analyses are restricted to subsamples which correspond to conventional institutional categories ("remedial," "average group," "AP").

A less arbitrary strategy is to base the sample restriction on prior test performance. In addition to the probability of proficiency scores, the students were also coded into dichotomous "proficient /not proficient" categories when they were sophomores. Students were coded as proficient if they correctly answered the equivalent of 3 out of 4 items within a given proficiency level item set. For each proficiency level outcome, then, we can restrict the sample used in the regression to those students who were not proficient as sophomores. A deficiency of this method is that the subsamples thus generated do not correspond to clearly identifiable institutional categories, and the practical implications are thus somewhat murky.

Table 5.5 summarizes the results of this analysis for mathematics. The columns of this table list the regression coefficients and standard errors for equations estimated for each of five mutually exclusive groups of students, categorized on the basis of their sophomore test results: (1) those who had not attained

[9] The articles by Kupermintz, et al. (in press) and Hamilton, et al. (in press) re-analyze the NELS:88 first follow-up test items and develop somewhat different subscales than the public-use file scales. They also analyze the relationships of instructional variables with achievement outcomes on the various tests they develop.

proficiency level 1 as sophomores; (2) those who had attained level 1 but not level 2; (3) those who had attained level 2 but not 3; (4) those who had attained level 3 but not level 4; and (5) those who had attained level 4 but not 5. The dependent variable for group (1) is the probability of proficiency at level 1; for group 2, the probability of proficiency at level 2; for group 3, the probability of proficiency at level 3; and so on.

Table 5.5. **Estimated effects of achievement level, teacher, and instruction variables on the probability of proficiency at different levels[a] of grade 12 mathematics: 1992.**

Dependent Variable:	Probability of Profic.: Level 1		Probability of Profic.: Level 2		Probability of Profic.: Level 3		Probability of Profic.: Level 4		Probability of Profic.: Level 5	
Subsample:	Grade 10 profic.<Level 1 (lowest)		Grade 10 profic.=Level 1		Grade 10 profic.=Level 2		Grade 10 profic.=Level 3		Grade 10 profic.=Level 4	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Class Achievement Level (vs. average)										
AP	--	--	28.323**	6.739	-7.786	11.949	12.555**	4.330	20.701**	2.125
Above Average	8.298**	2.688	3.112	3.540	.652	5.228	5.975*	2.610	5.704**	1.114
Low	-6.404*	3.120	-7.036	3.723	-15.869**	5.709	-6.115	4.635	2.775	3.050
Remedial	-17.839**	5.291	-15.053**	6.034	-20.669**	7.732	-2.729	10.393	4.797	3.963
Teacher Education (vs. major in field)										
College & graduate major	-.013	4.322	4.620	3.886	-6.509	4.792	1.802	3.524	1.124	1.606
Major & minor	4.419	3.302	-.184	5.121	-3.510	6.600	-4.703*	3.142	-4.385**	1.721
Minor only	2.277	3.599	0.033	3.873	-2.335	4.103	-3.289	2.275	-1.121	1.837
No major or minor	0.667	3.276	-1.342	4.792	5.821	6.457	-11.722**	3.763	-6.098	4.383
Instructional Variables										
% class time spent in whole group instruction	-.019	1.287	1.372	1.703	-4.748*	2.273	.515	1.522	2.010*	.934
% class time spent maintaining order	1.276	1.500	-2.789*	1.374	-2.338	2.253	.600	1.357	-2.814**	.726
Minutes/day of homework assigned	-.161*	.080	.120	.086	.406**	.141	.000	.082	-.045	.035
Emphasis on higher-order thinking skills	4.723*	2.415	0.225	2.858	7.423*	3.252	9.201**	2.236	-.602	1.325

Table 5.5. Estimated effects of achievement level, teacher, and instruction variables on the probability of proficiency at different levels[a] of grade 12 mathematics: 1992. (Continued)

Dependent Variable:	Probability of Profic.: Level 1		Probability of Profic.: Level 2		Probability of Profic.: Level 3		Probability of Profic.: Level 4		Probability of Profic.: Level 5	
Subsample:	Grade 10 profic.<Level 1 (lowest)		Grade 10 profic.=Level 1		Grade 10 profic.=Level 2		Grade 10 profic.=Level 3		Grade 10 profic.=Level 4	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Instructional Variables (cont'd)										
Emphasis on practical skills	-4.359*	2.207	-5.695*	2.853	-4.517	3.286	-4.774*	1.975	.252	1.124
Emphasis on mechanical skills	-3.806	2.675	-.948	2.962	3.166	3.419	-1.501	2.529	-1.519	1.300
R^2	.57		.50		.42		.53		.50	
Sample Size	367		656		506		1,066		1,152	

* p <= .05; ** p <= .01

[a] The levels of proficiency are described in the text of Chapter 5.

NOTE: All models include controls for individual and school SES, race/ethnicity, gender, sophomore math achievement, school urbanicity, region of the country, and school sector. See Appendix D for full regression equations.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table 5.6. Estimated effects of achievement level, teacher, and instruction variables on the probability of proficiency at different levels[a] of grade 12 science: 1992.

Dependent Variable:	Probability of Proficiency: Level 1		Probability of Proficiency: Level 2		Probability of Proficiency: Level 3		Probability of Proficiency: Level 4	
Subsample:	Grade 10 profic.<Level 1		Grade 10 profic.=Level 1		Grade 10 profic.=Level 2		Grade 10 profic.=Level 3	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Class Achievement Level (vs. average)								
AP	-3.059	11.218	9.473	6.637	16.756**	5.475	13.132*	5.876
Above Average	3.045	6.052	10.969**	3.062	7.613*	3.685	10.302*	4.764
Low	-1.386	6.912	-7.539*	3.610	-9.205	6.935	-19.509*	9.995
Teacher Education (vs. major in field)								
College & graduate major	5.609	6.542	2.906	3.336	2.569	3.482	5.496	3.596
Major & minor	13.435	7.267	-1.001	4.170	6.700	5.311	-.021	4.390
Minor only	-4.380	6.546	-5.213	3.382	-1.259	4.756	8.940	5.063
No major or minor	-9.088	10.625	-2.338	4.007	-.253	5.126	-4.288	8.092
Instructional Variables								
% class time spent in whole group instruction	5.186*	2.379	1.030	1.273	-1.806	1.558	.136	2.153
% class time spent maintaining order	-.350	3.122	-.253	1.744	-.027	1.941	3.680	2.311
Minutes/day of homework assigned	.176	.110	-.007	.080	.005	.066	-.168	.144
Minutes/week of lab	-.461	4.566	-.659	2.288	-1.879	2.615	-1.586	3.364
Emphasis on inquiry skills	7.349	5.979	2.650	3.045	6.346	3.686	4.878	4.256
Emphasis on practical skills	1.768	4.111	-2.578	1.932	-9.085**	2.128	1.868	2.278

Table 5.6. **Estimated effects of achievement level, teacher, and instruction variables on the probability of proficiency at different levels[a] of grade 12 science: 1992. (Continued)**

Dependent Variable:	**Probability of Proficiency: Level 1**		**Probability of Proficiency: Level 2**		**Probability of Proficiency: Level 3**		**Probability of Proficiency: Level 4**	
Subsample:	**Grade 10 profic.<Level 1**		**Grade 10 profic.=Level 1**		**Grade 10 profic.=Level 2**		**Grade 10 profic.=Level 3**	
	Coef	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Instructional Variables (cont'd)								
Emphasis on learning & memorizing facts, principals, & rules	1.349	3.256	-.574	1.664	-3.670	2.255	.732	2.211
Frequency of computer use	-4.033	4.117	-1.650	2.377	1.695	2.709	5.161	3.043
Frequency of student presentations	-6.077	5.415	4.290	2.396	-1.698	3.007	3.899	3.169
R^2	.46		.48		.33		.36	
Sample Size	283		684		821		572	

* p <= .05; ** p <= .01

[a] The levels of proficiency are described in the text of Chapter 5.

NOTE: All models include controls for individual and school SES, race/ethnicity, gender, sophomore science achievement, school urbanicity, region of the country, and school sector. See Appendix D for full regression equations.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

The question we are trying to answer is whether the class and instructional variables have the same effects for students at different starting points. The answer, predictably, is that some do and some don't; but a number of interesting relationships are apparent. One is that the class achievement level makes a big difference at all levels where there are enough sampled students to make solid comparisons. Students in remedial and low-ability classes generally are less likely to reach the next proficiency level than otherwise comparable students in classes where the average achievement level matches that of the school as a whole. Conversely, students in above-average and AP classes generally are more likely to advance to the next proficiency level than otherwise comparable students in average-level classes.

A second generalization is that teacher educational credentials are not good predictors of student success. We see some evidence that students whose teachers have no formal training in mathematics advance less. But whether a teacher has just a math minor as opposed to an undergraduate major or a graduate degree specialization seems to be inconsequential.

Third, the instructional variables show few robust relations with achievement growth. Teachers who devote more time to whole-class instruction realize higher level-5 achievement among the top students, but students at lower levels do not seem to benefit from it. Heavier homework assignments are associated with greater success among middle-level students but not the rest. Greater emphasis on problem-solving has a significantly positive relation with learning at levels 1, 3 and 4. Greater emphasis on the significance of mathematics for everyday life is negatively associated with achievement for students starting below achievement levels 1, 2, and 4. Finally, greater emphasis on mechanical operations does not seem to help achievement even at the simplest level among the lowest achievers.

Table 5.6 shows the results of the comparable analysis for science. The class achievement levels are not as closely tied to learning across the different levels in science. Students in below-average classes learn significantly less than average students who started at proficiency levels 1 or 3. Above average students show much higher growth than average-class students who started at proficiency levels 1, 2, or 3. Large positive effects of AP class enrollment are found for students who started at proficiency levels 2 or 3. The teacher credential effects on growth are erratic and insignificant.

The effects of the science instructional variables again prove to be almost uniformly negligible. The only exception to this is the large negative effect the "science and society" emphasis has on level 3 growth for the students who were the highest achievers as sophomores.

Summary

This chapter addressed the issue of whether the differences in students' instructional experiences we have documented are related to learning outcomes in mathematics and science. We approached this problem in three ways. The first approach looked for effects of instructional differences on summary scores of mathematics and science achievement. The second examined whether the instructional variables have different effects depending on the students' initial levels of achievement. The third assessed whether the effects of instructional variables depend on the kinds of skills one examines within the domains of math and science.

The strongest effects that emerge from the analysis are those associated with the students' class compositions, which we have referred to as their class achievement levels. Here we find that students in a higher achievement level class gained much more over the two year period on the NELS:88 math and science test scores than otherwise comparable students in lower achievement level classes. The results are more consistent in mathematics, but present in science as well.

Several of the instructional measures we examined for mathematics show significant associations with learning. Controlling for sophomore achievement level, social background, school characteristics, achievement level, and teacher credentials, we still find that students whose teachers place greater emphasis on higher-order skills and lower emphasis on practical applications tend to score higher on NELS:88 tests. Higher levels of homework assignments are also beneficial, though the benefits appear to be confined to average-level students and in the domain of simple problem solving ("level 3" in the NELS:88 math hierarchy). Finally, students lose when their teachers have to spend more time maintaining order in the class. The problem of order and the benefits of maintaining it are not confined to lower-achieving students in the lower-level classes. When high-achievers are in classes where order is problematic, their achievement is also lower.

The results from our analysis of science are not as strong as for math. While class-achievement level effects are again evident, the instructional variables do not show much connection with the variability in sophomore-to-senior achievement growth. The exception to this is the negative effect of greater emphasis on the role of science in society. The significance of this finding is unclear, though. We suspect that many of the teachers who pursue this emphasis do so in the interest of attracting students to their classes and engaging them once there. De-emphasizing the everyday ramifications of science may thus lead not to higher achievement, but to lower enrollments in senior science. Resolution of the ambiguity around this finding requires taking better account of the role of student interest and choice in enrollment decisions and the allocation of effort among those enrolled.

Chapter VI
Conclusions

This report has addressed two general questions, both of which have a number of facets. At this point, it is useful to return to the original questions, summarize the main findings, draw out what we see as the main implications, and suggest some avenues for further research.

Summary and Implications

(1) How equal are instructional opportunities, and what are the sources of inequalities?

A primary purpose of this report was to gain a better understanding of how and why high school mathematics and science classes differ along a number of dimensions that educational theorists and policy makers believe are important to student learning. We have conceptualized the main dimensions represented by the NELS:88 items as the content, the quantity, and the methods of instruction. The instruction students receive varies on each of these dimensions, so we first asked under what circumstances the differences arise, and examined three general hypotheses. The first is that students' instructional experiences vary according to the achievement levels of their math and science classes. The second hypothesis was that instructional experiences differ because of the social backgrounds of the students. The third hypothesis was that instruction differs because of school-level factors.

(a) Are students' instructional experiences associated with the achievement level of their classes?

The first point to emphasize is that many students do not take mathematics and science in their last year of high school: 34 percent did not take math and 52 percent did not take science. The seniors who take math and science are not enrolled strictly in advanced courses (see Table 1.1). About half of the enrolled mathematics students are in an advanced course (trigonometry, statistics, pre-calculus, or calculus), while 28 percent of the math enrollees are in algebra 1, applied, or basic math classes. In science, 56 percent of the enrollees are in regular physics, a specialized or interdisciplinary science offering, or an advanced-level biology, chemistry, or physics course. About 31 percent were at the other pole, enrolled in biology 1 or a basic-level (usually non-lab) science.

What about the content and conduct of these classes? Since the specific topic inventories of the NELS:88 survey were defined in terms that, for the most part, did not discriminate very much (see Tables 1.2 to 1.5), we focused instead on the teachers' reports of their emphases. The three main variables we examined were the emphasis on "higher-order" skills, learning facts, and learning about practical applications. Conduct of classes was also measured from teacher reports. The main dimensions are the use of lectures and whole-class instruction, small groups or student teams, student presentations, homework assignments, and time devoted to maintaining order. In science, we also considered the use of laboratories and computers.

The results from Chapter II showed that several of the content and conduct variables are correlated with the achievement level of the seniors' classes. Higher-order thinking and inquiry skills receive greater emphasis in the higher-level classes, while the teachers' emphasis on the importance of math and science in everyday life is lower in the higher classes. The teachers' emphasis on memorizing scientific facts is also lower in the higher-level classes.

The conduct of the classes is also associated with the achievement levels of the classes. Higher-level students have more homework assigned each day and spend more time in science laboratory sessions than their lower-level counterparts. Higher-level classes also use whole-class instruction more than lower-level classes, and spend less time maintaining order. Use of computers, cooperative groups, and student presentations show at most very small differences between higher- and lower-level classes.

It is important to note that, on most measures, we do not find strong evidence that students in lower-level classes are on average receiving markedly inferior instruction in either science or mathematics. The instructional experiences of students in lower-level classes seem to be of most concern with respect to the emphasis on higher-order thinking in both subjects, and laboratory work in science. Altering these inequalities may prove difficult, in light of the evidence that discipline and order tend to be more of an issue in lower-level classes.

From the perspective of reform recommendations, even the highest-level classes are problematic in some respects. Students rarely are asked to make presentations to the class, and use of cooperative groups is not a prominent part of most classes. Instruction tends instead to follow the traditional model of the teacher lecturing and asking questions to the whole group.

(b) What sorts of relationships can be found between student social background and the kinds of instruction they receive in high school?

Do students from less-advantaged backgrounds receive different instructional experiences in 12th grade science and mathematics? We focused on three aspects of student background: SES, race-ethnicity, and gender. In terms of simple course enrollments in senior-year science and math, gender and race-ethnicity differences are fairly small (Figure 3.1). Females are less likely to take senior mathematics, but are as likely as males to take science. Asians and blacks are more likely to take math than whites and Hispanics, and Asians are more likely than all other groups to take 12th grade science. Higher-SES students are more likely than lower-SES seniors to take both subjects.

The race-ethnicity and SES differences are greater when students are compared in terms of the achievement levels of their math and science classes (see Figures 3.2 and 3.3). Asians are more likely than whites, blacks, and Hispanics to take AP math and science; whites are more likely than blacks and Hispanics to take AP courses. Family SES is strongly correlated with class achievement levels in both subjects.

Since class achievement levels are associated with student social background and instructional experiences, we used multivariate regression techniques to estimate the independent effects of background on instructional variables (see Tables 3.3 and 3.4). Controlling for the achievement levels of the students' classes, higher-SES students are assigned more homework in both subjects, have mathematics teachers who place greater emphasis on higher-order skill development, and use computers more in science classes. The regression analysis also shows that significant race-ethnicity effects on instruction tend to favor blacks and Hispanics, once SES is held constant.

The main conclusions from the analysis in Chapter III are that (a) the instructional experiences of students do vary according to race-ethnicity and SES, (b) these differences mainly arise from the effects of race-ethnicity and SES on the achievement levels of the students' classes, and (c) even controlling for class achievement level, lower-SES students have lower levels of homework, math instruction emphasizing higher-order thinking, and access to computers in science.

(c) To what extent do instructional opportunities vary from school to school?

How much do students' instructional experiences depend on the school in which they are enrolled? The school variables we examined in Chapter IV included measures of the school's location, proportion of students from low-income households, public-versus-private control type, enrollment size, accountability structure, graduation requirements, administrative leadership, faculty influence over curriculum and teaching methods, and faculty collegiality. Our main focus was on the variables which are most directly subject to school or district policy decisions. Of those, the results indicate that students in schools with stronger teacher professional cultures are, other things equal, more likely to have teachers who emphasize higher-order thinking and practical applications. Those students are also more likely to have science teachers who incorporate the use of computers in their classes and who have students give oral presentations in class.

(2) Are differences in students' instructional experiences related to differences in achievement?

We used regression methods to estimate the relationships of the instruction variables and achievement growth from 10th to 12th grade. Since the instruction variables are correlated with students' social backgrounds and achievement level placements, we controlled for those variables in the analyses. We approached the problem in two ways, first looking for effects on composite, more general measures of learning in mathematics and science, and then looking at more fine-grained measures of the acquisition of specific proficiencies in each subject.

(a) Which instructional variables have the strongest relationships with achievement growth over the last two years of high school?

Several instructional variables have significant effects on mathematics achievement, but almost none were found to affect students' growth in science achievement from 10th to 12th grade. In both subjects, the instruction variables prove to have weaker effects than the teacher's report of the achievement level of the classes. Students enrolled in higher-level classes learn more, even controlling for individual student's initial level of achievement and social background. This implies that the best strategy for improving achievement is to try to make lower-level classes more like higher-level ones. Part of the class-achievement level effects on achievement growth are explained by instructional differences measured here, but most of the effects cannot be reduced to these variables. We suspect that the unexplained remainder can be attributed to more demanding content in the higher-level courses. A problem with increasing the demands placed upon students in the lower-level classes is that the students may not respond with greater effort. It may thus be necessary to also address the problem of incentives along with raising the demands.

(b) Are the effects essentially the same for all students, or are they different for students with different backgrounds?

