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ABSTRACT

The question examined in this paper is whether variability in the quantity of schooling students receive in different curricular areas is a contributor to observed differences in achievement not only among students attending different high schools, but among students in the same high school. A conceptual framework enumerates the determinants of achievement, including school and community characteristics, student background, and quantity of schooling in the specific curricular areas of mathematics, English, foreign language, fine arts, social studies, and science. The sample used was 9,195 high school seniors in 725 schools taken from the National Longitudinal Study of the High School Class of 1972, a nationally representative probability sample of high school seniors. The results suggest that quantity of schooling has a positive effect on academic achievement. The more the achievement is school-related, the larger is the resulting effect of the quantity of schooling. This was especially true for mathematics. Quantity of schooling also had positive effects on achievement in science and English; less clear results were found in the areas of vocabulary and reading comprehension, although quantity of schooling did continue to have a positive effect on achievement. (Author/MLF)

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THE HIGH-SCHOOL CURRICULUM: IT DOES MAKE A DIFFERENCE

William H. Schmidt

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Abstract

This paper examines the issue of whether variability in the quantity of schooling students receive in different curricular areas is a contributor to observed differences in achievement not only among students attending different high schools, but among students in the same high school. A conceptual framework is posited articulating the determinants of achievement, including school and community characteristics, student background, and quantity of schooling in a specific curricular area. Six areas of the curriculum are examined: mathematics, English, foreign language, fine arts, social studies, and science. The sample used in the paper was 9,195 high school seniors in 725 schools taken from a nationally representative probability sample of high school seniors (National Longitudinal Study of the High School Class of 1972). The results suggest, in general, that quantity of schooling has a positive effect on academic achievement. It would further appear that the more the achievement is school-related, the larger the resulting effect that the quantity of schooling has. This was especially true for mathematics. Also in areas of achievement such as science and English, positive effects were found for the quantity of schooling in the corresponding area. In those areas of achievement such as vocabulary and reading comprehension, that seem more likely to be influenced by non-school factors, there were less clear results, but quantity of schooling did continue to have a positive effect on achievement. The fact that the multiple R^2's for these analyses were less than those for mathematics, science, and English, indicates that these areas were most likely influenced by factors and events outside of school.

Acknowledgments

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THE HIGH-SCHOOL CURRICULUM: IT DOES MAKE A DIFFERENCE

William H. Schmidt[1]

Introduction

Researchers and policy makers have both noted the large variations in academic achievement among students within and between high schools (see Coleman, Cambell, Halsin, McPartland, Mood, Weinfeld, & York, Note 1; Jencks, 1972). This variability has been attributed to students' backgrounds and/or the quality of the school, as determined by the experience of its teachers and its facilities and resources. Recent work has also considered the social characteristics of high schools to further explain variations in student achievement (see Rutter, 1979). Varying degrees of student ability and/or prior achievement as well as different social class backgrounds have also been used to explain achievement differences.

The hypothesis here is simple: In addition to the above characteristics, variability in the quantity of schooling students receive in different curricular areas is a powerful contributer to the observed differences in achievement. These variations in quantity arise from differences in what is available to students as well as from variations in students' course selections. Differences in quantity of schooling potentially explain part of the differences in achievement not only among students attending different high schools, but among students in the same high school.

[1]William H. Schmidt is coordinator of IRT's Language Arts Project and a member of the Content Determinants Project. He is also an MSU professor of educational psychology.

Across high schools, differences in student achievement could result, at least in part, from differences in courses offered. For example, certain schools might not offer courses in mathematics beyond high school algebra. Students attending those schools would automatically be limited in the amount of mathematics coursework they could take.

Within a high school, achievement differences among students could be partly explained by differences in both the type and quantity of courses students take. Students may choose, or be advised to choose by school counselors, unique and individual class schedules. Thus although two students may attend the same school, they may, by their own choice, be exposed to radically different curricula.

Whether differences among students in curricular exposure are because of differences in course availability or in course selection, the hypothesized effect is the same: The more courses and time spent in a given curricular area, the better the resulting achievement in that area.

Recent work has examined the effect of quantity of schooling on academic achievement. Wiley and Harnischfeger (1974) demonstrated in elementary schools that the quantity of schooling children received is related to academic achievement as measured by tests of verbal ability, reading comprehension, and mathematics. Because they did not have specific curricular data defined at the student level, they relied on school characteristics such as length of the school day, average daily attendance, and length of the school year to define quantity of schooling. Their analyses simulated the effects of these school characteristics on pupil achievement.

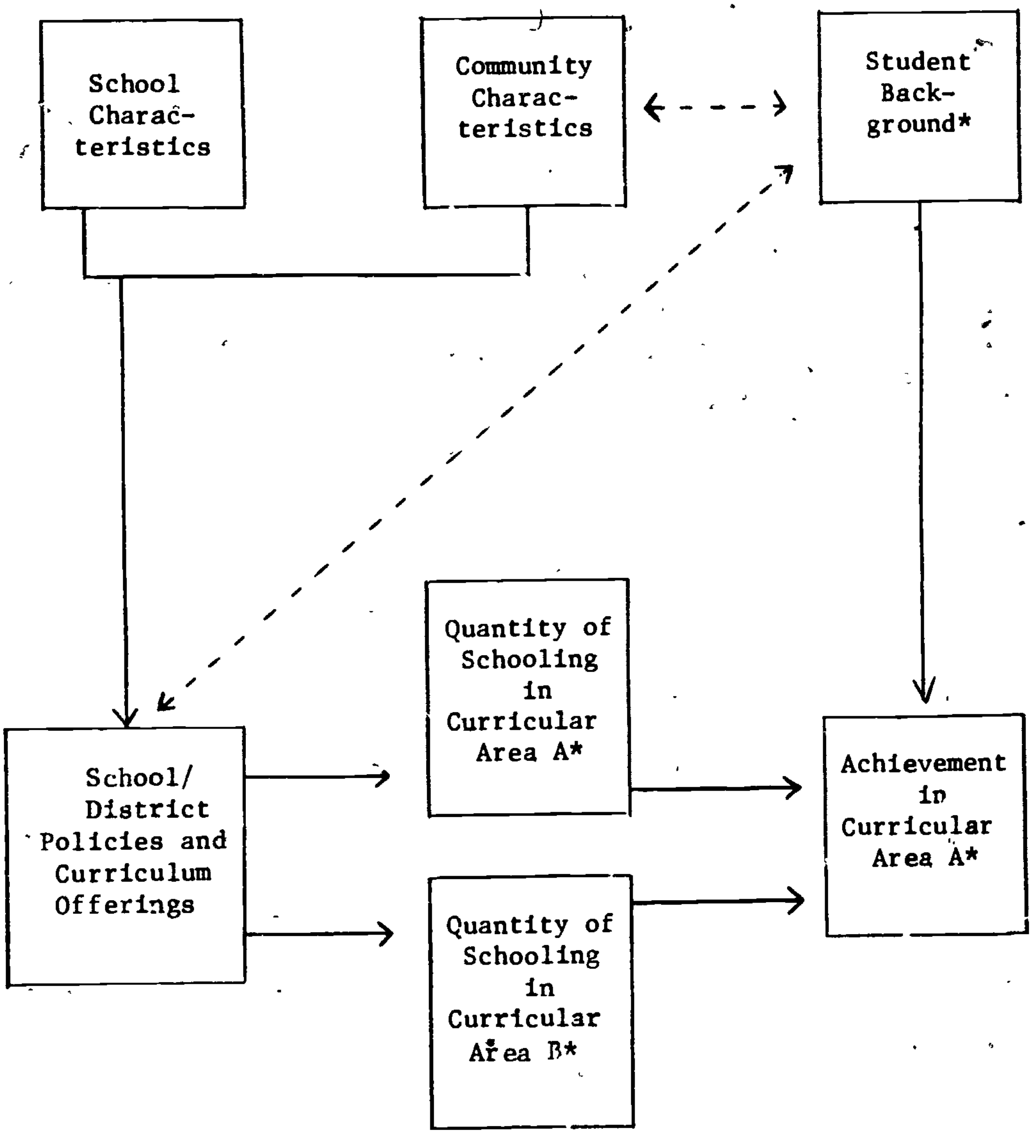
In the California Beginning Teacher Evaluation Study (Fisher, Filby, Marliave, Cahen, Dishaw, Moore, & Berliner, Note 2), data were collected on the amount of time individual students spent in academic pursuits related to reading and mathematics. This measure was related to student performance as measured by achievement tests in these two areas. Results again suggest, in general, that the more time spent in a subject matter, the higher the corresponding achievement. The researchers focussed on the amount of time students were actively engaged in the learning process and not the amount of time available to the students in the curricular area.

The research reported in this paper examines the effect of the quantity of schooling in six specific curricular areas (mathematics, English, foreign language, fine arts, social studies, and science) on academic achievement at the secondary-school level. Quantity of schooling is defined as the number of hours of instruction received by students during the last three years of high school. Measures of quantity of schooling were related to student academic performance as measured by tests of vocabulary, reading comprehension, mathematics achievement, science achievement, social studies achievement, and English achievement.

Conceptual Framework

Overview

The model shown in Figure 1 revoles around three basic concepts, each defined at the level of the individual student: background characteristics, achievement, and the quantity of schooling received in a particular curricular area. The major focus of the model is that achievement in a particular curricular area (A) is a function of both the student's background and the amount of schooling s/he receives in that curricular area (A) and in other curricular areas related to it (denoted as Curricular Area B in the model). The other three



* Defined at the individual student level.

Figure 1. Determinants of student achievement in Curricular Area A.

components of the model related to the quantity of schooling are characteristics of high schools, characteristics of communities in which the schools are located, and school and district policies and curriculum offerings.

The second focus of the model is the quantity of schooling received by a student and its relationship to school and district policies and the student's background. School and district policies include policies that define the length of an instructional period, the length of the school year, the number of class periods per week, and each school's curricular offerings. The model further states that such policies themselves are influenced by characteristics of high schools and of the communities those schools are in.

The dotted lines in Figure 1 suggest the probable relationships between student background and community characteristics and between student background and school and district policies. The exact nature of these relationships is complex and is not detailed in this paper because it is not of central interest to the work reported here.

School and district policies and course offerings play a central role in the model shown in Figure 1, but unfortunately no data are available to directly define their effects on quantity of schooling. For this reason, the empirical work reported in this paper examines the direct relationship of school and community characteristics to the quantity of schooling in different curricular areas instead of the indirect relationship posited in the model.

The work reported here centers on two issues: (1) student background and quantity of schooling as determinants of academic achievement, and (2) community and school characteristics and student background as determinants of the quantity of the schooling received in each curricular area.

Student Background

Four indicators were used (within the constraints of the data available) to characterize student background: sex, race, socio-economic status (SES), and ability. The inclusion of race in the model recognizes differences typically found in academic achievement between different racial groups. Inclusion of SES recognizes that students with different socio-economic statuses have different academic advantages. Ability, as used here, is thought of as indicative of the student's learning rate, which can be influenced by the student's prior achievement as well as his/her aptitudes. Ability would certainly be related to achievement in any curricular area.

Quantity of Schooling

The model suggests that the quantity of schooling in Curricular Area A is related to achievement in Curricular Area A, an obvious relationship. The quantity of schooling in Curricular Area B is included in the model to suggest that the quantity of schooling in other areas of the curriculum can influence achievement in Curricular Area A. For example, one would expect the quantity of schooling in mathematics to be related to achievement in science.

Quantity of schooling in a curricular area is defined as the total number of hours of instruction in that area a student receives during his/her last three years of high school. Figure 2 shows how this concept is defined. *Number of semesters* in a curricular area indicates the number of semesters a student has taken coursework in the curricular area during his/her last three years of high school. The courses meet for a specific *number of weeks per semester*. The two combined define the *total number of weeks* taken in that curricular area. The *number of periods per week* combines in a complex function

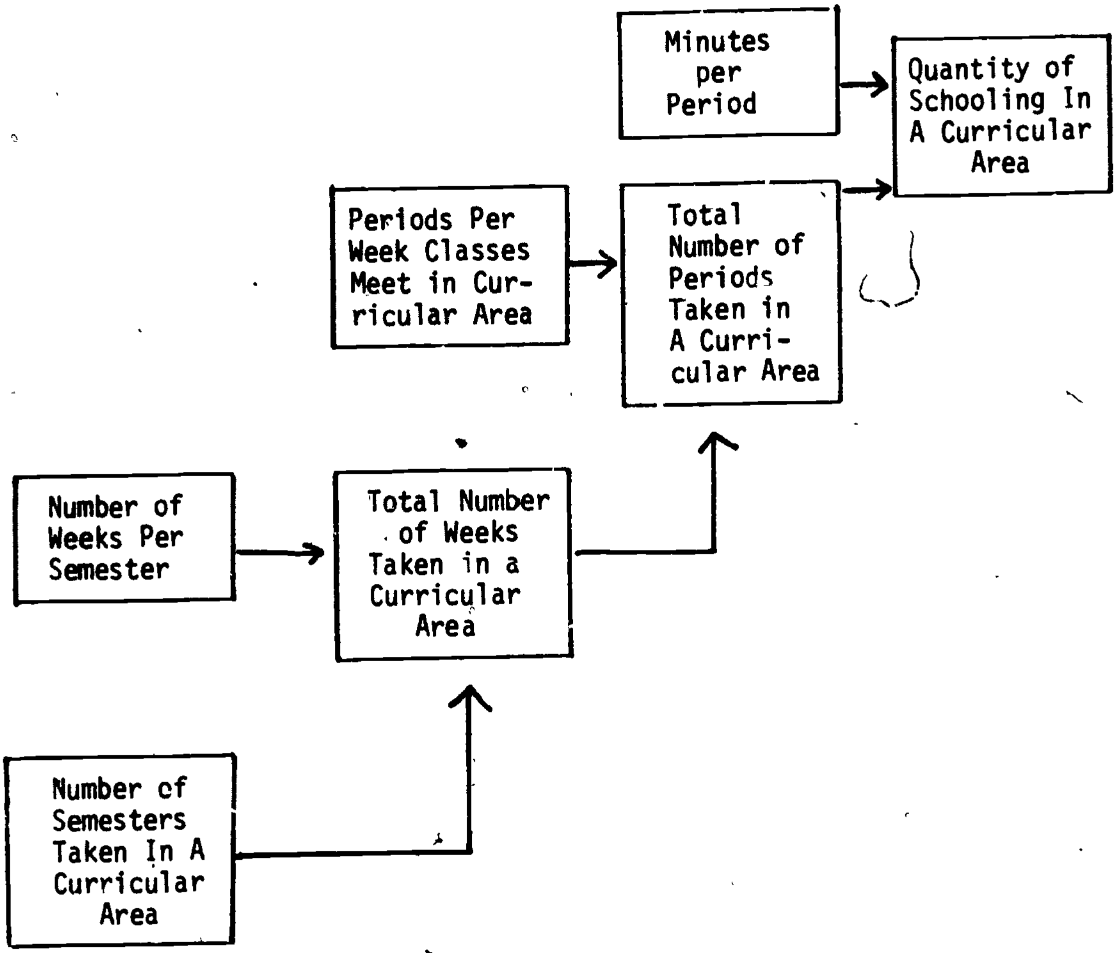


Figure 2. Definition of quantity of schooling in a curricular area for an individual student.

with the total number of weeks taken in a curricular area to define the *total number of periods* taken in a curricular area. The number of periods per week that a course meets can vary across curricular areas. This combines with the *number of minutes of instruction per period* to define the *total amount of time, expressed in hours, of potential exposure* in a curricular area.

