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Relationships Between the Noncognitive Characteristics, High School Course Work and Grades, and Test Scores for ACT-Tested Students

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Abstract

This study examined the relationships between students' noncognitive characteristics and their performance on the ACT Assessment. Of particular interest were the contributions of these noncognitive variables to explaining ACT Assessment performance (over and above course work taken, grades earned, and high school attended). The sample for the study consisted of 5,489 ACT-tested students from 106 schools who had completed a survey about their perceptions of themselves, their homes, and their school environment.

From 47% to 65% of the variance in ACT scores was explained by high school grade average, core courses taken, education-related factors, activities, background characteristics, students' perceptions of self, and high school attended. Students' noncognitive characteristics explained less than 15% additional variance in ACT scores, over and above grades and course work taken. However, by themselves students' noncognitive characteristics explained 31% of the variance in high school grade average and 21% and 12%, respectively of the variance in the number of years of mathematics or science courses taken. These results suggest that noncognitive characteristics impact students' choices of high school course work and the grades they earn in those courses, which, in turn, are strongly related to ACT scores.

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Relationships Between the Noncognitive Characteristics, High School Course Work and Grades, and Test Scores of ACT-tested Students

Introduction

In 1979, Messick examined the potential uses of noncognitive measures in education. Such measures can provide useful information for educational and career guidance of students, and can help inform decisions related to college admissions, course placement, instructional support, and program evaluation. "Noncognitive measures" generally pertain to family background characteristics (e.g., race/ethnicity, family income); affects, attitudes, and interests; temperament; social sensitivity and interpersonal competence; coping; cognitive styles; creativity; and values (Messick, 1979).

Since 1979, many studies have examined the relationships between noncognitive characteristics of students and educational achievement. More recently, possibly due to National Goals 2000 and an emphasis on equity in education, such research has achieved visibility in the media: articles have appeared in the New Yorker (Gladwell, 1998), Education Week (Sommers, 1998; Viadero, 1998), and the New York Times (Honan, 1996). Noncognitive characteristics such as family background (Chubb & Moe, 1990; Honan, 1996); academic behavior and attitudes, high school preparation, and valuing of education (Stricker, Rock, & Burton, 1992); students' self-concept and self-efficacy beliefs (Hamacheck, 1995; Schunk, 1991); work and homework (Viadero, 1998); and school support of students (Wehlage, 1991) have been shown to be associated with student achievement.

Noble & McNabb (1989) examined the relationships between student course taking, grades earned, students' background characteristics, and performance on the ACT Assessment. Family income, size of graduating class, the percentage of students of similar race to the students in the school, enrollment in a college preparatory curriculum, race/ethnicity, and gender were found to be

related to ACT performance, over and above the variance explained by courses taken and grades earned. Noble, Crouse, Sawyer, and Gillespie (1992) expanded on this study by including high school attended in regression models developed to explain ACT performance. They found that expected college freshman GPA, family income, and needs for help with reading and mathematics skills explained 5% to 8% of additional variance in ACT scores, over and above course work taken, grades earned, and high school attended. In sum, students' course work taken, grades earned, background characteristics, high school attended, and race/ethnicity or gender explained 39% to 64% of the variance in ACT scores.

Oakes (1990), in her summary of research on the educational achievement and persistence of women and minorities, noted three domains of influence on students: cognitive abilities and attitudes of individual students, schooling factors and opportunities, and societal factors. All of these domains are related to students' experiences at school. She further stated that, "…it is in the nexus between student characteristics and schooling opportunities that *alterable* influences…are likely to be found. All three domains, then, should be considered…" (p. 166). Many of the research studies on noncognitive characteristics and achievement have relied on a limited number of student characteristics; no one study has examined a broad spectrum of such variables. ACT research, for example, has been limited to race/ethnicity, gender, and other background and academic characteristics provided by students at the time they complete the ACT Assessment. The research has not included information about students' attitudes and perceptions, either about themselves; their families; or their schoolteachers, counselors, or administrators. The purpose of this study, therefore, was to examine the relationships between a comprehensive set of students' noncognitive characteristics, high school course work taken and grades earned, and ACT scores, with emphasis on students' attitudes and perceptions and their contribution to explaining ACT performance. Of

particular interest was the contribution of these noncognitive variables to explaining ACT Assessment performance, over and above course work taken, grades earned, and high school attended. Moreover, the contribution of noncognitive characteristics to explaining high school course work taken and grades earned was examined.

Data for the Study

Data Collection and Sample

A sample of students was identified from the populations of high school juniors and seniors who registered for the ACT Assessment either in April, 1996 (n = 444,776) or October, 1996 (n = 404,978). Two test dates were used because April ACT-tested students are typically juniors and October ACT-tested students are typically seniors. Including students from both test dates provides a more representative sample of the entire ACT-tested population.

It was determined that a sample size of 6000 students (3000 per test date) would achieve a reasonable level of precision; 9096 students were identified for the two test dates (approximately 5000 per test date) to allow for attrition (from ACT registration to testing) and for survey non-response. Sampling was done by school. Stratification variables included school size (based on the number of students registered for each test date), and geographic region. All students tested within a school were included in the sample.

Only those schools from which at least 60 students registered for the April or the October ACT test dates were included. For a given ACT test date, schools with less than 60 students registered to take the test comprise approximately 50% of all students registered for that test date. This sampling constraint was used to allow for student attrition from ACT registration to testing and student nonresponse to the survey, and to insure racial/ethnic representation from each school. An anticipated 40% to 50% decrease in the sample was anticipated.

Four weeks after the ACT Assessment was administered, students in the sample were sent a questionnaire designed to collect information about their behaviors and attitudes in several noncognitive areas. The questionnaire is described later in this report. Two weeks after the initial mailing, postcards were sent to non-respondents; a second copy of the questionnaire was mailed to non-respondents after one month. Of the original sample, 5,489 students from 106 schools completed and returned the questionnaire, for a response rate of 60%.

In order for the sample of respondents to represent the population from which it was selected, weights were applied to the data collected. The weights were calculated as follows:

$$W_{hi} = \frac{N_h}{n_h} * \frac{M_{hi}}{m_{hi}} * K,$$

where: h = the stratum to which school belongs,

i = school,

N_h = the number of schools, in the population, from stratum h,

n_h = the number of schools, in the sample, from stratum h,

M_{hi} = the number of students in the 1996 ACT-tested high school graduating class from school i in stratum h,

m_{hi} = the number of students in the sample from school i in stratum h, and

K = constant to make the weighted sample size equal to that of a simple random sample of equal precision.