The effects of the instructional variables could conceivably be quite different for different students. From a theoretical standpoint, the single most important background variable is the initial achievement level of the student. The main theoretical issue is whether teachers tend to adapt their instruction to what works best for the students in their classes, as opposed to adapting instruction to preconceived notions of what is appropriate. If the effectiveness of methods depends on the achievement level of the students, one should find that the statistical associations between methods and outcomes varies by class level. If methods work about the same for all students, then the estimated relationships should be about equal in higher- and lower-level classes.

The results of the regression analyses presented in Tables 5.3 and 5.4 show that the effects are generally consistent when one analyzes students with low, average, and high levels of sophomore achievement separately. The analysis presented in Tables 5.5 and 5.6 indicates that the effects of the instructional variables are also generally consistent when the outcomes are proficiency scores and the analyses are stratified by students' sophomore levels of proficiency.

Suggestions for Further Research

This study has left aside a number of important issues for which the NELS:88 data can be usefully analyzed. Four topics in particular develop directly out of the work in this report.

1. A comparison of instruction in grades 8, 10, and 12. How highly correlated are the instruction variables across grade levels? If the variables are correlated, then some of the differences we have seen between students from different social backgrounds and in different achievement levels and schools would accumulate across grades to create larger inequalities than those found in a cross-sectional analysis.

2. An analysis of the effects of schools on instruction using the NELS:88 High School Effects Study supplemental data. As noted in Chapter IV, the fact that the original NELS:88 students are not necessarily representative samples of their respective high school cohorts, coupled with the small numbers of sampled students enrolled in many of the high schools, makes certain types of school-level analyses problematic. Because of these shortcomings, NELS:88 developed the High School Effects Study by supplementing the student samples in 232 of the high schools so that representative samples of students in those schools were obtained. Multilevel data analysis would enable researchers to estimate the overall variation in students' instructional experiences and outcomes that lie between versus within high schools. That would give a better picture of the role of school policy in the overall variability we have documented in this report. Beyond that descriptive function, one could use the specialized multilevel data analysis techniques (see, for example, Bryk & Raudenbush, 1992) to obtain better estimates of the impacts of the school variables examined in this report, as well as others of interest.

3. Analysis of the student reports of instructional experiences. In addition to the information collected from teachers analyzed in the present report, the NELS:88 second follow-up survey asked students a number of questions about their course work in science and mathematics. One purpose of such comparisons would be essentially methodological. The student and teacher data could be usefully compared to see whether their reports agree. Finding that the reports agree with one another would give analysts greater confidence in the validity of the reports. However, it is likely that disagreements will be found for many respondents. In that case, it may be possible to combine the information to produce better measures of what happens in classrooms. For example, one may find that student achievement is more responsive to an emphasis on higher-order thinking when students and teachers agree on such an emphasis than when the teacher says one thing and the student another.

A second purpose is to see whether teacher decisions affect student perceptions. Students were asked to evaluate their science and math courses with respect to challenge, usefulness, and accessibility. Further research could look at the relationship of different instructional emphases and methods with the student evaluations. Do students find inquiry and problem-solving approaches more challenging? Do students find the increased ambiguity of the more open-ended approaches that many are now recommending to be stimulating or simply frustrating? The relationships between instructional practices and students' experiences may well vary from student to student, depending on such factors as their general interest in intellectual problems and future educational plans and career orientations.

4. Analysis of the effects of instructional differences on other outcomes, especially interest in science and math and persistence through high school and on into college. In the same vein, one usefully could explore the interactions of different instructional experiences and student background characteristics. We have addressed the question of whether certain types of instruction are particularly effective for students from less advantaged backgrounds from just one of several possible angles, and using just one type of outcome.

Conclusion

While much more can be usefully done with the NELS:88 data on classroom instruction, the main point to make is that the goal of identifying instructional practices closely associated with differences in learning outcomes remains elusive. Though elusive, this goal is still of critical importance. Substantial efforts at the national, state, and local levels have been made over the past decade to improve mathematics and science curricula, instruction, and outcomes. The curricula and outcomes are relatively well measured with the transcript and achievement test information now available in the NELS:88 database, but work on the instructional side has lagged. This study and others before it have shown that large learning gaps are found among students in different ability groups and achievement levels, even after adjusting for differences in the backgrounds of students. Lower-ability classes thus appear to be less effective, and it is critically important to understand why. If the answers given here are less than definitive, this study does make important contributions in raising the question of how the outcome differences arise and pointing the way toward gaining better answers in future data collections and research.

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Appendix A:

Supplemental Descriptive Data and Standard Error Tables

Table A1.1 Descriptive statistics for student-level variables used in the analyses of 12th grade math and science course enrollments, 1992.

Variable	N	Mean	Std Dev	Min.	Max.
1991-92 senior year transcript record available (F2TRNFL)	15,105	0.912	0.284	0.000	1.000
Enrolled in a math course senior year (from transcript)	13,862	1.342	0.474	1.000	2.000
Enrolled in a science course senior year (from transcript)	13,862	1.523	0.499	1.000	2.000
Socio-economic status composite (F2SES1)	14,945	0.048	0.769	-3.243	2.753
Student is female (F2SEX)	15,105	0.493	0.500	0.000	1.000
Student is Asian (F2RACE1)	15,067	0.044	0.205	0.000	1.000
Student is Hispanic (F2RACE1)	15,067	0.101	0.301	0.000	1.000
Student is Black (F2RACE1)	15,067	0.118	0.323	0.000	1.000
Student is American Indian (F2RACE1)	15,067	0.011	0.105	0.000	1.000
High school located in an urban area (G12URBN3)	15,105	0.274	0.446	0.000	1.000
High school located in a rural area (G12URBN3)	15,105	0.303	0.459	0.000	1.000
High school region: Midwest (G12REGON)	.15,105	0.257	0.437	0.000	1.000
High school region: South (G12REGON)	15,105	0.349	0.477	0.000	1.000
High school region: West (G12REGON)	15,105	0.195	0.396	0.000	1.000
High school sector: Catholic (G12CTRL2)	15,105	0.054	0.226	0.000	1.000
High school sector: NAIS (G12CTRL2)	15,105	0.016	0.127	0.000	1.000
High school sector: Other private (G12CTRL2)	15,105	0.024	0.154	0.000	1.000
6-20% of students in school receive free or reduced-price lunch (F2C25A)	15,105	0.303	0.459	0.000	1.000
21-50% of students in school receive free or reduced-price lunch (F2C25A)	15,105	0.276	0.447	0.000	1.000
51%+ of students in school receive free or reduced-price lunch (F2C25A)	15,105	0.094	0.292	0.000	1.000
Ln of high school grade 12 enrollment (G12ENROL)	14,749	5.298	0.851	0.693	7.164
Principal reports being rewarded for raising achievement levels (F1C89)	11,735	0.167	0.373	0.000	1.000
Principal report of influence of student standardized test scores on how he/she is evaluated (F2C62A)	13,430	2.249	0.677	1.000	3.000
High school has minimum competency math test for 12th graders (F2C45A)	14,832	0.500	0.500	0.000	1.000
High school has minimum competency science test for 12th graders (F2C45A)	14,832	0.163	0.370	0.000	1.000
Years of math required for high school graduation (F1C70B)	12,059	4.444	0.643	1.000	6.000
Years of science required for high school graduation (F1C70C)	12,092	4.173	0.624	1.000	6.000

NOTE: The names of the NELS:88 codebook variables are shown in parentheses. See Appendix B for complete descriptions of values and how variables were constructed.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table A1.2. Descriptive statistics for student-level variables used in the analyses of 12th grade mathematics instruction: 1992.

Variable	N	Mean	Std Dev	Min.	Max.
Socio-economic status composite (F2SES1)	6,286	0.100	0.778	-2.889	2.753
Student is female (F2SEX)	6,337	0.456	0.498	0.000	1.000
Student is Asian (F2RACE1)	6,320	0.046	0.209	0.000	1.000
Student is Hispanic (F2RACE1)	6,320	0.106	0.308	0.000	1.000
Student is Black (F2RACE1)	6,320	0.124	0.329	0.000	1.000
Student is American Indian (F2RACE1)	6,320	0.008	0.087	0.000	1.000
Achievement level of class: AP (F2T2_3 & F2T2_4)	5,714	0.087	0.282	0.000	1.000
Achievement level of class: above average (F2T2_3 & F2T2_4)	5,714	0.342	0.474	0.000	1.000
Achievement level of class: below average (F2T2_3 & F2T2_4)	5,714	0.124	0.330	0.000	1.000
Achievement level of class: remedial (F2T2_3 & F2T2_4)	5,714	0.040	0.196	0.000	1.000
Teacher's math education: college and grad. major	5,343	0.207	0.405	0.000	1.000
Teacher's math education: college or grad. major & minor	5,343	0.120	0.325	0.000	1.000
Teacher's math education: minor only	5,343	0.164	0.370	0.000	1.000
Teacher's math education: no major or minor	5,343	0.095	0.293	0.000	1.000
6-20% of students in school receive free or reduced-price lunch (F2C25A)	6,337	0.304	0.460	0.000	1.000
21-50% of students in school receive free or reduced-price lunch (F2C25A)	6,337	0.259	0.438	0.000	1.000
51%+ of students in school receive free or reduced-price lunch (F2C25A)	6,337	0.092	0.289	0.000	1.000
High school is located in an urban area (G12URBN3)	6,337	0.283	0.451	0.000	1.000
High school is located in a rural area (G12URBN3)	6,337	0.281	0.449	0.000	1.000
High school region: Midwest (G12REGON)	6,337	0.228	0.420	0.000	1.000
High school region: South (G12REGON)	6,337	0.390	0.488	0.000	1.000
High school region: West (G12REGON)	6,337	0.177	0.382	0.000	1.000
High school sector: Catholic (G12CTRL2)	6,337	0.063	0.242	0.000	1.000
High school sector: NAIS (G12CTRL2)	6,337	0.025	0.156	0.000	1.000
High school sector: Other private (G12CTRL2)	6,337	0.025	0.157	0.000	1.000
Ln of high school grade 12 enrollment (G12ENROL)	6,271	5.320	0.814	0.693	7.164
Number of years of math required for high school graduation (F1C70B)	5,156	4.491	0.657	1.000	6.000

Table A1.2. Descriptive statistics for student-level variables used in the analyses of 12th grade mathematics instruction: 1992. (Continued)

Variable	N	Mean	Std Dev	Min.	Max.
Principal reports being rewarded for raising achievement levels (F1C89)	5,032	0.191	0.393	0.000	1.000
Principal report of influence of student standardized test scores on how he/she is evaluated (F2C62A)	5,775	2.266	0.685	1.000	3.000
School has minimum competency math test (F2C45A)	6,306	0.508	0.500	0.000	1.000
Extent of leadership & support from principal	5,261	2.778	0.405	1.333	4.000
Extent of teacher influence: instructional methods	5,666	5.396	0.655	1.667	6.000
Extent of teacher influence: course content	5,665	4.196	1.343	1.000	6.000
Extent of content coordination in teacher's dept.	5,255	2.778	0.525	1.000	4.000
Extent teacher discusses content w/ other teachers	5,250	2.110	0.367	1.000	3.000
Degree of emphasis on higher-order skills	5,662	3.236	0.587	1.000	4.000
Degree of emphasis on relevance of math	5,662	3.238	0.610	1.000	4.000
Degree of emphasis on mechanical skills	5,666	3.032	0.549	1.000	4.000
Minutes per day of homework for class (F2T2_8)	5,648	33.966	17.262	0.000	180.000
% class time: whole class instruction (from F2T2_12A)	5,264	51.411	21.385	0.000	87.000
Ordinal class time spent instructing whole class (F2T2_12A)	5,264	4.518	0.933	1.000	6.000
% class time: maintaining discipline (from F2T2_12D)	5,205	6.268	13.438	0.000	87.000
Ordinal class time spent maintaining order (F2T2_12D)	5,205	1.812	0.904	1.000	6.000
1990 mathematics IRT-estimated number right (F12XMIRR)	5,871	45.855	13.130	16.650	72.760
1992 mathematics IRT-estimated number right (F22XMIRR)	5,553	50.863	13.574	17.690	78.100
1990 math level 1: probability of proficiency (F12XMPP1)	5,871	0.941	0.149	0.030	1.000
1990 Math level 2: probability of prof. (F12XMPP2)	5,871	0.707	0.403	0.000	1.000
1990 Math level 3: probability of prof. (F12XMPP3)	5,871	0.506	0.457	0.000	1.000
1990 Math level 4: probability of prof. (F12XMPP4)	5,871	0.232	0.343	0.000	1.000
1990 Math level 5: probability of prof. (F12XMPP5)	5,871	0.004	0.024	0.000	0.380
1992 Math level 1: probability of proficiency (F22XMPP1)	5,553	0.968	0.102	0.060	1.000
1992 Math level 2: probability of prof. (F22XMPP2)	5,553	0.813	0.342	0.000	1.000
1992 Math level 3: probability of prof. (F22XMPP3)	5,553	0.630	0.442	0.000	1.000
1992 Math level 4: probability of prof. (F22XMPP4)	5,553	0.358	0.412	0.000	1.000
1992 Math level 5: probability of prof. (F22XMPP5)	5,553	0.033	0.125	0.000	0.980

NOTE: The names of the NELS:88 codebook variables are shown in parentheses. See Appendix B for complete descriptions of values and how variables were constructed.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table A1.3. Descriptive statistics for student-level variables used in the analyses of 12th grade science instruction: 1992.

Variable	N	Mean	Std Dev	Min.	Max.
Socio-economic status composite (F2SES1)	4,250	0.197	0.757	-3.243	1.970
Student is female (F2SEX)	4,266	0.518	0.500	0.000	1.000
Student is Asian (F2RACE1)	4,260	0.050	0.217	0.000	1.000
Student is Hispanic (F2RACE1)	4,260	0.074	0.262	0.000	1.000
Student is Black (F2RACE1)	4,260	0.111	0.314	0.000	1.000
Student is American Indian (F2RACE1)	4,260	0.018	0.132	0.000	1.000
Achievement level of class: AP (F2T2_3 & F2T2_4)	3,855	0.097	0.296	0.000	1.000
Achievement level of class: above average (F2T2_3 & F2T2_4)	3,855	0.471	0.499	0.000	1.000
Achievement level of class: below average (F2T2_3 & F2T2_4)	3,855	0.081	0.273	0.000	1.000
Teacher's science education: college and grad. major & major	3,533	0.289	0.453	0.000	1.000
Teacher's science education: college or grad. major & minor	3,533	0.129	0.335	0.000	1.000
Teacher's science education: minor only	3,533	0.137	0.344	0.000	1.000
Teacher's science education: no major or minor	3,533	0.079	0.270	0.000	1.000
High school is located in an urban area (G12URBN3)	4,266	0.287	0.453	0.000	1.000
High school is located in a rural area (G12URBN3)	4,266	0.310	0.463	0.000	1.000
High school region: Midwest (G12REGON)	4,266	0.276	0.447	0.000	1.000
High school region: South (G12REGON)	4,266	0.290	0.454	0.000	1.000
High school region: West (G12REGON)	4,266	0.199	0.399	0.000	1.000
High school sector: Catholic (G12CTRL2)	4,266	0.066	0.249	0.000	1.000
High school sector: NAIS (G12CTRL2)	4,266	0.016	0.124	0.000	1.000
High school sector: Other private (G12CTRL2)	4,266	0.029	0.168	0.000	1.000
6-20% of students in school receive free or reduced-price lunch (F2C25A)	4,266	0.303	0.460	0.000	1.000
21-50% of students in school receive free or reduced-price lunch (F2C25A)	4,266	0.280	0.449	0.000	1.000
51%+ of students in school receive free or reduced-price lunch (F2C25A)	4,266	0.082	0.274	0.000	1.000
Ln of high school grade 12 enrollment (G12ENROL)	4,220	5.265	0.915	0.693	7.012
Principal reports being rewarded for raising achievement levels (F1C89)	3,384	0.152	0.359	0.000	1.000
Principal report of influence of student standardized test scores on how he/she is evaluated (F2C62A)	3,831	2.226	0.674	1.000	3.000
High school has minimum competency science test for 12th graders (F2C45A)	4,249	0.137	0.344	0.000	1.000

Table A1.3. Descriptive statistics for student-level variables used in the analyses of 12th grade science instruction: 1992. (Cont'd)

Variable	N	Mean	Std Dev	Min.	Max.
Years of science required for high school graduation (F1C70C)	3,548	4.241	0.656	1.000	6.000
Extent of leadership & support from principal	3,512	2.720	0.439	1.000	4.000
Extent of teacher influence: instructional methods	3,843	5.333	0.695	1.000	6.000
Extent of teacher influence: course content	3,844	4.812	1.160	1.000	6.000
Extent of content coordination in teacher's dept.	3,497	2.520	0.612	1.000	4.000
Extent teacher discusses content w/ other teachers	3,506	2.022	0.381	1.000	3.000
Minutes per day of homework for class (F2T2_8)	3,758	31.397	18.531	0.000	180.000
Minutes per week class meets for lab (F2T2_11)	3,471	56.858	46.517	0.000	350.000
Degree of emphasis on lab science	3,848	2.816	0.665	1.000	4.750
Degree of emphasis on scientific inquiry learning skills	3,608	3.328	0.510	1.000	4.000
Degree of emphasis on relevance of science	3,605	3.131	0.699	1.000	4.000
Degree of emphasis on memorizing scientific facts (F2T2_18B)	3,602	2.879	0.731	1.000	4.000
Degree of emphasis on computer use in science	3,842	1.385	0.622	1.000	5.000
Degree of emphasis on the use of student presentations in science	3,847	1.410	0.539	1.000	5.000
% class time: whole class instruction (from F2T2_12A)	3,472	52.441	23.421	0.000	87.000
Ordinal class time spent instructing whole class (F2T2_12A)	3,472	4.542	1.052	1.000	6.000
% class time: maintaining discipline (from F2T2_12D)	3,446	5.249	10.054	0.000	87.000
Ordinal class time spent maintaining order (F2T2_12D)	3,446	1.754	0.785	1.000	6.000
1990 science IRT-estimated number right (F12XSIRR)	3,951	23.228	5.807	10.320	34.680
1992 science IRT-estimated number right (F22XSIRR)	3,639	25.054	6.059	10.260	35.960
1990 science level 1: probability of proficiency (F12XSPP1)	3,951	0.883	0.275	0.000	1.000
1990 science level 2: probability of proficiency (F12XSPP2)	3,951	0.529	0.403	0.000	1.000
1990 science level 3: probability of proficiency (F12XSPP3)	3,951	0.172	0.324	0.000	1.000
1992 science level 1: probability of proficiency (F22XSPP1)	3,639	0.910	0.254	0.000	1.000
1992 science level 2: probability of proficiency (F22XSPP2)	3,639	0.637	0.392	0.000	1.000
1992 science level 3: probability of proficiency (F22XSPP3)	3,639	0.293	0.398	0.000	1.000

NOTE: The names of the NELS:88 codebook variables are shown in parentheses. See Appendix B for complete descriptions of values and how variables were constructed.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table A2.1: Numbers for Figure 2.1: Percentage of Grade 12 Mathematics and Science Students Enrolled in Classes by Achievement Level of the Class: 1991-1992

Achievement Level	**Mathematics**		**Science**	
	Percent Students	**Standard Error**	**Percent Students**	**Standard Error**
Remedial	4.0	0.47	--	--
Below-Average	12.4	1.08	8.1	0.76
Average	40.6	1.77	35.2	1.64
Above-Average	34.2	1.38	47.1	1.86
Advanced Placement	8.7	0.75	9.7	0.98
Total	100.0		100.0	

NOTE: The achievement levels of the classes were identified by the teachers. Two percent of the grade 12 science students were enrolled in remedial-level classes. These students were combined with "low" students in this report.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table A2.2. Numbers for Figure 2.2: Average emphasis math teachers of 12th-grade students place on different skills, by achievement level of the class: 1991-1992.