The concept of quantity of schooling refers to the total amount of schooling received by a student in a curricular area. This concept refers neither to the amount of time that the student is actively engaged in learning nor to the amount of time that s/he receives formal instruction, but rather to the amount of time that s/he is at least nominally exposed to schooling of some sort. In this way, quantity of schooling is a measure of exposure to a certain curricular area.

Quantity of schooling as represented in Figure 2 is applicable to any of the six curricular areas considered in this paper. Several concepts defining quantity of schooling, such as the total number of semesters taken and the number of periods per week that the course meets, are particular to each curricular area or course. The latter quantity is constant across students taking that course within a given high school, but can vary across courses within a high school as well as across different high schools.

Two of the other concepts are not idiosyncratic to each curricular area but are general across curricular areas within a school. These are the number of minutes in a period and the number of weeks in a semester. Although these concepts are constant with respect to students in the same school, they do vary across high schools.

School and Community Characteristics

School and community characteristics are included in the model to suggest our conception that they indirectly influence quantity of schooling (through curricular related policies and course offerings), and hence indirectly affect achievement.

Because of the availability of information in the data base, the only school characteristic used is enrollment size. The size of the school often affects the variety of course offerings, which in turn affect the quantity of schooling received.

The second concept is defined in terms of community characteristics. Two are considered: the percentage of minority students in attendance at the school and the wealth of the community the school is in.

Elaboration of the Relationships Posited in the Model

Relationships between the variables described above are suggested by the model. The major focus of this study is on the relationship between quantity of schooling (in each of the six curricular areas) and academic achievement.

The model suggests that achievement as measured in one curricular area is influenced by the quantity of schooling not only in that area, but also, at least potentially, by the quantity of schooling in other curricular areas. For example, one of the areas of achievement of concern in the present study is reading comprehension. It seems reasonable to believe that almost all curricular areas within the school might have an influence on achievement in such a broad area. The model in Figure 1 suggests this influence by the inclusion of the concept "quantity of schooling in Curricular Area B." The examination of this relationship must also account for the direct effect of student background on achievement; ability, race, sex, and socio-economic status do have achievement effects.

The student's background can influence quantity of schooling in numerous ways. For example, that which is valued in a student's home environment and that which s/he perceives is required to meet his/her occupational aspirations might influence his/her course selection.

A student's background might also influence his/her placement in a particular high-school program. American high schools generally have three programs: academic, vocational, and general. The conception on which this model is based suggests that a student's background can influence the way in which school personnel perceive him/her, and hence can influence the student's assignment to one of the three high-school programs. The student's high school program is likely to predispose him/her to take certain courses and not others.

School and community characteristics are also assumed to influence the quantity of schooling. The model suggests that they indirectly influence quantity of schooling through district or high-school policies.

School and community characteristics can also influence quantity of schooling by influencing curricular offerings. What the school has available as curricular offerings in a curricular area automatically sets limits on the quantity of schooling a student can receive.

Characteristics such as school size, percentage of minority students in the school, and the wealth of the community the school is in might influence the availability of such offerings.

Such characteristics can also influence the nature of the courses provided in a curricular area. Certain types of schools, such as those serving low-income areas, might provide more remedial offerings and less advanced course work. This has implications for the quantity of schooling received and its relationship to achievement. One might, for example, speculate in the above situation that the quantity of schooling would bear a different relationship to achievement in such schools.

The Data and Variables

Description of the NLS Sample

The data reported on in this paper were collected by the National Center for Education Statistics as a part of the National Longitudinal Study of the High School Class of 1972 (NLS). The primary purpose of the NLS was to describe and relate the status of young people after high school to their high-school experiences. A probability sample for the study was drawn to represent all twelfth graders who were enrolled in public, private, and church affiliated high schools in the U.S. in 1972.[2]

School and Community Variables

The sampling design for NLS contained six "super strata." The super strata were an integral part of the original sampling design and hence important to account for in the analyses. Also, they were based on characteristics of schools and communities relevant to the issues suggested in the previous section. Therefore, the

[2]The national probability sample was designed to include 1,200 high schools and 21,600 students. During the spring term of 1972, data were obtained on 16,683 students in 990 high schools throughout the United States. Because the students were sampled as a part of a national probability sample, the data can be weighted to represent national figures. The sample design for the study was a deeply stratified two-stage probability sample with schools selected at the first stage and students at the second stage. Seven variables were used to define the stratification of the high schools, which resulted in 600 final strata.

six super strata are used to further define the concepts of school and community characteristics.

The school variable is the grade-twelve enrollment of the high school. Size is characterized by three levels: (1) less than 300 (small); (2) 300-599 (middle-sized); and (3) 600 or more (large). The median income of the people in the area where the high school was located (community wealth) was combined with the racial-ethnic composition of the high school to represent the community variable. There were two levels to this variable, termed here type of high school: (1) high-minority and/or low-income schools--those located in low income areas as defined by the census data and/or those schools which have high proportions of minority students (20% or higher) and (2) all other high schools. The combination of these two variables, school type and school size, define the six categories of high schools surveyed in this study.

Student Background Variables

Race. A dichotomous index for race was created. Students were asked to identify themselves as either American Indian, black, Chicano or Mexican-American, Puerto Rican, other Latin American, Oriental, white, or other. Their responses were collapsed into two levels: (1) all students who indicated that they were white, and (2) students who indicated any other category.

Socio-economic status (SES) index. This is a composite measure based on father's education, mother's education, family income, father's occupation, and the possession of certain household items. The SES index, derived by NLS, was formed after the individual variables were subjected to a factor analysis that revealed a common factor with approximately equal weights for each of these variables. Each component was then standardized, and an equally weighted combination of the five standard scores yielded the SES composite. The SES variable is continuous and ranges from negative to positive values; the more negativ the value the lower the SES, and the more positive the value the higher the SES.

Ability Variables

Ability is used to account for differences in learning rate. Each student in the sample was asked to complete a 69-minute test measuring both verbal and nonverbal abilities. The test consisted of six sub-tests. The tests used to characterize ability are described below.

Picture number. This is a test of associative memory consisting of a series of drawings of familiar objects, each paired with a number. The student, after studying the picture-number pairs, was asked to recall the number associated with each picture (39 items, 10 minutes).

Letter groups. This test of inductive reasoning requires the student to draw general concepts from sets of data or to form and try out hypotheses in a nonverbal context. The items consist of five groups of letters among which four groups share a common characteristic while the fifth group is different. The student was to indicate which group differed from the others (25 items, 15 minutes).

Mosaic comparisons. This test measures perceptual speed and accuracy by asking the student to detect small differences between pairs of otherwise identical mosaics of tile-like patterns. This was deliberately a speeded test, consisting of increasingly more complex mosaic patterns (116 items, 9 minutes).

These three tests were not totally satisfactory as indicants of ability, but they are the only ability tests available from the NLS data base. The three tests do differ from other tests used to characterize achievement in that they are less directly related to the kinds of curricular experiences that students have in high school. In this way, they represent attainments less subject to the direct influence of the high-school curriculum.

Achievement Variables

Achievement is defined in terms of seven tests. The major analyses described in the next section used the three sub-tests administered as a part of the NLS battery referred to previously. The tests described below measure vocabulary, reading, and mathematics.

Vocabulary. This tests knowledge of synonyms. The items were selected to avoid academic or collegiate bias and to be of an appropriate difficulty level for twelfth-grade students (15 items, 5 minutes).

Reading. This test presents short passages (100-200 words) then asks several related questions concerning a variety of reading skills (analysis, interpretation), but primarily concerning comprehension (20 items, 15 minutes).

Mathematics. The student was to indicate which of two quantities was greater, whether they were equal, or whether there was a lack of sufficient data to determine which quantity was greater. This type of item was designed to measure basic mathematics competence (25 items, 15 minutes).

Also available are ACT scores for a subset of students in the sample. There are four ACT subtests: English Expression, Social

Studies, Science Reading, and Mathematics. Since these four tests were available on a very small proportion of the sample, they were only used in supplementary analyses to replicate and support the main analyses.

Quantity of Schooling Variables

The School Record Information Form (SRIF), collected as a part of the NLS, described the complete curricular history of each student during his/her last three years of high school by detailing the number of courses taken in each area and the number of periods per week that each course met. This information was provided by a high-school administrator, not by the student. The other variables needed to measure quantity of schooling as defined in Figure 2 were the number of weeks in a semester and the number of minutes in a standard period. These data were available from a school questionnaire. The latter was asked directly and given in minutes.

Use of this reported quantity to derive a measure of quantity of schooling assumes that the length of the class period did not change over the two years prior to the study. The number of weeks per semester was only available as the number of weeks in the school year. It was halved to indicate the number of weeks per semester. This, of course, assumes an equal number of weeks per semester, which is probably not totally accurate.

These variables were used to compute an estimate of the total number of hours of schooling that each student received in each of the six curricular areas over his/her last three years of high school (see Figure 3). These are generally overestimates because such things as absences, holidays, and assemblies are not taken into account.

The calculation of the six quantity-of-schooling variables can be described in the following way:

Let

x_1 = number of semester courses taken in area A which meet one period a week

x_2 = number of semester courses taken in area A which meet two periods a week

x_3 = number of semester courses taken in area A which meet three periods a week

x_4 = number of semester courses taken in area A which meet four periods a week

x_5 = number of semester courses taken in area A which meet five periods a week

x_6 = number of semester courses taken in area A which meet six periods a week

M = number of minutes per period
W = number of weeks per semester

then the total number of periods taken per week in Area A (represented as P) is given by

$$P = (1)(x_1) + (2)(x_2) + (3)(x_3) = (4)(x_4) + (5)(x_5) + (6)(x_6).$$

P, when multiplied by W, gives the total number of periods taken by the student during his last three years of high school.

$$T = P(W).$$

Multiplying T by M gives the total number of minutes of schooling in area A over the student's last three years of high school. Dividing T by 60 converts the metric to hours. This process was repeated for all of the six curricular areas and was done for each individual student.

Figure 3. Calculation of the six quantity-of-schooling variables.

However, they could be underestimates if the two previously cited assumptions necessary to their calculation were violated.

The quantity-of-schooling measure is also a measure of content exposure because more time spent studying in a curricular area generally results in more content exposure. Because of remedial courses and the general lack of comparability of courses to one another in some curricula, this relation does not hold unequivocally. But in general, given the above caveat, it can be assumed that the greater the quantity of schooling in a curricular area, the greater the content coverage.

Description of the Sample Used in the Analyses

After cleaning the data, the final sample for analysis included 725 schools and 9,195 students. These schools and students distributed themselves over the six categories of schools as described in Table 1. Table 1 not only gives the number of students and schools in the sample for each category, but also indicates the percentage of schools and students in each of these sub-populations.

It is clear from Table 1 that the vast majority of American high schools have less than 300 students enrolled in twelfth grade. Although the largest percentage of high schools have less than 300 twelfth graders, only about 50% of the seniors attend such high schools. By contrast, about 4% of the schools had senior enrollments of more than 600 students, yet over 15% of the twelfth graders in the United States attend such high schools. Slightly more than 28% of all senior students attend high-minority and/or low-income (as defined earlier) high schools.

Table 1

Population and Sample Frequencies
For the Total Sample and the Six School Categories

TYPE OF SCHOOL	SIZE OF SCHOOL	Number of Schools In the Sample	Percentage of Schools In the Population	Number of Students In the Sample	Percentage of Students In the Population
High Minority and/or Low Income	<300	174	33.29	2,128	15.06
	300-599	110	3.95	1,315	9.31
	≥600	58	1.10	651	3.95
All Others	< 300	171	49.25	2,347	34.23
	300-599	138	9.56	1,793	25.92
	≥600	74	2.85	961	11.54
All Types	<300	345	82.54	4,475	49.29
	300-599	248	13.51	3,108	35.23
	≥600	132	3.95	1,612	15.49
High Minority and/or Low Income	ALL SIZES	342	38.34	4,094	28.32
All Others	ALL SIZES	383	61.66	5,101	71.69
TOTAL SAMPLE		725	100.00	9,195	100.00

Analyses

Relationship of School and Community Characteristics to Background, Achievement, and Quantity of Schooling

Means for the achievement and background variables for each of the six categories of schools as well as for the three sizes and the two types of schools are presented in Table 2. Achievement in vocabulary, reading, and mathematics was less, on the average, for students attending schools with a high percentage of minority students and/or located in a low-income area. The ability measures also reflect these differences. Table 2 shows that the achievement of students attending large high schools was greater than that of students attending small schools. In fact, the average achievement increases, in a monotonic fashion, from those students attending small schools to those students attending large schools. This pattern, however, is not borne out by the ability measures.