The resulting weighted sample differed somewhat from ACT-tested students nationwide (ACT, 1996). The weighted mean ACT Composite score (22.2) and high school grade average (3.30) for the sample were higher than those for the entire 1996 ACT-tested high school graduating class (20.9 and 3.14, respectively). Although there was a higher percentage of females (62%) in the

sample than in the entire ACT-tested high school graduating class (56%), the distributions of race/ethnicity and region were similar for the two groups.

To adjust for the differences in mean ACT Composite score, the weighted sample was reweighted to reflect the distribution of ACT Composite scores of 1996 ACT-tested high school graduates nationwide. New weights were calculated as follows:

$$W'_{hi} = W_{hi} * \frac{PF(x)}{SF(x)} * \frac{\sum_y SF(y)}{\sum_y PF(y)},$$

where: x = ACT score

PF = population frequency at score x,

SF = sample frequency at score x, and

$\sum_y SF(y)$ and $\sum_y PF(y)$ are the total frequencies for the sample and population, respectively.

All analyses were conducted using weighted data. The total reweighted sample size was 1738.

Instruments

Data for this study were taken from two sources: the ACT Assessment (ACT Assessment Component), and a questionnaire developed to collect information about student attitudes and behaviors (ACT Survey Component). Information about the grouping and coding of all of the independent variables is provided in Table 1.

ACT Assessment Component. The ACT Assessment is a comprehensive evaluative, guidance, and placement program used by over one million college-bound students each year. It consists of four academic tests (in English, Mathematics, Reading, and Science Reasoning), a Course Grade Information Section (CGIS), a Student Profile Section (SPS), and the ACT Interest Inventory. The ACT Composite score is an arithmetic average of the scores for the four academic tests. Scores

are reported on a scale of 1 to 36. The five ACT scores were used as the dependent variables (outcome measures) for the study.

The CGIS provides information about students' course work and grades in 30 specific high school courses. Students are asked to indicate whether they have taken or are currently taking a particular course, or whether they plan to take it in the future. For courses already completed, students are also asked to indicate the letter grade they received (A-F). In earlier studies, students were found to report these data with a high degree of accuracy relative to information provided in their transcripts (Valiga, 1987; Sawyer, Laing and Houston, 1988). The CGIS was used to calculate high school grade average (based on grades in English, mathematics, social studies, and natural science) and individual courses taken or not taken. The grade average and course work variables were grouped into two blocks (Blocks 1 and 2) and were used as indicators of high school course work.

The SPS collects demographic and background information, and information about their interests, accomplishments, educational plans, and career plans. Items related to participation in a college preparatory curriculum and perceived needs for help in academic, personal, and career areas were grouped together in Block 3, representing education-related factors. Items about family income and the use of the English language in the home were grouped into Block 5, representing family background variables.

Each high school was identified using its ACT Assessment high school code. A series of effect-coded dummy variables was created to represent students' association with a particular high school. These variables were included in the regression models to account for differences among high schools (Block 9).

TABLE 1

Description of Independent Variables and Order of Entry into Regression Models

Variables within blocks	Description	Coding
1: High school grade average in 4 core areas	Average of course grades in 23 core courses in English, mathematics, natural sciences, and social studies	0.0 to 4.0
2: Courses taken/taking		
English (5 courses)	English 9, English 10, English 11, English 12, and Speech	Yes = 1; no = 0
Mathematics (7 courses)	Algebra 1, Algebra 2, Geometry, Trig., Calculus, Other math beyond Algebra 2, and Computer Math/Computer Science	Yes = 1; no = 0
Natural Sciences (4 courses)	General Physical/Earth Science, Biology, Chemistry, Physics	Yes = 1; no = 0
Social Studies (7 courses)	U.S. History, World History, Other History, Civics, Economics, Geography, Psychology	Yes = 1; no = 0
3: Education-related Factors		
College Prep.	Student is participating in a college preparatory curriculum	Yes = 1; no = 0
	Student reported needing help with	
Need help with mathematics skills	improving math skills.	Yes = 1; no = 0
Need help with reading comprehension and reading speed	improving reading comprehension and reading speed skills.	Yes = 1; no = 0
Need help with study skills	improving study skills.	Yes = 1; no = 0
Need help with writing skills	improving writing skills.	Yes = 1; no = 0
Need help with personal issues	personal issues.	Yes = 1; no = 0
Need help with educational plans	educational planning.	Yes = 1; no = 0
Reason for attending college		
Academic	E.g., to increase knowledge and skills, learn about other cultures, etc.	Yes = 1; no = 0
Social	E.g., to join a fraternity or sorority, to develop social skills, etc.	Yes = 1; no = 0
Negative	E.g., to get away from parents, can't find anything else to do after high school.	Yes = 1; no = 0
4: Activities		
	Average number of hours per week spent	0 hours/Does not apply = 0,
Educational Activities	participating in education-related activities.	1 - 5 hours = 1,
Social activities	participating in social activities.	6 - 10 hours = 2,
	Number of hours per week spent	11 – 15 hours = 3
Homework	working on schoolwork at home.	16 - 20 hours = 4,
Work	working at a job for pay.	More than 20 hours = 5
Extracurricular activities	participating in extracurricular activities.	
Watching TV	watching television.	

