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Science Course Taking, Out-of-Class Science Accomplishments, and Achievement in the High School Graduating Class of 1998

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Abstract

We studied the relationships among students' scores on the ACT Science Reasoning test, their science course work in high school, and their out-of-class accomplishments in science. Data for the study were from nearly one million ACT-tested students in the high school graduating class of 1998. Analyses were done for the total group of students and for subgroups defined by gender, race/ethnicity, and family income. Male and female students reported about the same number of years of high school science taken/planned, but the range of years was greater among racial/ethnic groups. Those reporting the least amount of science were low income students in each racial/ethnic group. Students taking all of four designated science courses earned an average ACT Science Reasoning score nearly five points higher than those taking only one science course. Among males, the difference associated with taking one course versus four courses was greater than five score points.

About one third of students reported participation in one or more of the seven out-of-class science accomplishments. Male students, on average, reported a larger number of the accomplishments than did female students, and larger percentages of males participated in each accomplishment. Students of each gender, racial/ethnic, and family income subgroup who responded *Yes* to a particular out-of-class science accomplishment tended to earn higher ACT Science Reasoning scores than did those who responded *No*. With few exceptions, ACT Science Reasoning scores increased with the amount of high school science course work and the number of out-of-class accomplishments in science. This relationship emerged even more clearly in the subgroup analyses.

Acknowledgments

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Introduction

Recent educational reforms have prompted more high school course taking in core subjects and stimulated greater interest in equity issues (Ekstrom, Goertz, & Rock, 1988). National Goal 5 (National Education Goals Panel, 1997) asked Americans to increase efforts to help students achieve in mathematics and science and to increase the number—especially among women and underrepresented minorities—of undergraduate and graduate students matriculating in mathematics, science, and engineering. These ambitious goals coincide with a potentially troubling supply and demand prediction by the U. S. Office of Technology Assessment (Congress of the U. S., 1998) that the supply of scientists and engineers is expected to decline while the demand for them is expected to grow. Although not all agree with this expectation (Berliner & Biddle, 1995), few dispute the need for balance in these areas. To make conditions more equitable, increasing the number of women and non-Asian minority groups in science is a reasonable goal for our society, one of high priority, and one toward which educators are willing to push.

Nearly two decades ago, Berryman's (1983) *Who Will Do Science?* described the educational pipeline that students must enter at an early age, certainly before high school, in order to become scientific professionals. By now, few deny that academic preparation is necessary to keep students in the talent pool that supplies the scientific pipeline. However, less attention has been drawn to the role of extracurricular and out-of-class science activities in opening up opportunity to achieve better preparedness and higher academic performance in science. According to Oakes (1990), opportunity is crucial. "Opportunity refers to the access students have to science and mathematics experiences, both in and out of school" (p. 157). Opportunity—and the lack thereof—affects science course taking, just as it affects participation in extracurricular and out-of-class activities. (See Pearson & Fechter, 1994.)

The presence or absence of opportunity is not the only factor affecting science achievement: Goal setting and related reforms have also helped. We see evidence of these reforms in increased science course taking and in higher levels of science proficiency on the ACT Assessment than a decade or so ago (McLure, G. T., Sun, & Valiga, 1997). Average ACT Composite scores for Native American, Black, Mexican American, and female students increased more during the 10-year period of 1987 to 1996 than did the scores of those for other racial/ethnic groups and males. We have evidence that increased course taking makes a difference in achievement (McLure, G.T., Sun, Valiga, 1997; McLure, G.T., 1998; Bartell & Noble, 1990). To boost achievement, the education community continues to encourage students to take more science courses. Yet achievement gaps remain. Male students tend to score a point or so higher on the ACT Science Reasoning test than do female students, and White and Asian students tend to score two to three points higher than do students of other racial/ethnic groups (ACT, Inc., 1991 to 1999).

Researchers have searched for ways to explain and remedy the gap, finding, for example, that female students have tended to take the life science courses, such as biology and chemistry, but have been less likely to take physics (National Science Board, 1998; McLure, G.T., Boatwright, Valiga, Farrant, & McLure, J.W., 1993). Between 1987 and 1996, science course taking among all ACT-tested students increased by 13 percentage points in chemistry (from 67% to 80%) and by 10 percentage points in physics (from 35% to 45%). During that period, course taking in chemistry increased for Native American students by 20 percentage points (from 49%

to 69%), for Mexican American students by 19 percentage points (from 57% to 76%), for Black students by 18 percentage points (from 59% to 77%), and for female students by 17 percentage points (from 64% to 81%). At the same time, course taking in physics among ACT-tested students increased more for female students (by 14 percentage points), Mexican American students (by 14 percentage points), and Native American students (by 11 percentage points) than for other groups (McLure, G.T., Sun, & Valiga, 1997). Although limited to college bound students, these findings are similar to those described in *Science and Engineering Indicators—1998* (National Science Board, 1998). Although gains have occurred among female students and underrepresented minorities, gaps remain.

Purpose. In this study we revisited high school science course taking in relation to ACT Science Reasoning scores and also examined the extent of out-of-class science accomplishments in relation to science achievement as measured by the same test. The ACT Assessment is an educational development test based on high school curricula (ACT, Inc., 1997). The more relevant high school courses are to a given ACT Assessment subject area test, the stronger the likelihood of a higher score on that test. Based on this assumption and on previous research, we expected to find not only that the more years of science and the more courses taken, the greater the likelihood of a higher ACT Science Reasoning test score. In addition, we expected that the more out-of-class science accomplishments students had experienced, the better their Science Reasoning scores would be.

To test these assumptions, we examined current science course taking patterns and asked whether out-of-class science accomplishments appear linked to higher performance on the ACT Science Reasoning test. Specifically, we examined the following questions by gender, racial/ethnic group, and family income level.

- How many years of high school science do college-bound students take or expect to take by graduation?
- How many of the four natural science courses (i.e., General/Physical/Earth Science, Biology, Chemistry, and Physics) listed in the ACT Assessment's *Course/Grade Information Section* (CGIS) do ACT-tested students expect to complete by graduation?
- What percentage of students take or plan to take each of the four science courses prior to graduation?
- Do ACT Science Reasoning test scores increase with increases in the number of science courses taken?
- On average, in how many of the seven out-of-class science accomplishments listed on the CGIS do students participate? Do ACT Assessment test scores increase as out-of-class accomplishments increase?
- How does student participation in out-of-class science accomplishments vary by the type of accomplishment?
- For those who did and did not participate in each of seven out-of-class science accomplishment items, are there differences in average ACT Science Reasoning test scores?

Method

Sample

This study examined data for all of the 997,069 ACT-tested students from the graduating class of 1998. About 64% of these students were seniors and 34% were juniors when they took the ACT Assessment. As shown in Table 1, about 57% of the students in the sample were female. Ten percent of students were Black, 71% were White, 5% were Hispanic, 3% were Asian, and 1% were Native American. Although 15.6% of the 1998 graduating class did not respond to the item about family income, of the total group nearly one-third (31.1%) reported a "Low" family income (under \$36,000), 28.2% reported "Medium" family income (\$36,000 to \$60,000), and 25.1% reported a "High" family income (above \$60,000). The percentages of students in each racial/ethnic group by income level are shown in the lower part of Table 1.

Table 1
Demographic Characteristics of the ACT-Tested 1998 High School Graduating Class

	N	%
Total	997,069	100
Gender		
Male	431,795	43.3
Female	565,274	56.7
Racial/Ethnic Background		
Black	100,574	10.1
Native American	11,134	1.1
White	707,613	71.0
Hispanic	52,140	5.2
Asian	30,997	3.1
Other	27,565	2.8
No Race Identified	67,046	6.7
Family Income[a]		
Low (below $36,000)	310,313	31.1
Medium ($36,000 to $60,000)	281,529	28.2
High (above $60,000)	250,180	25.1
Did not respond to income item	155,047	15.6
Racial/Ethnic by Income Level[a]		
Black		
Low	58,130	57.8
Medium	18,148	18.0
High	9,376	9.3
Did not respond to income item	14,920	14.8
Native American		
Low	5,365	48.2
Medium	2,788	25.0
High	1,469	13.2
Did not respond to income item	1,512	13.6
White		
Low	182,349	25.8
Medium	223,217	31.6
High	208,955	29.5
Did not respond to income item	93,092	16.2
Hispanic		
Low	26,759	51.3
Medium	11,604	22.3
High	7,156	13.7
Did not respond to income item	6,621	12.7
Asian		
Low	12,238	39.5
Medium	7,361	23.8
High	7,440	24.0
Did not respond to income item	3,958	12.8
Other		
Low	11,177	40.6
Medium	6,769	24.6
High	5,524	20.0
Did not respond to income item	4,095	14.9
No Race Identified		
Low	14,295	21.3
Medium	11,642	17.4
High	10,260	15.3
Did not respond to income item	30,849	46.0

Note. Data were based on the total number of students in the ACT-tested graduating high school class of 1998.

[a]Low income=below $36,000; Medium income=$36,000 to $60,000; High income=above $60,000

How to read. Of the 997,069 students in the ACT-tested graduating class of 1998, 43.3% were male.

Nearly six in ten Black students and five in ten Native American and Hispanic students were in the *Low* family income group. Only a quarter of White students indicated that their family income level was *Low*.

The number of students reported in each table varies, depending on the nature of the data being analyzed. Whenever feasible, percentages are based on the entire sample of 997,069 students. Exceptions occur when data are drawn from a section or item that significant numbers of students skipped—perhaps because they completed the section at an earlier test date or simply because they exercised the option of skipping it. For example, 39,543 students made fewer than two marks in the entire CGIS and were therefore not included in the percentages for that section. Means are based only on the total number responding to a given item. For example, 69,377 students did not respond to SPS Item 87 and were omitted from the analysis of the number of years of high school science courses taken. In several tables, we omitted the data for students who did not respond to the family income item.

Instrument

The ACT Science test is one of four tests (*English, Mathematics, Reading*, and *Science Reasoning*) included in the ACT Assessment (ACT, Inc., 1997). The scores for each test and for the ACT Composite range from 1 to 36. ACT Assessment test scores are accepted by virtually all colleges and universities nationwide; nevertheless, the population of ACT-tested students does not represent all high schools or all students in the country.

In addition to the four achievement tests, the ACT Assessment contains three noncognitive components, including the *Student Profile Section* (SPS) and the CGIS. The SPS contains nearly 200 background information questions grouped into eleven categories such as "Admissions/ Enrollment Information;" "Educational Plans, Interests, and Needs;" "Special Educational Needs, Interests, and Goals;" and "Out-of-Class Accomplishments." The CGIS was added to the ACT Assessment *National Registration Folder* in 1986 to collect information about 30 high school courses that form the basis of a college preparatory curriculum. For each course, students check one of the following three options: (1) "have taken or am taking," (2) "have not taken but will," and (3) "have not taken and will not." Students are encouraged, but not required, to complete the CGIS, and they are urged to do so accurately. Self-reported course work and grade data have been researched for decades and found to be fairly accurate (Valiga, 1987; Sawyer, Laing, & Houston, 1988).

Procedures

Means, percentages, and effect sizes were examined and t tests conducted to analyze the relationship among high school science course taking patterns, out-of-class science accomplishments, and achievement as measured by the ACT Science Reasoning test. Analyses were conducted by gender, racial/ethnic background, and family income level. We also examined years of science courses taken and number of high school science courses taken by family income level within racial/ethnic group.

The absolute effect size for each of the seven science accomplishments was calculated by subtracting the mean of those responding *No* from the mean of those responding *Yes* and dividing the result by the pooled standard deviation for both the *Yes* and *No* responders. Essentially, this compares the difference between the two means in terms of standard deviation units.

Definitions

Defining the number of science courses taken. We counted a science course as *taken* if the student marked either "have taken or am taking" or "have not taken but will" for the course or indicated a grade in the Grade section of the CGIS. In this way all courses that students expected to take by the time of high school graduation were included. For convenience, we sometimes refer to the courses as *taken/planned* (or *taken* or *studied*) and include courses both taken and planned in references to course taking patterns.