Table 3 indicates the mean number of hours of schooling for students attending each of the six categories of schools. In all areas except foreign language and fine arts, students attending high-minority and/or low-income schools received more hours of schooling than students attending other high schools. These differences were most pronounced in English; students attending high-minority and/or low-income schools received about 5% more schooling over three years in English than did students attending the other high schools.[3] The reverse pattern holds

[3] It must be remembered when examining the figures in Table 3 that it was not possible to discriminate between the different types of courses included within each curriculum category. So, for example, English would include remedial courses as well as advanced courses such as Elizabethan Literature. One explanation for the larger amount of time to which the typical student attending high-minority and/or low-income schools is exposed in the areas of English and mathematics might be that many of the courses taken are remedial. If so, the larger quantity would be misleading. Even though there is a larger quantity of schooling in these areas on the average, the courses might differ markedly in terms of content level.

Table 2

Means of the Background and Achievement Variables for the Total Sample and the Six School Categories

TYPE OF SCHOOL	SIZE OF SCHOOL	ACHIEVEMENT			ABILITY			%	SES	%
		Vocabulary	Reading	Mathematics	Picture Number	Letter Groups	Mosaic Comparisons	Male		White
High Minority and/or Low Income	<300	5.058	8.796	11.324	16.839	15.053	44.366	.475	-.378	.746
	300-599	5.776	9.020	11.508	16.478	15.356	43.362	.447	-.124	.625
	≥600	6.115	9.389	12.581	16.447	16.066	44.981	.479	-.007	.641
All Others	< 300	7.033	10.501	14.241	18.163	17.302	47.531	.486	.032	.925
	300-599	7.067	10.600	13.940	17.215	17.208	47.208	.484	.176	.904
	≥ 600	7.556	10.937	14.684	17.820	17.676	47.012	.487	.357	.916
All Types	< 300	6.094	9.690	12.854	17.533	16.233	46.026	.481	-.163	.840
	300-599	6.521	9.931	12.911	16.903	16.424	45.786	.468	.049	.786
	≥ 600	6.974	10.312	13.835	17.266	17.026	46.192	.484	.210	.805
High Minority and/or Low Income	ALL SIZES	5.457	8.962	11.583	16.661	15.311	44.141	.467	-.237	.690
All Others		7.143	10.618	14.219	17.765	17.339	47.444	.485	.144	.916
TOTAL SAMPLE		6.393	9.881	13.045	17.273	16.436	45.974	.477	-.026	.816

Table 3

Means of the Quantity of Schooling Variables for the Total Sample and the Six School Categories

TYPE OF SCHOOL	SIZE OF SCHOOL	Science	Social Studies	Foreign Language	English	Mathematics	Fine arts
High Minority and/or Low Income	< 300	308.233	438.332	111.520	508.100	304.522	130.302
	300-599	292.211	421.256	172.382	477.985	317.386	126.148
	≥ 600	300.508	409.065	200.540	470.192	327.368	152.167
All Others	< 300	291.565	416.181	179.953	463.405	289.429	141.388
	300-599	291.191	421.176	184.910	473.251	301.994	151.566
	≥ 600	277.432	393.324	192.666	464.787	300.116	144.688
All Types	< 300	299.491	426.714	147.411	484.659	296.606	136.116
	300-599	291.623	421.210	179.609	475.254	308.506	140.811
	≥ 600	286.751	399.681	195.846	466.970	311.122	147.708
High Minority and/or Low Income	ALL SIZES	301.858	428.193	145.224	492.399	312.287	132.445
All Others		288.771	413.63[illegible]	184.090	467.126	295.859	145.587
TOTAL SAMPLE		294.598	420.115	166.786	478.379	303.173	139.736

for foreign languages and fine arts. Students attending the other high schools were exposed to more schooling in these areas than were students attending the high-minority and/or low-income high schools. Students attending the other high schools received, on the average, 27% more time in foreign language than did students attending the high-minority and/or low-income high schools.

The number of hours of science, social studies, and English instruction decreases as the size of the school increases. For foreign language, mathematics, and fine arts, the opposite pattern holds. This might be because only large schools have enough students interested in the technical areas of foreign language, mathematics, and fine arts to justify hiring specialized teachers. The most dramatic difference is for foreign languages. Students attending large schools are exposed to foreign languages, on the average, for 33% more time than students attending small high schools.

Tables 4 and 5 present the same information given in Tables 2 and 3, only the means are weighted to reflect the national population. Note that there are very small differences between the weighted means and the unweighted means. The subsequent analyses in this paper were all done using the unweighted data.[4]

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[4]This was done because the computer software necessary to perform the correct weighted analyses, especially the correct estimation of the standard errors, was not available to me at the time of analysis. Given this limitation, the unweighted analyses were perfored because standard errors are essential to any correct interpretation of the data. The means in Tables 4 and 5 are presented to (1) suggest that the differences in using the weighted analyses are not likely to be that great and (2) to provide weighted national profiles on these variables.

(Footnote 4 continued on page 25.)

Table 4

Weighted Means of the Quantity of Schooling Variables for the Total Sample and the Six School Categories

TYPE OF SCHOOL	SIZE OF SCHOOL	% of Population in Each Category	Vocabulary	Reading	Mathematics	Picture Number	Letter Groups	Mosaic Comparisons	% Male	SES	% White
High Minority and/or Low Income	<300	15.06	5.09	8.82	11.45	16.90	15.15	44.50	.48	-.39	.76
	300-599	9.31	5.75	9.01	11.50	16.44	15.37	43.29	.45	-.11	.65
	≥600	3.95	6.24	9.53	12.77	16.58	16.25	44.77	.49	-.01	.67
All Others	<300	34.23	7.04	10.50	14.25	18.11	17.30	47.29	.48	.02	.93
	300-599	25.92	7.06	10.63	14.06	17.19	17.33	47.26	.49	.17	.91
	≥600	11.54	7.60	10.98	14.85	17.86	17.71	47.73	.49	.33	.93
All Types	<300	49.29	6.44	9.99	13.39	17.74	16.64	46.44	.48	-.11	.88
	300-599	35.23	6.71	10.20	13.38	16.99	16.81	46.21	.48	.10	.84
	≥600	15.49	7.25	10.61	14.32	17.53	17.34	46.98	.49	.24	.86
High Minority and/or Low Income	ALL SIZES	28.32	5.47	8.98	11.65	16.70	15.38	44.14	.47	-.24	.71
All Others		71.69	7.14	10.62	14.28	17.74	17.38	47.35	.49	.12	.93
TOTAL SAMPLE		100.00	6.69	10.19	13.58	17.46	16.84	46.49	.48	.02	.86

Table 5

Weighted Means of the Quantity of Schooling Variables for the Total Sample and the Six School Categories

TYPE OF SCHOOL	SIZE OF SCHOOL	% of Population in Each Category	Science	Social Studies	Foreign Language	English	Mathematics	Fine Arts
High Minority and/or Low Income	<300	15.06	305.50	437.64	109.31	506.74	299.46	129.88
	300-599	9.31	289.88	418.82	173.44	474.52	315.96	129.73
	≥600	3.95	300.44	412.74	207.51	473.68	327.22	152.22
All Others	<300	34.23	293.39	414.07	179.59	462.41	289.26	140.21
	300-599	25.92	293.13	424.08	189.89	471.10	303.32	154.85
	≥600	11.54	281.14	391.60	192.50	459.87	300.32	142.72
All Types	<300	49.29	297.09	421.27	158.12	475.95	292.38	137.05
	300-599	35.23	292.27	422.69	185.54	472.00	306.66	148.21
	≥600	15.49	286.06	396.99	196.33	463.39	307.18	145.14
High Minority and/or Low Income	ALL SIZES	28.32	299.66	427.98	144.09	491.54	308.76	132.94
All Others	ALL SIZES	71.69	291.32	414.07	185.39	465.14	296.12	145.91
TOTAL SAMPLE		100.00	293.53	417.73	174.47	472.15	299.54	142.45

Analysis of the Variation
in the Achievement, Background,
and Quantity of Schooling Variables

An analysis of variance was done to partition the total variation in the quantity of schooling, background characteristics, and achievement into that part of the variation which is attributable to students within schools, schools within the six categories of schools, and finally among the six categories of schools themselves. Since there was not the same number of students in each of the six school categories, it was necessary to do the analysis of variance twice.[5]

The results of these analyses for the achievement variables are presented in Table 6. The amount of variation among schools within the different school categories was small relative to the variation in achievement among students within the schools. In examining the variation among categories of schools, the F ratio suggests a marginal interaction of school type and school size for the vocabulary test. No such interactions were noted for either the reading or mathematics achievement tests. The major reason for the marginally significant interaction on the vocabulary test is that for students attending high-minority and/or low-income schools, there was a general increase as one moves from the smaller to the larger schools. But for students attending the other high schools, there was basically no achievement

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(Footnote 4 continued)

For several of the regression analyses presented in the analysis section, the weighted data were used as well, although they are not reported. The estimates of the coefficients arrived at using the weighted data were strikingly similar to the results obtained from the unweighted data in all cases. Since the correct standard errors were not attainable for the weighted analyses, I report only the unweighted analyses.

[5]The two ANOVA's were done with different orderings, one in which type of school was entered first in the decomposition and one in which size of school was entered first in the decomposition.

Table 6

Analysis Variance for Achievement Variables

Source of Variation	Degrees of Freedom	Mean Square		F-Ratio	
Among Groups of Schools					
Type of School	1				
Vocabulary		(6,191.06)*	6,462.03	(183.45)*	191.50
Reading		(6,057.57)	6,226.04	(128.42)	131.99
Mathematics		(15,470.95)	15,777.41	(140.22)	142.99
Size of School	2				
Vocabulary		(497.76)	362.28	(14.75)	10.74
Reading		(235.02)	150.78	(4.98)	3.20
Mathematics		(612.29)	459.05	(5.55)	4.16
Type by Size	2				
Vocabulary			116.29		3.45
Reading			5.35		.11
Mathematics			114.47		1.04
Among Schools Within Groups	719				
Vocabulary			33.74		2.31
Reading			47.17		2.12
Mathematics			110.34		2.37
Within Schools	8470				
Vocabulary			14.61		
Reading			22.30		
Mathematics			46.52		

* The results given in parentheses reflect the alternative ordering of the analysis and should be used for examining the effect of type of school, controlling for size of school. The results not given in parentheses are used for testing size of school, controlling for type of school.

difference between students attending the smallest school and students attending the next largest school.

The varying achievement differences across schools of different sizes are confirmed by the F ratios as being significant or at least marginally significant in all cases. The F ratio for vocabulary wa largest, indicating that the most pronounced difference across the three different school sizes had to do with vocabulary. This can be noted in Table 2, where the difference between students attending large and small schools represents about a 14% higher achievement level. (This difference in vocabulary is only interpretable if one chooses to ignore the marginal interactions suggested for vocabulary.)

The second analysis allowed examination of the differences among school type, controlling for school size. For all three variables, there are large differences between students attending high-minority and/or low-income schools and students attending all other high schools. These differences are all significant and, if one again chooses to ignore the type-of-school by size-of-school interaction for vocabulary, they are directly interpretable. The obvious conclusion is that, on the average, those students attending high-minority and/or low-income high schools achieve at considerably lower levels than students attending all other high schools.

These same issues can be examined for quantity of schooling (see Table 7). Again, two different analyses are presented. The differences among schools within school categories (Table 7) are much larger for the quantity-of-schooling variables than they were for the achievement variables (Table 6), All F ratios given in Table 7 for this source of variation are significant, indicating that a large percentage of the variation in quantity of schooling has to do with differences among

Table 7

Analysis Variance for Quantity of Schooling Variables

Source of Variation	Degrees of Freedom	Mean Square		R-Ratio	
Among Groups of Schools					
Type of School	1				
Hours of Science		(354,744.49)	389,005.78	(3.20)	.90
Hours of Foreign Language		(3,031,590.99)	3,430.785.05	(28.78)	32.57
Hours of Social Studies		(421,737.59)	481,654.75	(3.63)	4.14
Hours of English		(1,364,785.04)	1,450,647.60	(11.43)	12.14
Hours of Mathematics		(675,560.23)	612,928.33	(5.72)	5.20
Hours of Fine Arts		(365,356.74)	392,302.94	(2.41)	2.59
Size of School	2				
Hours of Science		(116,957.93)	99,827.29	(1.06)	.90
Hours of Foreign Language		(1,776,122.81)	1,576,525.78	(16.86)	14.97
Hours of Social Studies		(435,858.82)	405,900.24	(3.75)	3.49
Hours of English		(208,332.33)	165,401.05	(1.74)	1.38
Hours of Mathematics		(191,614.77)	222,930.72	(1.63)	1.89
Hours of Fine Arts		(82,342.87)	68,869.77	(.54)	.45
Type by Size	2				
Hours of Science			81,387.94		.74
Hours of Foreign Language			1,169,090.03		11.10
Hours of Social Studies			111,024.09		.95
Hours of English			446,532.39		3.74
Hours of Mathematics			23,317.43		.20
Hours of Fine Arts			141,321.02		.93
Among Schools Within Groups	719				
Hours of Science			110,690.52		5.82
Hours of Foreign Language			105,325.19		4.27
Hours of Social Studies			116,277.11		12.64
Hours of English			119,449.28		17.97
Hours of Mathematics			117,815.26		5.48
Hours of Fine Arts			151,781.50		4.19
Within Schools	8470				
Hours of Science			19,015.65		
Hours of Foreign Language			24,678.01		
Hours of Social Studies			9,197.30		
Hours of English			6,647.27		
Hours of Mathematics			21,496.27		
Hours of Fine Arts			36,206.07		

schools as compared to differences among students within schools. These differences reflect, at least in part, differences in course offerings and, hence, the availability of courses in each of the six curricular areas.

A further examination of Table 7 indicates that there is a significant interaction between school type and school size for the quantity of schooling in English and foreign languages. These differences are illustrated in Figure 4. Students attending small high-minority and/or low-income schools receive more English schooling than students attending other high schools. These differences are essentially negligible, however, for students attending schools in either of the two other size categories.

Students attending small high-minority and/or low-income schools received, on the average, 61% fewer hours of foreign language instruction than do students attending all other high schools. For the middle-sized schools, differences between the two groups were relatively small (only about 7%) and differences were even less than for the large schools. In fact, those students attending large high-minority and/or low-income schools received, on the average, more hours of foreign language than did their counterparts in other schools, although the differences are quite small (less than 5%).