TABLE 1 (Continued)

Variables within blocks	Description	Coding
5: Background variables		
Family income	Estimated, pre-tax parental income range.	1 - 10: ($18k or less = 1; increasing in increments of about $8k up to $100k
Negative home situations	Number of negative situations in the home (e.g., a recent divorce, health problems, etc.)	0 – 10
Parents' education	Average level of education of both parents or guardians.	Less than HS diploma or GED = 1; HS diploma or GED = 2; Some college, no degree = 3; Voc.-tech diploma or cert. = 4; Associate's degree = 5; Bachelor's degree = 6; Master's degree = 7; Doctoral or Professional degree = 8
Language	English is the predominant language spoken in the home.	Yes = 1; no = 0
Number of children in the home	Number of children in the home (age 20 or less)	
Number of adults in the home	Number of adults living in the home (age 21 or over)	
6: Perceptions of school		
Teachers	Perceptions about the supportiveness of the teachers in the student's school.	Strongly disagree = 1, …Strongly agree = 5;
Counselors	Perceptions about the helpfulness of the counselors in the student's school.	Does not apply = missing
7: Perceptions of home and friends		
Parents	Perceptions about the support and involvement of parents in the student's education.	Strongly disagree = 1, … Strongly agree = 5;
Friends	Perceptions about friends' encouragement to succeed in school.	Does not apply = missing
Pressure to participate in athletics	Pressure from parents to participate in organized school athletics.	
8: Perceptions of self		
Self-confidence	Perception of self-confidence for succeeding in academic activities.	Strongly disagree = 1, … Strongly agree = 5;
Healthy lifestyle	Participation in activities that promote a healthy lifestyle (e.g., exercise, proper diet).	Does not apply = missing
School value	Sense of value placed on school and school related activities.	
Positive attributions	Perception that academic success is related to high ability; failure to lack of effort.	
General anxiety	A pervasive sense of worry and anxiety about personal safety and security.	
9: High school attended	105 effect-coded dummy variables, each representing a particular high school in the sample.	Member of a particular high school = 1; all other high schools except the last = 0; last high school = -1

ACT Survey Component. The Survey of ACT-Tested Students was designed to provide information about students' attitudes and behavior in several areas including: a) reasons for attending college, b) attitudes toward self, school, friends and family, c) activities and interests, and d) educational and family background. Appendix A contains a copy of the questionnaire.

Items in Section 1 of the questionnaire asked students to identify their reasons for attending college. Reasons for attending college were combined into three categories: academic (e.g., wanting to increase my knowledge and skills), social (e.g., wanting to meet new people), or negative (e.g., wanting to get away from my parents). These variables were included in Block 3 (education-related factors).

The items in Section 2 asked students to indicate their level of agreement with statements about self, school and schoolwork, teachers, counselors, friends, and parents (see Table 1 for coding). These items were examined using exploratory factor analysis to help define associations among the items and to aid in making decisions about combining individual items. The items in Part A of Section 2 loaded on three related clusters: a general self-confidence factor, a healthy living habits factor, and a general anxiety factor. Ten of the 14 school and schoolwork items in Part B loaded onto two related factors: a school value factor and a positive attribution factor. The school values factor appeared to measure a student's belief that participation in school tasks is important, relevant, and valuable. The positive attribution factor was consistent with Weiner's (1986) concept of causal attribution, where students tend to seek a cause for their successes and failures. Students who attribute their success and failures to positive attributions (success is due to high ability, whereas failure is due to a lack of effort) tend to perform better than do their negatively oriented

counterparts. Negatively oriented students are those students who attribute their success to luck and their failure to low ability or to external sources.

The items in Parts C and D loaded on a "perception of teachers" factor and a "perception of counselors" factor, respectively. Items in Parts E and F loaded on three factors: a "perception of parental attitudes" factor, a "perception of friends' attitudes" factor, and a factor reflecting perceptions of parental pressure to participate in school athletics.

Scores for the noncognitive variables in Section 2 were created by averaging the responses (1-5) within each cluster. For items that were stated negatively, their scaling was first reversed so that positive responses resulted in higher values. The "perceptions of teachers" and "perceptions of counselors" variables were included in Block 6 (perceptions of school) and the "perceptions of parents," "perceptions of friends," and the "parental pressure to participate in athletics" variables were included in Block 7 (perceptions of home and friends). The five self-perception variables were included in Block 8 (perceptions of self).

Coefficient alpha reliability estimates were calculated for the items in Section 2 by cluster. Reliability estimates ranged from .50 for healthy lifestyle (two items) to .96 for perceived encouragement by friends (two items).

The items in Section 3 related to the typical amount of time the student participated in various activities, such as work, athletics, watching TV, and studying. All activities-related variables were included in Block 4 (activities).

The items in Section 4 asked students to identify those courses they had taken or were currently taking as honors, accelerated, or advanced courses. Unfortunately, students did not complete these items as directed; this section was therefore not included in the analyses.

Section 5 requested information about the total number of children and of adults living in the student's home. These items were included in Block 5 (background variables).

Section 6 collected information about the educational backgrounds of students' parents/guardians. Due to the high correlation between mother's and father's level of education, the rank values (eight levels of formal education; other was treated as missing) for both parents/guardians were averaged together to create a combined parents' level of education.

Items in Section 7 solicited "yes," "no," or "uncertain" responses to a series of questions about the negative situations present in the home, such as serious health problems, family discord, and financial difficulty. These were summed (yes = 1, no = 0) to create the number of negative situations in the home. The parental education and negative home situation variables were included with the other family background variables in Block 5 (background variables).

Method

Weighted descriptive statistics were calculated for all independent and dependent variables. Weighted zero-order correlations were also calculated between all independent variables and ACT scores. Independent variables that were not statistically significant ($p < .01$), or that were statistically significant but did not correlate at least .10 with ACT scores ($-.10 > r > .10$), were excluded from further analyses.

Stepwise multiple regression models were then developed using SAS Version 6.12 statistical software (1989) to explain the five ACT test scores (English, Mathematics, Reading, Science Reasoning and Composite) as a function of high school academic and noncognitive variables. Variable blocks 1 through 8 were entered into each model one at a time and in the order described in Table 1; variables within blocks were evaluated using a stepwise order of entry.

Using this approach would show the contribution of noncognitive variables to explaining ACT scores, over and above course work taken and grades earned. Of course, other variable orderings are possible; however, this ordering was used to consider first those variables over which students have some control. All regression analyses were based on weighted data.

In order to be retained in the models, variables within the blocks were required to be statistically significant ($p < .01$) and noncollinear with all other variables in the models (multicollinearity was identified using condition indices of 15 or greater and common variance proportions greater than .50, as described in Belsley, Kuh, & Welch, 1980). Upon entry, each variable was evaluated relative to the blocks of variables preceding it; this procedure continued until all of the blocks were entered. Moreover, independent variables that previously met the entry criteria were assessed again at the entry of each additional block. Those variables that no longer met the criteria were removed from the model. (Note: This procedure differs from traditional blockwise selection).

The regression model for each ACT score was developed separately. Independent variables were allowed to differ across ACT score models, resulting in slightly different sample sizes for each regression model. Weighted descriptive statistics and zero-order correlations between ACT scores and the independent variables that met the criteria for entry and retention in the models are presented in Appendix B.