Defining the number of years of science courses taken. We averaged the number of natural science courses students expected to take by graduation, as reported in SPS Item 87. Students registering for the ACT Assessment complete the SPS, which includes a section calling for students to indicate the number of years of certain subjects they have taken or will have taken by the time they graduate. Item 87 asks for the number of semesters the student will have taken high school science, and these were converted to years. The four science courses listed in the ACT Assessment's CGIS were (1) General/Physical/Earth Science, (2) Biology, (3) Chemistry, and (4) Physics.

Defining racial/ethnic groups. For this study, we used six racial/ethnic groups plus one group consisting of those who did not identify their racial/ethnic group. In the right-hand column below are racial/ethnic identifiers as they appear in the ACT SPS; in the left-hand column are the abbreviated names used in this paper. Because of a recent change in the racial/ethnic item on the ACT Assessment *Registration Folder*, we combined all Hispanic students into one category that includes Mexican American, Chicano, Puerto Rican, Cuban, Latino, and other Hispanic students under the name of Hispanic.

• Black	African-American/Black
• Native American	American Indian/Alaskan Native
• Asian	Asian-American/Pacific Islander
• Hispanic	Mexican American/Chicano/Puerto Rican/Cuban/Other Hispanic
• White	Caucasian American/White
• Other	Other, Multi-racial
• No Race Identified (NRI)	Prefer not to respond, blank

Defining family income groups. Although the ACT SPS item breaks family income into ten categories, we grouped the categories into *Low* (below $36,000), *Medium* ($36,000 to $60,000), and *High* (above $60,000). These three categories represent approximate thirds (31.1%, 28.2%, and 25.1%) of students who responded to the family income item (SPS Item 59). The remaining 15.6% were included in Tables 1 and 7 but omitted in others. Notes in the tables explain the basis for analysis in each instance.

Results

Years of Science Taken by Graduation

In response to SPS Item 87, female students reported taking 3.22 years of high school science, almost identical to the 3.21 years male students reported (see Table 2). Asian students reported an average of 3.43 years, more than that of any other group. White students reported an average of 3.25 years. Those reporting the least number of years of science were Low income students of each racial/ethnic group. Students in the Low income group reported a lower average (3.08) than those in the Medium (3.24) or High (3.37) income group. This pattern prevailed in each of the racial/ethnic groups: *The higher the income group, the greater the average number of years of science studied in high school.* (See Table 2.) Data for students who did not respond to the family income item were not included in the analyses of years of science by family income.

Number of Science Courses Taken by Graduation

The ACT Assessment's CGIS provides another measure of the number of science courses taken in high school. As noted earlier, those courses are (1) General/Physical/Earth Science, (2) Biology, (3) Chemistry, and (4) Physics. On average, students reported taking 3.06 of the four courses (see Table 3). Male students averaged 3.10 courses, and female students averaged 3.03 courses. Asian students averaged 3.32 courses; White students and Other/Multi-Racial students averaged 3.07. Students in the High family income group averaged 3.19. Groups with averages

Table 2
Years of Science Taken or Planned for Taking by the 1998 High School Graduating Class

Category	Number Responding to SPS Item 87[a] N	Years of Science Taken/Planned
Total	927,792	3.22
Gender		
Male	394,468	3.21
Female	533,324	3.22
Racial/Ethnic Background		
Black	94,016	3.01
Native American	10,448	2.99
White	676,351	3.25
Hispanic	49,283	3.07
Asian	29,415	3.43
Other/Multi-Racial	25,962	3.18
No Race Identified	42,317	3.18
Family Income[b]		
Low income	307,800	3.08
Medium income	279,810	3.24
High income	248,675	3.37
Racial/Ethnic by Income Level[b]		
Black		
Low income	57,578	2.95
Medium income	17,976	3.10
High income	9,301	3.20
Native American		
Low income	5,310	2.90
Medium income	2,767	3.08
High income	1,464	3.20
White		
Low income	181,154	3.13
Medium income	220,050	3.25
High income	207,851	3.38
Hispanic		
Low income	26,562	2.98
Medium income	11,527	3.16
High income	7,120	3.29
Asian		
Low income	12,133	3.29
Medium income	7,316	3.48
High income	7,382	3.60
Other		
Low income	11,043	3.06
Medium income	6,720	3.23
High income	5,481	3.36
No Race Identified		
Low income	14,020	3.03
Medium income	11,454	3.19
High income	10,076	3.34

Note. Data were based on the total number of students responding to SPS Item 87.

[a]SPS Item 87 asks for the number of years of natural sciences (biology, chemistry, physics) students expected to complete (or had completed) by high school graduation.

[b]Data for students not responding to the family income item or to Item 87 were omitted from this portion of the analysis (see Table 1). Low income=below $36,000; Medium income=$36,000 to $60,000; High income=above $60,000

How to read. The 927,792 students responding to SPS Item 87 expected to complete an average of 3.22 years of high school natural science (biology, chemistry, physics). Black students expected to complete 3.01 years. Low income Black students expected to take 2.95 years, Medium income Black students expected to take 3.10 years, and High income Black students expected to take 3.20 years of natural science.

Table 3
Number of High School Science Courses Taken or Planned for Taking by the 1998 High School Graduating Class

Category	Responding to the 4 science courses or grades in the CGIS[a] N	Average Number of 4 Science Courses Taken/Planned by Graduation (from the CGIS)
Total	961,985	3.06
Gender		
Male	412,602	3.10
Female	549,383	3.03
Racial/Ethnic Background		
Black	97,529	2.96
Native American	10,486	2.87
White	693,360	3.07
Hispanic	50,188	2.94
Asian	29,961	3.32
Other	25,886	3.07
No Race Identified	54,575	3.04
Family Income[b]		
Low income	306,706	2.96
Medium income	279,527	3.07
High income	248,327	3.19
Racial/Ethnic by Income Level[b]		
Black		
Low income	57,521	2.92
Medium income	17,968	3.03
High income	9,284	3.13
Native American		
Low income	5,138	2.80
Medium income	2,733	2.93
High income	1,442	3.02
White		
Low income	180,995	2.96
Medium income	221,958	3.07
High income	207,683	3.19
Hispanic		
Low income	26,352	2.87
Medium income	11,495	3.00
High income	7,079	3.11
Asian		
Low income	12,015	3.28
Medium income	7,266	3.33
High income	7,338	3.40
Other		
Low income	10,621	3.02
Medium income	6,583	3.07
High income	5,360	3.19
No Race Identified		
Low income	14,064	2.91
Medium income	11,524	3.04
High income	10,141	3.16

Note. Data were based on the total number of students responding to the 4 science courses or grades in the CGIS.

[a]The CGIS asks students to indicate which of 4 science courses they expected to complete by high school graduation. The 4 courses were General/Physical/Earth Science, Biology, Chemistry, and Physics.

[b]Data for students not responding to the family income item or to the science items in the CGIS were omitted from this portion of the analyses (see Table 1). Low income=below $36,000; Medium income=$36,000 to $60,000; High income=above $60,000

How to read. The 961,985 students responding to the science courses or grades in the CGIS indicated they had taken or planned to take an average of 3.06 of the 4 science courses listed. Low income Black students had taken or planned to take 2.92 of the 4 science courses, Medium income Black students had taken or planned to take 3.03 of the 4 courses, and High income Black students had taken or planned to take 3.13 of the 4 science courses.

below 3.00 courses were Low income Native American students (2.80), Low income Black students (2.92), and Low income Hispanic students (2.87). By separating racial/ethnic groups into the three family income groups, we can see that students from Low income families are less likely to take as many science courses as those from higher income groups. Whether counting specific *science courses* taken or planned as in Table 3 or counting *years* of science taken or planned as in Table 2, the pattern is the same: *The higher the family income, the higher the number of courses taken/planned.* This pattern holds true for each of the racial/ethnic groups.

Percentages of Individual Courses Taken

Based on responses to the CGIS, 80.8% of ACT-tested students had taken/planned General/Physical/Earth Science, 97.3% had taken/planned Biology, 81.4% had taken/planned Chemistry, and 46.3% had taken/planned Physics (see Table 4). As we compared the percentages taking each course by gender, racial/ethnic group, and family income group, the least variation occurred for Biology and the greatest variation occurred for Physics. Among racial/ethnic groups, the percentages taking Biology ranged from a low of 96.3% for Native American students to a high of 97.5% for White students. The percentages taking Physics ranged from a low of 35.4% for Native American students to a high of 71.1% for Asian students. Female students were slightly more likely to take Biology and Chemistry and less likely to take Physics than male students. Students in Low and Medium income groups were more likely to take General/Physical/Earth Science than were students in the High income group. Students in the High income group were more likely to take Physics than were those in the two lower income groups. A similar pattern occurred with regard to Chemistry, although to a lesser extent.

Table 4
Percentage of Students Who Had Taken or Planned to Take Each of Four High School Science Courses by the 1998 High School Graduating Class

	Responding to CGIS science courses/ grades	High School Science Courses			
		General/Physical/ Earth Science	Biology	Chemistry	Physics
Group	N	%	%	%	%
Total	961,985	80.8	97.3	81.4	46.3
Gender					
Male	412,602	81.4	96.6	80.2	51.5
Female	549,383	80.4	97.8	82.3	42.5
Racial/Ethnic Background					
Black	97,529	81.8	96.7	78.5	39.0
Native American	10,486	86.6	96.3	68.3	35.4
White	693,360	81.8	97.5	81.7	46.3
Hispanic	50,188	73.8	96.9	79.5	43.7
Asian	29,961	71.5	97.2	92.4	71.1
Other	25,886	77.2	96.4	81.9	51.6
No Race Identified	54,575	79.0	96.3	80.8	48.4
Family Income[a]					
Low income	306,706	82.7	96.7	76.4	39.9
Medium income	279,527	82.0	97.5	81.7	45.8
High income	248,327	77.9	98.0	87.6	55.3

Note. Data were based on the total number of students responding to the science courses or grades in the CGIS.

[a]Data for students not responding to the family income item or to the science items of the CGIS were omitted from this portion of the analysis (see Table 1). Low income=below $36,000; Medium income=$36,000 to $60,000; High income=above $60,000

How to read. Of the 961,985 responding to the CGIS section of the ACT Assessment, 80.8% indicated they had taken or planned to take high school General/Physical/Earth Science—81.4% of male students and 80.4% of female students. Higher percentages of female than male students had taken or planned to take Biology (97.8% versus 96.6%) and Chemistry (82.3% versus 80.2%).

Science Achievement in Relation to the Number of Science Courses Taken

The average ACT Science Reasoning test score was 21.11 for the ACT-tested graduating class of 1998 (see Table 5). Students who reported taking/planning only one of the four courses had an average ACT Science Reasoning test score of 17.99; those who reported taking/planning all four had an average of 22.75—*an average of 4.76 score points higher.* Regardless the number of science courses taken/planned, female students had test scores slightly lower than those of male students. Nevertheless, the scores of both male and female students rose considerably with an increase in the number of courses taken or planned. For each group of students studied, the same pattern occurred: *The more science courses taken, the higher the ACT Science Reasoning test score.*

ACT Science Reasoning Test Scores by the Number of Out-of-Class Science Accomplishments

On average, the 920,572 students who responded to the Out-of-Class Accomplishment section reported less than one (0.63) of the seven out-of-class science accomplishments. The majority reported none, but about one third reported one or more. The average ACT Science Reasoning test scores in relation to the number of reported out-of-class science accomplishments are shown in Table 6. For the total sample, the ACT Science score increased with each increase in the number of out-of-class accomplishments reported—unless all seven were reported—in which case the average score dropped to nearly the same as that for *None* reported (compare 20.79 for those reporting seven versus 20.73 for those reporting *None*). If we discount for a moment the responses of students who marked all seven accomplishments—even though some who marked all seven may have responded honestly, we have a pattern showing a positive relationship between the number of accomplishments reported and the ACT Science Reasoning test score. With few exceptions, all

Table 5
ACT Science Reasoning Test Scores in Relation to Number of Science Courses Taken/Planned by the 1998 High School Graduating Class

				Number of Science Courses Taken/Planned			
Group	N	Overall Science Score	No Response to CGIS[a]	1	2	3	4
Total	997,069	21.11	20.17	17.99	19.01	21.12	22.75
Gender							
Male	431,795	21.75	20.48	18.32	19.23	21.78	23.52
Female	565,274	20.61	19.79	17.69	18.86	20.68	22.04
Racial/Ethnic Background							
Black	100,574	17.30	16.47	15.57	16.22	17.40	18.34
Native American	11,134	19.44	17.40	17.24	18.05	20.00	21.03
White	707,613	21.79	20.72	18.62	19.62	21.76	23.45
Hispanic	52,140	19.10	17.99	16.61	17.57	19.36	20.58
Asian	30,997	21.60	20.49	17.89	18.94	21.59	22.38
Other/Multi Racial	27,565	20.46	19.71	17.86	18.68	20.54	21.73
No Race Identified	67,046	21.46	21.14	18.39	19.28	21.55	23.16
Family Income[b]							
Low income	310,313	19.79	18.30	17.15	18.05	19.60	21.03
Medium income	281,529	21.42	20.12	18.32	19.32	21.23	22.87
High income	250,180	22.55	21.48	19.13	20.11	22.40	23.87

Note. Data for the overall science score were based on the total number of students in the ACT-tested graduating high school class of 1998. Data for the number of science courses taken were based on the number responding to the science courses in the CGIS.