		Achievement Level of Students in the Class					
Emphasis on . . .		**Total**	**Remedial**	**Below Average**	**Average**	**Above Average**	**AP**
Developing higher-order thinking (mean of 4 items)	mean	3.24	2.80	2.92	3.21	3.36	3.54
	s.e.	.02	.10	.04	.03	.02	.03
	unw. N	5,643	211	595	2,108	2,076	653
Showing the importance of math in everyday life (mean of 2 items)	mean	3.24	3.38	3.35	3.25	3.18	3.19
	s.e.	.02	.07	.04	.04	.03	.06
	unw. N	5,643	211	595	2,109	2,075	653
Learning mechanical operations	mean	3.03	2.92	2.91	3.09	3.05	2.93
	s.e.	.02	.05	.06	.02	.02	.06
	unw. N	5,647	211	595	2,111	2,076	654

Note: The emphasis and class achievement level are reported by the teachers. The scale of the emphasis items has four levels: 1 = none, 2 = some, 3 = moderate, 4 = major).

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table A2.3. Numbers for Figure 2.3: Average emphasis science teachers of 12th-grade students place on different skills, by Achievement Level of the class: 1991-1992.

		Achievement Levels of Students in Class				
Emphasis on . . .		**Total**	**Below Average**	**Average**	**Above Average**	**AP**
Developing Inquiry skills (mean of 4 items)	mean	3.33	2.94	3.20	3.45	3.50
	s.e.	.02	.06	.03	.03	.04
	unw. N	3,591	280	1,214	1,661	436
Memorizing scientific facts, principles, and rules	mean	2.88	2.63	2.83	2.95	2.90
	s.e.	.03	.07	.04	.03	.09
	unw. N	3,585	277	1,213	1,659	·436
Showing the importance of science in everyday life (mean of 2 items)	mean	3.13	3.30	3.24	3.05	2.98
	s.e.	.03	.07	.04	.05	.06
	unw. N	3,588	281	1,212	1,659	436

Note: The emphasis and class achievement level are reported by the teachers. The scale of the emphasis items has four levels: 1 = none, 2 = some, 3 = moderate, 4 = major).

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table A2.4: Numbers for Figures 2.4 & 2.5: Average Minutes Per Day of Homework Assigned by Teachers of 12th Grade Math and Science Students, and Average Minutes Per Week Allocated for Science Labs, by Achievement Level of the Class: 1992

Achievement Level	Mathematics		Science	
	Mean	Standard Error	Mean	Standard Error
Minutes per day of homework assigned				
Overall	34.0	0.56	31.4	0.66
Remedial	23.0	1.30	--	--
Below-Average	26.4	1.44	21.7	1.16
Average	30.1	0.96	25.6	0.80
Above-Average	38.5	0.76	33.7	0.92
Advanced Placement	49.9	1.39	50.0	2.89
Average minutes per week allocated for science labs				
Overall	--		56.7	1.53
Below-Average	--		40.3	4.17
Average	--		49.7	2.79
Above-Average	--		60.9	2.13
Advanced Placement	--		76.4	7.25

NOTE: The achievement levels of the classes were identified by the teachers. Two percent of the grade 12 science students were enrolled in remedial-level classes. These students were combined with "low" students in this report.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table A2.5. Numbers for Figure 2.6: Average Use of Various Instructional Methods, As Reported by Teachers of 12-grade Math Students, by Achievement Level of Class: 1991-1992.

		Total	Remedial	Below Average	Average	Above Average	AP
Lecture	mean	4.0	3.6	3.9	4.0	4.0	4.0
	s.e.	.03	.12	.14	.04	.04	.06
	unw. N	5,253	186	561	1,943	1,948	615
Computer	mean	1.5	1.7	1.3	1.5	1.6	1.6
	s.e.	.03	.14	.05	.06	.06	.08
	unw. N	5,215	186	562	1,924	1,933	610
Audio-Visual Material	mean	2.2	2.3	2.1	2.2	2.3	2.1
	s.e.	.05	.14	.09	.09	.06	.14
	unw. N	5,184	185	559	1,923	1,916	601
Whole Group Discussion	mean	3.0	2.8	3.0	3.0	2.9	3.1
	s.e.	.05	.13	.10	.10	.06	.12
	unw. N	5,200	186	558	1,920	1,930	606
Oral Question Response	mean	4.1	4.0	4.1	4.2	4.1	4.0
	s.e.	.03	.08	.05	.05	.04	.08
	unw. N	5,255	186	567	1,941	1,954	607
Student-Led Discussion	mean	1.6	1.7	1.5	1.7	1.6	1.8
	s.e.	.04	.12	.07	.09	.04	.10
	unw. N	5,217	184	558	1,923	1,943	609
Coop Groups	mean	2.8	2.9	2.7	2.8	2.8	2.9
	s.e.	.04	.12	.08	.06	.05	.08
	unw. N	5,251	184	565	1,943	1,949	610
Written Assignment	mean	3.0	4.0	3.2	3.0	2.9	2.5
	s.e.	.06	.12	.17	.10	.06	.13
	unw. N	5,255	187	564	1,950	1,941	613
Oral Reports	mean	1.2	1.2	1.2	1.3	1.2	1.3
	s.e.	.03	.06	.06	.06	.02	.05
	unw. N	5,229	185	564	1,929	1,945	606

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table A2.6. Numbers for Figure 2.7: Average Use of Various Instructional Methods, As Reported by Teachers of 12th-grade Science Students, by Achievement Level of Class: 1991-1992.

		Total	Below Average	Average	Above Average	AP
Lecture	mean	3.5	3.2	3.5	3.6	3.6
	s.e.	0.4	.09	.06	.05	.07
	unw. N	3,466	275	1,169	1,600	422
Computer	mean	1.5	1.4	1.4	1.5	1.6
	s.e.	.03	.06	.04	.05	.07
	unw. N	3,429	270	1,142	1,595	422
Audio-Visual Material	mean	2.6	2.8	2.6	2.6	2.6
	s.e.	.04	.10	.05	.06	.10
	unw. N	3,471	275	1,171	1,601	424
Whole Group Discussion	mean	2.8	2.7	2.9	2.8	2.9
	s.e.	.05	.15	.06	.08	.08
	unw. N	3,468	276	1,161	1,607	424
Oral Question Response	mean	3.7	3.6	3.7	3.7	3.8
	s.e.	.04	.08	.04	.07	.12
	unw. N	3,486	275	1,173	1,614	424
Student-Led Discussion	mean	1.6	1.5	1.6	1.6	1.8
	s.e.	.04	.07	.04	.06	.09
	unw. N	3,452	272	1,162	1,599	419
Coop Groups	mean	2.9	2.8	2.8	2.9	2.7
	s.e.	.03	.09	.05	.04	.11
	unw. N	3,489	276	1,175	1,614	424
Written Assignment	mean	2.7	3.1	2.8	2.6	2.1
	s.e.	.05	.10	.06	.08	.10
	unw. N	3,495	274	1,179	1,618	424
Oral Reports	mean	1.3	1.3	1.3	1.3	1.4
	s.e.	.02	.05	.03	.03	.06
	unw. N	3,474	273	1,167	1,610	424

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table A2.7. Numbers for Figures 2.8 and 2.9: Percentage distributions of 12th grade mathematics and science students, by achievement level of the class and teacher educational background: 1992.

Class level and teacher education	Mathematics		Science	
	Percent	S.E.	Percent	S.E.
Remedial Classes				
College & graduate major in field	11.5	3.54	--	--
College or graduate major plus a minor in field	5.0	1.76	--	--
College or graduate major but no minor in field	33.4	5.08	--	--
College or graduate minor in field	22.9	7.31	--	--
No major or minor in field	27.1	4.58	--	--
Total	100%		--	--
Sample size	192		--	--
Below-Average Classes				
College & graduate major in field	11.5	2.15	15.5	2.93
College or graduate major plus a minor in field	11.0	2.76	13.6	3.44
College or graduate major but no minor in field	37.1	4.09	43.7	5.43
College or graduate minor in field	26.2	5.51	18.0	4.28
No major or minor in field	14.2	3.50	9.1	2.65
Total	100%		100%	
Sample size	568		277	
Average Classes				
College & graduate major graduate major in	15.1	1.71	25.4	2.43
College or graduate major plus a minor in field	9.1	1.17	14.6	2.73
College or graduate major but no minor in field	46.2	3.41	35.5	3.08
College or graduate minor in field	15.8	2.39	15.9	2.02
No major or minor in field	13.9	3.18	8.6	1.68
Total	100%		100%	
Sample size	1,974		1,189	

Table A2.7. Numbers for Figures 2.8 and 2.9: Percentage distributions of 12th grade mathematics and science students, by achievement level of the class and teacher educational background: 1992. (Continued)

Class level and teacher education	Mathematics		Science	
	Percent	S.E.	Percent	S.E.
Above Average Classes				
College & graduate major in field	27.3	1.99	29.3	3.44
College or graduate major plus a minor in field	14.1	1.48	11.6	1.78
College or graduate major but no minor in field	41.8	2.35	37.7	2.97
College or graduate minor in field	14.1	1.64	12.7	1.83
No major or minor in field	2.7	0.49	8.7	1.44
Total	100%		100%	
Sample size	1,959		1,618	
AP Classes				
College & graduate major in field	38.2	4.39	50.8	5.09
College or graduate major plus a minor in field	21.4	3.22	12.2	2.54
College or graduate major but no minor in field	30.1	3.61	29.4	4.80
College or graduate minor in field	9.1	4.58	6.7	2.00
No major or minor in field	1.2	0.56	0.9	0.56
Total	100%		100%	
Sample size	618		429	

NOTE: Owing to rounding, percentages may not sum to 100.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), First and Second Follow-Up surveys and 1992 High School Transcripts file.

Table A3.1. Numbers for Figure 3.1: Percentage of 1991-1992 12th Graders Taking Mathematics and Science Courses, by Student Background Characteristics.

Variable	Mathematics			Science		
	%	SE	N	%	SE	N
All Students	66	.95	13,862	48	1.02	13,862
Gender						
Male	68	1.29	6,952	49	1.42	6,952
Female	63	1.14	6,910	47	1.24	6,910
Race/Ethnicity						
Asian	76	2.94	1,024	60	3.43	1,024
Hispanic	64	2.54	1,572	42	2.71	1,572
Black	69	2.44	1,229	44	2.70	1,229
White	65	1.13	9,875	48	1.22	9,875
American Indian	65	7.45	132	52	9.62	132
Socio-economic Quartile						
Lowest	57	1.77	2,537	37	1.62	2,537
Low-Middle	60	1.84	3,209	39	1.58	3,209
High-Middle	67	1.40	3,471	49	1.56	3,471
Highest	75	1.68	4,532	61	2.05	4,532
1990 Math and Science Achievement Score Quartile						
Lowest	50	2.29	2,139	35	1.96	2,352
Low-middle	60	1.82	2,933	39	1.74	2,911
High-middle	67	1.41	3,467	46	1.83	3,411
Highest	79	1.30	4,226	65	1.74	4,027

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), First and Second Follow-Up surveys and 1992 High School Transcripts file.

Table A3.2. Numbers for Figure 3.2: Percentage of 1991-1992 twelfth grade mathematics students enrolled in classes with different achievement levels, by student background characteristics.

Variable		Remedial	Low	Average	Above Average	AP	Sample Size
All Students	%	4.0	12.4	40.6	34.2	8.7	5,714
	SE	.47	1.08	1.77	1.38	.75	
Gender							
Male	%	3.8	13.8	43.3	31.5	7.7	2,908
	SE	.54	1.74	2.66	1.88	.85	
Female	%	4.3	10.8	37.4	37.5	10.0	2,806
	SE	.75	1.04	1.82	1.66	1.23	
Race/Ethnicity							
Asian	%	4.6	8.1	25.6	43.1	18.7	450
	SE	1.54	2.89	3.22	3.91	2.51	
Hispanic	%	9.3	15.6	38.6	31.2	5.3	657
	SE	2.76	2.51	3.74	4.59	2.25	
Black	%	5.5	19.3	44.7	27.2	3.3	567
	SE	1.30	3.58	3.29	3.03	.82	
White	%	2.9	11.1	41.0	35.3	9.6	3,981
	SE	.42	1.24	2.25	1.68	.96	

Table A3.2. Numbers for Figure 3.2: Percentage of 1991-1992 12th grade mathematics students enrolled in classes with different achievement levels, by student background characteristics. (Continued)

Variable		Remedial	Low	Average	Above Average	AP	Sample Size
Socio-economic Quartile							
Lowest	%	7.5	17.9	44.5	27.6	2.6	967
	SE	1.08	1.99	3.05	2.60	.53	
Low-middle	%	4.9	14.6	43.5	32.5	4.5	1,250
	SE	1.24	1.99	3.65	2.72	1.21	
High-middle	%	3.0	10.6	41.6	35.9	8.8	1,465
	SE	.55	1.51	2.28	2.12	1.54	
Highest	%	2.0	9.2	35.5	38.0	15.3	1,990
	SE	.65	2.47	4.04	2.87	1.73	
1990 Achievement Score Quartile							
Lowest	%	12.1	30.2	47.0	10.0	0.6	737
	SE	1.49	2.75	2.76	1.38	.32	
Low-middle	%	4.6	15.9	56.9	22.3	0.3	1,109
	SE	.89	1.92	3.64	2.42	.15	
High-middle	%	1.5	8.3	42.2	44.8	3.1	1,494
	SE	.40	1.24	2.45	2.49	.96	
Highest	%	0.3	1.7	25.8	48.6	23.5	1,961
	SE	.17	.37	3.82	2.83	2.03	

NOTE: Blank cells indicate that there are less than 30 cases in the cell.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table A3.3. **Numbers for Figure 3.3: Percentage of 1991-1992 12th grade science students enrolled in classes with different achievement levels, by student background characteristics.**

Variable		Low	Average	Above Average	AP	Sample Size
All Students	%	8.1	35.2	47.1	9.7	3,855
	SE	.76	1.64	1.86	.98	
Gender						
Male	%	9.8	36.0	44.6	9.5	1,915
	SE	1.16	1.94	2.16	1.03	
Female	%	6.5	34.4	49.3	9.8	1,940
	SE	.94	2.41	2.65	1.46	
Race/Ethnicity						
Asian	%	8.1	22.6	44.9	24.4	359
	SE	3.64	3.20	4.59	3.94	
Hispanic	%	10.9	35.4	45.9	7.8	358
	SE	3.44	4.28	4.64	1.97	
Black	%	9.2	42.2	43.0	5.6	276
	SE	1.95	6.03	6.76	2.22	
White	%	7.6	35.0	47.8	9.6	2,818
	SE	.86	1.90	2.17	1.16	

Table A3.3. **Numbers for Figure 3.3: Percentage of 1991-1992 12th grade science students enrolled in classes with different achievement levels, by student background characteristics. (Continued)**

Variable		Low	Average	Above Average	AP	Sample Size
Socio-economic Quartile						
Lowest	%	15.2	47.8	33.8	3.1	514
	SE	1.95	3.62	3.62	.98	
Low-middle	%	11.0	38.9	46.3	3.8	759
	SE	1.78	2.82	2.72	.70	
High-middle	%	9.0	36.2	45.9	8.8	966
	SE	1.83	2.82	3.09	2.35	
Highest	%	3.2	27.5	53.5	15.7	1,603
	SE	.62	2.47	3.23	1.62	
1990 Achievement Score Quartile						
Lowest	%	18.5	52.1	28.0	1.4	457
	SE	2.55	4.38	4.55	.53	
Low-middle	%	10.3	51.4	35.6	2.8	696
	SE	2.16	3.48	3.57	.64	
High-middle	%	7.8	33.0	53.3	5.9	972
	SE	1.53	3.10	3.60	1.12	
Highest	%	2.1	20.4	59.6	17.9	1,451
	SE	.43	2.12	2.57	1.95	

NOTE: Blank cells indicate that there are less than 30 cases in the cell.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table A3.4. **Standard errors for means of math instructional variables reported by the teachers of the sampled 12th-grade math students, by student background (see Table 3.1 for means).**

Variable	Gender		Socioeconomic Quartile				Race-Ethnicity			
	Males	Females	Low	Mid-low	Mid-high	High	Asian	Hispanic	Black	White
Instructing whole class	1.059	.885	1.487	1.291	1.319	2.283	1.981	2.245	1.404	.892
Instructing small groups	.979	.481	2.117	.745	1.084	.747	.919	2.339	.920	.755
Instructing individuals	1.007	.667	.948	.596	.787	1.546	1.290	2.837	1.099	.733
Maintaining order	.698	.507	.758	.409	.690	.671	.576	1.613	1.996	.480
Administering tests	.489	.331	.826	.454	.487	.590	.742	.667	.757	.407
Administrative tasks	.196	.177	.366	.273	.294	.221	.507	.731	.535	.123
Conducting lab periods	.564	.150	.880	.882	1.008	1.125	.567	.372	.237	.427
Lecture	.048	.028	.055	.052	.052	.059	.101	.070	.077	.037
Use computers	.049	.039	.071	.043	.071	.044	.071	.149	.063	.038
Use audio-visual materials	.072	.048	.062	.064	.053	.055	.132	.119	.114	.058
Use teacher-led discussion	.076	.044	.061	.068	.070	.100	.108	.145	.096	.058
Recitation	.038	.031	.060	.048	.068	.070	.072	.067	.050	.033
Use student-led discussion	.046	.068	.052	.046	.064	.060	.072	.065	.076	.050
Cooperative groups	.052	.044	.062	.045	.060	.034	.094	.094	.070	.045
Seatwork	.085	.055	.080	.052	.087	.084	.100	.153	.085	.069
Student oral reports	.033	.052	.042	.029	.032	.030	.031	.049	.046	.037
Homework minutes/day	.756	.687	1.347	.985	.838	1.101	1.269	1.376	1.232	.665
Emphasis: Problem-solving	.021	.022	.046	.029	.028	.027	.050	.051	.045	.019
Emphasis: Applications	.034	.024	.051	.047	.041	.059	.046	.045	.041	.028
Emphasis: Mechanics	.024	.020	.044	.042	.040	.039	.043	.050	.040	.020

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table A3.5. Standard errors for means of science instructional variables reported by the teachers of the sampled 12th-grade math students, by student background (see Table 3.2 for means).