The activities variables (Block 4) were also examined to determine if their relationships with ACT scores were nonlinear. It was hypothesized that, while moderate amounts of time spent on various activities might be beneficial, too little or too much time spent on these activities might be detrimental to student achievement. Both linear and quadratic terms for these variables were

included in the models; the quadratic terms were retained in those models when the criteria for inclusion were met.

The 105 high school attended variables (Block 9) were added and retained in all models.

Results

Descriptive Statistics

Table 2 contains weighted descriptive statistics for each ACT test score. Means and standard deviations are given for the total sample and for each gender and racial/ethnic group. These statistics are based on the students with valid information for all variables used in the final regression models.

TABLE 2

Weighted Descriptive Statistics for ACT Test Scores, by Gender and Racial/Ethnic Group
(Sample Size)

Group	English		Mathematics		Reading		Science Reasoning		Composite	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total	20.7 (3928)	5.28	20.8 (3864)	4.89	21.2 (3924)	5.87	21.2 (3857)	4.44	21.1 (3849)	4.56
Males	20.5 (1394)	5.26	21.7 (1372)	5.25	21.2 (1392)	6.12	22.2 (1373)	4.82	21.6 (1368)	4.84
Females	20.8 (2534)	5.29	20.3 (2492)	4.61	21.2 (2532)	5.73	20.7 (2484)	4.12	20.9 (2481)	4.39
African-Americans	16.4 (283)	4.52	16.5 (270)	3.42	16.6 (283)	4.89	17.3 (271)	3.18	16.8 (269)	3.42
Caucasian-Americans	21.4 (3121)	5.07	21.3 (3076)	4.71	21.9 (3117)	5.64	21.8 (3069)	4.30	21.7 (3070)	4.36
Hispanics	19.4 (168)	5.17	19.9 (160)	4.82	20.5 (168)	6.24	20.0 (161)	4.42	20.2 (159)	4.63
Asian-Americans	20.4 (133)	5.43	23.4 (135)	5.08	20.8 (133)	6.08	21.6 (134)	4.06	21.7 (133)	4.45
Other	19.4 (98)	5.20	20.4 (96)	4.68	19.8 (98)	5.73	20.3 (95)	3.90	20.1 (96)	4.28

Note: Sample sizes for each group and test are shown in parentheses. Due to missing data, the sum of the sample sizes for the racial/ethnic groups may not equal that of the total sample.

Unweighted sample sizes for the total group ranged from 3,849 (Composite) to 3,928 (English); approximately 64% of the total group was female and 82% was Caucasian-American. Mean score differences for gender and racial/ethnic groups were similar in direction to those for the 1996 ACT-tested graduating class. However, for this sample, mean score differences between Caucasian American and African American students were larger than those nationally (by .2 to .8 scale score units), and mean differences between Hispanic students and Caucasian American students were smaller (by .6 to 1.3 scale score units). Differences in mean scores for Caucasian American and Asian Americans were similar to those nationally. Mean gender differences were slightly larger for the sample for Mathematics, Science Reasoning, and the Composite, and slightly smaller for English and Reading.

Regression Analyses-ACT Models

Table 3 and Figure 1 show the results of the final regression models. As shown in Figure 1, the total amount of variance explained across all five ACT scores ranged from 47% (Reading) to 65% (Mathematics). High school grade average and core courses taken accounted for the greatest proportion of explained variance in all five ACT test scores (R^2 = .29 to .53). These two blocks alone comprised 62% to 80% of the total variance explained by these models.

High school grade average was associated with a large proportion of the variance explained by the high school course work blocks. Of the 23 courses entered into the model, only mathematics, chemistry, and physics courses accounted for a statistically significant proportion of the variance in any of the ACT scores. This is not to say that other courses taken, including English and social studies courses, were unrelated to ACT performance. In general, the other courses taken were collinear with mathematics and science courses, or they were either mostly taken or not taken by

these students.

Individual unstandardized regression coefficients can be interpreted as the average change (increase or decrease) in ACT scores associated with a one-unit change in an independent variable, given the other variables in the model. For example, as shown in Table 3, taking trigonometry was associated with average ACT score increases of more than 1.0 scale score units for all ACT tests.

TABLE 3

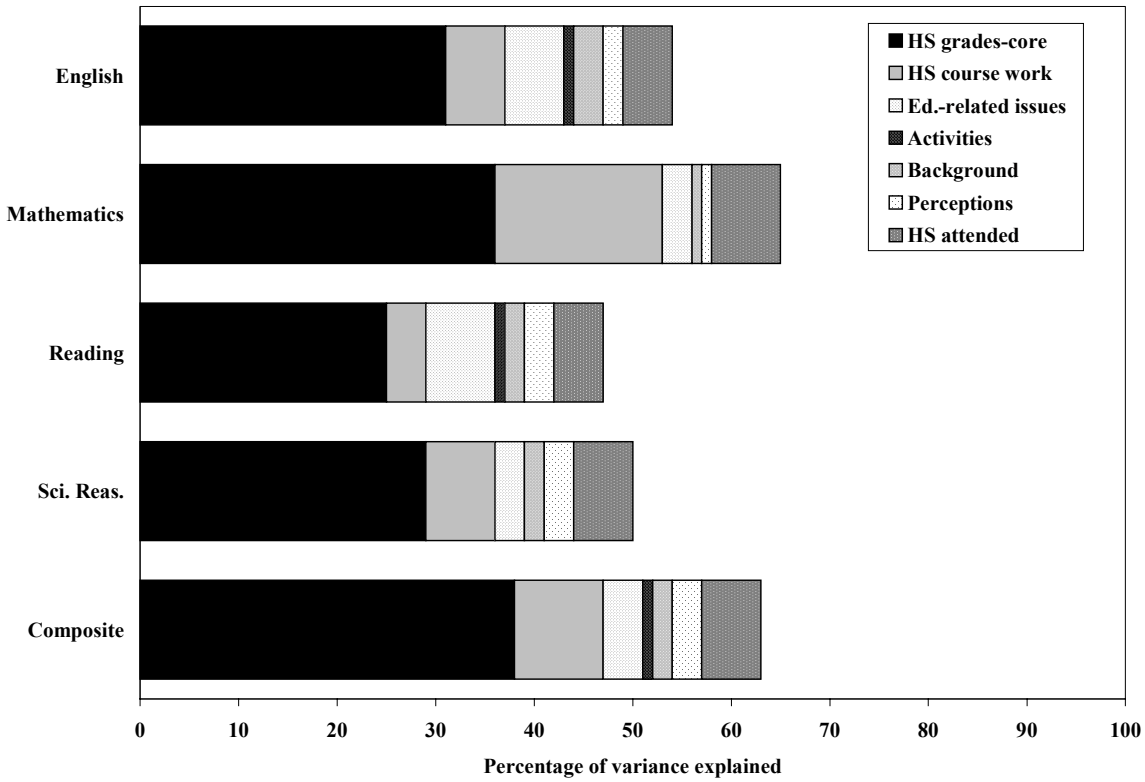
Weighted Regression Statistics for All Independent Variables and All ACT Tests