[a]The total not responding either to the four science courses or to grades in the CGIS consisted of 39,543 students, of which 21,482 were males and 18,061 were females. By racial/ethnic group, those not responding to the CGIS were as follows: Black = 3,882; Native American = 713; White = 16,735; Hispanic = 2,267; Asian = 1,165; Other/Multi Racial = 1,842; No Race Identified = 12,939. Of those responding to the Family Income item, non-responders to the CGIS were Low income = 4,267; Medium income = 3,978; High income = 2,541. A total of 155,047 did not respond to the Family Income item (see Table 1).

[b]Data for students not responding to the family income item were omitted from this portion of the analysis (see Table 1). Low income=below $36,000; Medium income $36,000 to $60,000; High income=above $60,000

How to read. Males in the 1998 ACT Assessment graduating class had an average ACT Science Reasoning test score of 21.75. Males who had taken or planned to take all four science courses had an ACT Science Reasoning Test score of 23.52.

Table 6
ACT Science Reasoning Test Score by the Number of Out-of-Class Science Accomplishments Reported by the 1998 ACT-Tested Graduating Class

			Number of Science Accomplishments Reported of 7 Listed in SPS							
			None	1	2	3	4	5	6	7
			616,236	158,433	70,689	38,474	21,406	10,129	3,993	1,212
			66.9%	17.2%	7.7%	4.2%	2.3%	1.1%	0.4%	0.1%
	N	Average Number of Accomplishments	ACT Science Reasoning Test Scores							
Total	920,572	0.63	20.73	21.85	22.01	22.04	22.35	23.04	23.87	20.79
Gender										
Male	391,111	0.74	21.31	22.59	22.80	22.83	23.03	23.76	24.47	21.33
Female	529,461	0.55	20.36	21.22	21.27	21.29	21.63	22.08	22.98	19.82
Racial/Ethnic Background										
Black	93,282	0.72	17.13	17.70	17.73	17.82	17.77	17.93	18.25	17.02
Native American	10,387	0.77	19.07	20.04	20.38	20.17	20.68	20.58	21.88	19.54
White	671,832	0.61	21.38	22.56	22.83	22.86	23.23	24.05	24.91	22.55
Hispanic	48,873	0.57	18.79	19.76	19.96	20.16	20.70	21.36	21.98	20.02
Asian	28,982	0.77	21.07	22.18	22.48	22.94	23.83	24.21	24.99	22.49
Other	25,714	0.72	20.04	21.16	21.28	21.47	21.52	21.82	23.13	20.25
No Race Identified	41,502	0.73	20.91	22.39	22.63	22.80	22.86	23.75	24.11	21.63
Family Income[a]										
Low income	306,159	0.64	19.44	20.39	20.50	20.56	20.70	21.29	21.97	18.92
Medium income	278,501	0.63	21.00	22.09	22.31	22.41	22.67	23.35	24.03	21.62
High income	247,286	0.65	22.06	23.32	23.60	23.55	23.96	24.66	25.34	23.32

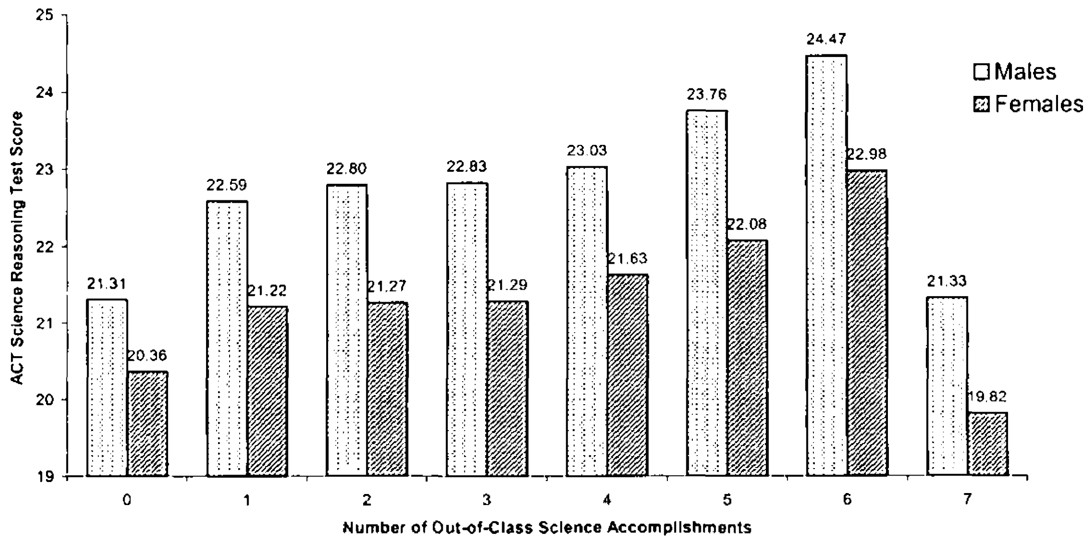
Note. Data were based on the number of students responding to Items 150-156 in the SPS.

[a]Data for students not responding to the family income item or to Items 150-156 were omitted from this portion of the analysis (see Table 1). Low income=below $36,000; Medium income=$36,000 to $60,000; High income=above $60,000

How to read: The average ACT Science Reasoning test score for the 158,433 students who reported one out-of-class science accomplishment was 21.85; for the 70,689 students who reported two, the score was 22.01; and for the 3,993 students who reported six, the score was 23.87.

small, this pattern persisted for both male and female students (see Figure 1), for each racial/ethnic group, and for each family income group.

***FIGURE 1*. ACT Science Reasoning Test Scores by the Number of Out-of-Class Science Accomplishments and Gender**



Note. Data for this figure were based on Table 6.

The number of students who indicated all seven accomplishments was relatively small—1,212 or 0.1% of the total. Of those, about 64% were male, 25% were Black, 46% were White, 9% were Asians, 5% were Hispanic, and 3% were Native American. Of the 1,123 who reported their family income, 49% were in the Low income group, 24% were in the Medium income group, and 27% were in the High income group. The standard deviation for the ACT Science Reasoning score (20.79) for this group of 1,212 students was 5.60, suggesting more variability in the scores of this group than in those of groups that responded *Yes* to *fewer* than seven of the science accomplishment items. Close to one fifth (19%) of the 1,212 students had ACT Science scores no higher than 15. In this group of 229 low scoring students, 61% were male, 53% were Black, 21% were White, and no more than 7% were in any other racial/ethnic group. Nearly two thirds (66%) were in the Low family income group. Some of the 1,212 students responding *Yes* to all seven items earned high ACT Science Reasoning scores—30% had scores of 24 or higher. Although it is not inconceivable that low scoring students completed all seven science accomplishments, it is at least possible that they may have anticipated low scores and responded *Yes* in an effort to enhance their academic image.

Seven Out-of-Class Accomplishments in Order of the Level of Student Participation in Each

The percentages of students who participated in the out-of-class science accomplishments are shown in Table 7. The science accomplishment reported by the largest percentage (16.5%) of students was Item 151, *Performed an independent scientific experiment (not as part of a course).* Male students were much more likely to report this accomplishment than were female students (21.6% versus 12.8%). Although larger percentages of male than female students reported each of the seven accomplishments, none of the other items yielded such diverse responses by gender.

Item 152, *Participated in a National Science Foundation summer program for high school students*, drew *Yes* responses from the lowest percentage (1.4%) of the total group responding to that item, especially the lowest percentage of White students (0.9%). At the same time, it drew responses from disproportionately higher percentages of Black and Native American students (4.0% and 3.4%). At least 11% of every group studied responded positively to three accomplishments—Item 151, *Performed an independent scientific experiment (not as part of a course)*; Item 156, *Participated in a scientific contest or talent search*; and Item 153, *Won a prize or award (of any kind) for scientific work or study.* No consistent pattern was apparent between the level of family income and responses to the various science accomplishment items.

Table 7
Seven Out-of-Class Science Accomplishments
Reported by the 1998 ACT-Tested Graduating Class

	N	Responding to Items	Seven Science Accomplishments in Order of the Level of Student Participation in Each						
			SPS Item Numbers						
			151	156	153	155	150	154	152
			N=919,305	N=918,318	N=919,131	N=918,749	N=919,012	N=918,901	N=918,993
		Average Number of Accomplishments	*% Yes*	*% Yes*	*% Yes*	*% Yes*	*% Yes*	*% Yes*	*% Yes*
Total	920,572	0.63	16.5	12.3	12.3	9.1	8.4	3.4	1.4
Gender									
Male	391,111	0.74	21.6	13.9	13.0	10.1	10.0	4.1	1.7
Female	529,461	0.55	12.8	11.2	11.8	8.4	7.2	2.9	1.3
Racial/Ethnic Background									
Black	93,282	0.72	15.3	15.5	14.8	10.9	7.7	3.9	4.0
Native American	10,387	0.77	18.4	14.3	15.3	12.6	8.7	5.0	3.4
White	671,832	0.61	16.4	11.6	11.8	8.8	8.4	3.3	0.9
Hispanic	48,873	0.57	14.4	11.9	11.6	8.5	6.4	2.6	2.0
Asian	28,982	0.77	18.5	16.9	13.9	9.4	10.4	5.0	2.8
Other	25,714	0.72	20.3	14.3	13.0	9.1	9.6	3.5	2.3
No Race Identified	41,502	0.73	20.6	13.3	13.4	9.4	10.4	4.0	1.8
Family Income[a]									
Low income	306,159	0.64	16.3	12.6	12.4	9.4	7.6	3.3	1.8
Medium income	278,501	0.63	16.5	11.9	12.1	9.0	8.3	3.4	1.3
High income	247,286	0.65	16.7	12.2	12.2	8.7	9.8	3.7	1.2
Did not respond	88,626	0.57	10.0	7.8	7.8	5.6	4.7	2.0	0.8

Note. Data were based on the number of students responding to Items 150-156 in the SPS out-of-class accomplishment section. The 7 out-of-class science accomplishments are listed below.

SPS Item 151 Performed an independent scientific experiment (not as part of a course)
SPS Item 156 Participated in a scientific contest or talent search
SPS Item 153 Won a prize or award (of any kind) for scientific work or study
SPS Item 155 Placed first, second, or third in a school science contest
SPS Item 150 Wrote an independent paper on a scientific topic which received the highest possible grade given in my school
SPS Item 154 Placed first, second, or third in a regional or state science contest
SPS Item 152 Participated in a National Science Foundation summer program for high school students

[a]Low income=below $36,000; Medium income=$36,000 to $60,000; High income=above $60,000

How to read: The 920,572 students responding to Items 150-156 in the out-of-class accomplishment section reported an average of 0.63 out of 7 listed. Males averaged 0.74 out-of-class science accomplishments, and females averaged 0.55. Of the 7 items, Item 151, *Performed an independent scientific experiment (not as part of a course)*, drew the highest percentage of *Yes* responses (16.5%).