Variable	Gender		Socioeconomic Status Quartile				Race-Ethnicity			
	Male	Female	Low	Mid-low	Mid-high	High	Asian	Hispanic	Black	White
Instructing whole class	1.063	1.746	1.487	1.291	1.319	2.283	1.964	1.972	1.886	1.345
Instructing small groups	.718	.941	2.117	.745	1.084	.747	1.084	3.776	1.206	.726
Instructing individuals	.600	1.169	.948	.596	.787	1.546	1.477	1.469	1.098	.480
Maintaining order	.434	.559	.758	.409	.690	.671	.400	.642	1.403	.316
Administering tests	.352	.519	.826	.454	.487	.590	.743	1.001	1.297	.335
Administrative tasks	.199	.227	.336	.273	.294	.221	.231	.421	.389	.217
Conducting lab periods	.710	.946	.880	.882	1.008	1.125	1.479	1.086	1.364	.782
Lecture	.042	.047	.055	.052	.052	.059	.093	.073	.080	.040
Use computers	.038	.048	.071	.043	.071	.044	.065	.101	.157	.032
Use audio-visual materials	.046	.046	.062	.064	.053	.055	.108	.082	.110	.043
Use teacher-led discussion	.050	.081	.061	.068	.070	.100	.094	.102	.125	.061
Recitation	.040	.063	.060	.048	.068	.070	.084	.082	.161	.045
Use student-led discussion	.045	.044	.052	.046	.064	.060	.062	.071	.142	.037
Cooperative groups	.037	.037	.062	.045	.060	.034	.091	.096	.061	.035
Seatwork	.048	.075	.080	.052	.087	.084	.074	.099	.179	.056
Student oral reports	.022	.026	.042	.029	.032	.030	.038	.066	.066	.021
Homework minutes/day	.772	.874	1.347	.985	.838	1.101	1.843	2.638	1.853	.704
Laboratory minutes/week	2.037	1.998	3.210	2.325	2.654	2.224	4.177	3.714	4.403	1.736
Emphasis: Inquiry	.024	.026	.046	.029	.028	.027	.038	.078	.055	.022
Emphasis: Science & Society	.031	.050	.051	.047	.041	.059	.076	.057	.107	.037
Emphasis: Memorizing Facts	.032	.032	.044	.042	.040	.039	.060	.050	.057	.030
Composite frequency of computer use	.028	.031	.052	.034	.038	.036	.053	.055	.080	.026
Composite frequency of student presentations	.021	.025	.034	.029	.029	.031	.040	.048	.058	.021

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Appendix B:

Methodological and Technical Notes

Appendix B: Methodological and Technical Notes

B.1 Description of the Sample

The data analyzed in this report are drawn primarily from the NELS:88 second (1992) follow-up surveys of students and their teachers. NELS:88 began in 1988 with a national sample of about 24,000 eighth-graders selected from 1,052 public and private schools. The study collected questionnaire and cognitive achievement data from the students in 1988, 1990, and 1992, and followed the students beyond high school with mail questionnaires and phone interviews in 1994. While the students were in middle and high school, data were also collected from their teachers, principals, and parents. The high school transcripts of the students were collected after the 1991-1992 school year. Participants who dropped out of high school were followed up in 1990 and 1992. In 1992, 12 percent of the 1988 eighth-grade cohort were classified as dropouts in the NELS:88 survey (McMillan, Kaufman, & Whitener, 1994, Table 18).

The base year students dispersed into a much larger number of high schools, such that it was infeasible to collect information from the teachers and principals in all of the schools represented by the original student sample. Subsampling of the original students was thus used in the 1990 and 1992 follow-up surveys. The data collected by the NELS:88 second follow-up teacher survey were restricted to the math and science teachers of those NELS:88 students who were enrolled in one of 1,374 schools which were selected for the teacher and principal surveys. These data allow researchers to investigate the effects of school experiences on student outcomes, and the sample is thus referred to as the "contextual sample" of schools and students. These schools were a systematically-drawn subset of the 2,258 schools NELS:88 sample members were attending in the spring of 1991, when student tracing for the second follow-up took place. While drawn systematically, the subsample of original students was not fully representative of the 1991-1992 population of high school seniors. This was because some seniors were repeating that grade, had skipped ahead a grade at some point, or had stopped out of high school for a time but had returned. To gain full representation of the sophomore and senior cohorts, NELS:88 augmented its original eighth-grade sample with 862 students in the first follow-up and 264 new respondents in the second follow-up.

The contextual subsample included 15,695 students, 96 percent of whom were enrolled as seniors in 1992. Since our concern in this study is focused on the seniors, we excluded all students who were not classified as seniors in the 1991-92 school year. This left a full sample of 15,105 students. Of the 15,105, 10,603 were enrolled in a science or math course during the 1991-1992 school year and thus had teachers eligible for the survey. The goal of the NELS:88 second follow-up teacher survey was to obtain data from either a science or a mathematics teacher of each student enrolled in those courses. Since about 40 percent of the seniors were taking both courses simultaneously, this goal required certain selection procedures. The rule used was to select the same subject area as the 1988 base year subject which was selected for the student.

From the pool of 10,603 seniors, 6,337 were selected to have their mathematics teachers surveyed and 4,266 were selected to have their science teachers surveyed. The science and mathematics teachers were surveyed in the spring of 1992. Questionnaires were mailed to a total of 5,657 teachers; 5,100, or 90 percent, completed a form. The completed forms covered the targeted classes of 9,634 of the 10,603 (91 percent) seniors enrolled in science or mathematics.

It is important to keep in mind at all points of this study that (a) many 12th graders do not take science and math, and (b) the 12th graders who do take these subjects are on average higher achievers and thus not a representative sample of the larger grade or age cohorts. Nonetheless, it is not the case that only the most advanced students take science and mathematics during their senior years. As was evident, students from a wide range of ability levels and social backgrounds take these courses.

The result of this complex design is that the sample of students, properly weighted, is representative of 1991-1992 school year seniors. Further, the subsamples with teacher-supplied information on science and mathematics courses are representative of seniors who took those courses. The weight used in all of the tabulations included in this report is the NELS:88 contextual-sample weight, named F2CXTWT.

As a result of the decision to include only one set of teacher data per eligible student, the proportions of students who have science or mathematics teacher data are substantially lower than the proportions who actually took science or mathematics as seniors. To obtain an estimate of the latter, one must turn to the transcript data. Transcripts were collected for 13,862 of the 15,105 seniors (92 percent). These students are used in the analyses of senior-year enrollments. All tabulations of data from the transcript study included in this report also used the contextual-sample weight, F2CXTWT.

Missing data. This report uses data from several different components of the NELS:88 data base, and data from one or more the components are missing for many students. Students who are missing values for one or more of the variables used in the tables are excluded from the table, but are not excluded from other tabulations where they have complete data. The main sources of missing data are from instrument nonresponse on the transcript data, the 1990 and 1992 principal questionnaires (used in ch. 4), and the 1990 and 1992 achievement tests. We did not find any large differences on the variables used in the analyses across subsamples. Our rationale for not excluding cases on a listwise basis was that, for descriptive purposes, it is better to use all the information available in obtaining estimates. Listwise deletion is appropriate when a series of models is estimated, and one thus wants to make sure that sample differences are not producing misrepresentations of patterns (or lack thereof) across models.

B.2 Sampling Errors

Sampling errors refer to the chance discrepancies between the population and a sample drawn from it. The size of the errors are inversely related to the sample size, but determining the proper degrees of freedom is complicated when surveys use complex sample designs. The NELS:88 sampling procedures were designed to produce a sample that would be broadly representative of students across the country from public and private schools, and from many different types of social backgrounds. This required a complex classification of all schools and further subclassifications of students within selected schools. Students from the different cells defined by the classification scheme were sampled with different probabilities of inclusion. In order to obtain accurate estimates of population values, analysts must thus use sampling weights which adjust the contributions of each case according to the number of other individuals in the sampled population whom he or she represents. All numbers presented in this report are calculated using the NELS:88 public-use design weight named **F2CXTWT**. This weights the sampled individuals according to the number of 1992 twelfth graders that each sampled member represents. The subset of cases for whom this weight was defined consisted of the 15,695 students who attended the schools selected for inclusion in the teacher and school administrator components and who participated in the 1992 survey. Early graduates were also included in this sample.

The clustering and stratification used in the NELS:88 sampling design also results in larger uncertainty of population values than would an equal-sized simple random sample. All estimates, standard errors, and significance tests reported were thus calculated taking into account the sample design. The SUDAAN statistical analysis program was used to estimate the standard errors taking into account the complex survey design. The program uses a Taylor Series estimator for the variance calculations.

B.3 Description of Measures

STUDENT BACKGROUND VARIABLES. Student background variables such as gender, race/ethnicity, family socioeconomic status, and others listed below were used to define subgroups for comparison throughout this report. Except as specified below, these were taken directly from the student data file; the variable name from that file is indicated in parentheses following the descriptive variable name.

SES: The measure of student socioeconomic status (SES) is a composite constructed from parent reports of their educational attainments (highest degrees earned), occupation (ranked in terms of prestige), and income; and student reports of household possessions. These four components were each standardized to have a mean of zero and a standard deviation of one, and then averaged for each student. The resulting continuous variable is named F2SES1, and is used in the correlational analyses presented here. For categorical breakdowns, we used the SES quartile variable named F2SES1Q. The quartiles were defined from the weighted distribution of F2SES1; as a result, the unweighted sample sizes in each quartile differ significantly.

Gender: Student sex was coded mainly from base year self-reports which were checked and corrected with information from the first and second follow-ups and name information (F2SEX).

Race/ethnicity: Student race-ethnicity (F2RACE1). This is a composite variable coded mainly from base-year self-reports, but corrected as additional information from the first and second follow-ups became available. The composite was constructed from two questions, one asking for the student's race, and the other asking for Hispanic ethnic identity. Hispanic identity was given precedence over racial identification.

COURSE TYPES. Two variables are used in this report to characterize the types of courses in which the seniors were enrolled: the subject-area of the courses, derived from the NELS:88 1992 Transcript Study; and the achievement level or track of the class about which the teacher responded in the 1992 teacher questionnaire. Appendix C contains a discussion of the difficulties of linking the transcript data to the teacher reports.

Achievement level of class: This is a composite variable constructed from the teacher's responses to two questions in the 2nd follow-up questionnaire:

(1) "Which of the following best describes the "track" this class is considered to be? (a) remedial, (b) general, (c) vocational/technical/business, (d) college-prep/ honors, or (e) AP." (F2T2_3);

(2) "Which of the following best describes the achievement level of the students in this class compared with the average 12th grade student in this school? This class consists primarily of students with: (a) higher achievement levels, (b) average achievement levels, (c) lower achievement levels, or (d) widely differing achievement levels." (F2T2_4).

We constructed a composite with the following five levels: remedial, below average, average, above average, and AP. Remedial and AP assignments were made first, based on information from F2T2_3. Uncoded cases were then assigned to the remaining categories based on the values of F2T2_4. Students in classes which the teacher characterized as "widely differing achievement levels" were coded as "average."

TOPICAL COVERAGE: Topical coverage within math and science courses was measured with items asking teachers whether various topics were covered in the course in which one or more NELS:88 students were enrolled. Different batteries of topics were used for teachers of mathematics, biology, chemistry, and physics. Teachers were asked "Have you taught or reviewed the following topics in this math (Biology/ Chemistry/ Physics) class this year?" Response options included (1) "No, but it was taught previously," (2) "Yes, but I reviewed it only," (3) "Yes, I taught it as new content," (4) "No, but I will teach or review it later this school year," and (5) "No, topic is beyond the scope of this course." For present purposes, the first four options were collapsed into a single category, to create a dichotomy between "past or present coverage" versus "no coverage."

The topics asked of math teachers included:

- integers (F2T2_15A);
- patterns and functions (F2T2_15B);
- linear equations (F2T2_15C);
- polynomials (F2T2_15D);
- properties of geometric figures (F2T2_15E);
- coordinate geometry (F2T2_15F);
- proofs (F2T2_15G);
- trigonometry (F2T2_15H);
- statistics (F2T2_15I);
- probability (F2T2_15J);
- calculus (F2T2_15K).

Biology topics covered were:

- cell structure and function (F2T2_20A);
- genetics (F2T2_20B);
- diversity of life (F2T2_20C);
- metabolism/regulation of organism (F2T2_20D);
- behavior of the organism (F2T2_20E);
- reproduction/development of the organism (F2T2_20F);
- human biology (F2T2_20G);
- evolution (F2T2_20H);
- ecology (F2T2_20I).

Topics asked of chemistry teachers included:

- atomic and molecular structure (F2T2_21A);
- properties and changes in matter (F2T2_21B);
- periodic system (F2T2_21C);

- energy relationships (F2T2_21D);
- reactions (F2T2_21E);
- inorganic chemistry (F2T2_21F);
- organic chemistry (F2T2_21G);
- environmental chemistry (F2T2_21H);
- chemistry of life processes (F2T2_21I);
- nuclear chemistry (F2T2_21J).

Topics asked of physics teachers included:

- sources of energy (F2T2_22A);
- forces, time, and motion (F2T2_22B);
- molecular/nuclear physics (F2T2_22C);
- energy/matter transformations (F2T2_22D);
- sound and vibrations (F2T2_22E);
- light (F2T2_22F);
- electricity and magnetism (F2T2_22G);
- solids/fluids/gases (f2T2_22H).

INSTRUCTIONAL VARIABLES. Instructional variables include the goals, methods, and time allocations of teachers. The measures used here are all taken from the NELS:88 1992 Teacher Questionnaire. All items refer to the specific math and science courses in which the sampled NELS:88 students were enrolled. Factor analysis was used to determine whether the large number of instructional variables could be reduced to a smaller set of readily-interpretible underlying common factors. All composite variables described below were constructed from items which factored together; the items were combined into the composites by averaging the nonmissing values across the indicated items.

Time Availability: Two variables measuring the overall availability of instruction time are taken directly from teacher responses. A question about the amount of class time asked, "Approximately how many minutes per week does this class meet regularly (not including lab periods)?" (F2T2_10). A second question about time for laboratories asked, "Approximately how many minutes per week does this class have lab sessions?" (F2T2_11). Both questions asked the teacher to write in the number of minutes.

Instructional Emphases: These items asked teachers, "In this math (science) class, how much emphasis do you give to each of the following objectives?" Response options included (1) None, (2) Minor, (3) Moderate, and (4) Major. For mathematics, the objectives were:

- Understanding the nature of proofs (F2T2_14A);
- Memorizing facts, rules, and steps (F2T2_14B);
- Learning to represent problem structures in multiple ways (e.g., graphically, algebraically, numerically, etc.) (F2T2_14C);
- Integrating different branches of mathematics (e.g., geometry, algebra) into a unified framework (F2T2_14D);
- Conceiving and analyzing effectiveness of multiple approaches to problem solving (F2T2_14E);

- Performing calculations with speed and accuracy (F2T2_14F);
- Showing importance of math in daily life (F2T2_14G);
- Solving equations (F2T2_14H);
- Raising questions and formulating conjectures (F2T2_14I);
- Increasing students' interest in math (F2T2_14J).

For science, the objectives were:

- Increasing students' interest in science (F2T2_18A).
- Learning and memorizing scientific facts, principles, and rules (F2T2_18B).
- Learning scientific methods (F2T2_18C).
- Preparing students for further study in science (F2T2_18D).
- Developing problem solving/inquiry skills (F2T2_18E).
- Developing skills in lab techniques (F2T2_18F).
- Learning about application of science to environmental issues (F2T2_18G).
- Showing the importance of science in daily life (F2T2_18H).

Time Allocations: Teachers in both subjects were asked to "Indicate about what percent of class time is spent in a typical week doing each of the following with this class?" Six response options were provided: (1) None, (2) <10%, (3) 10-24%, (4) 25-49%, (5) 50-74%, and (6) 75-100%. For some tabulations, these were recoded to the midpoints of the categories, and the variables were treated as continuous percent measures. Activities included the following:

- Providing instruction to the class as a whole (F2T2_12A);
- Providing instruction to small groups of students (F2T2_12B);
- Providing instruction to individual students (F2T2_12C);
- Maintaining order/ disciplining students (F2T2_12D);
- Administering tests or quizzes (F2T2_12E);
- Performing routine administrative tasks (e.g., taking attendance, making announcements, etc.) (F2T2_12F);
- Conducting lab periods (F2T2_12G).

Teaching Methods: Teachers in both subjects were asked, "How often do you use the following teaching methods or media?" Five response options were offered: (1) Never/ Rarely, (2) 1-2 Times a Month, (3) 1-2 Times a Week, (4) Almost Every Day, and (5) Every Day.

- Lecture (F2T213AA);
- Use computers (F2T213AB);
- Use audio-visual material (F2T213AC);
- Have teacher-led whole-group discussion (F2T213AD);
- Have students respond orally to questions on the subject matter (F2T213AE);
- Have student-led whole-group discussions (F2T213AF);
- Have students work together in cooperative groups (F2T213AG);
- Have students complete individual written assignments or worksheets in class (F2T213AH);
- Have students give oral reports (F2T213AI).

<u>Science Class Activities</u>: Science teachers were asked, "How often do you do each of the following activities in this science class?" Response options were (1) Never/ Rarely, (2) 1-2 Times a Month, (3) 1-2 Times a Week, (4) Almost Every Day, and (5) Every Day. The activities listed were:

- Have students do an experiment or observation individually or in small groups (F2T2_19A).
- Demonstrate an experiment or lead students in systematic observations (F2T2_19B).
- Require students to turn in written reports on experiments or observations (F2T2_19C).
- Discuss current issues and events in science (F2T2_19D).
- Have students use computers for data collection and analysis (F2T2_19E).
- Use computers for demonstrations/simulations (F2T2_19F).
- Have students give oral reports (F2T2_19G).
- Have students independently design and conduct their own science projects (F2T2_19H).
- Discuss career opportunities in scientific and technological fields (F2T2_19I).
- Discuss controversial inventions and technologies (F2T2_19J).

<u>Amount of Homework Assigned</u>: Teachers in both subjects were asked, "Approximately how much homework do you typically assign each day to this class?" Responses were recorded in minutes per day (F2T2_8).

Composite variables created to characterize mathematics instruction:

- <u>Emphasis on higher-order thinking skills</u> (α=.75), calculated by taking the mean of
  - Learning to represent problem structures in multiple ways (e.g., graphically, algebraically, numerically, etc.) (F2T2_14C);
  - Integrating different branches of mathematics (e.g., geometry, algebra) into a unified framework (F2T2_14D);
  - Conceiving and analyzing effectiveness of multiple approaches to problem solving (F2T2_14E);
  - Raising questions and formulating conjectures (F2T2_14I).

- <u>Emphasis on the relevance of math</u> (α=.58), calculated by taking the mean of
  - Showing importance of math in daily life (F2T2_14G);
  - Increasing students' interest in math (F2T2_14J).