Block/independent variables	English (unweighted n = 3928)		Mathematics (unweighted n = 3864)		Reading (unweighted n = 3924)		Science Reasoning (unweighted n = 3853)		Composite (unweighted n = 3849)	
	Regression coefficient	Increase in R^2	Regression coefficient	Increase in R^2	Regression coefficient	Increase in R^2	Regression coefficient	Increase in R^2	Regression coefficient	Increase in R^2
Intercept	5.11		9.28		8.64		10.81		8.03	
1: High school grade average in 4 core areas	3.27	.31	2.63	.36	3.24	.25	2.39	.29	2.93	.38
2: Core courses taken (1=yes; 0=no)		.06		.17		.04		.07		.09
Algebra 2	.87		.95		.94		--		.86	
Geometry	1.38		1.13		--		.87		.79	
Trigonometry	1.25		1.97		1.09		1.08		1.38	
Calculus	2.04		3.48		2.27		1.77		2.39	
Other math beyond Alg. 2	.51		1.26		.71		.55		.77	
Chemistry	--		--		--		.82		--	
Physics	--		.99		--		.76		.66	
3: Education-related factors		.06		.03		.07		.03		.04
College prep. curriculum (1=yes; 0=no)	1.13		.46		1.05		.62		.80	
Need help with math skills	--		-1.43		--		-.39		--	
Need help with reading	-1.70		--		-2.66		-1.03		-1.35	
Need help with writing skills	-.77		--		--		--		-.31	
4: Activities (hours per week; 0-5)		<.01		--		.01		--		<.01
Educational activities	1.62		--		2.45		--		1.07	
Quadratic term	-.51		--		-.65		--		-.29	
Homework	--		--		-1.12		--		--	
Quadratic term	--		--		.18		--		--	
5: Family background variables		.03		.01		.02		.02		.02
Parents' level of education (1-8)	.28		.20		.28		.21		.24	
Primary language at home is English (1=yes; 0=no)	1.94		--		1.91		1.12		1.20	
8: Perception variables (1-5)		.02		.01		.03		.03		.03
Perception of self										
General anxiety	-.71		-.49		-1.01		-.68		-.74	
9: High school attended		.05		.07		.05		.06		.06
Total R^2	.52		.65		.47		.50		.63	
Standard error of estimate (SEE)	2.09		1.64		2.45		1.80		1.59	

Note: Unstandardized regression coefficients for all achievement and noncognitive variables were statistically significant ($p < .01$).
Regression coefficients for all variables in Blocks 6 and 7 were not statistically significant ($p > .01$).
The sum of the values in the R^2 columns may not equal the corresponding total R^2 due to rounding error.

Taking a calculus course was associated with average ACT score increases of more than 2.0 scale score units for all ACT tests except Science Reasoning (1.77), over and above the other variables in the models. Taking chemistry was statistically significant ($p < .01$) only for Science Reasoning; taking physics was statistically significantly related to Mathematics, Science Reasoning, and the Composite.

FIGURE 1. **Variance in ACT Assessment Scores Attributable to High School Course Work Variables, Noncognitive Variables, and High School Attended**



The four noncognitive variable blocks (Blocks 3, 4, 5, and 8) together accounted for between 5% (Mathematics) and 13% (Reading) of the variance in ACT scores, over and above the variance accounted for by the other variables in the models. Much of this was due to the contribution of the education-related factors block (Block 3). None of the variables in Blocks 6 or 7 met the criteria for inclusion in the final models.

Being enrolled in a college preparatory curriculum, and needing help with mathematics skills, reading skills, or writing skills were related to ACT performance, but the relationships varied by ACT test. For example, being enrolled in a college preparatory curriculum was associated with mean ACT scale score differences of 1.13 and 1.15 for English and Reading, respectively. However, corresponding mean differences for Mathematics and Science Reasoning were less pronounced (.46 and .62, respectively).

Students indicating a need for help with mathematics skills, reading skills, or writing skills had lower scores, on average, than those not needing help, given the other variables in the models. On average, students indicating a need for help with reading scored more than 1.0 scale score units lower on all ACT tests except Mathematics than those not needing help. Needing help with mathematics skills was associated with a decrease of 1.43 scale score units for Mathematics and .39 scale score units for Science Reasoning. Needing help with writing skills was associated with a decrease in English and Composite scores of less than 1 scale score unit.

Hours spent on educational activities and hours spent on homework were the only activity variables that met the criteria for inclusion in any of the models, over and above the other independent variables in the models. Of special interest was the fact that these relationships were not linear. Though the relationship between ACT scores and educational activities was moderately positive for students spending 0 to 10 hours per week on educational activities, ACT scores tended to decline for students spending more than 10 hours on educational activities. Hours per week spent on homework was positively related to ACT Reading scores of students who spent 1 to 5 hours a week or more on homework. In contrast, students indicating that they spent no time each week on homework had higher average Reading scores than those spending 1 to 5 hours each week on

homework. Many students, both high-scoring and low-scoring, indicated that they spent 0 hours per week doing homework.

The family background variables (parents' level of education and primary language in the home is English) explained only 1% to 3% of the variance in ACT scores, over and above the other variables in the models. Each increment of parents' level of education was associated with ACT test score increases of .20 to .28 scale score units. The use of English as the primary language in the home was associated with relatively large mean score increases of 1.12 to 1.94 for all ACT tests except Mathematics.

Noticeably absent from the block of background variables was family income, which had a moderate zero-order correlation with ACT test scores. However, family income proved to be highly correlated with each of several other independent variables, including high school grade average, parents' level of education, and the number of negative situations in the home. Moreover, a substantial number of students did not report their family income. These factors resulted in its exclusion from the models.