The results in Figure 4 show that students attending high-minority and/or low-income schools received, on the average, more schooling in English but less in foreign language than did students attending other schools. The differences in English might suggest that small schools that also have a high-minority and/or low-income composition might tend to concentrate more of their curricular offerings on remediation, thus providing considerably more English courses than other schools of the same size. By contrast, it would appear that small

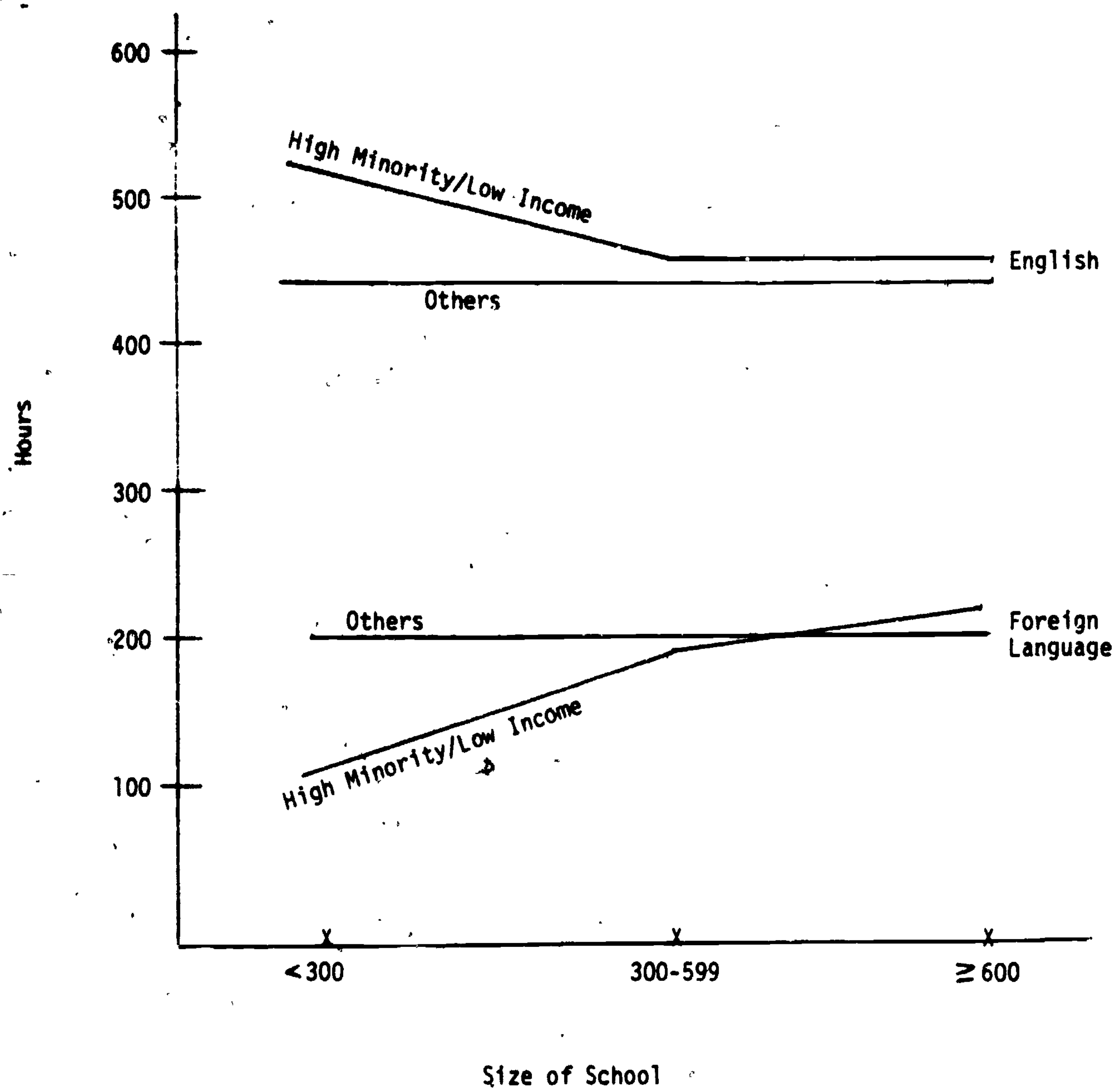

Figure 4. Graph of means for quantity of schooling variables English and foreign language for the six school categories.

high-minority and/or low-income schools provide considerably fewer courses in foreign language than do large schools.

A further examination of Table 7 indicates that different sized schools provide different amounts of social studies schooling. The biggest difference is that students attending large schools get fewer hours of course work in social studies than students attending middle-sized and small schools. There are minimal differences between middle-sized and small schools in quantity of social-studies schooling. All other differences in exposure among the three sizes of schools were not significant.

Table 7 gives results showing the effect of type of school on the quantity of schooling. The F ratios suggest differences in mathematics. (Note that there are significant F ratios for both foreign language and English, but these have already been discussed in the context of the significant interaction.) Students attending high-minority and/or low-income schools receive, on the average, about 6% more schooling in mathematics than do students attending all other schools (see Table 3). The nature of these courses is not known, and so these differences may indicate more mathematics of a highly sophisticated nature, more general remedial math courses, or more general business mathematics courses.

Table 8 presents the results of a similar analysis done with respect to the six background characteristics (the three ability tests, sex, race, and socio-economic status). There were differences for some of the ability measures and for race and SES.

Race exhibited a significant school-type by school-size interaction (see Figure 5). In small schools, there was a higher

Table 8
Analysis Variance for Background Variables

Source of Variation	Degrees of Freedom	Mean Square		F-Ratio	
Among Groups of Schools					
Type of School	1				
Picture-Number		(2,918.10)	2,770.39	(26.84)	25.48
Letter Groups		(9,108.31)	9,341.00	(141.35)	141.35
Mosaic Comparisons		(24,908.82)	24,780.60	(25.84)	25.71
Sex		(.83)	.81	(2.21)	2.14
SES		(301.84)	330.15	(190.36)	208.22
Race		(118.65)	115.48	(207.02)	201.47
Size of School	2				
Picture-Number		(364.30)	438.16	(3.35)	4.03
Letter Groups		(373.22)	255.88	(5.79)	3.98
Mosaic Comparisons		(99.46)	163.56	(.10)	.17
Sex		(.19)	.20	(.49)	.53
SES		(95.62)	81.47	(60.31)	51.38
Race		(2.78)	4.37	(4.84)	7.62
Type by Size	2				
Picture-Number			91.01		.84
Letter Groups			72.38		1.12
Mosaic Comparisons			630.22		.65
Sex			.18		.48
SES			2.73		1.72
Race			2.75		4.80
Among Schools Within Groups	719				
Picture-Number			108.71		1.80
Letter Groups			64.44		2.24
Mosaic Comparisons			963.97		5.49
Sex			.38		1.58
SES			1.59		4.18
Race			.47		5.70
Within Schools	8470				
Picture-Number			60.24		
Letter Groups			28.80		
Mosaic Comparisons			175.74		
Sex			.24		
SEX			.38		
Race			.10		

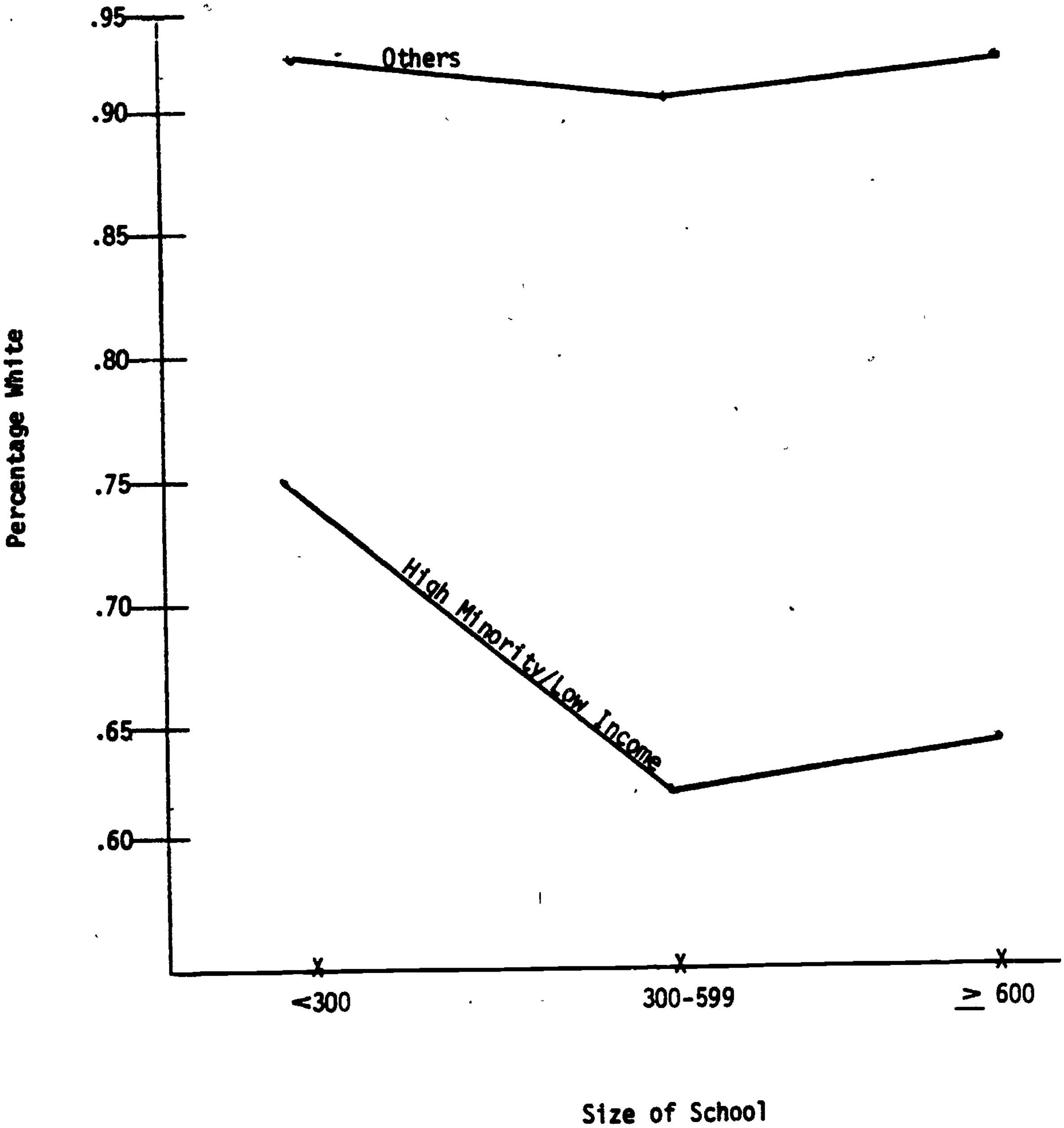

Figure 5. Graph of percentage White in the six school categories.

percentage of white students than in the middle-sized or large schools. This was especially true for small schools classified as high-minority and/or low-income.

Table 8 also gives the results of an examination of the effects of the two types of high schools on the six background characteristics. The results indicate large differences between the two types of high schools on two of the three ability measures--picture number and letter groups--and also on socio-economic status. This latter difference, however, is not very important because the economic status of the community was used, at least in part, to define the differences between the two types of schools. The significant F for race is not directly interpretable due to its involvement in a significant interaction. With respect to the two ability measures, the differences indicate that, on the average, students attending the high-minority and/or low-income schools performed more poorly than did students attending all other schools.

There were large differences across schools of different sizes in socio-economic status. Those students attending large schools were, on the average, of high socio-economic status, whereas those students attending small schools were, on the average, of low socio-economic status. This most likely reflects the nature of housing patterns within the United States. Most large high schools are located in and around major metropolitan areas, whereas small high schools are often located in small towns and rural areas. In general, the small towns and rural areas are populated with people of lower socio-economic status than are those areas surrounding the major metropolitan centers. It is likely that many of the large high schools are in suburban metropolitan areas. The one caveat that needs mentioning here is that large, central-city schools, which would have students with a lower SES, are so few in number that the average results in a higher SES overall for large schools.

A Further Analysis of the Variation Among Schools

Because the schools in the study are a probability sample of schools within each of the six categories of schools, and the students represent a random sample within each of the different schools, schools and students can be considered as random factors. As a way of further summarizing the results contained in Tables 6, 7, and 8 with regard to the amount of variation that is attributable to among-school differences versus among-students-within-school differences, intra-class correlation coefficients were calculated. These suggest the proportion of variation that is accounted for by differences among schools when contrasted with the differences among students within schools. Thus the larger these coefficients, the larger the variation that can be attributed to among-school differences as opposed to differences among students within schools.

The differences among students within schools reflect, in part, individual and family differences, whereas differences among schools indicate differences in the schools themselves and the neighborhoods in which they are located. However, because the among-school differences were derived within each of the six categories of schools, any of the major differences among schools that are related to or represented by the dimensions used to define the categories would be removed from the among-school differences. For example, some of the differences associated with the socio-economic status of the neighborhoods were removed because the definition of a low-income school was based on median income for the neighborhood in which the school was located (according to the U.S. census). This implies that the differences remaining among schools within categories are reflective of differences other than those captured in the definition of the six categories of schools.

Differences have to do with the course offerings available within a school, other characteristics of the school's educational environment, or neighborhood differences not controlled for by the six categories.

The intra-class correlations are presented in Table 9. Also in Table 9 are the national means for each of the variables as well as the standard deviation for schools and for students within schools. The coefficient of variation is the ratio of the standard deviation to the national mean. It makes the standard deviations for the different variables more directly comparable, since they are adjusted with respect to the variables' means and, hence, for their scale.

The intra-class correlations for the three achievement tests indicate that around 8 to 10% of the achievement variation is attributable to differences among schools. This is consistent with Wiley's (1973) figures of 10 to 12% for similar tests. The smaller values reported in this paper most likely reflect the among-school variation removed here, but not in the Wiley analysis, by controlling for the six categories of schools.