- <u>Emphasis on mechanical skills</u> (α=.42), calculated by taking the mean of
  - Memorizing facts, rules, and steps (F2T2_14B);
  - Performing calculations with speed and accuracy (F2T2_14F);
  - Solving equations (F2T2_14H).

Composite variables created to characterize science instruction:

- <u>Emphasis on inquiry skills</u> (α=.63), calculated by taking the mean of
  - Learning scientific methods (F2T2_18C).
  - Preparing students for further study in science (F2T2_18D).
  - Developing problem solving/inquiry skills (F2T2_18E).

   - Developing skills in lab techniques (F2T2_18F).

- Emphasis on relevance of science (α=.65), calculated by taking the mean of
   - Learning about application of science to environmental issues (F2T2_18G).
   - Showing the importance of science in daily life (F2T2_18H).

- Use of labs in science (α=.70), calculated by taking the mean of
   - Conducting lab periods (F2T2_12G);
   - Developing skills in lab techniques (F2T2_18F).
   - Have students do an experiment or observation individually or in small groups (F2T2_19A).
   - Require students to turn in written reports on experiments or observations (F2T2_19C).

- Frequency of computer usage (α=.88), calculated by taking the mean of
   - Use computers (F2T213AB);
   - Have students use computers for data collection and analysis (F2T2_19E).
   - Use computers for demonstrations/simulations (F2T2_19F).

- Frequency of student presentations in class (α=.76), calculated by taking the mean of
   - Have student-led whole-group discussions (F2T213AF);
   - Have students give oral reports (F2T213AI, asked of both math & science teachers);
   - Have students give oral reports (F2T2_19G, asked of science teachers only).

INDIVIDUAL TEACHER BACKGROUND.

Education: Teachers were asked, "What were your major and minor fields of study for your bachelor's degree?" (F2T4_9A1 — F2T4_9I1, F2T4_9A2 — F2T4_9I2), and "What were your primary and secondary fields of study for your highest graduate degree?" (F2T410A1 — F2T410I1, F2T410A2 — F2T410I2). Response options for both questions were identical and included "(b) Mathematics," "(c) Natural/physical sciences," and "(d) Life/biological sciences." We combined the responses to create two five level typologies, one for math teachers and one for science teachers:

1 = Undergraduate major and primary graduate study in field (i.e., math or science).
2 = Undergraduate major or graduate primary study in field, and undergraduate minor or graduate secondary study in field.
3 = Undergraduate major or graduate primary study in field, but no minor or secondary study.
4 = Undergraduate minor and/or graduate secondary study in field.
5 = No major or minor in field at either the undergraduate or graduate level.

SCHOOL LOCATION AND DEMOGRAPHIC CHARACTERISTICS.

Region: Region of the country in which the student's second follow-up school was located (G12REGON). The four levels of the variable are Northeast, Midwest, South. and West. These correspond to the standard U.S. Census regions.

Urbanicity: Type of school district, diocese, or county in which the student's second follow-up school was located (G12URBN3). Schools are classified as (1) urban: located in a central city of one of the U.S. Census Metropolitan Statistical Areas (MSA); (2) suburban: located in the area surrounding a central city, and within the MSA; and (3) rural: located outside of any MSA.

School Enrollment Size: Number of students enrolled in 12th grade during the 1991-1992 school year (G12ENROL). In order to normalize the distribution of this variable for the regression analyses, the natural logarithm of G12ENROL is used.

School SES Composition: Principals were asked, "What percentage of the total student body in your school receives the following special services?" One of the services listed was "Free or reduced-price school lunch program" (F2C25A). Students are eligible for free school lunches if their household is at or below the official U.S. poverty level, and are eligible for reduced lunch if their household income is 100-120% of the official poverty level. For present purposes, this variable was collapsed in four categories: 1 = 0-5%, 2 = 6-20%, 3 = 21-50%, and 4 = more than 50%.

School Sector: All schools in the NELS:88 study were classified as either public, Catholic, National Association of Independent Schools (NAIS), or other private (G12CTRL2).

SCHOOL- AND DEPARTMENT-ORGANIZATIONAL CHARACTERISTICS.

Teacher Coordination. Teachers were asked in the 2nd follow-up questionnaire, "To what extent do you agree that each of the following statements describes either a characteristic or enforced policy of your department or subject area?" Responses to the following statements were averaged to construct a composite measure of teacher coordination. These items show a very similar pattern of intercorrelations for science and math teachers. The student-level items have internal consistency coefficients of α=.63 in math and α=.73 in science.

- I am encouraged to be familiar with the contents and specific goals of the courses taught by other teachers in my department (F2T3_5C);
- I am encouraged to coordinate the content of my courses with teachers in my department (F2T3_5D);
- Faculty consultation or approval is needed for changes in course objectives or content (F2T3_5E);
- I am encouraged to coordinate the content of my courses with teachers outside my department (F2T3_5F).

Teachers' Discussions about Instructional Matters: Teachers in both subjects were asked, "How frequently do you discuss each of the following issues with other teachers or a department advisor?" Response options were (1) Never, (2) Sometimes, and (3) Often. These items share a common factor and were averaged to form a composite measure of collegial discussions. The student-level items have an internal consistency of α=.82 in math and α=.82 in science.

- Adapting material to particular students (F2T3_10B);
- New instructional techniques in my subject (F2T3_10C);
- Subject area curriculum (F2T3_10D);
- Curriculum for a particular course (F2T3_10E);
- Test content and testing procedures (F2T3_10F);
- Grading issues (F2T3_10G).

Control Teacher Has over Content and Methods: Teachers in both subjects were asked, "How much control do you feel you have IN YOUR CLASSROOM over each of the following areas of your planning and teaching?" Response options ranged from No control=1 to Complete control=6. The items factored into two sets, control over content (α=.73 in math and α=.69 in science) and control over methods (α=.66 in math and α=.64 in science). The content items include:

- Selecting textbooks and other instructional materials (F2T3_1A);
- Selecting content, topics, and skills to be taught (F2T3_1B).

The control over methods items include:

- Selecting teaching techniques (F2T3_1C);
- Disciplining students (F2T3_1D);
- Determining amount of homework (F2T3_1E).

Principal's Leadership. Teachers in both subjects were asked, "To what extent do you agree that each of following statements describes a characteristic or enforced policy of your school or school administrator?" Response options are 1=Strongly disagree, 2=Disagree, 3=Agree, and 4=Strongly agree. The following nine items were averaged to construct composite measures, with student-level internal consistencies of α=.86 in math and α=.86 in science:

- The academic standards at this school are too low (F2T3_7A, reverse coded);
- There is broad agreement among the entire school faculty about the central mission of the school (F2T3_7B);
- The school administrator knows what kind of school he/she wants and has communicated it to the staff (F2T3_7C);
- The school administrator deals effectively with pressures from outside the school (parents, school board, budgetary) that might otherwise affect my teaching (F2T3_7D);
- The school administrator knows the problems faced by staff (F2T3_7E);
- Necessary materials (e.g., textbooks, supplies, copy machine) are readily available as needed by the staff (F2T3_7F);
- Staff members are recognized for a job well done (F2T3_7G);
- Grading practices are consistent and fair (F2T3_7H);
- Rules against cheating are actively enforced (F2T3_7I).

School Graduation Requirements: Principals were asked in 1992 if students are required to pass a minimum competency tests in math and science. In 1990, the principals were asked to indicate the number of math and science courses students had to complete in order to graduate.

- math is included on a minimum competency test for 12th grade (F2C45A);
- science is included on a minimum competency test for 12th grade (F2C45B);
- amount of math course-work required for graduation (F1C70B);
- amount of science course-work required for graduation (F1C70C).

Accountability for Student Achievement: Principals were asked in 1992, "How much influence do you feel each of the following factors has on how *your* superiors evaluate your performance?" One factor was "The performance of your school's students on standardized tests." Response options were 1=No influence, 2=Minor influence, and 3=Great deal of influence (F2C62A).

In 1990, the principals were asked whether the state or local district offers a financial award or recognition to schools for raising student achievement levels (F1C89).

INDIVIDUAL STUDENT ACHIEVEMENT. Scores on the NELS:88 1992 math and science achievement tests are used as the dependent variables in the analysis presented in Chapter V. All of the equations include the 1990 test scores as independent variables.

Composite Achievement Scores: First and second follow-up achievement scores based on IRT-estimated number right:

- mathematics (F12XMIRR and F22XMIRR);
- science (F12XSIRR and F22XSIRR).

Probability of Proficiency Scores & Proficiency Levels: The probability of proficiency scores index the likelihood that the student has mastered different levels of achievement. The proficiency level variables are dichotomous indicators of whether the student's probability of proficiency exceeds .75 for the skill level in question. The first and second follow-up proficiency probability and levels for math and science are defined in the NELS:88 second follow-up codebook as follows:

- Math Level 1: Simple arithmetical operations on whole numbers; essentially single step operations which rely on rote memory (F22XMPP1 & F22XMPL1);

- Math Level 2: Simple operations with decimals, fractions, powers and roots (F22XMPP2 & F22XMPL2);

- Math Level 3: Simple problem solving, requiring the understanding of low level mathematical concepts (F22XMPP3 & F22XMPL3);

- Math Level 4: Understanding of intermediate level mathematical concepts and/or having the ability to formulate multi-step solutions to word problems (F22XMPP4 & F22XMPL4);

- Math Level 5: Proficiency in solving complex multi-step word problems and/or the ability to demonstrate knowledge of mathematics material found in advanced mathematics courses (F22XMPP5 & F22XMPL5);

- Highest Level of Math Proficiency, defined by combining the dichotomous proficiency level indicators to create a single index (F22XMPRO);

- Science Level 1: Understanding of everyday science concepts; "common knowledge" that can be acquired in everyday life (F22XSPP1 & F22XSPL1);

- Science Level 2: Understanding of fundamental science concepts upon which more complex science knowledge can be built (F22XSPP2 & F22XSPL2);

- Science Level 3: Understanding of relatively complex scientific concepts; typically requiring an additional problem-solving step (F22XSPP3 & F22XSPL3);

- Highest Level of Science Proficiency, defined by combining the dichotomous proficiency level indicators to create a single index (F22XSPRO);

Test Quartiles: Used as a measure of student's academic background. These variables were constructed by grouping students into quartiles of the distribution of the first follow-up mathematics and science IRT-estimated number-right scores (math: F12XMQ, science: F12XSQ).

Appendix C:

Identifying Courses in the NELS:88 2nd Follow-up Teacher Data

Appendix C: Identifying Courses in the NELS:88 2nd Follow-up Teacher Data

The NELS:88 second follow-up data have three different course-type variables, each with different strengths and weaknesses. One measure is the subject matter of the courses as identified in the student transcripts; we examined the numbers of students in each of these course types in Chapter I. Ability levels of the mathematics curriculum usually follow the subject designations of classes quite closely and range from pre-algebra to algebra 1, geometry, algebra 2, trigonometry, pre-calculus, and calculus. The students for whom teacher data were collected were distributed across these levels as follows:

basic (basic, general, applied, & pre-algebra)	594	10.3
algebra 1	204	3.5
geometry	385	6.7
algebra 2	641	11.1
advanced (trigonometry, pre-calculus, probability & statistics	1,762	30.6
calculus	789	13.7
transcript, but can't identify	1,095	19.0
missing transcript data	281	4.9
	5,751	100.0%

Levels in science are somewhat less clearly linked to subject areas, but generally correspond to biology, chemistry, physics, and advanced laboratory courses.

basic - survey	270	7.0
biology 1 or bio. specialty	646	16.6
chemistry 1 or chem. specialty	518	13.3
physics 1 or physics specialty	1,007	25.9
specialized survey	46	1.2
advanced biology	229	5.9
advanced chemistry or physics	243	6.3
transcript, but can't identify	713	18.4
missing transcript data	211	5.4
	3,883	100.0%

While in many respects optimal, the subject designations from the transcript file were not directly linked to the second follow-up teacher data, and some disjunctures between the files make the linkage difficult for many students. As the figures above show, 19 percent of the math students and 18.4 percent of the science students lack sufficient information to determine which one of the courses on the student's transcript the teacher was referencing. Another 4.9 percent of the math students and 5.4 percent of the science students had no transcript data available. Despite their richness and theoretical utility, the missing data for 24 percent of the cases renders the transcript data unusable as a means of characterizing the courses which the teachers described unless further archival work and coding is completed.

The other available measures refer mainly to the achievement or ability level of the classes. One measure is the teacher's report of the "track" designation of the class. Prior research has mainly conceptualized high school curriculum differentiation in terms of three tracks: vocational, college-preparatory, and general. That scheme has been mainly used to classify students, rather than classes. In fact, recent studies have called that schema into question, because the traditional categories do not correspond to distinct courses within particular subjects. In mathematics, virtually all of the courses taken by 12th graders are encompassed by algebra, geometry, trigonometry, precalculus, and calculus. But which of these are vocational, college-preparatory, and general? The NELS:88 second follow-up survey answered this question by asking the math and science teachers to categorize each of their courses as one of five different tracks (F2T2_3). Students are distributed among the tracks as follows:

	Math	Science
Remedial	5	2
General	21	25
Vocational, Technical, Business	6	3
College Prep or Honors	59	61
AP	9	9
	100%	100%

The strength of this scheme is that it maps the courses onto a familiar set of categories. However, the meanings of the "general," "vocational," and "college prep" tracks are less than obvious when one focuses on science and mathematics, and it is conceivable that teachers interpreted these rubrics in quite different ways. The meanings of "remedial" and "AP," in contrast, are much less ambiguous and thus more useful.

Yet another measure of the type of the class comes from teacher responses to a question asking about the achievement level of the students in the class compared with the average 12th grade student in the school as a whole (F2T2_4). The distribution of students across the four response options was as follows:

	Math	Science
Higher achievement levels	47	56
Average achievement levels	31	26
Lower achievement levels	14	8
Widely differing achievement levels	8	9
	100%	100%

The advantage of this variable is that it directly taps the achievement or ability grouping dimension of curriculum differentiation. One possible problem for some purposes is that the levels of the classes are defined in reference to the school, as opposed to a less contextualized, more absolute standard. The relative level of achievement in a given class may be high in relation to a low-achieving senior class, but only average or below compared to seniors across the country. Another problem is that the question is "double-barreled": the response options mix two dimensions, the central tendency and the dispersion. The fourth response option, "widely differing," could in principle pick up classes at high, average, or low mean achievement levels; but courses which teachers describe as "high," "average," or "low" could also have widely differing levels of achievement. One obvious shortcoming is that the response options do not discriminate among the roughly 50 percent of students in classes with above-average achievement levels. Most senior mathematics and science classes are quite selective, taken by students seeking admission in more demanding college programs. Despite being "above average," the average achievement levels of these classes are often very different. In mathematics, for example, the algebra 2, trigonometry, analytic geometry, and calculus classes taken by seniors are all likely to have above-average achievement levels in many high schools.

Since the transcript-derived course data have an unacceptably high number of missing data, we confined our efforts to measuring only the other dimension, the achievement or ability level of the classes. Each of the latter two measures has its strengths and weaknesses, and we thus developed a composite typology drawing mainly on the achievement-level variable, but distinguishing classes described as "remedial" and "AP" on the track variable. Since the number of remedial science students was so small, these students were combined with the "below average" category in science. For the science and mathematics classes described as having "widely differing" levels of achievement and which were not also classified as remedial or AP, we assumed the level was "average." The distribution of the resulting composite variable is shown in Table A2.1 and Figure 2.1 in the text.

Appendix D:

Regression Tables

Table D3.1. Estimated effects of student background variables and the achievement level of the student class on teacher-reported mathematics instructional variables from OLS regressions: 1992.

Dependent Variable	Variable	Model 1		Model 2	
		Coeff.	S.E.	Coeff.	S.E.
% class time for whole-group instruction	Intercept	43.805	7.602	57.33	10.985
	Female (vs. male)	0.025	1.301	-0.654	1.177
	Asian (vs. white)	0.6	2.058	-0.259	1.943
	Hispanic (vs. white)	-1.054	2.472	0.01	2.131
	Black (vs. white)	3.191	1.668	4.47	1.71
	American Indian (vs. white)	4.345	4.63	4.827	4.207
	SES	1.783	1.058	0.724	1.034
	Achievement Level: AP (vs. avg)			7.068	2.406
	Achievement Level: Above Avg (vs. avg)			2.879	1.507
	Achievement Level: Low (vs. avg)			-7.715	2.634
	Achievement Level: Remedial (vs. avg)			-16.818	3.467
	R-Squared	0.006		0.06	
	N	5,222		5,200	
Class time spent on whole-group instruction	Intercept	4.219	0.338	4.956	0.509
	Female (vs. male)	-0.008	0.057	-0.037	0.05
	Asian (vs. white)	0.034	0.086	0.001	0.081
	Hispanic (vs. white)	-0.076	0.13	-0.023	0.105
	Black (vs. white)	0.149	0.069	0.205	0.071
	American Indian (vs. white)	0.184	0.196	0.207	0.173
	SES	0.076	0.045	0.028	0.044
	Achievement Level: AP (vs. avg)			0.3	0.098
	Achievement Level: Above Avg (vs. avg)			0.122	0.062
	Achievement Level: Low (vs. avg)			-0.335	0.115
	Achievement Level: Remedial (vs. avg)			-0.878	0.217
	R-Squared	0.007		0.07	
	N	5,222		5,200	

Table D3.1. Estimated effects of student background variables and the achievement level of the student class on teacher-reported mathematics instructional variables from OLS regressions: 1992. (Cont'd)

Dependent Variable	Variable	Model 1		Model 2	
		Coeff.	S.E.	Coeff.	S.E.
% class time for discipline	Intercept	5.637	4.25	10.163	7.125
	Female (vs. male)	-0.752	0.799	-0.271	0.747
	Asian (vs. white)	-1.676	0.702	-0.901	0.596
	Hispanic (vs. white)	1.051	1.597	0.872	1.62
	Black (vs.white)	4.203	2.183	3.68	2.035
	American Indian (vs. white)	-2.283	0.915	-2.546	0.921
	SES	-1.238	0.465	-0.697	0.48
	Achievement Level: AP (vs. avg)			-5.177	0.793
	Achievement Level: Above Avg (vs. avg)			-3.315	0.93
	Achievement Level: Low (vs. avg)			2.969	1.797
	Achievement Level: Remedial (vs. avg)			1.642	1.714
	R-Squared	0.021		0.053	
	N	5,164		5,142	
Class time spent maintain-ing order	Intercept	1.818	0.295	2.393	0.447
	Female (vs. male)	-0.083	0.051	-0.034	0.047
	Asian (vs. white)	-0.165	0.069	-0.079	0.059
	Hispanic (vs. white)	0.073	0.093	0.056	0.098
	Black (vs. white)	0.307	0.128	0.25	0.116
	American Indian (vs. white)	-0.126	0.123	-0.156	0.112
	SES	-0.098	0.033	-0.04	0.031
	Achievement Level: AP (vs. avg)			-0.591	0.067
	Achievement Level: Above Avg (vs. avg)			-0.34	0.058
	Achievement Level: Low (vs. avg)			0.288	0.101
	Achievement Level: Remedial (vs. avg)			0.139	0.128
	R-Squared	0.028		0.104	
	N	5,164		5,142	

Table D3.1. Estimated effects of student background variables and the achievement level of the student class on teacher-reported mathematics instructional variables from OLS regressions: 1992. (Cont'd)

Dependent Variable	Variable	Model 1		Model 2	
		Coeff.	S.E.	Coeff.	S.E.
Homework minutes/ day	Intercept	21.402	5.378	2.456	7.177
	Female (vs. male)	2.671	0.963	1.567	0.946
	Asian (vs. white)	4.196	1.416	1.77	1.169
	Hispanic (vs. white)	5.62	1.651	6.219	1.65
	Black (vs. white)	-0.199	1.427	1.387	1.286
	American Indian (vs. white)	-2.021	3.32	-1.122	2.881
	SES	3.696	0.751	2.095	0.803
	Achievement Level: AP (vs. avg)			18.824	1.737
	Achievement Level: Above Avg (vs. avg)			8.051	1.175
	Achievement Level: Low (vs. avg)			-3.576	1.685
	Achievement Level: Remedial (vs. avg)			-7.074	1.52
	R-Squared	0.038		0.174	
	N	5,603		5,581	
Emphasis on higher-order thinking skills	Intercept	2.842	0.168	3.065	0.259
	Female (vs. male)	0.059	0.028	0.032	0.029
	Asian (vs. white)	0.06	0.051	0.02	0.044
	Hispanic (vs. white)	0.038	0.05	0.065	0.059
	Black (vs. white)	0.078	0.05	0.127	0.045
	American Indian (vs. white)	0.104	0.099	0.116	0.086
	SES	0.124	0.023	0.085	0.023
	Achievement Level: AP (vs. avg)			0.293	0.045
	Achievement Level: Above Avg (vs. avg)			0.134	0.035
	Achievement Level: Low (vs. avg)			-0.291	0.049
	Achievement Level: Remedial (vs. avg)			-0.39	0.102
	R-Squared	0.027		0.11	
	N	5,617		5,599	

Key: **Model 1: student background variables only.**
Model 2: student background variables plus achievement level of the class.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table D3.2. Estimated effects of student background variables and the achievement level of the student class on teacher-reported science instructional variables from OLS regressions: 1992.