Perceived general anxiety was the only perception variable that appeared related to all ACT scores, over and above the other variables in the models. For example, each increment in the level of perceived anxiety (e.g., agree to strongly agree) was associated, on average, with a 1.01 scale score unit decrease in Reading scores, and accounted for 1% to 3% of the variance in ACT scores.

High school attended (Block 9) accounted for 5% to 7% of the variance in ACT scores, over and above the other variables in the models.

Regression Analyses-High School Course Work and Grade Average Models

As noted earlier, the noncognitive variables explained only 5% to 13% of additional variance in ACT scores, over and above high school grades and course work taken. Though the zero-order

correlations with ACT scores were statistically significant for many noncognitive variables, some of these variables also appeared related to high school course work and grade average. These variables could represent characteristics that impact student achievement, as measured by high school average and course work taken, which, in turn, appear to impact strongly students' performance on the ACT Assessment.

To further clarify the relationship between noncognitive variables, high school grade average and course work taken, and ACT performance, additional regression models were developed. In these models, the dependent (outcome) variables were the most important variables for explaining ACT scores, namely high school course work taken and high school grade average. As in the ACT score models, course work taken was represented by whether the student had taken or was currently taking calculus or physics, the number of years of mathematics courses taken, and the number of years of science courses taken. Number of years of courses taken was calculated by weighting the courses as 1-year or ½-year courses, as follows: first-year algebra, second-year algebra, geometry, general/physical/earth science, biology, chemistry and physics were defined as 1-year courses. Trigonometry, calculus, other mathematics beyond second-year algebra, and computer mathematics/computer science were defined as half-year courses.

Linear multiple regression models were developed for explaining high school grade average and the number of years of courses taken. These models were developed in the same manner as the ACT score regression models (i.e., the blocks were entered in a fixed order using the same criteria for entry and retention in the models). For comparison purposes, these models were based on the sample of students used for the full models. Differences in sample sizes between the ACT, high school grade average, and high school course work models were caused by the inclusion of variables in the latter models that were not included in the ACT score models.

Taking or not taking calculus, and taking or not taking physics are dichotomous variables. Stepwise logistic regression models, rather than linear regression models, were therefore developed for explaining these variables using the noncognitive independent variables. Variables were entered and retained in the model in a manner similar to that used for the other models; however, the criteria for entry and retention was limited to zero-order correlations of at least .10 ($-1.0 > r > .10$) and statistical significance ($p < .01$).

High school grade average. The results of the regression of high school grade average on the noncognitive variables are shown in Table 4. The model explained 26% of the variance in high school grade average; the standard error of estimate was .29.

TABLE 4

Regression Statistics for Noncognitive Variables and High School Grade Average

	HS grade average in four core subjects (unweighted n = 3821)	
Block/Independent variable	**Regression coefficient**	**Increase in R^2**
Intercept	2.05	
3: Education-related factors (1=yes; 0=no)		.15
College prep. curriculum	.15	
Need help with study skills	-.32	
4: Activities (hours per week; 0-5)		.04
Extracurricular activities	.15	
Quadratic term	-.03	
Watching TV	-.04	
5: Family background variables		.03
Number of negative situations in the home	-.04	
Parents' level of education (1-8)	.05	
8: Perception variables (1-5)		.04
Perception of self		
Self-confidence	.18	
School value	.06	
Total R^2	.26	
Standard error of estimate (SEE)	.29	

Note: Unstandardized regression coefficients were statistically significant ($p < .01$) unless marked with an asterisk. The sum of the values in the R^2 columns may not equal the corresponding R^2 due to rounding error.

Education-related factors accounted for the largest proportion of variance in high school grade average (15%). Mean high school grade averages differed by .15 for students who were and

were not enrolled in a college preparatory curriculum. Students needing help with study skills had high school grade averages that were .32 lower, on average, than those of students who did not need help.

Hours spent per week on extracurricular activities or watching TV were the only two activity variables that were related to high school grade average, contributing 4% of additional explained variance. Time spent watching TV was negatively related to high school grade average. In contrast, the relationship between time spent on extracurricular activities and high school grade average was nonlinear. The relationship was moderately positive for students spending less than 10 to 15 hours each week on this activity. However, students spending more than 10 to15 hours each week on extracurricular activities tended to have lower high school grade averages than those who spent less time on these activities.

The number of negative home situations and parents' level of education were associated with an increase in R^2 of .03, over and above the other variables in the model. An increase in the number of negative situations in the home was associated with a slight, but statistically significant ($p < .01$) average decrease in high school grade average of .04. An increase in parents' level of education was associated with a slight average increase of .05 in high school grade average.

The perception variables accounted for a .04 increase in explained variance in high school grade average, over and above the other variables in the model. Each increment in either the level of self-confidence or school value was associated with an average increase in high school grade average of .18 and .06, respectively.

High school course taking. Logistic regressions of calculus or physics course taking on the noncognitive variables are summarized in Table 5. The statistically significant ($p < .01$) independent

variables and their associated odds ratios are provided. The odds ratio is defined as the increase in the odds of an event occurring, given a one unit change in the independent variable.

TABLE 5

Weighted Logistic Regression Statistics for All Independent Variables and Calculus or Physics Course Taking

Block/independent variable	Odds ratio	
	Calculus (unweighted n = 3852)	**Physics (unweighted n =3852)**
3. Education-related factors		
College prep. curriculum (1=yes; 0=no)	4.52	1.87
Need help with math skills	.30	.59
4. Activities (hours per week; 0-5)		
Homework	1.40	1.26
5. Family background variables		
Parents' level of education (1-8)	--	1.10
8. Perception variables (1-5)		
Perception of self		
Self-confidence	2.06	1.34

Consistent with the results for high school grade average, enrollment in a college preparatory curriculum and students' perceived self-confidence were both positively related to the probability of students' taking either calculus or physics. For example, the odds of taking calculus for students who were enrolled in a college preparatory curriculum, as compared to students not enrolled in a college preparatory curriculum, were more than 4 to 1, given the other variables in the model. The odds of taking physics increased by 34% with each unit increase in the self-confidence variable (e.g., strongly disagree (1) to disagree (2)). The odds of students with the highest level of self-confidence (5) taking physics were 3 to 1, compared to those with lowest level of self-confidence (1), given the other variables in the model. The number of hours spent each week on homework was also related to a student's probability of taking either calculus or physics. The odds of students taking calculus who studied 20 or more hours each week (5) , relative to those studying zero hours each week (0), were more than 5 to 1. Corresponding odds for taking physics were 3.2 to 1.