ACT Science Reasoning Test Scores of Students Who Responded YES Versus NO to Accomplishments

The ACT Science Reasoning test scores of students who responded *Yes* to each of the science accomplishment items were compared with scores of those who responded *No* (see Tables 8 to 14). Comparisons were made for the total group, male students, female students, each racial/ethnic group, and each family income group. With the exception of Item 152, *Participated in a National Science Foundation summer program for high school students*, t test comparisons of ACT Science scores for those who responded *Yes* versus *No* were statistically significant, most at the $p < .0001$ level, favoring those who responded *Yes* to the particular accomplishment. However, large sample sizes, such as the one in this study, tend to result in statistically significant t tests, even for fairly small differences. For this reason, we have also chosen to interpret these differences in terms of standard deviation units or "effect size" (Carver, 1993; Cohen, 1988). Tables 8 to 14 contain effect sizes in the final columns.

Total group responses to Items 150 to 156. Overall, the pattern of differences in ACT Science Reasoning test scores favored those who responded *Yes* rather than *No* to six of the seven out-of-class science accomplishment items. Based on the data in Tables 8 to 14, Figure 2 shows the total group's ACT Science scores for *Yes* versus *No* responders to each out-of-class science accomplishment. Except for a small, reversed pattern for Item 152, perhaps created by a low number of *Yes* responders (1.4%), students responding *Yes* to the various accomplishments had higher average ACT Science scores than did those responding *No*. Not only was the difference statistically significant, but the effect size for most tended to be fairly strong—above .20 for five of the six accomplishments favoring students who responded *Yes*.

Table 8
First Out-of-Class Science Accomplishment: A Comparison of ACT Science Reasoning Test Means by Response to SPS Item 150

SPS Item 150 Wrote an independent paper on a scientific topic which received the highest possible grade given in my school	**Responding to Item** N	**Responding *Yes*** %	**Means if *Yes***	**Means if *No***	**Difference in Means**	***t* Statistic**[b]	**Effect Size**
Total	919,012	8.4	22.87	20.99	1.88	109.15	.41
Gender							
Male	390,345	10.1	23.44	21.67	1.77	68.49	.36
Female	528,667	7.2	22.29	20.51	1.78	77.79	.41
Racial/Ethnic Background							
Black	93,114	7.7	17.57	17.33	0.24	5.72	.07
Native American	10,366	8.7	20.82	19.38	1.44	9.72	.33
White	670,900	8.4	23.68	21.66	2.02	104.04	.46
Hispanic	48,773	6.4	20.66	19.05	1.61	21.20	.39
Asian	28,893	10.4	23.28	21.45	1.83	20.05	.39
Other	25,651	9.6	21.80	20.36	1.44	14.93	.32
No Race Identified	41,315	10.4	23.43	21.31	2.12	26.50	.43
Family Income[a]							
Low income	305,751	7.7	21.04	19.69	1.35	45.34	.31
Medium income	278,149	8.4	23.13	21.67	1.46	61.69	.42
High income	246,944	9.9	24.38	22.36	2.02	66.19	.45

Note. Data were based on the total number of students responding "yes" or "no" to the item.

[a]Of the total number of students responding to SPS Item 150, there were 88,168 who did not respond to the family income item. Low income=below $36,000; Medium income=$36,000 to $60,000; High income=above $60,000

[b]With the large sample sizes, every relationship was significant at the .0001 level.

How to read. Of the 919,012 students responding to SPS Item 150, "Wrote an independent paper on a scientific topic," 8.4% said *Yes*. Of the 390,345 males responding to the item, 10.1% responded *Yes*. Of the 528,667 females responding to the item, 7.2% responded *Yes*. Regardless of students' gender, racial/ethnic background, or family income—each group that marked *Yes* to SPS Item 150 had a higher ACT Science Reasoning test score than did their counterparts who marked *No*. Except for that of Black students, the effect size for each subgroup was above .30.

Table 9
Second Out-of-Class Science Accomplishment: A Comparison of ACT Science Reasoning Test Means by Response to SPS Item 151

SPS Item 151 Performed an independent scientific experiment (not as part of a course)	Responding to Item N	Responding *Yes* %	Means if *Yes*	Means if *No*	Difference in Means	*t* Statistic[b]	Effect Size
Total	919,305	16.5	22.17	20.95	1.22	94.67	.27
Gender							
Male	390,490	21.6	22.85	21.58	1.27	67.25	.26
Female	528,815	12.8	21.33	20.54	0.79	44.68	.18
Racial/Ethnic Background							
Black	93,127	15.3	17.78	17.27	0.51	15.88	.14
Native American	10,375	18.4	20.56	19.26	1.30	12.05	.31
White	671,080	16.4	22.87	21.63	1.24	85.19	.28
Hispanic	48,795	14.4	20.09	19.00	1.09	20.79	.27
Asian	28,911	18.5	22.48	21.45	1.03	14.37	.22
Other	25,664	20.3	21.46	20.25	1.21	17.09	.27
No Race Identified	41,353	20.6	22.81	21.20	1.61	26.58	.32
Family Income[a]							
Low income	305,816	16.5	20.81	19.59	1.22	56.83	.28
Medium income	278,230	16.7	22.43	21.23	1.20	53.80	.27
High income	247,038	16.9	23.56	22.35	1.21	49.28	.26

Note. Data were based on the total number of students responding "yes" or "no" to the item.

[a]Of the total number of students responding to SPS Item 150, there were 88,168 who did not respond to the family income item. Low income=below $36,000; Medium income=$36,000 to $60,000; High income=above $60,000

[b]With the large sample sizes, every relationship was significant at the .0001 level.

How to read. Of the 919,305 students responding to SPS Item 151, "Performed an independent scientific experiment," 16.5% said *Yes*. Of the 390,490 males responding to the item, 21.6% responded *Yes*. Of the 528,815 females responding to the item, 12.8% responded *Yes*. Regardless of students' gender, racial/ethnic background, or family income—students who marked *Yes* to SPS Item 151 had higher average ACT Science Reasoning test scores than did their counterparts who marked *No*. Except for female students and Black students, the effect size for each subgroup was above .20.

Table 10
Third Out-of-Class Science Accomplishment: A Comparison of ACT Science Reasoning Test Means by Response to SPS Item 152

SPS Item 152 Participated in a National Science Foundation summer program for high school students	**Responding to Item** **N**	**Responding *Yes*** **%**	**Means if *Yes***	**Means if *No***	**Difference in Means**	***t* Statistic**[b]	**Effect Size**
Total	918,993	1.4	20.89	21.16	-0.27	-6.59***	.06
Gender							
Male	390,317	1.7	21.31	21.86	-0.55	-9.03***	.11
Female	528,676	1.3	20.49	20.64	-0.15	-2.86*	.03
Racial/Ethnic Background							
Black	93,101	4.0	17.90	17.32	0.58	9.84***	.16
Native American	10,369	3.4	19.98	19.48	0.50	2.06	.12
White	670,895	0.9	22.82	21.82	1.00	17.48***	.22
Hispanic	48,771	2.0	19.76	19.14	0.62	4.65***	.15
Asian	28,889	2.8	22.16	21.63	0.53	3.12*	.11
Other	25,642	2.3	20.07	20.51	-0.44	-2.28	.10
No Race Identified	41,326	1.8	21.40	21.53	-0.13	-0.72	.03
Family Income[a]							
Low income	305,715	1.8	19.13	19.81	-0.68	-11.46***	.15
Medium income	278,175	1.3	21.55	21.42	0.13	1.70	.03
High income	246,957	1.3	23.23	22.55	0.68	8.27***	.15

Note. Data were based on the total number of students responding "yes" or "no" to the item. Missing data were not included in the analyses.

[a]Of the total number of students responding to SPS Item 152, there were 88,146 who did not respond to the family income item. Low income=below \$36,000; Medium income=\$36,000 to \$60,000; High income=above \$60,000

[b]With the large sample sizes, every relationship was significant at the .0001 level except for the means of Native American, Other, No Race Identified, and Medium Income students for which there was no significant difference in means and for Female and Asian students for which the difference in means was significant at the .01 level.

How to read. Of the 918,318 students responding to SPS Item 152, "Participated in a National Science Foundation summer program for high school students," 1.4% said *Yes*. Of the 390,317 males responding to the item, 1.7% responded *Yes*. Of the 528,676 females responding to the item, 1.3% responded *Yes*. On average, students who marked *No* had significantly higher ACT Science Reasoning test score means than did those who marked *Yes*. A smaller percentage of White students (0.9%) than of any other group studied marked *Yes* to this item. Even so, the ACT score for White students who did participate was higher than for those who did not (effect size=.22).

* $p < .01$
*** $p < .0001$

Table 11
Fourth Out-of-Class Science Accomplishment: A Comparison of ACT Science Reasoning Test Means by Response to SPS Item 153

SPS Item 153 Won a prize or award (of any kind) for scientific work or study	Responding to Item N	Responding *Yes* %	Means if *Yes*	Means if *No*	Difference in Means	*t* Statistic[b]	Effect Size
Total	919,131	12.3	22.07	21.02	1.05	71.67	.23
Gender							
Male	390,403	13.0	22.93	21.69	1.24	53.44	.25
Female	528,728	11.8	21.37	20.54	0.83	45.24	.19
Racial/Ethnic Background							
Black	93,120	14.8	17.84	17.26	0.58	17.70	.16
Native American	10,367	15.3	20.29	19.36	0.93	7.97	.22
White	670,957	11.8	22.91	21.69	1.22	72.63	.27
Hispanic	48,787	11.6	20.16	19.02	1.14	19.70	.28
Asian	28,891	13.9	23.10	21.41	1.69	21.16	.36
Other	25,641	13.0	21.43	20.36	1.07	12.63	.23
No Race Identified	41,368	13.4	22.74	21.35	1.39	19.29	.28
Family Income[a]							
Low income	305,751	12.6	20.53	19.69	0.84	35.31	.19
Medium income	278,178	12.3	22.38	21.29	1.09	42.36	.24
High income	246,985	12.4	23.66	22.40	1.26	42.23	.28

Note. Data were based on the total number of students responding "yes" or "no" to the item.

[a]Of the total number of students responding to SPS Item 153, there were 88,217 who did not respond to the family income item. Low income=below $36,000; Medium income=$36,000 to $60,000; High income=above $60,000

[b]With the large sample sizes, every relationship was significant at the .0001 level.

How to read. Of the 919,131 students responding to SPS Item 153, "Won a prize or award (of any kind) for scientific work or study," 12.3% said *Yes*. Of the 390,403 males responding to the item, 13.0% responded *Yes*. Of the 528,728 females responding to the item, 11.8% responded *Yes*. Regardless of the students' gender, racial/ethnic background, or family income—each group that marked *Yes* to SPS Item 153 had higher ACT Science Reasoning test scores than did their counterparts who marked *No*, with effect sizes above .20 for all subgroups except Female, Black, and Low income students.

Table 12
Fifth Out-of-Class Science Accomplishment: A Comparison of ACT Science Reasoning Test Means by Response to SPS Item 154

SPS Item 154 Placed first, second, or third in a regional or state science contest	Responding to Item N	Responding *Yes* %	Means if *Yes*	Means if *No*	Difference in Means	*t* Statistic[b]	Effect Size
Total	918,901	3.4	22.82	21.09	1.73	65.29	.37
Gender							
Male	390,280	4.1	23.64	21.77	1.87	47.67	.38
Female	528,621	2.9	21.95	20.60	1.35	38.14	.31
Racial/Ethnic Background							
Black	93,081	3.9	17.55	17.34	0.21	3.58	.06
Native American	10,375	5.0	20.42	19.45	0.97	4.98	.23
White	670,839	3.3	23.74	21.77	1.97	64.94	.45
Hispanic	48,777	2.6	21.14	19.10	2.04	17.58	.50
Asian	28,881	5.0	24.23	21.50	2.73	21.39	.58
Other	25,636	3.5	22.00	20.44	1.56	10.01	.34
No Race Identified	41,312	4.0	23.47	21.45	2.02	16.16	.40
Family Income[a]							
Low income	305,690	3.3	20.95	19.75	1.20	27.00	.27
Medium income	278,152	3.4	23.12	21.37	1.75	37.74	.40
High income	246,926	3.7	24.44	22.48	1.96	40.34	.43

Note. Data were based on the total number of students responding "yes" or "no" to the item.