For the quantity-of-schooling variables, the intra-class correlations are generally much larger. They range from approximately 20 to 50%. This indicates that a considerable amount of quantity-of-schooling variation has to do with among-school differences. One explanation for the large proportion of variation that exists among schools, as contrasted with that among students within schools, is variety of course availability. The greatest variation among schools was in English and social studies. One explanation for the large intra-class correlation coefficient in English is that course requirements are regulated tightly within high schools that demand a fair amount of

Table 9

Intra-class Correlations (Proportions of Variance Accounted for by Schools) of the Three Achievement Tests (Reading, Vocabulary, and Mathematics) and of the Quantity of Schooling Measures in the Eight Curricular Areas, the Ability Measures, and the Background Characteristics

Variables	National Mean	BETWEEN SCHOOLS Standard Deviation	Coeff. of Variation	WITHIN SCHOOLS Standard Deviation	Coeff. of Variance	Intraclass correlation
Achievement						
Mathematics Test	13.045	10.504	.805	6.821	.523	.096
Vocabulary Test	6.393	5.809	.909	3.822	.598	.092
Reading Test	9.881	6.868	.695	4.772	.478	.079
Quantity of Schooling						
Hours/Science	294.598	332.702	1.129	137.897	.468	.271
Hours/Foreign Language	166.786	324.538	1.945	157.092	.942	.201
Hours/Social Studies	420.115	340.994	.812	95.903	.228	.473
Hours/English	478.379	345.614	.713	81.534	.170	.566
Hours/Math	303.173	343.173	1.132	146.616	.484	.256
Hours/Fine Arts	139.736	389.591	2.788	190.278	1.362	.197
Ability						
Picture Number	17.273	10.426	.604	7.761	.449	.058
Letter Groups	16.436	8.027	.488	5.367	.327	.087
Mosaic Comparisons	45.974	31.048	.675	13.257	.288	.257
Background						
Sex	.477	.616	1.292	.490	1.027	.042
Race	.816	.755	.925	.316	.387	.268
SES	-.026	1.261	-48.498	.616	-23.709	.197

uniformity across students. Those requirements do seem, however, to vary from school to school.

The intra-class correlation coefficients for the ability measures are somewhat consistent with those for the achievement tests, with the exception of the mosaic comparisons test. That test seems to have a much larger among-school component than the other five tests.

Tables 10 and 11 present further among-school results, only in this case the intra-class correlations reflect an adjustment for background characteristics and quantity of schooling. Table 10 gives the intra-class correlations for the three achievement tests and for the quantity-of-schooling measures adjusted for the ability and background characteristics. The results of this analysis reflect the proportion of variation attributable to differences among schools when contrasted with the variation among students within schools, after adjustments have been made to both the within-school and between-school standard deviations for differences in the ability and background variables. The results suggest that once one controls for the ability and background characteristics, the proportion of variation in achievement attributable to among-school differences drops substantially to between 2 and 4%. This implies that some of the achievement differences among schools were in part related to differences among schools in students' general ability and backgrounds.

Perhaps the most striking finding in Table 10 is that even after adjusting for the student's background and ability, the intra-class correlations for the quantity-of-schooling variables remain essentially the same as those given in Table 12. This implies that the large variations among schools in the quantity-of-schooling measures cannot be accounted for by corresponding differences among these schools in terms of average ability or of different student populations.

Table 10

Intraclass Correlations (Proportions of Variance Accounted for by Schools) of the Three Achievement Tests (Reading, Vocabulary and Mathematics and of the Quantity of Schooling Measures in the Eignt Curricular Areas Adjusted for the Ability and Background Variables

Variables	National Mean	BETWEEN SCHOOLS Adj. Sd. deviation	BETWEEN SCHOOLS Coeff. of Variance	WITHIN SCHOOLS Adj. Sd. deviation	WITHIN SCHOOLS Coeff. of Variance	Adjusted Intraclass Correlation
Achievement						
Mathematics Test	13.045	6.073	.466	4.901	.376	.040
Vocabulary Test	6.393	3.957	.619	3.381	.529	.028
Reading Test	9.881	4.331	.438	3.896	.394	.018
Quantity of Schooling						
Hours/Science	294.598	326.265	1.107	128.732	.437	.294
Hours/Foreign Language	166.786	287.204	1.721	145.493	.872	.182
Hours/Social Studies	420.115	340.571	.811	95.606	.228	.474
Hours/English	478.379	346.035	.723	81.174	.170	.569
Hours/Math	303.173	333.806	1.101	135.546	.447	.280
Hours/Fine Arts	139.736	384.639	2.753	188.481	1.349	.196

Table 11

Intraclass Correlations (Proportions of Variance Accounted for by Schools) of the Three Achievement Tests (Reading, Vocabulary and Mathematics) adjusted for the Quantity of Schooling Measures in the Eight Curricular Areas, and the Ability and Background Variables

Variables	National Mean	BETWEEN SCHOOLS Adj.Sd. Deviation	Coeff.of Variance	WITHIN SCHOOLS Adj.Sd. Deviation	Coeff.of Variance	Adjusted Intraclass Correlation
Achievement						
Mathematics Test	13.045	6.722	.515	4.463	.342	.089
Vocabulary Test	6.393	4.142	.648	3.233	.516	.047
Reading Test	9.881	4.617	.467	3.758	.380	.038

Table 11 presents the results of the corresponding analyses for the three achievement tests. There the adjustment is not only for the ability and background variables, but for the quantity of schooling measures in the six curricular areas as well. The intra-class correlations in this case drop appreciably for both the vocabulary and reading tests from those reported in Table 9, but do not differ much for the mathematics tests. Note also that across Tables 9, 10, and 11, the greatest proportion of variation attributable to among-school differences in achievement is with respect to mathematics.

Relationship of School, Community, and Background Characteristics to Quantity of Schooling

An analysis of covariance was performed on the quantity-of-schooling measures adjusted for background characteristics. The results presented in Table 12 show the relationship of size and type of school to quantity of schooling after adjusting for differences in ability, race, sex, and SES.[6] The basic question is "How much of the differences among the categories of schools noted in the previous analyses of variance disappear when adjustments are made for differences in the background characteristics?"

Consider first the interaction between type and size of school. The F ratios in Table 12 suggest that the quantity-of-schooling

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[6] The results in Table 12 are based on tests of differences among categories of schools using the among schools within categories adjusted source of variation as the error term. The results of the analysis depicting the among-schools-within-categories differences using the among students within schools adjusted source of variation as the error term was presented in Tables 10 and 11 where the adjusted intra-class correlation coefficients were presented. The analyses presented in Table 12 center on the remaining issue, i.e., distinguishing among the different categories of schools. Also included in this section of Table 14 are the regression coefficients relating the quantity of schooling variables to the six background characteristics.

Table 12

Analysis of Covariance for Quantity of Schooling Variables Adjusted for Background Variables

Source of Variation	Degrees of Freedom	Mean Square		F-Ratio	
Among Groups of Schools					
Type of Schools	1				
Hours of Science		(885,617.39)	982,843.46	(8.46)	9.39
Hours of Foreign Language		(214,327.64)	217,627.63	(2.8[illegible])	2.88
Hours of Social Studies		(167.565.51)	200,768.18	(1.47)	1.77
Hours of English		(786,984.29)	8,363.30	(6.64)	7.06
Hours of Mathematics		(1,050,218.26)	1,061.287.75	(9.65)	9.75
Hours of Fine Arts		(9,001.09)	5,296.56	(.06)	.04
Size of School	2				
Hours of Science		(507,381.85)	452,544.16	(4.85)	4.32
Hours of Foreign Language		(14,785.28)	11,704.23	(.20)	.15
Hours of Social Studies		(391,341.83)	375,277.30	(3.44)	3.30
Hours of English		(175,773.93)	145,132.83	(1.48)	1.22
Hours of Mathematics		(37,673.16)	25,949.73	(.35)	.24
Hours of Fine Arts		(81,962.87)	84,697.79	(.56)	.58
Type by Size	2				
Hours of Science			171,841.62		1.64
Hours of Foreign Language			413,120.66		5.47
Hours of Social Studies			76,483.68		.67
Hours of English			391,291.53		3.30
Hours of Mathematics			45,069.11		.41
Hours of Fine Arts			166,576.98		1.14
Among Schools Within Groups	719				
Hours of Science			104,637.32		
Hours of Foreign Language			75,519.60		
Hours of Social Studies			113,669.40		
Hours of English			118,515.76		
Hours of Mathematics			108,856.48		
Hours of Fine Arts			146,508.55		

variables in foreign language and English are significant. This was also the case in Table 7. In fact, a graphing of these interactions suggests the same pattern as illustrated in Figure 4, except that some of the differences between students in high-minority and/or low-income schools are, when contrasted to the other schools, larger or smaller for each of the different sizes of schools. The pattern for English is almost the same as that shown in Figure 4. The differences in amount of foreign language schooling between students attending a high-minority and/or low-income school and students attending other high schools was lessened for the small schools and increased slightly for the large schools. Otherwise, the pattern was exactly as suggested in Figure 4.

In examining further the results presented in Table 12, the F ratios for size of school indicate a significant difference for social studies and science. The result with respect to social studies is the same as noted previously. The other significant difference concerns quantity of schooling in science across schools of different sizes. This result is different from that shown in Table 7. The differences in the pattern of means in Table 3 is that the quantity of science schooling decreases monotonically as the size of the school increases. This same pattern emerges in Table 12, but the significant F indicates that differences across the three school sizes are more pronounced. The means of the quantity of schooling variables, adjusted for the background variables found in Table 13, reflect these differences. This same monotonic trend, which is inversely related to the size of the school, exists, but in a more exaggerated fashion. This means that after one controls for the differences in background, there are major differences in the amount of science schooling received by students attending the largest schools.

Table 13

Means of the Quantity of Schooling Variables Adjusted for the Background Variables

TYPE OF SCHOOL	SIZE OF SCHOOL	Science	Social Studies	Foreign Language	English	Mathematics	Fine Arts
High Minority and/or Low Income	<300	323.54	436.97	150.15	506.68	321.49	145.73
	300-599	391.93	419.99	166.57	477.21	313.18	124.13
	≥600	292.25	404.54	180.73	468.37	313.36	145.29
All Others	<300	289.76	418.83	178.71	465.31	290.59	143.37
	300-599	285.73	420.48	171.39	472.88	296.41	142.46
	≥600	264.09	395.97	156.78	466.26	285.37	130.09

The analysis of school type, adjusted for school size, is also presented in Table 12. The F ratios associatei with this analysis indicate that the major differences among school types exist for the quantity of schooling received in science, mathematics, and English, if one chooses to ignore the marginally significant interaction with respect to English. Science and mathematics are concentrated on here. Table 3 suggests that students attending high-minority and/or low-income schools receive, on the average, more science schooling than do students attending other schools. The adjusted means in Table 13 reflect this pattern, but the differences are more notable.

The same basic pattern emerges when examining the quantity of mathematics schooling. The unadjusted means in Table 3 indicate that students attending high-minority and/or low-income schools receive more hours in mathematics than do students attending other schools. After adjusting for student background (Table 13), the differences in quantity of mathematics schooling are larger. For these two measures, the differences among types of schools reflected in the analyses in Table 7 were associated with differences in student population. Once these differences were adjusted for, the differences in the quantity of schooling variables became even larger than those reflected in the unadjusted analyses. It is again worthwhile to note that the results in Table 12 are quite consistent with the results in Table 7, except that some of the differences in patterns noticed previously are even more exaggerated.

Table 14 presents the results of the regression analysis within schools relating the background characteristics of the students to the quantity of schooling variables. The purpose of this analysis is

Table 14

Relationship of Background to Quantity of Schooling
Controlling for School/Community Characteristics

QUANTITY OF SCHOOLING VARIABLE

Explanatory/ Variable	Hrs. SCIENCE			Hrs. FOREIGN LANGUAGE			Hrs. SOCIAL STUDIES		
	Coefficient	Standard Error	Coefficient / Standard Error	Coefficient	Standard Error	Coefficient / Standard Error	Coefficient	Standard Error	Coefficient / Standard Error
Picture-Number	1.719	.201	8 552	2.423	227	10 674	085	.149	.570
Letter Groups	5 147	.314	16 392	6 408	355	18 051	- 080	.236	-.342
Mosaic Comparisons	142	.125	1.136	176	142	1 239	- 408	.093	-4 387
Sex	53 745	2 914	18 444	-19 579	3 293	-5 94	8 833	2.164	4 082
SES	31 901	2 397	13 309	44 073	2 709	16 269	6 426	1 780	3 610
Race	-5 337	4 659	-1 146	-19.113	5 266	-3 629	-3 035	3 460	-.877
Multiple Correlation Squared (R^2)		129			142			007	

Explanatory/ Variable	Hrs. ENGLISH			Hrs. MATHEMATICS			Hrs. FINE ARTS		
	Coefficient	Standard Error	Coefficient / Standard Error	Coefficient	Standard Error	Coefficient / Standard Error	Coefficient	Standard Error	Coefficient / Standard Error
Picture-Number	.137	.127	1.079	1.887	.212	8.901	-.347	.294	-1.180
Letter Groups	.627	.198	3.167	5.689	.331	17.187	.004	.460	.009
Mosaic Comparisons	.073	079	.924	518	.132	3 924	.517	.184	2.810
Sex	.209	1.837	114	64 140	3.069	20.906	-63.913	6.266	-10 294
SES	8.298	1.511	5 491	31.981	2.523	12 676	22.728	3.509	6.477
Race	3.352	2.938	1.141	-17.475	4 906	-3 562	-10.638	6.021	-1 530
Multiple Correlation Squared (R^2)		.010			.146			020	

46

to determine if a student's background characteristics influence the amount of schooling s/he receives, controlling for school size and type. Such a relationship can exist because (1) students' background characteristics directly influence them to choose some courses over others, and/or (2) the school might be influenced by students' background characteristics when placing them in programs that influence the quantity of schooling they will receive in each of the different curricular areas.

In all cases, the multiple R^2 indicates that a small percentage of the quantity-of-schooling variation within schools is accounted for by the student background characteristics. The range is from as little as 2% to around 15%.

Consider first the quantity of schooling in science. Two of the three ability measures were significantly related to the quantity of schooling, as was an individual's sex and socio-economic status. All the background variables were found to influence the quantity of schooling received in foreign language with the exception of the mosaic comparisons ability test. In social studies, sex and socio-economic status were found to be important in predicting the quantity of schooling received. For English, the letter-group ability measure and socio-economic status were found to be related to the quantity of schooling received.