Needing help with math skills was negatively related to the probability of students' taking either calculus or physics. The odds of students who indicated that they needed help with math skills were .3 to 1 for taking calculus, and .6 to 1 for taking physics, compared to students who did not need help with math skills. Parents' level of education was positively related only to physics course taking; the odds of taking physics were about two to one for students with parents having the highest level of education, compared to students with parents having the lowest level of education.

Table 6 summarizes the linear regression of the numbers of years of mathematics or science courses taken on the noncognitive variables. Regression coefficients and the associated increase in R^2 for each variable block are shown for each dependent variable.

TABLE 6

Weighted Regression Statistics for All Independent Variables and Number of Years of Mathematics and Science Courses Taken/Taking

	Number of years of mathematics courses taken/taking (unweighted n = 3847)		**Number of years of science courses taken/taking (unweighted n = 3851)**	
Block/independent variables	**Regression coefficient**	**Increase in R^2**	**Regression coefficient**	**Increase in R^2**
Intercept	2.27		2.14	
3: Education-related factors		.15		.07
College prep. curriculum (1=yes; 0=no)	.33		.27	
Need help with math skills	-.37		-.16	
4: Activities (hours per week; 0-5)		.03		.03
Educational activities	.25		.24	
Quadratic term	-.09		-.09	
Homework	.07		.06	
5: Family background variables		.01		.01
Negative situations in the home	-.03		--	
Parents' level of education (1-8)	.04		.03	
8: Perception variables (1-5)		.01		.01
Perception of self				
Self-confidence	.13		.10	
Total R^2	.20		.12	
Standard error of estimate (SEE)	.38		.35	

Notes: Unstandardized regression coefficients for all independent noncognitive variables were statistically significant ($p < .01$).

The sum of the values in the R^2 columns may not equal the corresponding total R^2 due to rounding error.

In general, the models results for the numbers of years of mathematics or science course taking were similar to those for high school grade average and calculus or physics course taking in the variables included in the models. The model explained 20% and 12% of the variance in mathematics or science course taking, with standard errors of estimate of .38 and .35, respectively.

Education-related factors were the variables most strongly related to mathematics or science course taking, and respectively accounted for 15% and 7% of the variance. Students enrolled in a college preparatory curriculum tended to take one quarter to one-third more years of mathematics or science courses than those not enrolled in a college preparatory curriculum. In contrast, students needing help with math skills tended to take fewer years of mathematics and science courses (by .37 and .16, respectively) than those not needing help.

Hours spent each week on extracurricular activities or doing homework accounted for 3% of the variance in mathematics or science course work. The relationship between time spent on extracurricular activities and mathematics or science course taking was nonlinear. The relationship was moderately positive for students spending less than 10 to 15 hours each week on this activity. However, students who spent more than 10 to 15 hours each week on extracurricular activities tended to take fewer years of mathematics or science courses than those who spent less time on these activities. The relationship between hours spent on homework each week and mathematics or science course taking was moderately positive, with regression coefficients of .07 and .06, respectively.

Family background variables were associated with an increase in R^2 of .01 for mathematics or science, over and above the other variables in the model. A one-unit increase in the number of

negative situations in the home was associated with a slight average decrease in the number of years of mathematics courses taken (.03). A one-unit increase in parents' level of education was associated with a slight average increase of .03 and .04, respectively, in the number of years taken of either mathematics or science courses.

Self-confidence was the only perception variable that was statistically significantly ($p < .01$) related to mathematics or science course taking, accounting for 1% of the variance, over and above the other variables in the model. Each increment in the level of self-confidence was associated with average increases in the numbers of years of mathematics or science courses taken of .13 and .10, respectively.

Discussion

The results of this study show that about 50% to 65% of the variance in ACT scores can be explained by high school grade average; mathematics and science course work taken; enrollment in a college preparatory curriculum; needs for help with reading, mathematics skills, and writing skills; time spent on educational activities and homework; parent's level of education and English as primary language in the home; perceived anxiety; and high school attended. In comparison to earlier research (Noble, et al., 1992), the explained variance for this study was slightly higher (by about 2% to 5%) for all ACT scores, except for Reading and Science Reasoning. (The models in the Noble, et al. study also included race/ethnicity or gender, which contributed to 1% to 2% of the explained variance).

The explained variance in Reading and Science Reasoning scores was much higher in this study than in the previously-cited research (47% vs. 39% and 50% vs. 42%, respectively). This increase was attributable to the increase in the contributions of course work and grade average. This result could be due to two factors: First, the course work and grade average variables differed

between the two studies. For this study, individual mathematics and science courses were included in the final models, and the high school grade average was limited to grades in the four core subjects. The earlier study used averages of all grades in English and social studies, and sums of course grades in mathematics and science. Second, the samples used for the two studies differed both in size and in characteristics. The Noble, et al. (1992) study was based on a representative sample of 40,000 ACT–tested students, whereas this study was based on samples of students who registered for two of five national test dates and who completed the Survey of ACT-tested Students.

As was found in earlier research (Noble, et al., 1992; Noble & McNabb, 1989), the variables most strongly associated with most ACT scores were high school course work, grade average, and high school attended. In particular, whether students had or had not taken specific mathematics or science courses appeared to result in sizeable mean ACT score differences. As noted earlier, there was limited variability in students' English and social studies course taking. Moreover, English and social studies course work taken was related to course work taken in mathematics and science. Thus, English and social studies courses were excluded from the models because of their lack of variability or their collinearity with other variables. These findings are also consistent with other studies (e.g., Noble & McNabb, 1989; Schiel, Pommerich, & Noble, 1996) that examined course work, grade, and ACT score relationships.

The contribution of the noncognitive variables to explaining ACT performance, relative to course work, grades, or high school attended, was small. Further analyses revealed that this was due, in part, to the strength of the relationships between these variables and high school grade average and mathematics or science course work. With course work and grade average included in the models, some of the noncognitive variables either did not explain additional variance in ACT scores, and/or were collinear with other variables in the models. Explaining course work taken and high

school grade average resulted in additional noncognitive variables being included in the models, as well as an increase in the variance explained by variables common to these models and the ACT models. Moreover, the contribution of the noncognitive variables was much larger in the high school grade average and course work models than in the ACT models, even though anxiety and English as primary language were included in the ACT models, but not in the grade average and course work models. These findings support the hypothesis that noncognitive characteristics, particularly education-related factors, impact student achievement, as measured by high school average and course work taken. Students' ACT scores, in turn, appear to be a function of high school grade average, courses taken, and high school attended, as well as education-related factors.