[a]Of the total number of students responding to SPS Item 154, there were 88,133 who did not respond to the family income item. Low income=below $36,000; Medium income=$36,000 to $60,000; High income=above $60,000

[b]With the large sample sizes, every relationship was significant at the .0001 level with the exception that the difference in means for Black students was statistically significant at the .001 level.

How to read. Of the 918,901 students responding to SPS Item 154, "Placed first, second, or third in a regional or state science contest," 3.4% said *Yes*. Of the 390,280 males responding to the item, 4.1% responded *Yes*. Of the 528,621 females responding to the item, 2.9% responded *Yes*. Regardless of the students' gender, racial/ethnic background, or family income—each group that marked *Yes* to SPS Item 154 had higher average ACT Science Reasoning test scores than did their counterparts who marked *No*, with effect sizes of .23 or above for all except Black students.

Table 13
Sixth Out-of-Class Science Accomplishment: A Comparison of ACT Science Reasoning Test Means by Response to SPS Item 155

SPS Item 155 Placed first, second, or third in a school science contest	**Responding to Item** **N**	**Responding *Yes*** **%**	**Means if *Yes***	**Means if *No***	**Difference in Means**	***t* Statistic[b]**	**Effect Size**
Total	918,749	9.1	21.66	21.10	0.56	32.99	.12
Gender							
Male	390,223	10.1	22.52	21.78	0.74	28.50	.15
Female	528,526	8.4	20.89	20.62	0.27	12.84	.06
Racial/Ethnic Background							
Black	93,074	10.9	17.62	17.31	0.31	8.39	.09
Native American	10,368	12.6	19.92	19.44	0.48	3.81	.11
White	670,722	8.8	22.43	21.78	0.65	33.94	.15
Hispanic	48,761	8.5	20.05	19.07	0.98	14.82	.24
Asian	28,871	9.4	23.07	21.49	1.58	16.47	.33
Other/Multi Racial	25,634	9.1	21.03	20.45	0.58	5.85	.13
No Race Identified	41,319	9.4	22.15	21.47	0.68	8.09	.14
Family Income[a]							
Low income	305,623	9.5	20.27	19.74	0.53	19.23	.12
Medium income	278,091	9.1	21.97	21.37	0.60	20.28	.13
High income	246,907	8.8	23.18	22.50	0.68	20.99	.15

Note. Data were based on the total number of students responding "yes" or "no" to the item. Missing data were not included in the analyses.

[a]Of the total number of students responding to SPS Item 155, there were 88,128 who did not respond to the family income item. Low income=below $36,000; Medium income=$36,000 to $60,000; High income=above $60,000

[b]With the large sample sizes, every relationship was significant at the .0001 level.

How to read. Of the 918,749 students responding to SPS Item 155, "Placed first, second, or third in a school science contest," 9.1% said *Yes*. Of the 390,223 males responding to the item, 10.1% responded *Yes*. Of the 528,526 females responding to the item, 8.4% responded *Yes*. Regardless of the students' gender, racial/ethnic background, or family income—each group that marked *Yes* to SPS Item 155 had higher ACT Science Reasoning test scores than did their counterparts who marked *No*.

Table 14
Seventh Out-of-Class Science Accomplishment: A Comparison of ACT Science Reasoning Test Means by Response to SPS Item 156

SPS Item 156 Participated in a scientific contest or talent search	Responding to Item N	Responding *Yes* %	Means if *Yes*	Means if *No*	Difference in Means	*t* Statistic[b]	Effect Size
Total	918,318	12.3	22.14	21.02	1.12	76.62	.24
Gender							
Male	390,007	13.9	23.02	21.66	1.36	60.31	.28
Female	528,311	11.2	21.32	20.55	0.77	40.59	.18
Racial/Ethnic Background							
Black	93,011	15.5	17.89	17.24	0.65	20.23	.18
Native American	10,366	14.3	20.47	19.34	1.13	9.40	.26
White	670,400	11.6	23.01	21.68	1.33	78.88	.30
Hispanic	48,723	11.9	20.26	19.00	1.26	22.02	.31
Asian	28,885	16.9	23.17	21.34	1.83	24.78	.39
Other	25,622	14.3	21.51	20.33	1.18	14.52	.26
No Race Identified	41,311	13.3	22.78	21.34	1.44	19.89	.29
Family Income[a]							
Low income	305,439	12.8	20.53	19.69	0.84	35.30	.19
Medium income	277,961	12.0	22.48	21.28	1.20	46.32	.27
High income	246,808	12.4	23.82	22.38	1.44	51.71	.32

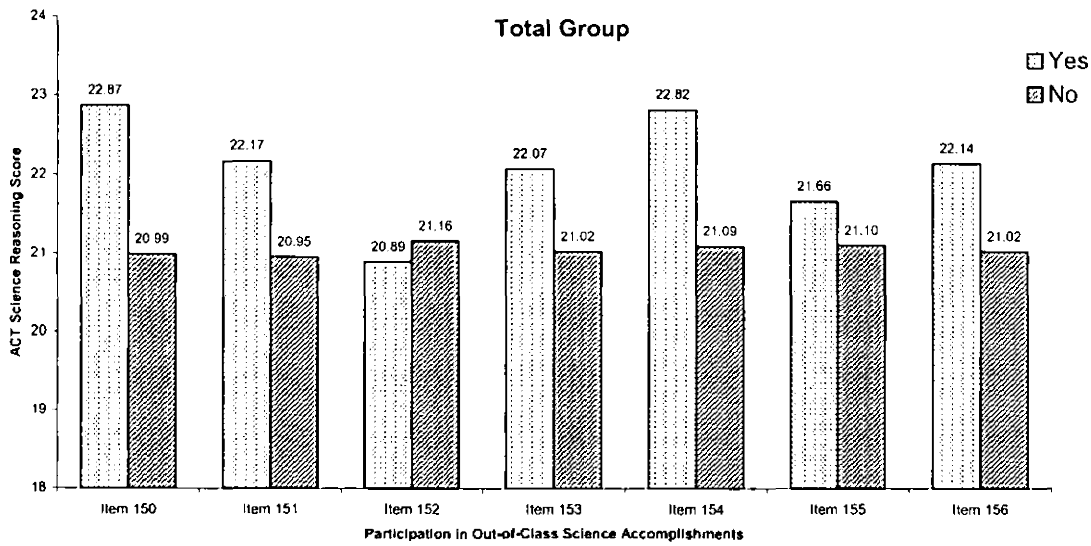
Note. Data were based on the total number of students responding "yes" or "no" to the item.

[a]Of the total number of students responding to SPS Item 156, there were 88,110 who failed to respond to the family income item. Low income=below $36,000; Medium income=$36,000 to $60,000; High income=above $60,000

[b]With the large sample sizes, every relationship was significant at the .0001 level.

How to read. Of the 918,318 students responding to SPS Item 156, "Participated in a scientific contest or talent search," 12.3% said *Yes*. Of the 390,007 males responding to the item, 13.9% responded *Yes*. Of the 528,311 females responding to the item, 11.2% responded *Yes*. Regardless of the students' gender, racial/ethnic background, or family income—each group that marked *Yes* to SPS Item 156 had higher ACT Science Reasoning test scores than did their counterparts who marked *No*.

Figure 2. **ACT Science Reasoning Test Scores by Out-of-Class Science Accomplishments**



Note. Data for this figure were based on Tables 8-14.

Of the six accomplishment items with total ACT Science scores favoring students who responded *Yes*, the one with the weakest total effect size was Item 155, *Placed first, second, or third in a school science contest* (effect size = .12; see Table 13 and Figure 2). Nevertheless, the *total* group that responded *Yes* to this item had ACT Science scores that averaged more than half a score point above those that responded *No* (compare 21.66 to 21.10), but this pattern was not constant across that item's subgroups. For example, Hispanic students who responded *Yes* had an average ACT Science score 0.98 points higher than did Hispanic students who responded *No*, an effect size of .24. Asian students who responded *Yes* had an average ACT Science score 1.58 points higher than did Asian students who responded *No*, an effect size of .33.

The two highest total ACT Science score averages were earned by students who responded *Yes* to Items 150, *Wrote an independent paper on a scientific topic which received the* *highest possible grade given in my school*, and 154, *Placed first, second, or third in a regional or state science contest.* The lowest total ACT Science score average was earned by those who responded *Yes* to Item 152, *Participated in a National Science Foundation summer program for high school students.*

For the total group, the small number of *Yes* responders to Item 152 (n = 13,302 or 1.4% of the 918,993 responding to that item) had *lower* average ACT Science scores, by 0.27 points, than did those who responded *No.* This overall pattern was different from that of the other six items for which the ACT Science Reasoning scores were *higher* for those responding *Yes.* Although it is not possible to pinpoint exactly why this occurred, it is important to point out that the National Science Foundation has numerous summer programs for high school students, many of which appear to include large numbers of students with less academic preparation. Higher percentages of minority students than were represented in the total sample were also among *Yes* responders to Item 152. Compared with each group's percentages in the total sample (see Table 1), *Yes* responders to Item 152 included larger percentages of Black students (28.2% versus 10.1%), Native American students (2.6% versus 1.1%), Hispanic students (7.4% versus 5.2%), and Asian students (6.0% versus 3.1%) but a smaller percentage of White students—45.8% versus 71%. Although paradoxically for the *total* group of responders to Item 152, the pattern does not hold, it *does hold* for each identified racial/ethnic group. For Black students (effect size = .16), Native American students (effect size = .12), White students (effect size = .22), Hispanic students (effect size = .15), and Asian students (effect size = .11), the ACT Science Reasoning scores were *higher* for those who responded *Yes.*

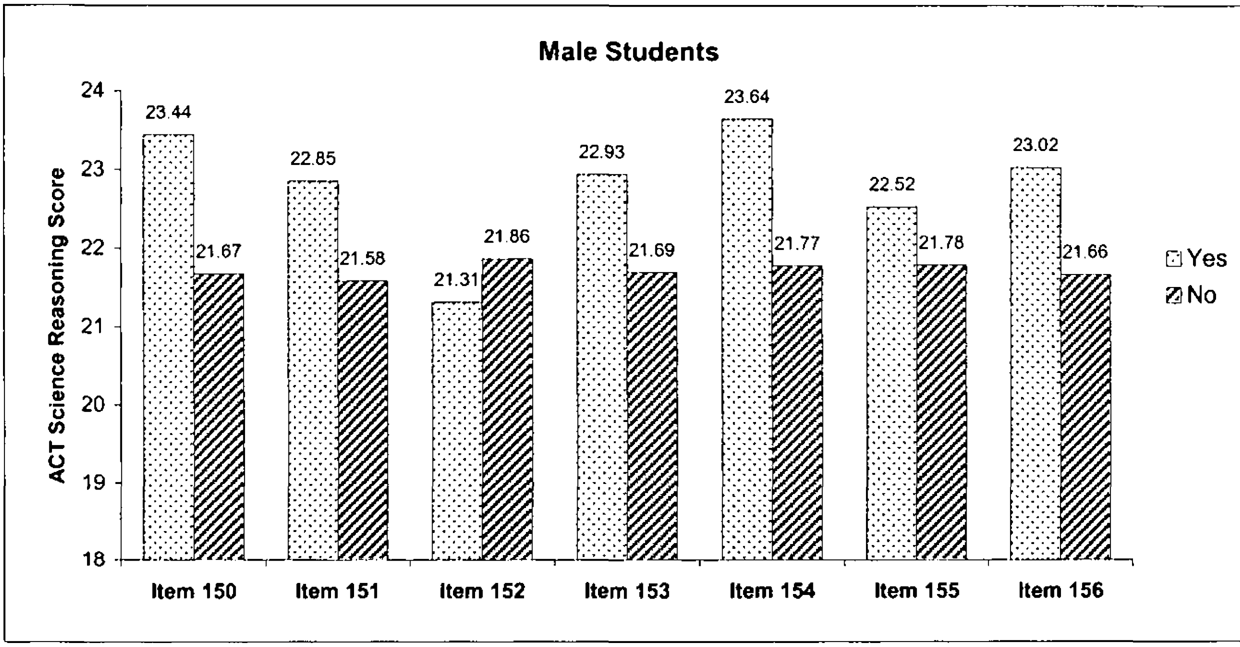
The remaining figures are also based on data in Tables 8 to 14 and contain bar charts for male and female students, for each racial/ethnic group, and for each of the three income groups.