Dependent Variable	Variable	Model 1		Model 2	
		Coeff.	S.E.	Coeff.	S.E.
% class time for whole-class instruction	Intercept	77.507	15.855	73.508	17.961
	Female (vs. male)	2.288	1.699	1.955	1.656
	Asian (vs. white)	-1.646	2.228	-2.606	2.076
	Hispanic (vs. white)	-2.401	2.197	-2.616	2.112
	Black (vs. white)	1.012	2.246	0.736	2.17
	American Indian (vs. white)	-25.222	13.841	-25.507	14.042
	SES	0.978	0.986	-0.056	0.993
	Achievement Level: AP (vs. avg)			5.959	2.414
	Achievement Level: Above Avg (vs. avg)			2.631	2.239
	Achievement Level: Low (vs. avg)			-3.464	2.387
	R-Squared	0.022		0.031	
	N	3,460		3,444	
Class time spent on whole-class instruction	Intercept	6.187	1.001	5.999	1.083
	Female (vs. male)	0.085	0.075	0.072	0.073
	Asian (vs. white)	-0.062	0.096	-0.104	0.09
	Hispanic (vs. white)	-0.1	0.095	-0.108	0.092
	Black (vs. white)	0.057	0.096	0.045	0.093
	American Indian (vs. white)	-1.648	0.917	-1.659	0.923
	SES	0.034	0.044	-0.009	0.044
	Achievement Level: AP (vs. avg)			0.258	0.106
	Achievement Level: Above Avg (vs. avg)			0.109	0.099
	Achievement Level: Low (vs. avg)			-0.133	0.105
	R-Squared	0.041		0.049	
	N	3,460		3,444	

Table D3.2. Estimated effects of student background variables and the achievement level of the student class on teacher-reported science instructional variables from OLS regressions: 1992. (Cont'd)

Dependent Variable	Variable	Model 1		Model 2	
		Coeff.	S.E.	Coeff.	S.E.
% class time for discipline	Intercept	-12.427	8.913	-10.515	9.369
	Female (vs. male)	0.019	0.563	0.252	0.581
	Asian (vs. white)	-0.33	0.506	0.175	0.544
	Hispanic (vs. white)	0.871	0.745	1.042	0.799
	Black (vs. white)	2.105	1.356	2.216	1.297
	American Indian (vs.white)	14.77	8.166	14.866	8.309
	SES	-1.186	0.321	-0.572	0.331
	Achievement Level: AP (vs. avg)			-3.82	0.573
	Achievement Level: Above Avg (vs. avg)			-1.604	0.651
	Achievement Level: Low (vs. avg)			2.971	1.245
	R-Squared	0.049		0.071	
	N	3,434		3,418	
Class time spent maintaining order	Intercept	0.514	0.637	1.011	0.695
	Female (vs. male)	-0.007	0.046	0.019	0.046
	Asian (vs. white)	0.003	0.055	0.077	0.057
	Hispanic (vs. white)	0.051	0.071	0.079	0.078
	Black (vs. white)	0.119	0.106	0.134	0.096
	American Indian (vs. white)	1.076	0.576	1.09	0.596
	SES	-0.149	0.028	-0.071	0.029
	Achievement Level: AP (vs. avg)			-0.546	0.058
	Achievement Level: Above Avg (vs. avg)			-0.236	0.058
	Achievement Level: Low (vs. avg)			0.236	0.096
	R-Squared	0.056		0.111	
	N	3,434		3,418	

Table D3.2. Estimated effects of student background variables and the achievement level of the student class on teacher-reported science instructional variables from OLS regressions: 1992. (Cont'd)

Dependent Variable	Variable	Model 1		Model 2	
		Coeff.	S.E.	Coeff.	S.E.
Homework minutes/ day	Intercept	-2.261	8.81	-29.681	9.141
	Female (vs. male)	0.814	0.98	0.115	0.935
	Asian (vs. white)	7.44	1.877	4.186	1.839
	Hispanic (vs. white)	6.177	2.599	4.856	2.28
	Black (vs. white)	3.771	1.936	3.423	1.876
	American Indian (vs. white)	12.711	7.066	12.574	6.491
	SES	3.868	0.661	1.062	0.631
	Achievement Level: AP (vs. avg)			24.033	2.801
	Achievement Level: Above Avg (vs. avg)			8.09	1.192
	Achievement Level: Low (vs. avg)			-3.534	1.375
	R-Squared	0.038		0.181	
	N	3,744		3,726	
Lab minutes/ week	Intercept	38.991	12.895	16.387	19.849
	Female (vs. male)	1.402	2.649	1.137	2.536
	Asian (vs. white)	6.847	4.428	3.088	4.521
	Hispanic (vs. white)	5.315	4.123	0.306	3.563
	Black (vs. white)	5.755	4.751	4.853	4.641
	American Indian (vs. white)	-3.991	5.598	-4.651	4.794
	SES	3.298	1.642	-0.31	1.749
	Achievement Level: AP (vs. avg)			26.469	9.02
	Achievement Level: Above Avg (vs. avg)			10.959	3.38
	Achievement Level: Low (vs. avg)			-9.68	5.065
	R-Squared	0.004		0.04	
	N	3,459		3,442	

Table D3.2. Estimated effects of student background variables and the achievement level of the student class on teacher-reported science instructional variables from OLS regressions: 1992. (Cont'd)

Dependent Variable	Variable	Model 1		Model 2	
		Coeff.	S.E.	Coeff.	S.E.
Emphasis on lab use	Intercept	3.001	0.308	2.846	0.395
	Female (vs. male)	0.017	0.043	0.001	0.04
	Asian (vs. white)	-0.022	0.057	-0.037	0.057
	Hispanic (vs. white)	0.079	0.067	0.051	0.059
	Black (vs. white)	-0.02	0.066	-0.023	0.063
	American Indian (vs. white)	-0.252	0.242	-0.261	0.27
	SES	0.037	0.025	-0.001	0.027
	Achievement Level: AP (vs. avg)			0.158	0.095
	Achievement Level: Above Avg (vs. avg)			0.201	0.051
	Achievement Level: Low (vs. avg)			-0.209	0.074
	R-Squared	0.005		0.04	
	N	3,834		3,817	
Emphasis on inquiry skills	Intercept	3.196	0.158	2.923	0.199
	Female (vs. male)	0.001	0.029	-0.026	0.028
	Asian (vs. white)	-0.011	0.04	-0.043	0.039
	Hispanic (vs. white)	0.005	0.078	-0.022	0.075
	Black (vs. white)	0.049	0.055	0.04	0.05
	American Indian (vs. white)	0.067	0.08	0.049	0.072
	SES	0.071	0.021	0.017	0.02
	Achievement Level: AP (vs. avg)			0.294	0.052
	Achievement Level: Above Avg (vs. avg)			0.25	0.04
	Achievement Level: Low (vs. avg)			-0.256	0.058
	R-Squared	0.01		0.109	
	N	3,596		3,579	

Table D3.2. Estimated effects of student background variables and the achievement level of the student class on teacher-reported science instructional variables from OLS regressions: 1992. (Cont'd)

Dependent Variable	Variable	Model 1		Model 2	
		Coeff.	S.E.	Coeff.	S.E.
Use of computers	Intercept	1.358	0.219	1.105	0.251
	Female (vs. male)	-0.026	0.038	-0.029	0.038
	Asian (vs. white)	0.034	0.058	0.025	0.06
	Hispanic (vs. white)	-0.017	0.062	-0.018	0.061
	Black (vs. white)	0.175	0.082	0.178	0.08
	American Indian (vs. white)	-0.155	0.133	-0.156	0.14
	SES	0.068	0.024	0.051	0.025
	Achievement Level: AP (vs. avg)			0.116	0.064
	Achievement Level: Above Avg (vs. avg)			0.103	0.047
	Achievement Level: Low (vs. avg)			-0.01	0.064
	R-Squared	0.014		0.021	
	N	3,828		3,811	
Use of Student Presentations	Intercept	0.981	0.155	0.912	0.186
	Female (vs. male)	0.019	0.028	0.02	0.028
	Asian (vs. white)	-0.031	0.043	-0.045	0.044
	Hispanic (vs. white)	0.061	0.05	0.061	0.051
	Black (vs. white)	0.16	0.06	0.16	0.06
	American Indian (vs. white)	0.181	0.086	0.188	0.089
	SES	0.027	0.019	0.021	0.019
	Achievement Level: AP (vs. avg)			0.091	0.06
	Achievement Level: Above Avg (vs. avg)			-0.017	0.038
	Achievement Level: Low (vs. avg)			0.001	0.054
	R-Squared	0.01		0.013	
	N	3,833		3,816	

Key: **Model 1: student background variables only.**
Model 2: student background variables plus achievement level of the class.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table D4.1. **Logistic regression estimates of the effects of student background and school variables on the odds of students taking mathematics and science in 1991-1992 school year: 1992.**

Variable	Mathematics Model 1		Mathematics Model 2		Science Model 1		Science Model 2	
	Coeff.	S.E	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	0.812	0.134	-0.342	0.519	-0.002	0.108	-1.15	0.563
Student Background Variables								
SES Composite	0.418	0.051	0.419	0.054	0.485	0.054	0.511	0.052
Black (vs. white)	0.366	0.136	0.381	0.151	0.075	0.119	-0.013	0.135
Hispanic (vs. white)	0.317	0.131	0.222	0.136	-0.024	0.125	-0.074	0.149
Asian (vs. white)	0.601	0.157	0.491	0.171	0.328	0.156	0.301	0.162
American Indian (vs. white)	0.177	0.274	0.014	0.254	0.305	0.414	-0.064	0.32
Female (vs. male)	-0.218	0.069	-0.224	0.066	-0.047	0.067	-0.103	0.064
Urbanicity								
Urban (vs. suburban)	0.086	0.112	0.104	0.126	0.21	0.109	0.01	0.128
Rural (vs. suburban)	0.005	0.097	0.03	0.096	-0.023	0.084	-0.07	0.095
Region of U.S								
Midwest (vs. Northeast)	-0.158	0.115	-0.044	0.124	-0.297	0.115	-0.234	0.124
South (vs. Northeast)	-0.061	0.128	-0.039	0.135	-0.572	0.117	-0.525	0.128
West (vs. Northeast)	-0.407	0.13	-0.304	0.147	-0.189	0.124	-0.092	0.145
School control type								
Catholic (vs. public)	0.458	0.191	0.233	0.211	0.412	0.2	0.396	0.238
NAIS (vs. public)	1.256	0.429	0.917	0.455	1.511	0.372	1.041	0.334
Other Private (vs. public)	0.075	0.362	-0.56	0.363	0.056	0.442	-0.39	0.433

Table D4.1. Logistic regression estimates of the effects of student background and school variables on the odds of students taking mathematics and science in 1991-1992 school year: 1992. (Cont'd)

Variable	Mathematics Model 1		Mathematics Model 2		Science Model 1		Science Model 2	
	Coeff.	S.E	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Percent students eligible for subsidized lunch								
6-20% (vs. 0-5%)	-0.062	0.123	-0.166	0.117	0.065	0.108	0.1	0.11
21-50% (vs. 0-5%)	-0.151	0.126	-0.33	0.125	0.224	0.11	0.214	0.124
51%+ (vs. 0-5%)	0.05	0.17	-0.145	0.177	0.29	0.16	0.161	0.189
School organizational variables								
12th grade enrollment size (natural log)			0.05	0.065			0.06	0.073
Importance of test scores in evaluation of principal			0.036	0.064			0.011	0.066
School rewarded for high achievement vs. not			-0.052	0.111			-0.003	0.113
School has minimum competency requirement for math/science vs. not			-0.113	0.1			-0.287	0.096
Years math/science required for graduation			0.214	0.074			0.22	0.069
R-Squared	0.04		0.045		0.057		0.061	
N	13,743		9,886		13,743		9,917	

Key: Model 1: all variables listed except school organizational variables.
Model 2: school organizational variables included.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88).

Table D4.2. Estimated effects of student background and school variables on mathematics instruction variables, from OLS regressions: 1992.

Independent Variables	Higher-order thinking		Emphasis: practical applications		Emphasis: mechanical operations		Minutes/day of homework assigned		% class time devoted to whole-class		% class time devoted to discipline	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	1.718	0.526	2.863	0.615	2.511	0.471	10.847	16.096	-3.758	19.021	15.521	8.723
Student Socioeconomic Background												
SES Composite	0.145	0.022	-0.039	0.021	0.031	0.018	3.89	0.596	2.497	0.818	-1.173	0.375
Student Sex (vs. Male)												
Female	0.027	0.026	-0.002	0.027	-0.014	0.023	2.244	0.791	0.534	1.1	-0.431	0.577
Student Race/Ethnicity (vs. White)												
Asian	0.078	0.068	-0.065	0.065	0.024	0.051	3.226	1.7	-1.222	2.131	-3.368	1.449
Hispanic	0.013	0.051	0.13	0.059	-0.003	0.043	0.096	1.422	-4.261	3.437	-0.921	1.929
Black	0.045	0.048	0.076	0.053	0.088	0.044	0.87	1.507	0.484	2.168	-1.112	1.346
American Indian	-0.033	0.123	-0.258	0.18	0.157	0.128	-8.52	3.342	-1.151	5.221	-3.167	1.99
Urbanicity (vs. Suburban)												
Urban	0.077	0.047	0.03	0.051	-0.019	0.037	1.442	1.502	-2.951	1.902	2.652	1.528
Rural	-0.045	0.048	-0.013	0.049	-0.044	0.044	-1.728	1.398	-1.722	2.096	-0.113	1.009

Table D4.2. Estimated effects of student background and school variables on mathematics instruction variables, from OLS regressions: 1992. (Cont'd)

Independent Variables	Higher-order thinking		Emphasis: practical applications		Emphasis: mechanical operations		Minutes/day of homework assigned		% class time devoted to whole-class		% class time devoted to discipline	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Region of U.S. (vs. Northeast)												
Midwest	0.021	0.055	-0.056	0.061	-0.004	0.045	4.826	1.392	-6.87	2.369	-0.579	0.874
South	0.074	0.054	0.115	0.055	0.151	0.042	2.737	1.434	-5.395	2.329	0.54	0.874
West	-0.08	0.061	-0.003	0.068	-0.021	0.046	4.481	1.472	-11.775	2.535	1.788	1.562
School Control Type (vs. Public)												
Catholic	-0.026	0.081	-0.226	0.102	-0.071	0.077	-0.066	2.673	14.668	3.064	-1.918	1.708
NAIS	-0.116	0.088	-0.103	0.148	-0.267	0.124	4.196	3.307	16.906	3.75	-2.307	1.558
Other Private	-0.016	0.108	-0.204	0.177	-0.102	0.216	4.361	6.373	15.771	4.311	1.706	4.028
% Students Receiving Federal Lunch (vs. 0-5%)												
6-20%	-0.02	0.048	0.013	0.053	0.043	0.041	-1.175	1.424	3.837	1.874	0.374	0.622
21-50%	0.002	0.055	0.095	0.052	0.127	0.044	-1.635	1.56	6.105	2.185	0.395	0.743
51%+	0.135	0.08	-0.074	0.096	0.123	0.072	-0.544	2.736	10.166	3.723	5.649	4.372
Number 12th Graders Enrolled in the School												
Ln(enrollment)	-0.018	0.025	-0.092	0.033	-0.033	0.025	-1.125	0.848	3.276	1.065	0.038	0.39

Table D4.2. Estimated effects of student background and school variables on mathematics instruction variables, from OLS regressions: 1992. (Cont'd)

Independent Variables	Higher-order thinking		Emphasis: practical applications		Emphasis: mechanical operations		Minutes/day of homework assigned		% class time devoted to whole-class		% class time devoted to discipline	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Accountability of Principals for Achievement Outcomes												
Importance of student performance and standardized tests on evaluation of principal	0.035	0.025	0.016	0.028	0.001	0.023	0.929	0.875	-0.83	1.157	-1.368	0.904
Effective schools recognized (0-1)	-0.095	0.044	-0.021	0.049	-0.005	0.036	1.372	1.239	0.262	1.919	1.138	0.67
Graduation Requirements												
Must pass math min. competency (0-1)	0.037	0.038	0	0.042	0.002	0.033	-0.377	1.099	4.534	1.57	1.106	0.811
Years of math required	0.023	0.028	0.005	0.034	-0.001	0.025	-0.741	0.772	-2.772	1.06	-0.453	0.425

Table D4.2. Estimated effects of student background and school variables on mathematics instruction variables, from OLS regressions: 1992. (Cont'd)

Independent Variables	Higher-order thinking		Emphasis: practical applications		Emphasis: mechanical operations		Minutes/day of homework assigned		% class time devoted to whole-class		% class time devoted to discipline	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
School Organizational Characteristics												
Teacher's rating of principal's leadership	-0.069	0.037	0.019	0.042	0.017	0.037	0.794	1.135	-0.441	1.506	0.532	0.846
Teacher influence: methods	0.033	0.026	0.064	0.037	0.021	0.025	0.163	0.738	2.157	1.274	-1.13	0.444
Teacher influence: curriculum	0.041	0.016	0.03	0.015	-0.003	0.015	0.494	0.49	0.684	0.751	-0.216	0.369
Teachers coordinate content	0.159	0.038	0.099	0.038	0.033	0.032	0.811	1.025	0.111	1.565	-0.652	0.546
Teachers discuss content w/tchrs	0.285	0.046	0.239	0.051	0.087	0.045	2.455	1.644	0.052	2.116	0.197	0.889
R-Squared	0.144		0.1		0.049		0.083		0.076		0.06	
N	3,823		3,823		3,825		3,807		3,807		3,760	

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table D4.3. Estimated effects of student background and school variables on science instruction variables, from OLS regressions: 1992.