In the area of mathematics, all of the background variables were found to be significantly related to the quantity of schooling received. It is interesting to note that in this area, the strength of the relationship of the background variables to the quantity-of-schooling variable is the strongest. For fine arts, the mosaic-comparisons ability test, the sex of the individual, and socio-economic status were found to be related to the quantity of schooling received.

A summary of these analyses suggests that student background variables are related to the quantity of schooling received by individual students within schools. The strength of this relationship, however, in terms of the background variables defined in this study, is not very great. This is especially true for the quantity of schooling received in social studies, English, and fine arts, where the proportion of variation accounted for is only 1 or 2%. In the areas of mathematics, science, and foreign language, there was a stronger relationship between the background variables and the quantity of schooling received, but again, the strength of the relationship is relatively weak with background variables accounting for only 13 to 15% of the variation.

In all three cases, student ability was related to quantity of schooling received in these areas. The coefficients indicated that in general, those students who were more able, as measured by these three tests, received more schooling in science, foreign language, and mathematics. For these same three areas, sex was found to be significantly related to the quantity of schooling received. Males received more hours of science and mathematics and fewer hours of foreign languages than females.

The results also indicate that the higher the socio-economic status of the student, the greater the quantity of schooling s/he received in mathematics, foreign language, and science. Notice that this is true even while controlling for ability. Race was not significant in predicting the quantity of schooling received in science, but it was in foreign language and mathematics.

The results of these analyses suggest that a student's background is related to the quantity of schooling received in each of the six curricular areas. The strength of the relationship is not great, but it does indicate that students' background characteristics do have some impact on the quantity of schooling they receive, especially in science, foreign language, and mathematics.

Relationship Between Background Characteristics, Quantity of Schooling and Achievement

The second major focus of this paper is to determine the relationship between quantity of schooling and achievement when controlling for student background characteristics. To explore this issue, an analysis of covariance on the three achievement tests was performed, adjusting for student background characteristics and quantity-of-schooling measures. These analyses are reported in Table 15. They parallel those presented in Table 12. The analyses to estimate the relationship between background, quantity of schooling, and achievement were done in this fashion to control for school and community characteristics. Before turning to the results of the regression analyses, achievement differences across different categories of schools will be explored.

After adjusting for student background and quantity of schooling, there are no major differences across school categories. This suggests that the very large differences found, for example, among types of schools on the three achievement measures as reported in Table 6 are in large part due to differences among these schools in terms of the types of students that attend them as well as differences in the average quantity of schooling received. The larger differences found in Table 6 disappear once an adjustment is made for student background and quantity of schooling. Table 16 presents the means of the achievement variables adjusted for the background and quantity of schooling variables.

Next, the relationship between quantity of schooling and achievement was examined. Academic achievement in each of the three areas was

Table 15

Analysis of Covariance for Achievement Variables Adjusted for Background and Quantity of Schooling Variables

Source of Variation	Degrees of Freedom	Mean Square		F-Ratio	
Among Groups of Schools					
Type of School	1				
Vocabulary		(36.47)	36.07	(2.68)	2.65
Reading		(17.62)	21.30	(1.02)	1.24
Mathematics		(.76)	.03	(.02)	.003
Size of School	2				
Vocabulary		(.62)	.61	(.05)	.04
Reading		(37.23)	35.46	(2.16)	2.06
Mathematics		(92.23)	93.38	(2.85)	2.88
Type by Size	2				
Vocabulary			19.68		1.45
Reading			15.12		1.18
Mathematics			6.64		.52
Among Schools Within Groups	707				
Vocabulary			13.62		
Reading			17.25		
Mathematics			32.38		

Table 16

Means of the Achievement Variables Adjusted for the Background and Quantity of Schooling Variables

TYPE OF SCHOOL	SIZE OF SCHOOL	Vocabulary	ACHIEVEMENT Reading	Mathematics
High Minority and/or Low Income	< 300	6.242	10.085	13.186
	300-599	6.423	9.846	12.811
	≥ 600	6.286	9.694	13.040
All Others	< 300	6.519	9.858	13.217
	300-599	6.397	9.866	12.902
	≥ 600	6.437	9.685	12.902
All Types	< 300	6.387	9.966	13.202
	300-599	6.408	9,857	12.863
	≥ 600	6.376	9.689	13.029
High Minority and/or Low Income	ALL SIZES	6.307	9.946	13.042
All Others		6.461	9.828	13.047
TOTAL SAMPLE		6.392	9.881	13.045

regressed on student background and on quantity of schooling received in each of the six curricular areas. These regression analyses were done on the total sample of individuals as well as separately for students in each of the six categories of schools. The analyses were performed using data on individual students.[7]

The results of these analyses are presented in Tables 17, 18 and 19 for vocabulary achievement, reading achievement, and mathematics achievement, respectively. In these tables, the regression coefficients, relating the quantity of schooling to achievement, and their standard errors are reported both for the total sample and for each of the six categories of schools. The regression coefficients for the background variables are not included in these tables. In addition to this, the regression coefficients for the quantity of schooling measures and their corresponding standard errors are presented for the three school sizes and for the two types of schools.[8]

Mathematics achievement had the greatest proportion of its variance accounted for (57%) by these analyses, with reading achievement next at 37%. Vocabulary achievement had the smallest proportion of its variance accounted for (29%). This implies that the same quantity-of-schooling variables account for almost twice as much variance in the mathematics test as they do in the vocabulary test.

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[7]To do the analyses for the total sample, the within-school covariance matrices were pooled across the entire sample and it was on this matrix that the regression analyses were done. To do the analyses within any one of the six categories of schools, the covariance matrices were first pooled for all schools contained within that category and then a regression analysis was done using that covariance matrix.

[8]These analyses were not done as previously described, that is, by pooling the covariance matrices. The regression coefficients arrived at for the six categories of schools were weighted according to the number of students contained in each of those categories, resulting in a weighted estimate of the regression coefficient for that particular marginal category. The standard errors were computed using the linear transformation applied to the original regression coefficients.

Table 17

Estimated Regression Coefficients* for the Quantity of Schooling Variables in predicting Vocabulary for the Total Sample and the Six School Categories

TYPE OF SCHOOL	SIZE OF SCHOOL	Science	Foreign Language	Social Studies	English	Mathematics	Fine Arts
High Minority and/or Low Income	<300	.3150 (.0622)**	.3538 (.0546)	.1514 (.0715)	.2489 (.0927)	.2465 (.0591)	.0912 (.0409)
	300-599	.3389 (.0785)	.3805 (.0616)	.0775 (.0893)	.3474 (.1317)	.1067 (.0565)	.0934 (.0493)
	≥600	.2588 (.1212)	.6366 (.0926)	.0864 (.1715)	.2620 (.1778)	-.1458 (.1245)	.0896 (.0672)
All Others	<300	.5382 (.0611)	.4108 (.0533)	.2356 (.0770)	.3077 (.0928)	.0790 (.0612)	.0156 (.0388)
	300-599	.2182 (.0660)	.5454 (.0552)	.0625 (.0830)	.1172 (.0924)	.0808 (.0672)	.0477 (.0392
	≥600	.2781 (.0920)	.5386 (.0755	-.0912 (.1157)	.2715 (.1192)	.1235 (.0984)	.1632 (.0577)
All Types	<300	.4321 (.0436)	.3837 (.0382)	.1956 (.0528)	.2797 (.0657)	.1587 (.0426)	.0516 (.0281)
	300-599	.2693 (.0505)	.4756 (.0412)	.0688 (.0637)	.2146 (.0533)	.0918 (.0445)	.0670 (.0308)
	≥600	.2703 (.0735)	.5782 (.0585)	.0195 (.0977)	.2677 (.1010)	.0147 (.0773)	.1335 (.0438)
High Minority and/or Low Income	ALL SIZES	.3137 (.0453)	.4073 (.0376)	.1173 (.0561)	.2826 (.0701)	.1392 (.0408)	.0917 (.0286)
All Others	ALL SIZES	.3767 (.0404)	.4822 (.0344)	.1132 (0508)	.2339 (.0582)	.0880 (.0412)	.0547 (.0250)
TOTAL SAMPLE		.3422 (.0299)	.4501 (.0250)	.1197 (.0373)	.2481 (.0441)	.1212 (.0283)	.0720 (.0187)

*For Tables 17 through 19, the three background variables and the three ability measures were included in the analyses but the coefficents are not reported in the tables or the corresponding figures.

**For Tables 17 through 19, coefficients are multiplied by 100 and the Standard Errors are given in parentheses.

Table 18

Estimated Regression Coefficients for the Quantity of Schooling Variables in Predicting Reading for the Total Sample and the Six School Categories

TYPE OF SCHOOL	SIZE OF SCHOOL	Science	Foreign Language	Social Studies	English	Mathematics	Fine Arts
High Minority and/or Low Income	<300	.2765 (.0732)	.2644 (.0642)	-.0642 (.0841)	.3588 (.1090)	.3685 (.0696)	.0486 (.0481)
	300-599	.4411 (.0958)	.4309 (.0752)	.1612 (.1212)	-.0849 (.1608)	.0971 (.0690)	.0589 (.0602)
	≥600	.3008 (.1488)	.4799 (.1147)	.0657 (.2123)	.3729 (.2202)	.0347 (.1542)	.1875 (.0831)
All Others	<300	.5466 (.0697)	.4906 (.0608)	.2631 (.0879)	.2285 (.1058)	.0489 (.0698)	.0653 (.0442)
	300-599	.3343 (.0724)	.5567 (.0606)	-.0419 (.0911)	.1149 (.1014)	.1542 (.0737)	.0429 (.0431)
	≥600	.2937 (.1079)	.4841 (.0886)	.0648 (.1357)	.3003 (.1399)	.2647 (.1155)	.0794 (.0677)
All Types	<300	.4182 (.0505)	.3830 (.0441)	.1075 (.0610)	.2905 (.0759)	.2009 (.0494)	.0574 (.0326)
	300-599	.3795 (.0582)	.5035 (.0473)	.0440 (.0734)	.0304 (.0897)	.1300 (.0516)	.0497 (.0358)
	≥600	.2966 (.0880)	.4824 (.0703)	.0652 (.1179)	.3296 (.1219)	.1718 (.0928)	.1231 (.0525)
High Minority and/or Low Income	ALL SIZES	.3332 (.0544)	.3521 (.0451)	.0288 (.0676)	.2185 (.0843)	.2282 (.0490)	.0740 (.0343)
All Others	ALL SIZES	.4243 (.0457)	.5126 (.0389)	.1185 (.0576)	.2021 (.0658)	.1266 (.0466)	.0601 (.0285)
TOTAL SAMPLE		.3802 (.0347)	.4393 (.0291)	.0627 (.0433)	.2276 (.0513)	.1679 (.0328)	.0678 (.0217)

Table 19

Estimated Regression Coefficients for the Quantity of Schooling Variables in Predicting Mathematics for the Total Sample and the Six School Categories

TYPE OF SCHOOL	SIZE OF SCHOOL	Science	Foreign Language	Social Studies	English	Mathematics	Fine Arts
High Minority and/or Low Income	<300	.4605 (.0903)	.3129 (0792)	-.3484 (.1038)	.1401 (.1345)	1.2407 (.0858)	-.0582 (.0593)
	300-599	.6275 (.1123)	.5381 (.0881)	.0907 (.1422)	-.2988 (.1885)	.5012 (.0809)	-.0788 (.0706)
	≥600	.4683 (.1592)	.6274 (.1227)	-.3072 (.2272)	.0693 (.2356)	.5696 (.1650)	.0201 (.0890)
All Others	<300	.7760 (.0811)	.4492 (.0709)	.1820 (.1023)	-.2168 (.1233)	1.1031 (.0813)	-.0602 (.0515)
	300-599	.4947 (.0886)	.4336 (.0741)	-.0483 (.1115)	-.1760 (.1241)	1.0744 (.0902)	.0118 (.0527)
	≥600	.5229 (.1244)	.6181 (.1022)	-.3202 (.1565)	.0081 (.1614)	1.0716 (.1332)	.0511 (.0781)
All Types	<300	.6260 (.0604)	.3844 (.0529)	-.0702 (.0729)	-.0471 (.0910)	1.1685 (.0590)	-.0592 (.0390)
	300-599	.5509 (.0697)	.4778 (.0567)	.0105 (.0881)	-.2280 (.1072)	.8319 (.0623)	-.0265 (.0426)
	≥600	.5009 (.0982)	.6208 (.0785)	-.3149 (.1309)	.0328 (.1353)	.8689 (.1037)	.0386 (.0588)
High Minority and/or Low Income	ALL SIZES	.5154 (.0644)	.4348 (.0536)	-.2008 (.0794)	-.0121 (.0998)	.8965 (.0579)	-.0524 (.0408)
All Others		.6294 (.0540)	.4755 (.0460)	.0064 (.0680)	-.1601 (.0778)	1.0870 (.0551)	-.0139 (.0335)
TOTAL SAMPLE		.6004 (.0412)	.4775 (.0346)	-.0987 (.0514)	-.0849 (.0609)	.9553 (.0390)	-.0291 (.0258)

Vocabulary Achievement

Consider vocabulary achievement for the entire sample. The coefficients for all the predictor variables, except for sex and the mosaic-comparison test, were statistically significant. Apparently, there are no sex differences among high school students in vocabulary, given that the other background characteristics and the quantity-of-schooling measures are controlled for. (The ability tests, other than the mosaic test, are positively related to vocabulary achievement.) The regression coefficients for the other background factors suggest a positive effect for white students and for students who come from families of high socio-economic status.

The quantity of schooling measures that have the most pronounced effect on vocabulary achievement are the number of hours received in science and foreign language. Vocabulary achievement represents a broad sampling of the meaning of words known by the student. It is certainly reasonable to expect that one's achievement in vocabulary could be increased by the quantity of schooling received in all of the curricular areas or to school in general. This would imply that no one of the six areas should necessarily have any greater effect on vocabulary achievement. When contrasted with the other achievement areas, vocabulary has the smallest proportion of its variance accounted for. This is probably because vocabulary is influenced by the student's home environment and his/her previous schooling much more than achievement in an area such as mathematics. This rationale might explain why it is that the regression coefficients for all six of the curricular areas are significant, but that the overall R^2 is relatively small. This implies that the greater the quantity of schooling there is in each of the curricular areas, the more positive is the effect on achievement in vocabulary.