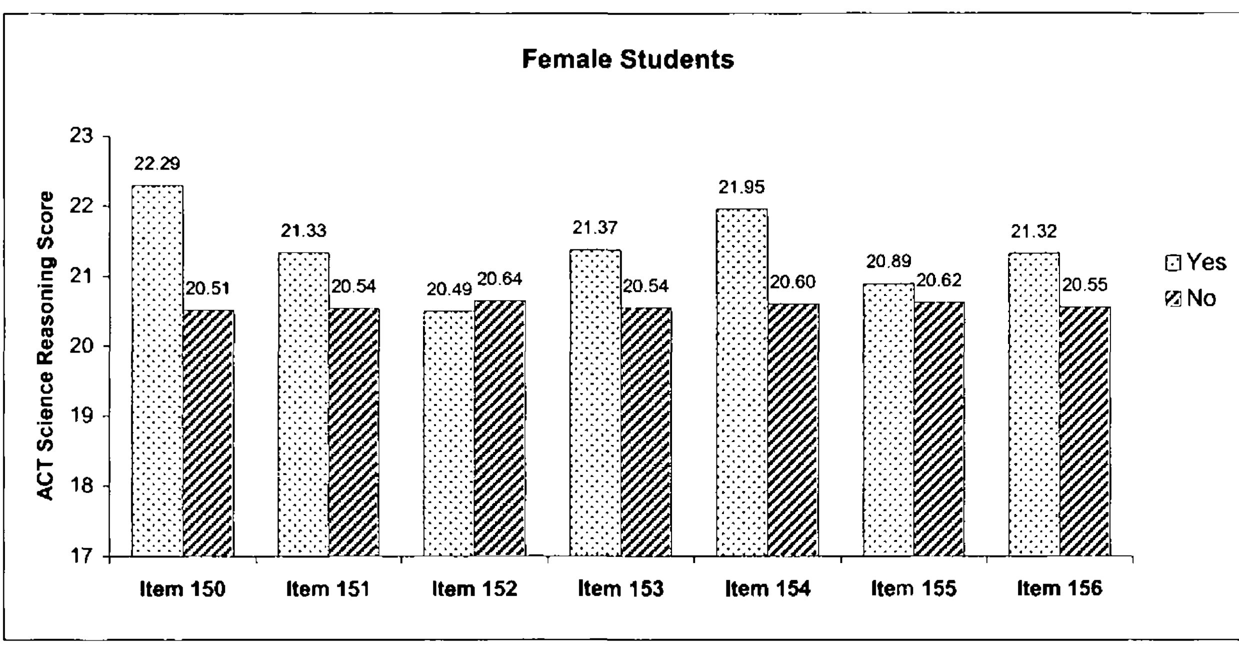
Male students. For male students, the greatest differences in average ACT Science scores between those responding *Yes* and those responding *No* were for Item 154, *Placed first, second, or third in a regional or state science contest* (1.87 points, effect size = .38) and to Item 150, *Wrote an independent paper on a scientific topic which received the highest possible grade given in my school* (1.77 points, effect size = .36). Male students who responded *Yes* tended to have higher ACT Science scores in relation to all but one of the seven out-of-class accomplishments—the exception again being those who responded *Yes* to Item 152, *Participated in a National Science Foundation summer program for high school students.* (See the first graph in Figure 3.)

Female students. For female students, the greatest differences in average ACT Science scores between those responding *Yes* and those responding *No* were in response to Item 154, *Placed first, second, or third in a regional or state science contest* (1.87 points, effect size = .38) and to Item 150, *Wrote an independent paper on a scientific topic which received the highest possible grade given in my school* (1.77 points, effect size = .36). The score point difference between female students' *Yes* and *No* responses to Item 150 was 1.78 (effect size = .41)—larger than that for male students (effect size = .36) for the same item. (See the second graph in Figure 3.)

Male students compared to female students. For those who provided *Yes* responses to Items 150 to 156, male students' average ACT Science scores were higher than female students' average. The same pattern was true for male and female students who selected *No* responses to Items 150 to 156. Male students responding *Yes* to these items had ACT Science scores averaging 23.0 or above for five of the seven items. Female students responding *Yes* had only one of the seven ACT Science score averages above 22.0—that of Item 150. (See both graphs in Figure 3 and Tables 8-14.)

Figure 3. ACT Science Reasoning Test Scores by Participation in Out-of-Class Science Accomplishments: Males and Females





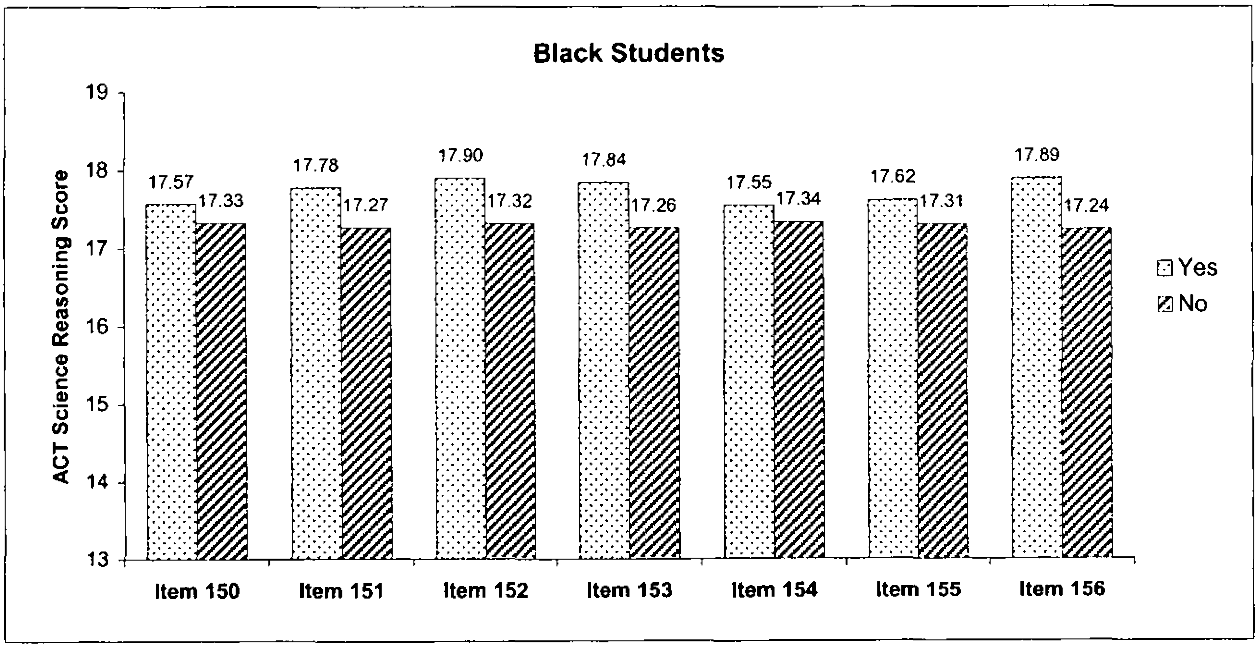
Note. Data for these bar charts appear in Tables 8-14.

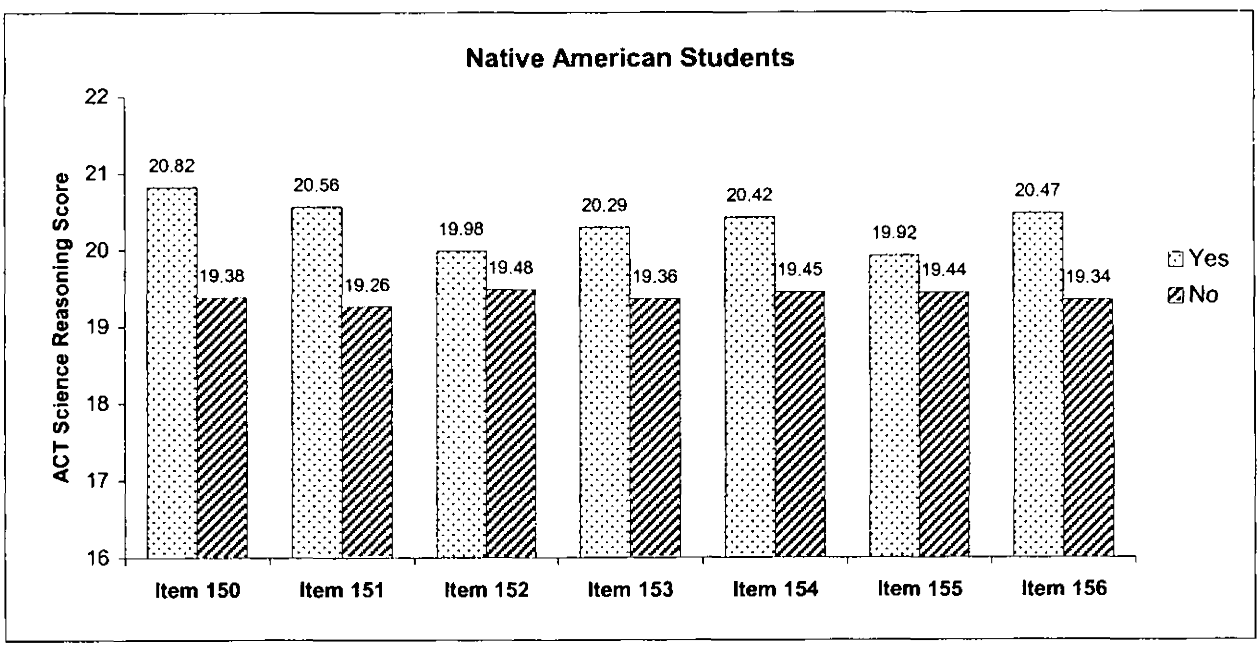
SPS Item 150	Wrote an independent paper on a scientific topic which received the highest possible grade given in my school
SPS Item 151	Performed an independent scientific experiment (not as part of a course)
SPS Item 152	Participated in a National Science Foundation summer program for high school students
SPS Item 153	Won a prize or award (of any kind) for scientific work or study
SPS Item 154	Placed first, second, or third in a regional or state science contest
SPS Item 155	Placed first, second, or third in a school science contest
SPS Item 156	Participated in a scientific contest or talent search

Black students. Even though only 4% of Black students responded *Yes* to Item 152, *Participated in a National Science Foundation summer program for high school students*, this percentage was larger than that for any other racial/ethnic, gender, or income group. Black students responding *Yes* to this item had a slightly higher average ACT Science score (17.90) than did Black students responding *Yes* to any of the other six items. This pattern was not true of any other subgroup examined—no other racial/ethnic group of *Yes* responders to Item 152 earned its highest ACT Science score average on this item. Black students' next highest science score average (17.89) was earned by those responding *Yes* to Item 156, *Participated in a scientific contest or talent search*, the item for which the largest percentage (15.5%) of Black students responded *Yes*. For this item, a larger difference in ACT Science scores (0.65 points) occurred between Black students responding *Yes* versus *No* than to any other of the seven items. Even so, this difference in Black students' *Yes* versus *No* Science score averages (and the corresponding effect size) for Item 156 was smaller than that of any other racial/ethnic group. Effect sizes for other racial/ethnic groups for Item 156 ranged from .26 to .39, whereas the effect size for Black students was .18. (See the first graph in Figure 4 and Tables 8-14.)

Native American students. For Native American students, Item 151, *Performed an independent scientific experiment (not as a part of a course)*, drew the largest percentage (18.4%) of *Yes* responses and an average ACT Science score 1.30 points higher than that of the *No* responders (effect size = .31). Native American *Yes* responders to Item 150, *Wrote an independent paper on a scientific topic which received the highest possible grade given in my school*, earned an average ACT Science score of 1.44 points higher than did Native American No responders (effect size = .33). (See the second graph in Figure 4 and Tables 8-14.)