Independent Variables	Emphasis: inquiry learning		Emphasis: practical applications		Emphasis: facts and principles		Minutes/day of homework assigned		Minutes/week lab work	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	1.581	0.643	1.931	0.994	0.672	1.004	22.357	21.921	36.346	46.904
Student Socioeconomic Background										
SES Composite	0.078	0.02	-0.042	0.031	-0.014	0.031	3.119	0.667	3.565	.655
Student Sex (vs. Male)										
Female	0.048	0.027	0.036	0.041	0.041	0.043	1.39	1.095	3.42	2.319
Student Race/Ethnicity (vs. White)										
Asian	0.025	0.05	-0.148	0.076	-0.087	0.08	9.258	2.249	15.433	4.945
Hispanic	-0.044	0.064	-0.002	0.077	0.069	0.084	0.814	2.512	4.128	5.543
Black	-0.056	0.057	-0.077	0.123	-0.038	0.071	0.5	1.946	4.479	5.115
American Indian	-0.03	0.113	0.158	0.197	0.386	0.209	-6.684	4	-15.138	9.179
Urbanicity (vs. Suburban)										
Urban	0.072	0.051	0.209	0.083	-0.006	0.084	1.34	2.271	-2.694	4.423
Rural	0.062	0.055	0.012	0.076	0.074	0.075	-0.274	1.586	-4.092	5.43
Region of U.S. (vs. Northeast)										
Midwest	-0.006	0.071	-0.054	0.094	0.267	0.083	-1.962	1.817	-4.062	5.564
South	0.106	0.075	0.098	0.097	0.228	0.087	0.878	1.733	-4.91	5.069
West	-0.049	0.067	-0.027	0.111	0.032	0.104	0.011	2.539	-10.209	6.02
School Control Type (vs. Public)										
Catholic	0.095	0.087	-0.13	0.132	0.167	0.168	-1.526	3.138	1.119	7.112
NAIS	0.239	0.107	-0.361	0.187	0.133	0.216	9.079	6.97	19.793	10.876
Other Private	0.1	0.123	-0.097	0.419	0.053	0.258	-1.738	5.69	-8.568	8.375
% Federal Lunch (vs. 0-5%)										
6-20%	0.166	0.055	0.133	0.087	0.078	0.095	-1.169	1.798	6.35	4.223
21-50%	0.171	0.065	0.179	0.091	-0.006	0.1	-0.534	1.983	6.412	6.227
51%+	0.174	0.092	0.079	0.158	-0.021	0.132	1.955	3.385	-6.805	7.556

Table D4.3. Estimated effects of student background and school variables on science instruction variables, from OLS regressions: 1992. (Cont'd)

Independent Variables	Emphasis: inquiry learning		Emphasis: practical applications		Emphasis: facts and principles		Minutes/day of homework assigned		Minutes/week lab work	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Number 12th Grade Students Enrolled										
Ln(enrollment)	0.007	0.032	-0.05	0.048	0.028	0.046	-1.051	1.081	3.097	2.5
School Accountability										
Eval. by test scores	0.084	0.038	-0.038	0.046	0.051	0.042	0.947	0.912	4.602	2.597
School recognition	-0.015	0.061	0.041	0.096	0.043	0.11	-2.248	1.636	1.949	3.741
Graduation Requirements										
Science min. competency	-0.02	0.056	0.091	0.085	0.069	0.074	2.059	2.095	-1.443	4.293
Years science	-0.094	0.034	0.01	0.041	0.055	0.045	-2.272	0.916	-5.98	2.529
School Organizational Characteristics										
Teachers' rating of principal's leadership	-0.078	0.037	-0.095	0.054	-0.035	0.059	-2.322	1.344	-2.843	3.747
Teacher influence: methods	0.058	0.029	0.109	0.046	0.008	0.048	0.832	0.978	-0.443	2.462
Teacher influence: curriculum	0.025	0.017	-0.001	0.028	0.013	0.023	0.523	0.594	2.779	1.49
Teachers coordinate content	0.035	0.034	0.147	0.057	0.094	0.059	1.897	1.752	3.072	3.154
Teachers discuss content	0.173	0.056	0.273	0.083	-0.115	0.083	0.373	1.987	1.809	4.309
R-Squared	0.102		0.094		0.044		0.063		0.047	
N	2,493		2,492		2,491		2,463		2,464	

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88).

Table D4.3. Effects of school variables on science instruction, from OLS regressions. (Cont'd)

Independent Variables	Emphasis on lab work		% class time devoted to whole-class		% class time devoted to discipline		Frequency of computer use		Frequency of student oral reports	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	1.07	0.823	40.579	28.439	3.181	9.089	0.731	0.716	0.967	0.552
Student Socioeconomic Background										
SES Composite	0.062	0.028	0.406	0.949	-1.108	0.257	0.074	0.022	0.017	0.018
Student Sex (vs. Male)										
Female	0.094	0.039	2.191	1.196	0.288	0.425	0.006	0.037	0.045	0.025
Student Race/Ethnicity (vs. White)										
Asian	0.073	0.072	-1.971	2.15	-0.702	0.716	0.139	0.066	0.006	0.048
Hispanic	0.047	0.076	-3.262	2.245	1.402	1.05	-0.051	0.065	-0.007	0.061
Black	0.004	0.084	-0.723	2.37	1.547	1.323	0.161	0.09	0.057	0.062
American Indian	-0.04	0.173	-0.807	7.038	0.925	1.493	-0.08	0.084	0.12	0.133
Urbanicity (vs. Suburban)										
Urban	-0.015	0.066	2.849	2.437	-1.143	0.726	-0.042	0.062	0.051	0.053
Rural	0.033	0.084	-3.054	2.763	-0.476	0.782	-0.079	0.065	-0.018	0.049
Region of U.S. (vs. Northeast)										
Midwest	-0.015	0.101	2.483	3.155	0.052	0.787	0.006	0.081	-0.037	0.057
South	-0.052	0.098	4.105	3.416	0.328	0.923	-0.061	0.065	0.133	0.056
West	-0.094	0.095	-2.581	3.344	0.027	0.918	-0.165	0.082	0.083	0.061
School Control Type (vs. Public)										
Catholic	0.062	0.109	3.106	4.569	1.086	1.201	-0.125	0.12	-0.16	0.097
NAIS	0.39	0.157	5.015	4.549	-0.695	1.167	0.188	0.168	-0.119	0.138
Other Private	-0.15	0.16	4.003	10.468	1.776	3.655	-0.247	0.121	0.016	0.243
% Federal Lunch (vs. 0-5%)										
6-20%	0.197	0.074	-3.674	2.203	-0.394	0.646	0.071	0.063	0	0.05
21-50%	0.221	0.094	-2.415	2.929	0.213	0.798	0.085	0.063	-0.064	0.055
51%+	0.048	0.158	3.778	3.641	-0.979	1.023	0.064	0.105	-0.07	0.095

Table D4.3. Effects of school variables on science instruction, from OLS regressions. (Cont'd)

Independent Variables	Emphasis on lab work		% class time devoted to whole-class		% class time devoted to discipline		Frequency of computer use		Frequency of student oral reports	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Number 12th Grade Students Enrolled										
Ln(enrollment)	0.083	0.043	-0.204	1.444	0.164	0.444	0.04	0.041	-0.051	0.034
School Accountability										
Eval. by test scores	0.117	0.048	-1.863	1.689	0.306	0.385	0.021	0.038	-0.05	0.025
School recognition	0.004	0.053	1.644	2.103	0.93	0.845	-0.068	0.06	-0.101	0.046
Graduation Requirements										
Science min. competency	-0.133	0.073	3.348	2.545	2.743	1.131	-0.033	0.068	0.068	0.047
Years science	-0.09	0.043	0.194	1.347	0.66	0.426	-0.011	0.037	-0.011	0.028
School Organizational Characteristics										
Teachers' rating of principal's leadership	-0.083	0.052	-2.382	1.861	-0.224	0.644	-0.035	0.054	0.011	0.044
Teacher influence: methods	0.022	0.041	3.375	1.564	-0.938	0.456	0.005	0.031	0.016	0.029
Teacher influence: curriculum	0.045	0.023	-0.096	0.887	-0.736	0.276	0.063	0.023	0.004	0.017
Teachers coordinate content	0.018	0.049	0.182	1.558	0.581	0.548	0.025	0.055	0.061	0.036
Teachers discuss content	0.222	0.065	-4.617	2.302	-0.545	0.814	0.17	0.065	0.221	0.054
R-Squared	0.094		0.052		0.055		0.072		0.074	
N	2,518		2,475		2,446		2,516		2,520	

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88).

Table D5.1. Effects of student background, school variables, class achievement level, teacher education, and instructional variables on sophomore-to-senior achievement growth in mathematics, from OLS regressions: 1992.

Independent Variables	Model 1		Model 2		Model 3	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	15.363	4.35	16.158	4.711	17.137	4.553
Sophomore IRT-Estimated Number Right: Math						
Test Score	0.866	0.014	0.862	0.015	0.848	0.014
Urbanicity (vs. Suburban)						
Urban	0.151	0.437	-0.176	0.447	-0.063	0.422
Rural	-0.004	0.36	-0.09	0.361	-0.028	0.354
Region of the Country (vs. Northeast)						
Midwest	-0.506	0.412	-0.622	0.417	-0.599	0.426
South	-0.589	0.382	-0.574	0.398	-0.456	0.415
West	-1.284	0.466	-1.219	0.485	-1.102	0.5
School Control Type (vs. Public)						
Catholic	0.496	0.7	0.779	0.714	0.524	0.702
NAIS	0.493	0.658	1.413	0.759	1.133	0.712
Other Private	0.669	0.853	0.975	0.882	0.625	0.865
% Students Receiving Subsidized Lunches (vs. 0-5%)						
6-20%	-0.053	0.392	-0.18	0.411	-0.191	0.394
21-50%	-0.651	0.342	-0.657	0.355	-0.577	0.36
51%+	-0.712	0.532	-0.628	0.537	-0.705	0.537
Number 12th Grade Students						
Ln(enrollment)	0.101	0.255	0.201	0.254	0.069	0.252
Student Sex (vs. Male)						
Female	-1.041	0.257	-1.037	0.267	-1.017	0.271

Table D5.1. Effects of student background, school variables, class achievement level, teacher education, and instructional variables on sophomore-to-senior achievement growth in mathematics, from OLS regressions: 1992. (Cont'd)

Independent Variables	Model 1		Model 2		Model 3	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Student Sex (vs. Male)						
Female	-1.041	0.257	-1.037	0.267	-1.017	0.271
Student Race/Ethnicity (vs. White)						
Asian	0.323	0.441	0.183	0.491	0.006	0.539
Hispanic	0.046	0.585	0.069	0.588	-0.051	0.616
Black	-0.833	0.445	-0.753	0.466	-0.92	0.481
American Indian	0.88	0.847	1.25	0.937	0.937	0.921
Student Socioeconomic Background						
SES Composite	0.574	0.203	0.549	0.213	0.508	0.216
Class Achievement Level (vs. Average)						
AP	2.718	0.607	2.739	0.63	2.438	0.733
Above Average	1.161	0.344	1.148	0.364	0.934	0.377
Low	-1.656	0.428	-1.569	0.441	-1.157	0.469
Remedial	-3.129	0.708	-3.018	0.75	-2.509	0.776
Teacher Education (vs. Major/none)						
Major/major			0.156	0.357	0.121	0.356
Major/minor			-0.514	0.39	-0.611	0.405
Minor only			-0.461	0.375	-0.435	0.376
None/none			-1.528	0.457	-1.155	0.439

Table D5.1. Effects of student background, school variables, class achievement level, teacher education, and instructional variables on sophomore-to-senior achievement growth in mathematics, from OLS regressions: 1992. (Cont'd)

Independent Variables	Model 1		Model 2		Model 3	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Instructional Variables						
% class time spent in whole group discussion					0.125	0.17
% class time spent maintaining order					-0.405	0.157
Minutes/day of homework assigned					0.013	0.01
Emphasis on higher-order thinking skills					0.732	0.248
Emphasis on practical applications					-0.594	0.272
Emphasis on mechanical operations					0.041	0.259
R-Squared	0.856		0.858		0.862	
N	4,671		4,354		4,110	

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table D5.2. **Effects of student background, school variables, class achievement level, teacher education, and instructional variables on sophomore-to-senior achievement growth in science, from OLS regressions: 1992.**

Independent Variables	Model 1		Model 2		Model 3	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E
Intercept	12.255	2.873	12.174	2.816	11.877	2.872
Sophomore IRT-Estimated Number Right: Science						
Test Score	0.726	0.018	0.725	0.019	0.729	0.017
Urbanicity (vs. Suburban)						
Urban	0.202	0.29	0.162	0.304	0.355	0.252
Rural	0.154	0.277	0.237	0.276	0.486	0.241
Region of U.S. (vs. Northeast)						
Midwest	0.033	0.265	0.003	0.275	-0.049	0.267
South	-0.346	0.258	-0.32	0.279	-0.436	0.266
West	0.096	0.306	0.191	0.329	0.325	0.307
School Control Type (vs. Public)						
Catholic	0.515	0.669	0.421	0.688	0.063	0.409
NAIS	-1.032	1.212	-1.134	1.309	-1.403	1.323
Other Private	-0.439	0.598	-0.232	0.622	-0.605	0.635
% Students Receiving Subsidized Lunch (vs. 0-5%)						
6-20%	-0.026	0.335	0.039	0.345	-0.257	0.256
21-50%	-0.429	0.312	-0.472	0.318	-0.682	0.276
51%+	-0.519	0.384	-0.536	0.407	-0.908	0.379
Number 12th Grade Students						
Ln(enrollment)	0.212	0.125	0.202	0.132	0.254	0.118
Student Sex (vs. Male)						
Female	-0.559	0.2	-0.576	0.21	-0.42	0.194
Student Race/Ethnicity (vs. White)						
Asian	-0.122	0.363	-0.315	0.293	-0.466	0.312
Hispanic	-0.548	0.284	-0.526	0.306	-0.455	0.31
Black	-0.915	0.304	-0.912	0.322	-0.779	0.316
American Indian	-2.152	0.832	-2.625	0.826	-1.823	0.779

Table D5.2. Effects of student background, school variables, class achievement level, teacher education, and instructional variables on sophomore-to-senior achievement growth in science, from OLS regressions: 1992. (Cont'd)

Independent Variables	Model 1		Model 2		Model 3	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E
Student Socioeconomic Background						
SES Composite	0.304	0.129	0.241	0.134	0.22	0.136
Student Achievement Level (vs. Average)						
AP	1.092	0.347	0.993	0.378	0.77	0.423
Above Average	0.917	0.211	0.9	0.22	0.913	0.221
Low	-0.813	0.377	-0.749	0.393	-0.524	0.419
Teacher Education (vs. Major/none)						
Major/major			0.484	0.304	0.371	0.268
Major/minor			0.122	0.296	0.239	0.3
Minor only			0.032	0.267	0.006	0.259
None/none			-0.092	0.272	-0.064	0.313
Instructional Variables						
% class time spent in whole group instruction					0.054	0.095
% class time spent maintaining order					-0.009	0.152
Minutes/day of homework assigned					0.002	0.007
Emphasis on lab work					-0.02	0.175
Emphasis on inquiry skills					0.246	0.221
Emphasis on practical applications					-0.351	0.146
Emphasis on scientific facts					0.063	0.135
Use of computers					0.142	0.171
Use of student presentations					0.041	0.17
R^2	0.668		0.666		0.683	
N	3,090		2,832		2,619	

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table D5.3. Estimated effects of student background, school, class achievement level, teacher, and instruction variables on grade 12 composite mathematics achievement, by grade 10 composite mathematics achievement quartile, from OLS regressions: 1992.

Subsample:	Grade 10 achievement quartile 1 (lowest)		Grade 10 achievement quartiles 2 & 3 (middle)		Grade 10 achievement quartile 4 (highest)	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	5.22	8.724	21.423	6.163	27.554	6.628
Sophomore IRT-Estimated Number Right: Mathematics						
Test Score	0.953	0.082	0.779	0.03	0.622	0.036
Urbanicity (vs. Suburban)						
Urban	-0.797	0.644	0.086	0.547	0.303	0.515
Rural	0.083	0.529	-0.156	0.502	0.18	0.393
Region of U.S. (vs. Northeast)						
Midwest	-0.828	0.917	-1.147	0.564	0.135	0.358
South	0.47	0.688	-0.828	0.567	-0.356	0.436
West	0.025	0.882	-0.893	0.656	-1.367	0.474
School Control (vs. Public)						
Catholic	2.888	3.054	0.316	0.87	0.522	0.827
NAIS	-2.324	1.475	-1.792	1.601	1.753	0.855
Other private	-5.07	2.057	1.134	1.245	0.011	0.988
% Students Receiving Subsidized Lunch (vs. 0-5%)						
6-20%	1.392	0.77	-0.18	0.532	-0.808	0.418
21-50%	0.62	0.819	-0.601	0.477	-0.823	0.499
51%+	-0.602	0.829	-0.416	0.636	0.25	0.694
Number 12th Grade Students						
Ln(enrollment)	0.348	0.353	0.039	0.321	0.019	0.29
Student Sex (vs. Male)						
Female	-0.979	0.486	-1.372	0.405	-0.482	0.284
Student Race/Ethnicity (vs. White)						
Asian	3.342	1.456	-0.915	0.68	0.158	0.59
Hispanic	0.357	0.606	-0.747	0.782	0.42	0.653
Black	-1.056	0.645	-0.419	0.62	-1.546	1.064
American Indian	0.716	1.434	1.003	1.116	0.23	1.115

Table D5.3. Estimated effects of student background, school, class achievement level, teacher, and instruction variables on grade 12 composite mathematics achievement, by grade 10 composite mathematics achievement quartile, from OLS regressions: 1992. (Cont'd)

Subsample:	Grade 10 achievement quartile 1 (lowest)		Grade 10 achievement quartiles 2 & 3 (middle)		Grade 10 achievement quartile 4 (highest)	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Student Socioeconomic Background						
SES Composite	0.567	0.364	0.357	0.263	0.529	0.244
Student Achievement Level (vs. Average)						
AP	3.387	1.288	5.713	2.416	3.568	0.641
Above Average	2.128	0.803	1.007	0.491	1.221	0.438
Low	-0.761	0.552	-0.93	0.626	-0.129	1.01
Remedial	-1.392	0.832	-2.346	1.25	-3.648	1.148
Teacher Education (vs. Major/none)						
Major/major	0.559	0.924	0.242	0.508	-0.022	0.406
Major/minor	0.559	0.983	-0.696	0.57	-0.591	0.418
Minor only	-0.534	0.646	-0.322	0.45	-0.475	0.572
None/none	-0.277	0.653	-1.511	0.586	-0.82	0.604
Instructional Variables						
% class time spent in whole group instruction	0.098	0.245	0.254	0.255	0.008	0.162
% class time spent maintaining order	-0.442	0.206	-0.504	0.2	-0.084	0.197
Minutes/day of homework assigned	0.028	0.017	0.018	0.014	0	0.01
Emphasis on higher order thinking skills	0.409	0.429	0.737	0.325	0.703	0.389
Emphasis on practical applications	-1.006	0.514	-0.548	0.347	-0.33	0.27
Emphasis on mechanical operations	-0.069	0.469	-0.089	0.361	0.034	0.302
R-Squared	0.388		0.577		0.47	
N	536		2,009		1,565	

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table D5.4. Estimated effects of student background, school, class achievement level, teacher, and instruction variables on composite grade 12 science achievement, by grade 10 composite science achievement quartile, from OLS regressions: 1992.