One caveat that needs explaining is the large effect that the quantity of schooling in foreign languages has in this and in all other analyses. As indicated in a previous section, the three tests we have used to define ability do not seem to adequately measure ability and, therefore, do not adequately control for it in these regression analyses. I believe that the number of hours of exposure in foreign languages serves, in part, as a surrogate measure of ability. This would in part explain the consistently large effect for this measure of quantity of schooling across all analyses. One reason for this phenomenon is that only the more able or college-bound students generally take foreign language courses. Thus, the estimated regression coefficients for the number of hours of schooling in foreign languages would most likely be biased upwards, reflecting this confounding with ability.

In examining the regression coefficients for each of the quantity of schooling variables (as related to vocabulary) within each of these six categories of schools, a pattern emerges. In Figure 6, the regression coefficients are plotted for the six groups for the quantity of schooling in both science and English. The regression coefficients for fine arts, mathematics, and social studies were not plotted because many of the coefficients within specific categories of schools were nonsignificant. The regression coefficients for foreign language were not included because this variable most likely not only reflects quantity of schooling but also serves as a surrogate measure of ability.

The pattern is quite mixed. For students in middle-sized high-minority and/or low-income schools, more hours of English has a much larger effect than it does for students attending all other high schools. On the other hand, between the small and large schools, the quantity-of-schooling effect in English is not very different.

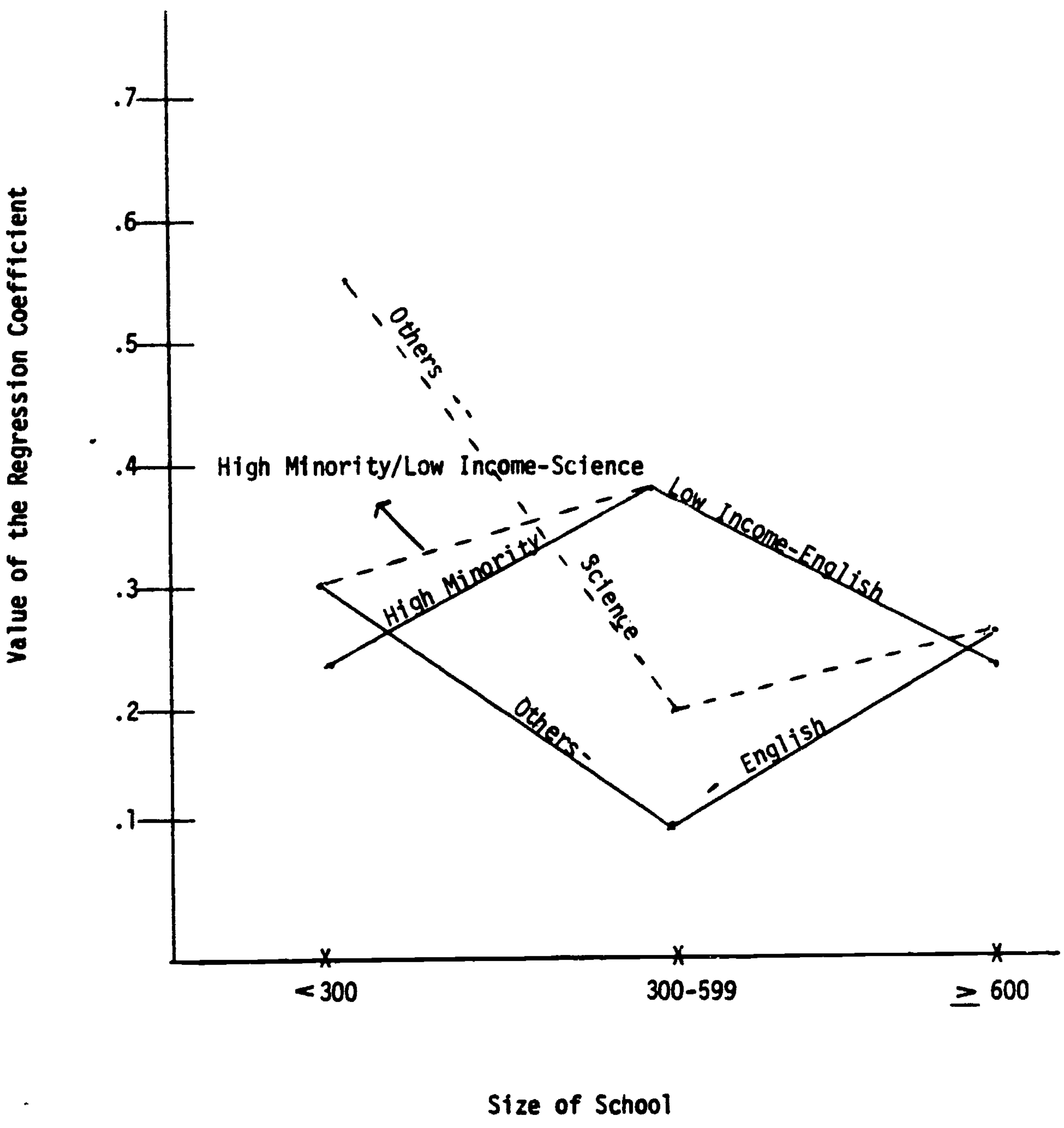

Figure 6. Graph of the regression coefficients for vocabulary achievement for the six school categories.

In small schools, the effect of more science schooling on vocabulary achievement is much greater for students attending other types of schools than it is for students attending high-minority and/or low-income schools. For the middle-sized schools, the trend is just the opposite: The effect of more science schooling is greater for students attending high-minority and/or low-income schools than it is for students attending other schools. And for large schools, there are essentially no differences in terms of the effect that the quantity of schooling in science has on vocabulary achievement. These results seem to suggest, at least with respect to vocabulary achievement, that the quantity of schooling in science and English have differential effects, depending upon the school type and size.

A further examination of the results in Table 17 indicates that for the total sample, if one were to increase the amount of science instruction by 100 hours for students with the same background characteristics, one could correspondingly predict a 2.5% increase in vocabulary achievement. This predicted increase in the percentile score on the vocabulary test is based upon an examination of the distribution of vocabulary-achievement scores across the entire sample. This analysis determined that, on the average, an increase of one point on the test corresponded to an increase of 6.5% in the percentile distribution. Using this information, the regression coefficients in Table 17 were converted to reflect the predicted percentile increase in vocabulary achievement for each 100 hours of additional instruction. An increase of 100 hours of instruction is the equivalent, under some very general assumptions, of a one-semester course that meets for five or six hours per week. The analyses for vocabulary achievement suggest that an additional semester of science would produce an increase in vocabulary achievement of 2.5 percentiles.

For English, the increase would be slightly more than 1.5 percentiles, and for foreign languages, the predicted increase would be three percentiles.

Reading Achievement

The multiple R^2 for reading achievement (37%) was higher than that for vocabulary. Consider first the entire sample. All of the quantity-of-schooling variables are statistically significant, with the exception of number of hours received in social studies. The background characteristics have similar effects to those described for vocabulary achievement, but additionally there is an effect for sex, with males, on the average, performing better at reading.

For reading achievement, the potential amount of schooling in science and foreign language, again, had the greatest effect among the quantity-of-schooling variables. All variables, including social studies, had a positive effect, although the magnitude of the standard error associated with the social studies coefficient does not enable one to distinguish it from zero. The pattern evidenced here for reading achievement is very similar to that already reported for vocabulary achievement. The next largest coefficients, after those for foreign languages, were science and English. This is essentially the same result as that for vocabulary achievement, and a similar explanation holds here. Reading comprehension is influenced by time spent in reading. Reading is done in almost all academic courses and so one would expect increased reading achievement as a result of more schooling in these six curricular areas. This type of achievement would also be influenced by home environment and previous experiences (but less so than for vocabulary achievement), resulting in a slightly larger R^2.

An examination of the score distributions for the reading comprehension test indicated that an increase of one point on this test is equivalent to a 5.5 percentile increase. Using this information, effects on reading achievement can be predicted. For an additional 100 hours of schooling (a one-semester course meeting five or six hours per week) in science, the predicted increase in reading achievement is two percentiles. In foreign languages, the predicted increase for a similar amount of additional schooling is 2.5 percentiles, and for English, it is 1.25 percentiles.

Table 18 also presents the results of the regression analyses examining the effect of the quantity-of-schooling variables on reading achievement within each of the six categories of schools. Using only those quantity-of-schooling variables in which the coefficient is distinguishable from zero (based on a comparison with its standard error) and excluding foreign language based on the fact that this coefficient is most likely biased, I examined only the quantity of schooling in science and English. A graph of the coefficients for the six school categories is given in Figure 7. A pattern similar to the one observed with vocabulary achievement emerges. The effect that the quantity of schooling in English has on reading achievement between students attending high-minority and/or low-income schools is similar to that for students attending other schools. However, in small and large schools, the effect of English on reading achievement was higher for students from high-minority and/or low-income schools. For the middle-sized schools, the effect was reversed. More schooling in English affects students from high-minority and/or low-income schools less than it does students from other high schools.

The effect of more schooling was considerably less for students attending high-minority and/or low-income schools than it was for

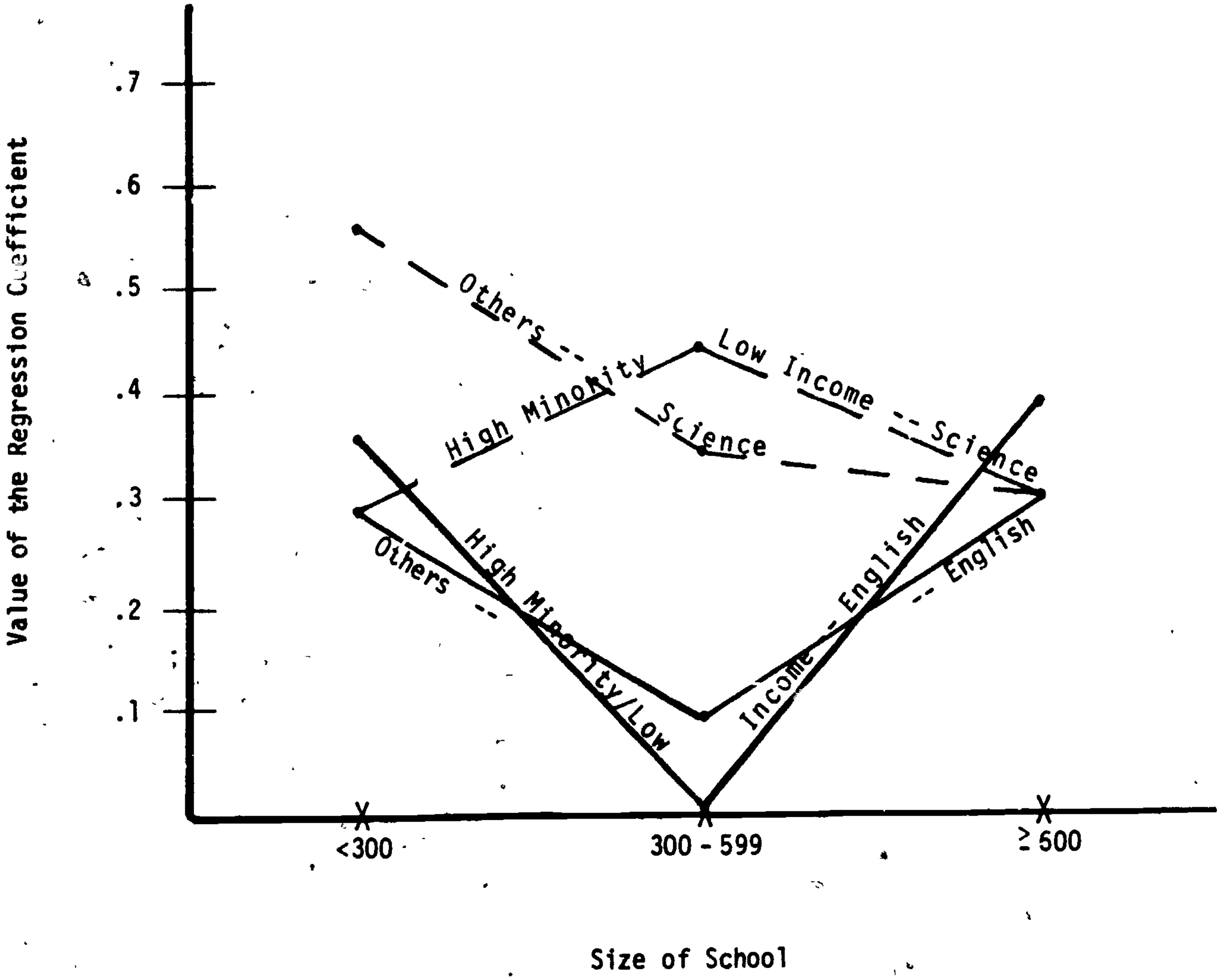

Figure 7. Graph of the regression coefficients for reading achievement for the six school categories.

students attending other high schools and schools with small enrollments. However, in middle-sized schools, the effect of more science schooling on reading achievement is greater for students attending high-minority and/or low-income schools than for students attending other high schools. This difference, however, is not as large as it was for the reverse pattern in the small schools. The differences in effect are negligible for students attending the two different types of schools where those schools also have large enrollment figures.

Mathematics Achievement

Mathematics is almost solely learned in school. Vocabulary and reading achievement are certainly learned and influenced by schooling, but research suggests that achievement in these areas is greatly influenced by the home environment. This does not seem to be as true for mathematics achievement, explaining the large R^2 obtained for the regression analyses (see Table 19). This coefficient indicates that 57% of the variation among students within schools was accounted for by the background characteristics and the quantity-of-schooling measures. Quantity of schooling appears to have its greatest impact in mathematics.

The background variables have similar effects to those of the other two achievement tests on mathematics achievement, although the sex effect is more pronounced. There was a similar large effect on mathematics achievement for the amount of schooling in foreign languages. This reflects the bias suggested previously and, in fact, tends to substantiate the argument even more strongly, since it is difficult to imagine logically why increased schooling in foreign languages would increase achievement in mathematics.