Figure 4. ACT Science Reasoning Test Scores by Participation in Out-of-Class Science Accomplishments: Seven Racial/Ethnic Groups

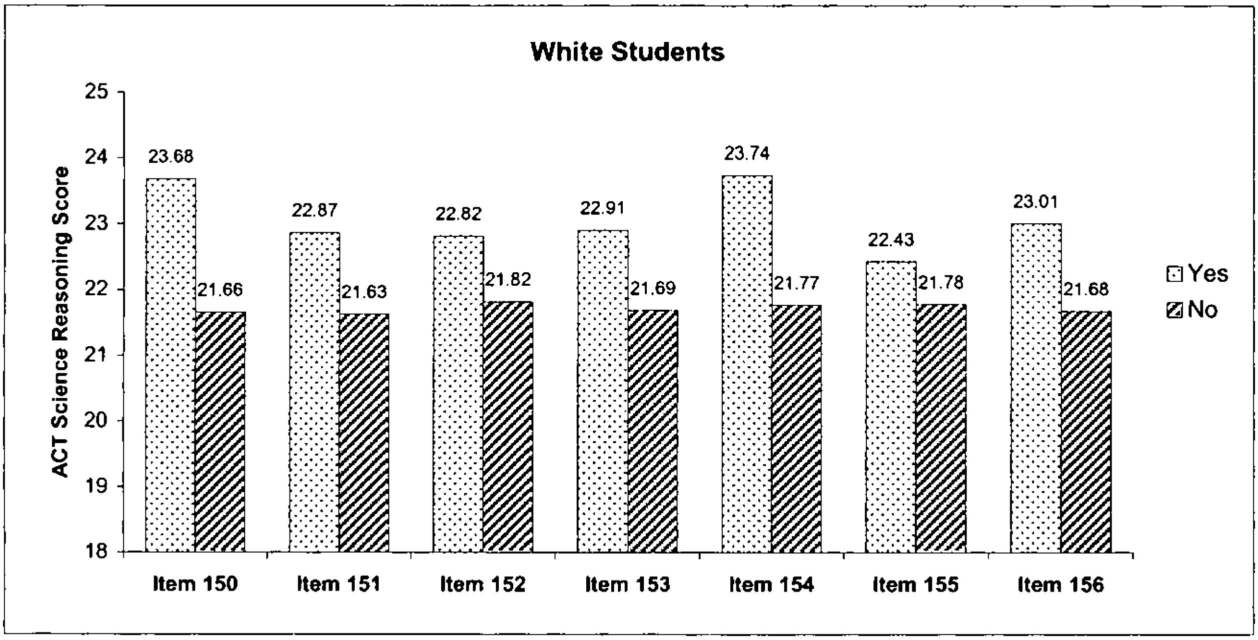


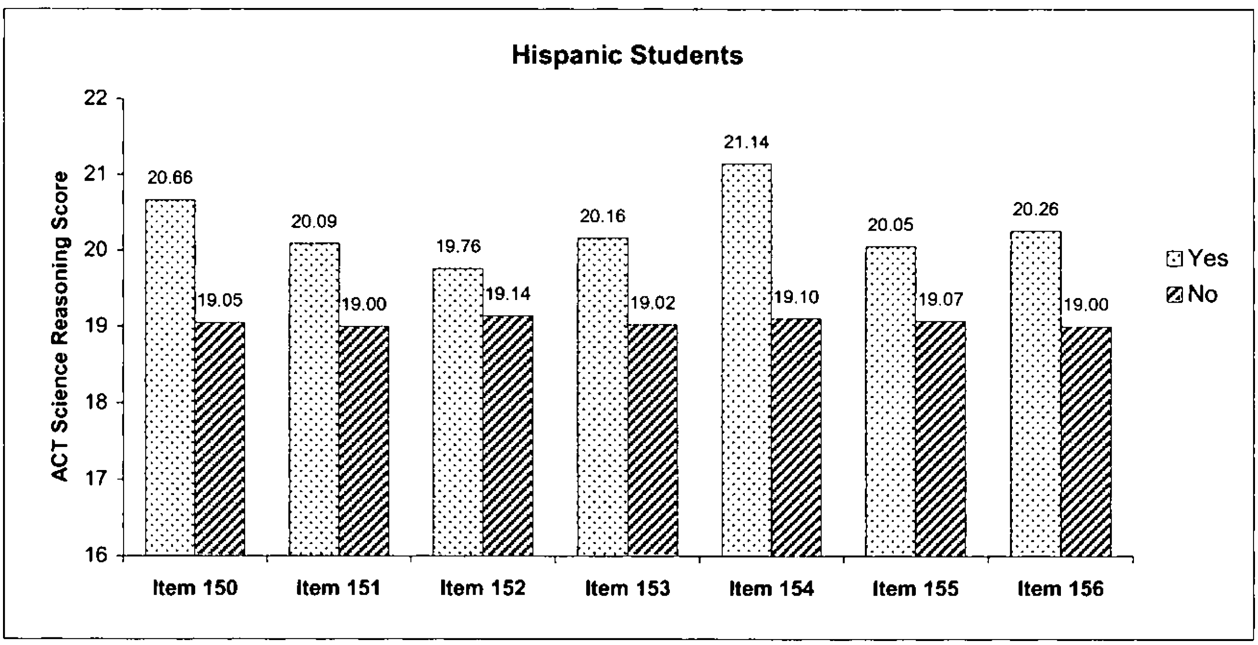


Note. Data for these bar charts appear in Tables 8-14.

SPS Item 150	Wrote an independent paper on a scientific topic which received the highest possible grade given in my school
SPS Item 151	Performed an independent scientific experiment (not as part of a course)
SPS Item 152	Participated in a National Science Foundation summer program for high school students
SPS Item 153	Won a prize or award (of any kind) for scientific work or study
SPS Item 154	Placed first, second, or third in a regional or state science contest
SPS Item 155	Placed first, second, or third in a school science contest
SPS Item 156	Participated in a scientific contest or talent search

Figure 4. (continued) ACT Science Reasoning Test Scores by Participation in Out-of-Class Science Accomplishments: Seven Racial/Ethnic Groups

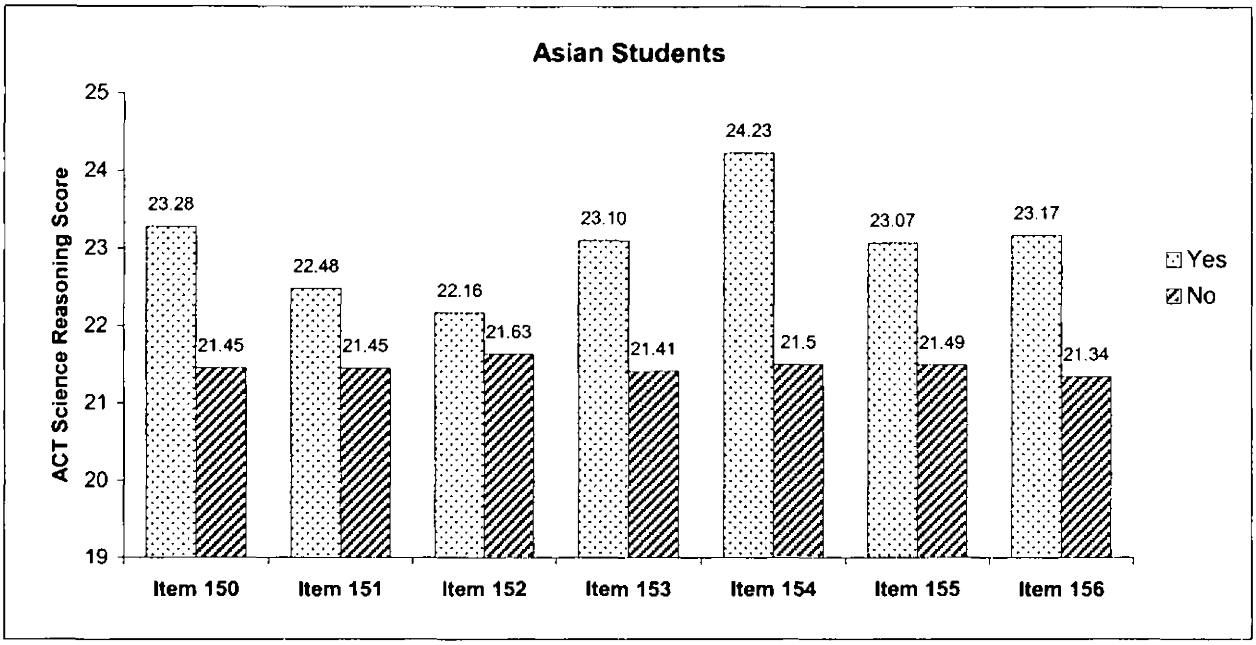


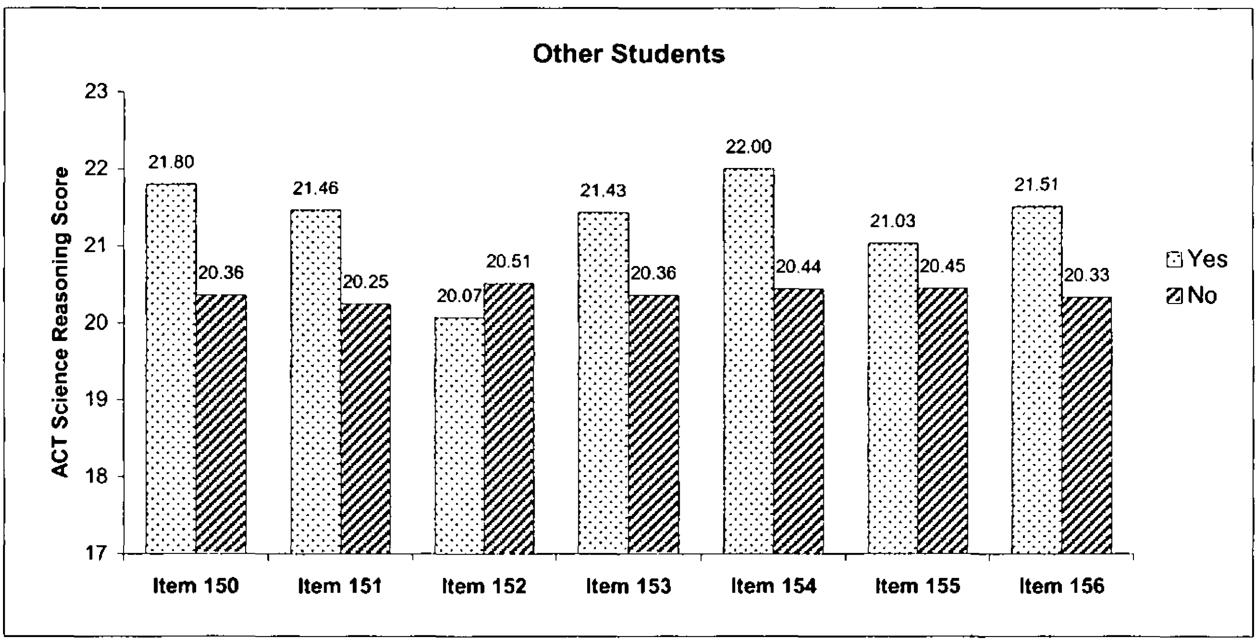


Note. Data for these bar charts appear in Tables 8-14.