Subsample:	Grade 10 achievement quartile 1 (lowest)		Grade 10 achievement quartiles 2 & 3 (middle)		Grade 10 achievement quartile 4 (highest)	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	16.362	6.791	6.582	3.414	15.675	4.655
Sophomore IRT-Estimated Number Right: Science						
Test Score	0.336	0.117	0.842	0.049	0.521	0.047
Urbanicity (vs. Suburban)						
Urban	0.21	0.62	0.475	0.311	0.619	0.452
Rural	1.029	0.564	0.361	0.285	0.284	0.349
Region of U.S. (vs. Northeast)						
Midwest	-1.605	0.617	0.027	0.31	-0.299	0.349
South	-1.323	0.69	-0.296	0.31	-0.541	0.357
West	0.292	0.752	0.773	0.413	-0.397	0.464
School Sector (vs. Public)						
Catholic	0.758	1.03	0.205	0.566	-0.573	0.52
NAIS	1.378	1.563	-0.631	0.812	-1.881	1.588
Other Private	-1.519	1.688	-0.119	0.826	0.085	1.178
% Students Receiving Subsidized Lunch (vs. 0-5%)						
6-20%	0.321	0.836	-0.216	0.343	-0.153	0.285
21-50%	-0.492	0.726	-0.366	0.332	-0.743	0.362
51%+	-0.693	0.872	-0.441	0.482	-1.232	0.666
Number 12th Grade Students						
Ln(enrollment)	-0.058	0.325	0.301	0.15	0.032	0.176
Student Sex (vs. Male)						
Female	0.471	0.513	-0.587	0.255	-0.391	0.248
Student Race/Ethnicity (vs. White)						
Asian	-1.668	1.484	-1.324	0.411	0.758	0.385
Hispanic	-1.955	0.794	-0.446	0.437	0.408	0.543
Black	-1.696	0.589	-0.43	0.353	-0.062	0.878
American Indian	-3.938	1.365	0.884	0.732	-0.449	0.99

Table D5.4. Estimated effects of student background, school, class achievement level, teacher, and instruction variables on composite grade 12 science achievement, by grade 10 composite science achievement quartile, from OLS regressions: 1992. (Cont'd)

Subsample:	Grade 10 achievement quartile 1 (lowest)		Grade 10 achievement quartiles 2 & 3 (middle)		Grade 10 achievement quartile 4 (highest)	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Student Socioeconomic Background						
SES Composite	0.034	0.368	0.196	0.195	0.304	0.19
Student Achievement Level (vs. Average)						
AP	0.431	1.267	1.075	0.513	0.867	0.537
Above Average	0.998	0.646	0.983	0.302	0.622	0.315
Low	0.696	0.84	-0.66	0.4	-1.986	0.761
Teacher Education (vs. Major/none)						
Major/major	0.196	0.701	0.772	0.311	0.19	0.375
Major/minor	2.243	0.775	-0.084	0.421	0.413	0.352
Minor only	0.147	0.713	-0.367	0.325	0.664	0.385
None/none	0.285	0.755	0.047	0.44	0.272	0.546
Instructional Variables						
% class time spent in whole group instruction	0.124	0.226	-0.095	0.131	0.134	0.115
% class time spent maintaining order	-0.345	0.3	0.004	0.173	0.217	0.217
Minutes/day of homework assigned	0.037	0.012	0.004	0.008	-0.005	0.01
Emphasis on lab	-0.003	0.362	-0.157	0.231	-0.029	0.258
Emphasis on inquiry learning	0.608	0.558	-0.117	0.335	0.485	0.306
Emphasis on practical applications	-0.391	0.444	-0.51	0.192	-0.078	0.185
Emphasis on scientific facts	0.566	0.342	-0.025	0.18	0.02	0.181
Use of computers	-0.373	0.298	0.107	0.224	0.425	0.244
Use of student presentations	0.035	0.447	0.355	0.239	-0.312	0.236
R-Squared	0.34		0.438		0.231	
N	309		1,224		1,086	

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table D5.5. Estimated effects of student background, school variables, class achievement level, teacher education, and instructional variables on the probability of proficiency[a] at different levels of grade 12 mathematics, from OLS regression: 1992.

Dependent Variable:	Probability of Profic.: Level 1		Probability of Profic.: Level 2		Probability of Profic.: Level 3		Probability of Profic.: Level 4		Probability of Profic.: Level 5	
Subsample:	Grade 10 profic.<Level 1 (lowest)		Grade 10 profic.=Level 1		Grade 10 profic.=Level 2		Grade 10 profic.=Level 3		Grade 10 profic.=Level 4	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	41.153	44.306	0.728	45.279	170.409	61.953	64.008	41.115	-33.942	18.903
Grade 10 Probability of Proficiency at Each Level										
Grade 10 test	0.406	0.053	0.75	0.055	0.615	0.056	0.834	0.041	2.451	0.208
Student Sex (vs. Male)										
Female	-2.42	2.544	-1.48	2.796	-7.185	3.726	-1.888	2.094	-4.487	1.18
Student Race/Ethnicity (vs. White)										
Asian	1.612	3.957	3.427	9.613	1.871	8.022	-16.76	4.875	-0.652	2.629
Hispanic	2.74	2.981	-1.669	4.201	-11.029	6.282	-2.125	5.673	-0.291	2.407
Black	-6.075	3.466	-4.264	4.536	2.537	5.559	-5.644	7.875	-7.397	2.672
American Indian	-4.25	4.689	2.852	8.031	5.841	23.112	-0.444	12.289	-7.577	2.342
Student Socioeconomic Background										
SES Composite	-2.094	1.796	10.859	2.536	6.482	2.581	1.845	1.865	0.816	0.772
Urbanicity (vs. Suburban)										
Urban	-9.228	3.53	-4.903	4.942	2.264	5.393	4.14	3.844	1.667	1.823
Rural	-0.646	3.166	-2.577	3.951	9.441	5.051	-2.086	3	4.853	1.699

Table D5.5. Estimated effects of student background, school variables, class achievement level, teacher education, and instructional variables on the probability of proficiency[a] at different levels of grade 12 mathematics, from OLS regression: 1992. (Cont'd)

Dependent Variable:	Probability of Profic.: Level 1		Probability of Profic.: Level 2		Probability of Profic.: Level 3		Probability of Profic.: Level 4		Probability of Profic.: Level 5	
Subsample:	Grade 10 profic.<Level 1 (lowest)		Grade 10 profic.=Level 1		Grade 10 profic.=Level 2		Grade 10 profic.=Level 3		Grade 10 profic.=Level 4	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Region of U.S. (vs. Northeast)										
Midwest	-5.999	3.889	-1.242	4.358	-10.796	5.671	2.819	3.078	4.727	2.005
South	-1.851	3.593	9.529	4.891	-9.074	5.366	3.317	3.028	1.337	2.472
West	-4.233	4.172	-0.77	5.397	1.844	6.395	-3.091	4.243	-0.804	2.359
School Control Type (vs. Public)										
Catholic	13.02	6.615	11.856	8.453	15.139	9.907	-7.386	5.653	0.768	2.553
NAIS	4.875	9.896	41.766	10.982	-7.162	12.333	4.22	7.781	13.588	7.181
Other Private	0	0	-14.257	11.743	-34.561	20.464	8.276	7.639	6.592	3.96
% Students Receiving Subsidized Lunch (vs. 0-5%)										
6-20%	5.838	3.835	0.519	4.429	-8.022	5.384	-10.105	3.237	-3.81	1.645
21-50%	7.702	4.029	-0.215	4.264	-10.12	5.113	-9.257	3.369	-2.738	1.888
51%+	5.14	4.085	-4.665	4.995	-1.569	7.343	-4.459	4.95	-6.93	2.486

Table D5.5. Estimated effects of student background, school variables, class achievement level, teacher education, and instructional variables on the probability of proficiency[a] at different levels of grade 12 mathematics, from OLS regression: 1992. (Cont'd)

Dependent Variable:	Probability of Profic.: Level 1		Probability of Profic.: Level 2		Probability of Profic.: Level 3		Probability of Profic.: Level 4		Probability of Profic.: Level 5	
Subsample:	Grade 10 profic.<Level 1 (lowest)		Grade 10 profic.=Level 1		Grade 10 profic.=Level 2		Grade 10 profic.=Level 3		Grade 10 profic.=Level 4	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Number 12th Grade Students										
Ln(enrollment)	6.084	2.335	1.394	2.11	-2.125	2.95	0.87	2.022	2.649	0.943
Achievement Level (vs. Average)										
AP	0	0	28.323	6.739	-7.786	11.949	12.555	4.33	20.701	2.125
Above Average	8.298	2.688	3.112	3.54	0.652	5.228	5.975	2.61	5.704	1.114
Low	-6.404	3.12	-7.036	3.723	-15.869	5.709	-6.115	4.635	2.775	3.05
Remedial	-17.839	5.291	-15.053	6.034	-20.669	7.732	-2.729	10.393	4.797	3.963
Teacher Education (vs. Major/none)										
Major/major	-0.013	4.322	4.62	3.886	-6.509	4.792	1.802	3.524	1.124	1.606
Major/minor	4.419	3.302	-0.184	5.121	-3.51	6.6	-4.703	3.142	-4.385	1.721
Minor only	2.277	3.599	0.033	3.873	-2.335	4.103	-3.289	2.725	-1.121	1.837
None/none	0.667	3.276	-1.342	4.792	5.821	6.457	-11.722	3.763	-6.098	4.383

Table D5.5. **Estimated effects of student background, school variables, class achievement level, teacher education, and instructional variables on the probability of proficiency[a] at different levels of grade 12 mathematics, from OLS regression: 1992. (Cont'd)**

Dependent Variable:	Probability of Profic.: Level 1		Probability of Profic.: Level 2		Probability of Profic.: Level 3		Probability of Profic.: Level 4		Probability of Profic.: Level 5	
Subsample:	Grade 10 profic.<Level 1 (lowest)		Grade 10 profic.=Level 1		Grade 10 profic.=Level 2		Grade 10 profic.=Level 3		Grade 10 profic.=Level 4	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Instructional Variables										
% class time spent in whole group instruction	-0.019	1.287	1.372	1.703	-4.748	2.273	0.515	1.522	2.01	0.934
% class time spent maintaining order	1.276	1.5	-2.789	1.374	-2.338	2.253	0.6	1.357	-2.814	0.726
Minutes/day of homework assigned	-0.161	0.08	0.12	0.086	0.406	0.141	0	0.082	-0.045	0.035
Emphasis on higher order thinking skills	4.723	2.415	0.225	2.858	7.423	3.252	9.201	2.236	-0.602	1.325
Emphasis on practical applications	-4.359	2.207	-5.695	2.853	-4.517	3.286	-4.774	1.975	0.252	1.124
Emphasis on mechanical operations	-3.806	2.675	-0.948	2.962	3.166	3.419	-1.501	2.529	-1.519	1.3
R-Squared	0.567		0.500		0.424		0.534		0.497	
N	367		656		506		1,066		1,152	

[a] **The levels of proficiency are described in the text of Chapter 5.**

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), Second Follow-Up survey.

Table D5.6. **Estimated effects of student background, school variables, class achievement level, teacher education, and instructional variables on the probability of proficiency[a] at different levels of grade 12 science, from OLS regression: 1992.**

Dependent Variable:	Probability of Proficiency: Level 1		Probability of Proficiency: Level 2		Probability of Proficiency: Level 3		Probability of Proficiency: Level 3	
Subsample:	Grade 10 profic.<Level 1		Grade 10 profic.=Level 1		Grade 10 profic.=Level 2		Grade 10 profic.=Level 3	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Intercept	137.571	59.175	-23.475	40.928	61.275	43.853	82.03	56.701
Grade 10 Probability of Proficiency at Each Level								
Grade 10 test	0.251	0.057	0.637	0.04	0.631	0.054	0.376	0.059
Urbanicity (vs. Suburban)								
Urban	6.04	6	6.376	3.914	7.178	3.862	3.672	4.224
Rural	9.434	6.586	2.814	3.322	5.837	3.552	-1.655	4.732
Region of U.S. (vs. Northeast)								
Midwest	-9.761	7.836	1.717	3.723	3.662	3.727	-5.347	4.353
South	-5.28	8.139	0.535	3.787	1.117	3.64	-6.058	5.02
West	13.071	8.47	4.454	4.306	8.921	5.455	-1.694	5.145
School Control Type (vs. Public)								
Catholic	6.793	11.988	3.761	5.825	6.007	7.773	-4.855	7.666
NAIS	10.387	13.01	3.041	9.5	-3.784	8.192	-1.134	13.948
Other Private	-29.538	13.58	15.574	13.506	-16.181	11.881	-8.563	14.384

Table D5.6. Estimated effects of student background, school variables, class achievement level, teacher education, and instructional variables on the probability of proficiency[a] at different levels of grade 12 science, from OLS regression: 1992. (Cont'd)

Dependent Variable:	Probability of Proficiency: Level 1		Probability of Proficiency: Level 2		Probability of Proficiency: Level 3		Probability of Proficiency: Level 3	
Subsample:	Grade 10 profic.<Level 1		Grade 10 profic.=Level 1		Grade 10 profic.=Level 2		Grade 10 profic.=Level 3	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
% Students Receiving Subsidized Lunch (vs. 0-5%)								
6-20%	-0.471	7.006	4.851	3.973	-1.916	3.927	0.919	3.5
21-50%	-1.894	6.371	-0.206	4.118	-10.265	4.201	-3.493	4.745
51%+	-19.11	10.235	-1.962	4.883	-10.358	7.031	-17.232	9.532
Number 12th Grade Students								
Ln(enrollment)	-2.738	3.879	2.067	1.894	2.094	2.071	0.905	2.293
Student Sex (vs. Male)								
Female	9.045	5.171	-8.317	2.371	-8.974	2.934	-6.101	3.311
Student Race/Ethnicity (vs. White)								
American Indian	-41.745	18.166	10.363	6.84	8.46	13.152	-26.709	15.266
Asian	-33.131	11.431	-3.92	4.944	-10.821	4.364	3.552	6.121
Hispanic	-16.707	8.886	-1.796	4.744	-13.171	5.803	4.3	8.072
Black	-9.557	7.019	-10.695	4.481	-8.079	5.505	-21.573	10.396
Student Socioeconomic Background								
SES Composite	1.767	3.096	0.41	1.948	3.478	2.455	6.321	2.711

Table D5.6. Estimated effects of student background, school variables, class achievement level, teacher education, and instructional variables on the probability of proficiency[a] at different levels of grade 12 science, from OLS regression: 1992. (Cont'd)

Dependent Variable:	Probability of Proficiency: Level 1		Probability of Proficiency: Level 2		Probability of Proficiency: Level 3		Probability of Proficiency: Level 3	
Subsample:	Grade 10 profic.<Level 1		Grade 10 profic.=Level 1		Grade 10 profic.=Level 2		Grade 10 profic.=Level 3	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Achievement Level (vs. Average)								
AP	-3.059	11.218	9.473	6.637	16.756	5.475	13.132	5.876
Above Average	3.045	6.052	10.969	3.062	7.613	3.685	10.302	4.764
Low	-1.386	6.912	-7.539	3.61	-9.205	6.935	-19.509	9.995
Teacher Education (vs. Major/none)								
Major/major	5.609	6.542	2.906	3.336	2.569	3.482	5.496	3.596
Major/minor	13.435	7.267	-1.001	4.17	6.7	5.311	-0.021	4.39
Minor only	-4.38	6.546	-5.213	3.382	-1.259	4.756	8.94	5.063
None/none	-9.088	10.625	-2.338	4.007	-0.253	5.126	-4.288	8.092

Table D5.6. Estimated effects of student background, school variables, class achievement level, teacher education, and instructional variables on the probability of proficiency[a] at different levels of grade 12 science, from OLS regression: 1992. (Cont'd)

Dependent Variable:	Probability of Proficiency: Level 1		Probability of Proficiency: Level 2		Probability of Proficiency: Level 3		Probability of Proficiency: Level 3	
Subsample:	Grade 10 profic.<Level 1		Grade 10 profic.=Level 1		Grade 10 profic.=Level 2		Grade 10 profic.=Level 3	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Instructional Variables								
% class time spent in whole group instruction	5.186	2.379	1.03	1.273	-1.806	1.558	0.136	2.153
% class time spent maintaining order	-0.35	3.122	-0.253	1.744	-0.027	1.941	3.68	2.311
Minutes/day of homework assigned	0.176	0.11	-0.007	0.08	0.005	0.066	-0.168	0.144
Emphasis on lab	-0.461	4.566	-0.659	2.288	-1.879	2.615	-1.586	3.364
Emphasis on inquiry skills	7.349	5.979	2.65	3.045	6.346	3.686	4.878	4.256
Emphasis on science in society	1.768	4.111	-2.578	1.932	-9.085	2.128	1.868	2.278
Emphasis on scientific facts	1.349	3.256	-0.574	1.664	-3.67	2.255	0.732	2.211
Use of computers	-4.033	4.117	-1.65	2.377	1.695	2.709	5.161	3.043
Use of student presentations	-6.077	5.415	4.29	2.396	-1.698	3.007	3.899	3.169
R-Squared	0.46		0.477		0.331		0.362	
N	283		684		821		572	

[a] The levels of proficiency are described in the text of Chapter 5.

United States
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