An examination of the coefficients for the quantity of schooling in each of the six curricular areas for the entire sample reveals significant effects for exposure in the areas of science and mathematics.

in addition to the effect already referred to for foreign languages. For the quantity of schooling in social studies and fine arts, the estimated coefficients are all negative, indicating a negative effect on mathematics achievement for an increase in schooling in each of these three areas, although the standard errors indicate that these coefficients cannot be distinguished from zero.

The largest effect on mathematics achievement is clearly and dramatically the quantity of schooling in mathematics. This is the result that one would expect, with a secondary effect for the quantity of schooling in science, since many of the sciences use mathematics. However, the sheer magnitude of the effect in comparison to its standard error is remarkable. This coefficient is well determined from the data. Note also that in contrast to vocabulary and reading achievement, the coefficients indicating the effect of increased exposure in mathematics and science are both larger than the coefficient for foreign languages. This underscores the effect of the quantity of schooling in curricular areas most related to mathematics achievement.

Examining the distribution of test scores in mathematics achievement suggests that a one-point increase in performance on the mathematics test is equivalent to a four-percentile increase. Employing this result, the regression analysis suggests that, in general, for an additional 100 hours of instruction in mathematics, a four-percentile increase in mathematics achievement can be predicted. This is the largest percentile increase for any of the achievement areas for the addition of 100 hours of instruction. The magnitude of the coefficient for science suggests a 2.5 percentile increase in mathematics achievement for each additional semester course in science. Mathematics achievement seems to be clearly related to the quantity of mathematics schooling received.

The results of an examination of differences in the effect of increased exposure in mathematics for students attending the six different categories of schools are summarized in Figure 8. Consider first the effect of increasing the amount of mathematics schooling. For students attending high-minority and/or low-income schools, the effect is similar to that for students attending schools where the enrollment is less than 300 students.

This is clearly not the case for students attending either the middle-sized or the large schools. The effect of the quantity of mathematics schooling for students attending high-minority and/or low-income schools is over 50% less than the effect for students attending other high schools.

For example, for students attending high-minority and/or low-income high schools with 600 or more seniors enrolled, an additional semester-course in mathematics increases mathematics achievement about 2.25 percentiles. However, for students attending other high schools with the same enrollment, the effect of one additional course is 4.25 percentiles.

This might reflect that an increase in mathematics instruction in high-minority and/or low-income schools is primarily an increase in remedial mathematics courses. For other schools, an increase might mean more advanced courses. The latter increase in the quantity of schooling would most likely have the greatest impact on achievement as measured by the NLS test.

The point that should not be lost, however, is that in all types of schools there is a positive effect for increased mathematics instruction on mathematics achievement. This did not hold for small

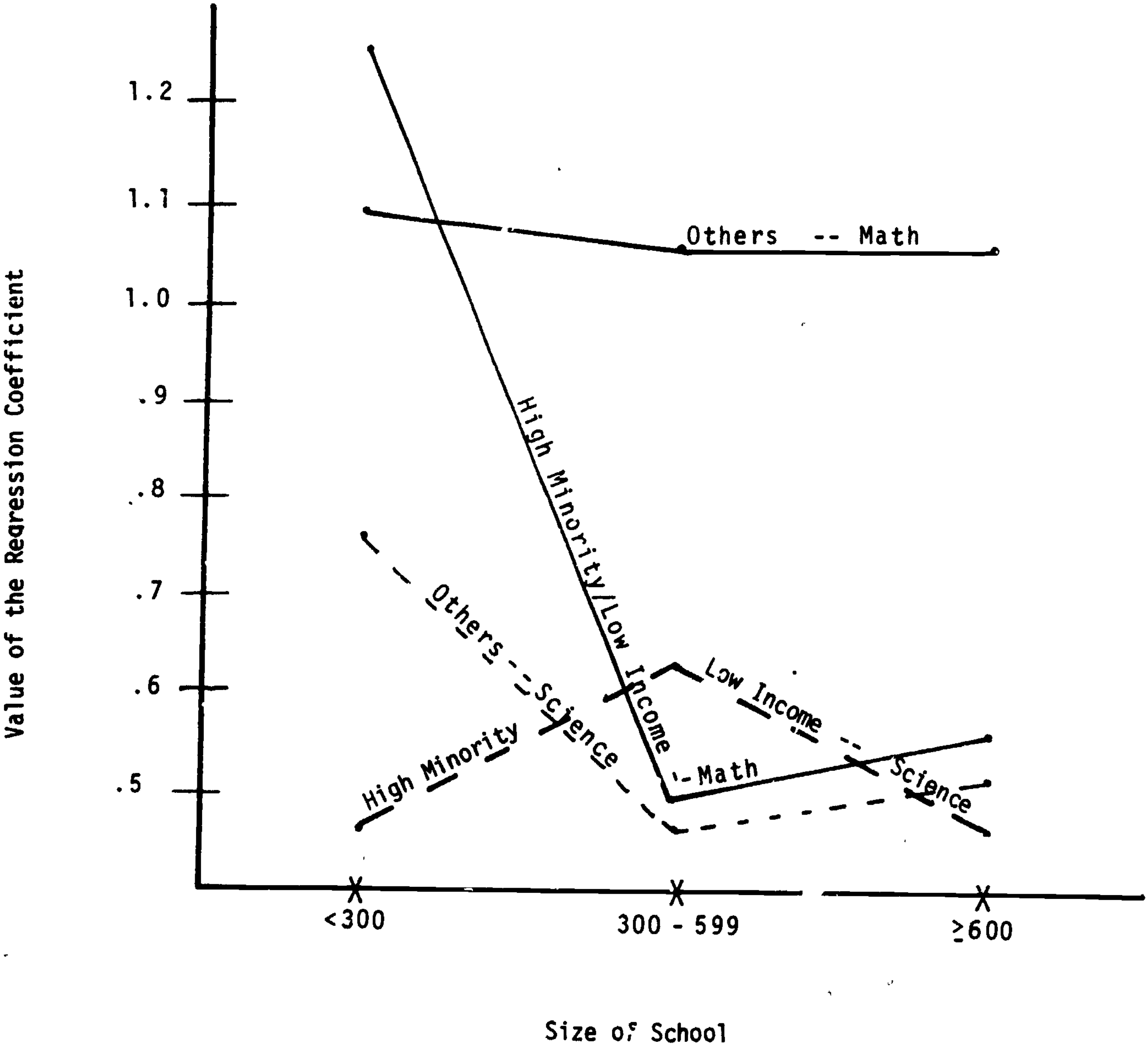

Figure 8. Graph of the regression coefficients for mathematics achievement for the six school categories.

schools. Perhaps because most of these schools tend to be located in small towns and rural areas, the mathematics curriculum for high-minority and/or low-income schools is actually similar to that in other schools.

Achievement Measured by the ACT

To further examine and replicate the findings cited in the previous sections, the four achievement tests contained in the ACT battery were also analyzed. Data on the ACT tests were not available for the entire NLS sample, but they were available for 1,421 of the students. Since data were available on such few cases, the analyses of the previous section were not repeated for each of the six categories of schools, but only for the total sample.

The ACT battery provided data on the curricular areas of science, English, and social studies that were not available through the NLS achievement measures. Although the vocabulary and reading-comprehension achievement measures are certainly related to the ACT English achievement measure, the latter is more directly tied to what is taught in in the high-school English curriculum. The ACT also has a mathematics achievement measure, the results of which can be compared with those found on the NLS measure. The results of these analyses are summarized in Tables 20 and 21.

For science, a significant positive effect was noted for the quantity of schooling in science, foreign languages, mathematics, and at least marginally in social studies. The multiple R^2 associated with this analysis indicated that 31% of the science-achievement variance was accounted for by these measures as well as by the background characteristics. The largest effect was for quantity of science schooling; the regression coefficient for science was more than two times the coefficient for any other area. Quantity of mathematics schooling had the second largest effect.

Table 20

Results of the Within-School Regression Analyses for the Total Sample Using the ACT Tests

Explanatory Variable	ACT/Science Coefficient	ACT/Science Standard Error	ACT/Mathematics Coefficient	ACT/Mathematics Standard Error
PICTURE	.099598	.020065	.102698	.018711
LETTER	.302900	.036111	.466144	.033675
MOSAIC	.051572	.013078	.052605	.012196
SEX	2.444108	.302205	2.085287	.281815
SES	.381035	.239450	.019821	.223294
RACE	1.877089	.568312	.655333	.529968
HRS/SCI	.008725	.001103	.003324	.001029
HRS/LAN	.003891	.000931	.004536	.000868
HRS/SS	.003023	.001375	.000171	.001282
HRS/ENG	.001621	.001648	.000059	.001537
HRS/MAT	.004299	.001116	.017202	.001040
HRS/ART	.000952	.000673	.000925	.000627
Multiple Correlation Squared (R^2)	.3113		.4878	

(Outcome variable: ACT/Science and ACT/Mathematics.)

Table 21

Results of the Within-School Regression Analyses for the Total Sample Using the ACT Tests

	OUTCOME VARIABLE			
	ACT/English		ACT/Social Studies	
Explanatory Variable	Coefficient	Standard Error	Coefficient	Standard Error
PICTURE	.076832	.015841	.112538	.022952
LETTER	.359471	.028509	.331901	.041306
MOSAIC	.032124	.010325	.040518	.014960
SEX	-1.173597	.238583	1.137090	.345682
SES	.540667	.189839	1.182829	.273898
RACE	1.541614	.468657	1.476894	.650072
HRS/SCI	.001451	.000871	.005458	.001262
HRS/LAN	.005986	.000735	.006180	.001065
HRS/SS	.001184	.001086	.004186	.001573
HRS/ENG	.005629	.001301	.005871	.001886
HRS/MAT	.003057	.000881	.006389	.001276
HRS/ART	.001409	.000531	.000839	.000769
Multiple Correlation Squared (R^2)	.3567		.2727	

The quantity of schooling in foreign language again had a large positive effect, reinforcing the earlier notion that this coefficient is biased. This was also true for the other three ACT tests. The coefficient was not as large, however, relative to the other coefficients, as it was for the three NLS achievement measures. This may, in part, reflect the fact that those students who take the ACT test tend to be the more able students or at least those who are college bound. The fact, then, that this analysis was done on a restricted population in terms of ability might explain why these coefficients are not as large as were those involving a broader range of high-school students.

The results for the ACT mathematics test are very similar to the results obtained for the NLS mathematics achievement measure. The multiple R^2 indicated that 49% of the variance was accounted for. The largest coefficient was for the quantity of mathematics schooling. This coefficient was more than four times the size of any of the other coefficients. This again indicates a clear school effect. The regression coefficients also indicated that the quantity of schooling in science and foreign languages had a positive effect on mathematics achievement.

The results for the effect of the quantity of schooling on English achievement indicated that 36% or the variance was accounted for. Exposure in the curricular areas of English and foreign languages had the largest effects on achievement in English. The largest coefficient was for foreign language, although it was only marginally different from the coefficient for English. All other curricular areas, except for social studies, had significant positive effects.

The final achievement measure from the ACT test battery used in these analyses was the social studies test. The quantity of schooling in all of the curricular areas, except for fine arts, suggested a positive effect on achievement in social studies. However, aside from the coefficient indicating the effect of fine arts on achievement in social studies, the coefficient for the curricular area of social studies itself was the smallest of all the coefficients. This indicates that the quantity of schooling received in science, foreign languages, English, and mathematics were all more important in predicting social studies achievement than was the quantity of schooling received in social studies itself. This result seems baffling. It suggests that what is being taught in high-school social studies classes is not what is being tested in social studies, at least on the ACT.

The results of the analyses in Tables 20 and 21 with respect to the ACT achievement tests tend to confirm the results found in the previous section. The largest effects were noted for mathematics, and the quantity of mathematics schooling was most strongly related to mathematics achievement. For both science and English achievement, the quantity of schooling in the corresponding curricular area was the single largest predictor of achievement. These results are certainly consistent with what was found in mathematics achievement, both for the NLS measures and the ACT tests.

Summary

Student background and school and community characteristics serve as least in part as determiners of quantity of schooling. The magnitude of these background effects, however, is not large, and it appears that other factors also determine curricular exposure.

In examining the effect that quantity of schooling has on achievement, clear and positive results suggested positive school effects. Earlier studies attempting to examine whether schools make a difference concluded that they did not, in part, because the school characteristics examined had very little to do with the curriculum. This paper focuses on one aspect of the curriculum--the quantity of schooling received in each of the six curricular areas. It would certainly have been more desirable if the nature of the courses within each of the six curricular areas could be distinguished so as to indicate not only what the quantity was in each of these areas but something more specific about course content. This information, however, was not available as a part of the National Longitudinal Study.

The results suggest in general that the quantity of schooling has a positive effect on academic achievement. It would further appear that the more that the achievement is school-based as opposed to home-based, the larger the resulting effect that the quantity of schooling has. This was especially notable for mathematics. In areas such as science and English, notable positive effects were found for the quantity of schooling in the corresponding curricular area, using the ACT test battery.

A caveat that needs to be considered is that the presumed positive effects associated with quantity of schooling are biased, reflecting the fact that the more able students tend to take more advanced courses, and hence the positive effect for quantity of schooling merely serves as a surrogate for ability. Ability was controlled for in the analyses, but probably not totally. However, if the coefficients are biased, the magnitudes are so striking that even if they were halved, the conclusions suggesting positive effects for quantity of schooling would still be reasonable.

In those areas of achievement that seem more broadly influenced, such as vocabulary and reading comprehension, there were less clear results, but quantity of schooling did have a positive effect on achievement in these areas. The fact that the multiple R^2's for these analyses were, in general, less than those for mathematics, science, and English, indicates that these areas are probably influenced by factors and events outside the school.

The effects were certainly the largest and the most pronounced in the area of mathematics. Recall that for mathematics achievement, an additional semester course resulted in a four-percentile increase in achievement. This would imply that if a student took two more years of mathematics after the first two years of high school, that student's mathematics achievement would increase by 16 percentiles. These effects are large and suggest that the quantity of schooling does have an effect on academic achievement.

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