The strength of the relationships between needs for help with reading and mathematics skills, enrollment in a college preparatory curriculum, and ACT scores were consistent with prior research. Inclusion of needs for help with writing skills was unique to this study, and was weakly associated with English and Composite scores, relative to needs for help with mathematics and reading.

The only activities variables that contributed to explaining ACT performance, over and above the other variables in the models, were those related to students' education: educational activities and homework. It is interesting to note that these relationships were nonlinear. To some extent, time spent on educational activities (e.g., taking college courses, using educational facilities in the community, reading for fun, etc.) appeared beneficial to students' educational achievement. However, students who spent extensive amounts of time on educational activities achieved lower scores, on average. It may be hypothesized that by spending extensive amounts of time on educational activities, students would have much less time to spend on homework or other school activities, evidently to their detriment.

It is worth noting that the regression coefficients associated with hours spent on homework were statistically significant only for ACT Reading. This finding may be due to the level of homework typically associated with social studies courses: They are arguably some of the most homework intensive courses in school, and typically require a great deal of reading. Also, some students appeared to be doing well without studying at home, and others were studying for many hours without benefit. Some students may have the time and the opportunity to complete their homework at school; other students may lack the study skills necessary to do their homework efficiently, whether at home or at school.

This study used a fixed order of entry of the independent variables into the regression models. The relative contribution of course work, grades, and other education-related factors to explaining ACT scores might have resulted from the order of entry used into the regression models. With a "true" stepwise regression, other results might be found. To test this hypothesis, ordinary stepwise regression models were developed for each test score, where the independent variables were allowed to enter the models based only on the strength of their relationships with ACT scores. For all models, high school average remained the variable most strongly related to ACT scores, followed by student anxiety. However, variables following anxiety in the models were either course work variables or education-related factors.

Implications

For students to achieve higher ACT scores, and thus to increase their likelihood of success in college, they need to focus on taking rigorous course work and achieving good grades. In particular, mathematics and science course taking appear to benefit students, regardless of the grades they receive. To some extent, students' educational achievement can also benefit from time spent

on educational activities, such as reading or spending time at the library, or on homework, as long as they engage in these activities in moderation.

There are some factors students can not change, including the quality of the education they receive. This study showed substantial variability among schools in the academic achievement of their students. The responsibility for providing a challenging, quality education falls to administrators, teachers, and counselors, as well as to the communities that support the school system.

Counselors and teachers can support students by encouraging them to do well in school, to have high aspirations, and by helping them cope with the stresses and anxiety of school life. Moreover, by resolving students' needs for help in reading, mathematics, and writing, improved achievement will likely result. Students appear to have a good idea about those areas in which they need additional help.

This study showed that selected noncognitive variables contributed little additional information beyond high school course work, high school grades, and high school attended for explaining ACT scores.). Further research on noncognitive variables not included in this study may help identify other important variables for explaining ACT performance. Additional analyses could also be conducted to determine the extent to which the remaining unexplained variance in ACT scores may be due to measurement error in the variables studied (e.g., reliability of course grades).

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Appendix A

Survey of ACT-tested Students

Appendix B

Weighted Descriptive Statistics for All Variables in the Full Models

Block/Independent variable	English (unweighted n = 3928)				Mathematics (unweighted n = 3864)				Reading (unweighted n = 3924)				Science Reasoning (unweighted n = 3857)				Composite (unweighted n = 3849)			
	Mean	SD	%*	r	Mean	SD	%*	r	Mean	SD	%*	r	Mean	SD	%*	r	Mean	SD	%*	r
1: High school GPA in 4 core areas	3.19	.34		.56	3.20	.34		.60	3.19	.34		.50	3.19	.34		.54	3.20	.34		.61
2: Core courses taken (1=yes; 0=no)																				
Algebra 2			62	.28			61	.31			62	.24			---	---			61	.31
Geometry			68	.20			67	.22			---	---			67	.18			67	.20
Trigonometry			27	.36			27	.50			27	.31			26	.38			26	.43
Calculus			6	.25			6	.38			6	.23			6	.26			6	.31
Other Math beyond Algebra 2			21	.24			21	.34			21	.22			21	.24			21	.29
Chemistry			---	---			---	---			---	---			56	.26			---	---
Physics			---	---			19	.34			---	---			19	.25			19	.28
3: Education-related factors																				
College prep. (1=yes; 0=no)			55	.27			54	.26			55	.24			54	.24			54	.29
Need help with math skills (0=yes;			---	---			26	-.42			---	---			27	-.31			---	---
1=no)			22	-.24			---	---			22	-.28			21	-.18			21	-.22
Need help with reading (0=yes;			18	-.21			---	---			---	---			---	---			18	-.19
1=no)																				
Need help with writing skills (0=yes;																				
1=no)																				
4: Activities (hours per week; 0-5)																				
Educational activities	.77	.28		.12	---	---		---	.77	.28		.14			---	---	.77	.28		.13
Homework activities	---	---		---	---	---		---	1.99	.64		.13			---	---	---	---	---	---
5: Background variables	4.12	1.0	69	.31	4.13	1.00		.31	4.12	1.00	69	.29	4.13	1.00	67	.30	4.13		67	.34
Parents' level of education (1-8)				.11	---	---		---				.11				.08		1.0		.09
Primary language at home is English																		0		
(1=yes; 0=no)																				
8: Perception variables (1-5)																				
Perception of self																				
General anxiety	2.30	.49		-.29	2.29	.49		-.26	2.30	.49		-.31	2.29	.49		-.30	2.29	.49		-.33

* Values in the percent columns indicate the percentage of all students who responded affirmatively to a dichotomous item (e.g. have taken Algebra =1; have not =0).

Notes: All of the variables listed above meet the criteria for inclusion in the models ($p < .01$, zero-order $r >= .10$), based on the overall sample of 5,489 students. Some correlations reported above may be less than .10, due to the smaller sample sizes for the full models.