SPS Item 150	Wrote an independent paper on a scientific topic which received the highest possible grade given in my school
SPS Item 151	Performed an independent scientific experiment (not as part of a course)
SPS Item 152	Participated in a National Science Foundation summer program for high school students
SPS Item 153	Won a prize or award (of any kind) for scientific work or study
SPS Item 154	Placed first, second, or third in a regional or state science contest
SPS Item 155	Placed first, second, or third in a school science contest
SPS Item 156	Participated in a scientific contest or talent search

Figure 4. (continued) ACT Science Reasoning Test Scores by Participation in Out-of-Class Science Accomplishments: Seven Racial/Ethnic Groups

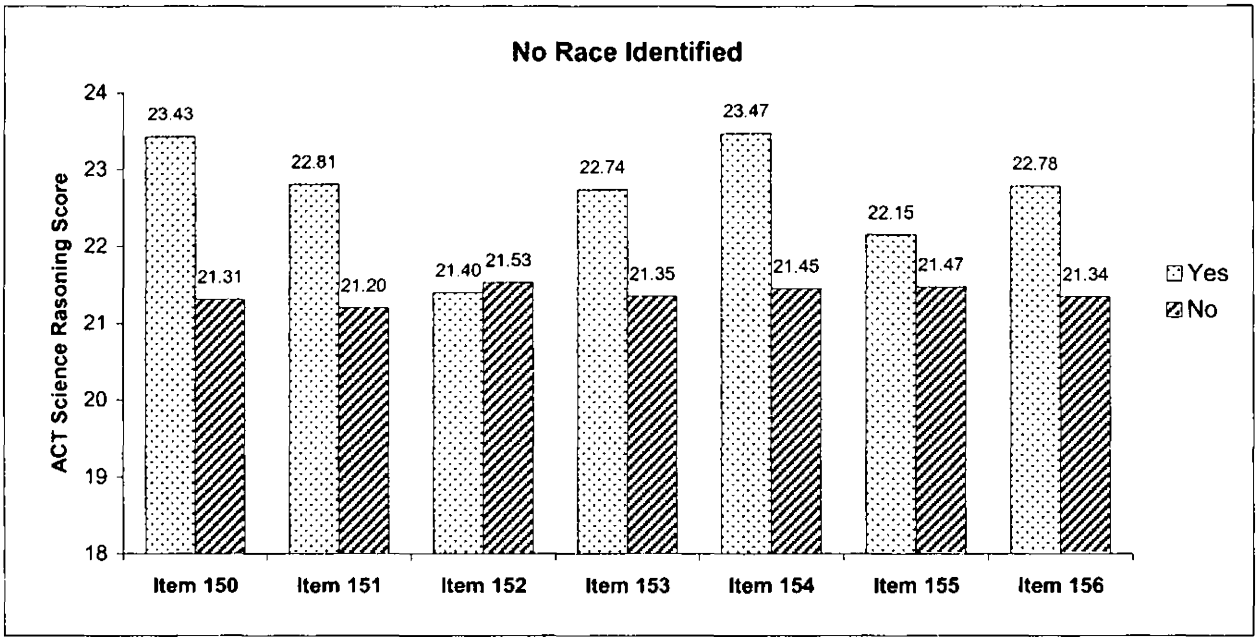




Note. Data for these bar charts appear in Tables 8-14.

SPS Item 150	Wrote an independent paper on a scientific topic which received the highest possible grade given in my school
SPS Item 151	Performed an independent scientific experiment (not as part of a course)
SPS Item 152	Participated in a National Science Foundation summer program for high school students
SPS Item 153	Won a prize or award (of any kind) for scientific work or study
SPS Item 154	Placed first, second, or third in a regional or state science contest
SPS Item 155	Placed first, second, or third in a school science contest
SPS Item 156	Participated in a scientific contest or talent search

Figure 4. (continued) ACT Science Reasoning Test Scores by Participation in Out-of-Class Science Accompiishments: Seven Racial/Ethnic Groups



Note. Data for these bar charts appear in Tables 8-14.

SPS Item 150	Wrote an independent paper on a scientific topic which received the highest possible grade given in my school
SPS Item 151	Performed an independent scientific experiment (not as part of a course)
SPS Item 152	Participated in a National Science Foundation summer program for high school students
SPS Item 153	Won a prize or award (of any kind) for scientific work or study
SPS Item 154	Placed first, second, or third in a regional or state science contest
SPS Item 155	Placed first, second, or third in a school science contest
SPS Item 156	Participated in a scientific contest or talent search

White students. For White students, Item 151, *Performed an independent scientific experiment (not as a part of a course)*, drew the greatest percentage (16.4%) of *Yes* responses. The two items with the greatest differences in ACT Science scores between White students responding *Yes* and *No* were Item 150, *Wrote an independent paper on a scientific topic which received the highest possible grade given in my school* (2.02 points; effect size = .46) and Item 154, *Placed first, second, or third in a regional or state science contest* (1.97 points; effect size = .45). (See the third graph in Figure 4 and Tables 8-14.)

Hispanic students. Hispanic students who responded *Yes* to Item 154, *Placed first, second, or third in a regional or state science contest,* had average ACT Science scores 2.04 points higher than did Hispanic students who responded *No* (effect size = .50). Similarly, Hispanic students who responded *Yes* to Item 150, *Wrote an independent paper on a scientific topic which received the highest possible grade given in my school,* had average ACT Science scores 1.61 points higher than did Hispanic students who responded *No* to this item (effect size = .39). Hispanic students who responded *Yes* to Item 156, *Wrote an independent paper on a scientific topic which received the highest possible grade given in my school,* also had higher average ACT Science scores than those who responded *No* (effect size = .31). (See the fourth graph in Figure 4 and Tables 8-14.)

Asian students. The greatest difference in average ACT Science scores between the *Yes* and *No* responders of any subgroup occurred for Asian students in their responses to Item 154, *Placed first, second, or third in a regional or state science contest* (2.73 points, effect size = .58). Asian students also surpassed other racial/ethnic subgroups in the size of the differences in ACT Science scores for *Yes* and *No* responses to three other items—Item 156, *Participated in a scientific contest or talent search* (1.83 points, effect size = .39); Item 155, *Placed first, second,* *or third in a school science contest* (1.58 points, effect size = .36); and Item 153, *Won a prize or award (of any kind) for scientific work or study* (1.69 points, effect size = .33). (See the fifth graph in Figure 4 and Tables 8-14.)

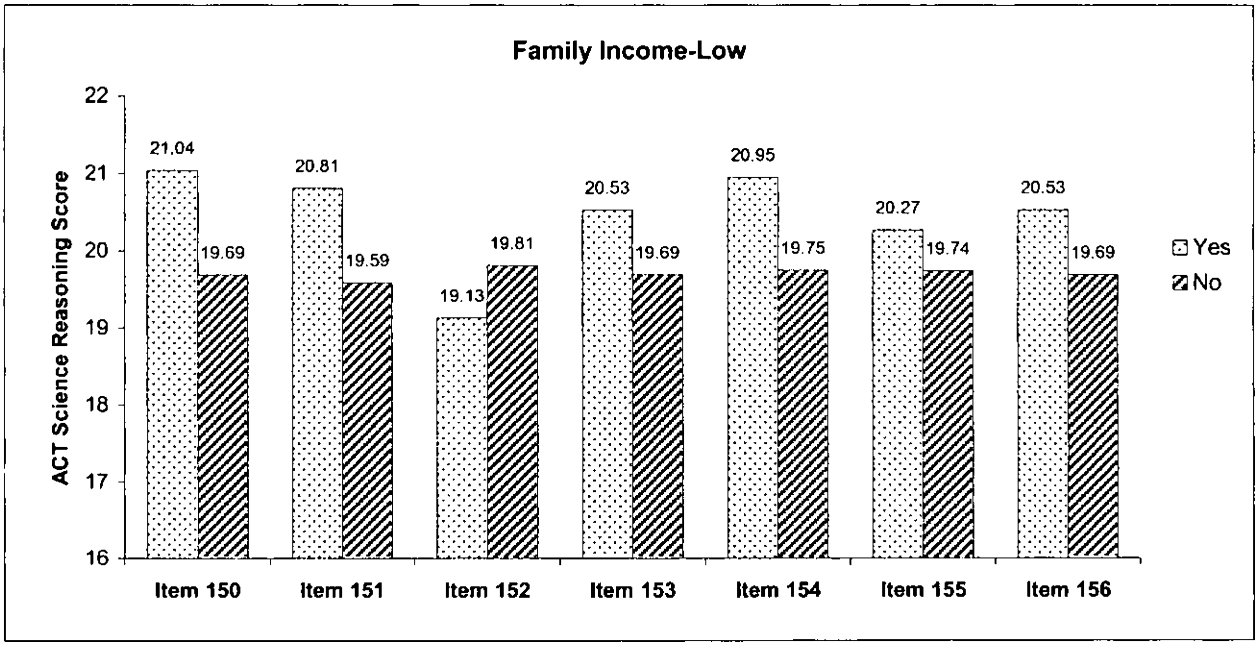
Family income groups. For two items, Item 154, *Wrote an independent paper on a scientific topic which received the highest possible grade given in my school,* and Item 156, *Participated in a scientific contest or talent search*, there were greater differences between the ACT Science scores for students who responded *Yes* and *No* among students with Medium to High family income than among those with Low family income. Responses to Item 150 followed a similar pattern, as did Item 156, although to a slightly lesser extent. For Item 154, the *Yes* versus *No* effect size for Low income students was .27, and the score point difference was 1.20; the *Yes* versus *No* effect sizes for Medium and High income students, were .40 and .43, respectively. The score point difference for *Yes* and *No* responders in the Medium income group was 1.75 and in the High income group was 1.96. (See the three graphs in Figure 5 and Tables 8-14.)

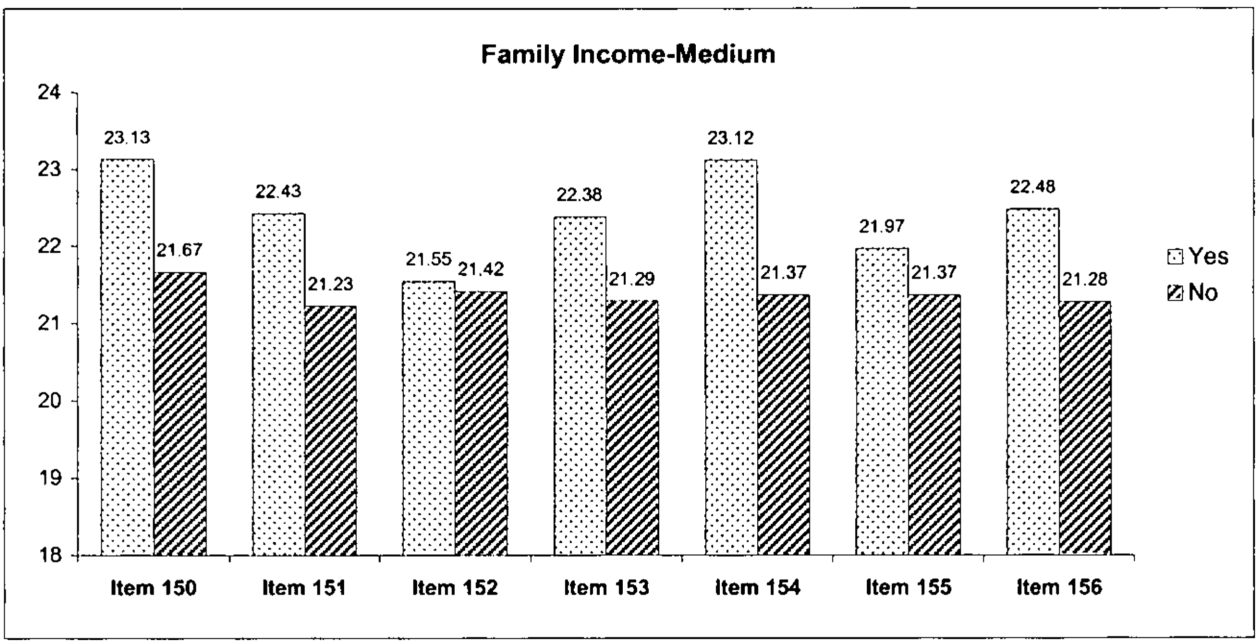
Discussion

This study not only supports earlier findings that more years of high school science course work accompany higher ACT Science Reasoning test scores, it further suggests that higher science achievement scores are linked to participation in out-of-class science accomplishments.

We analyzed patterns of science course taking and of out-of-class science accomplishments by gender, race/ethnicity, and family income in relation to scores on the ACT Science Reasoning test for 997,069 high school students in the ACT-tested graduating class of 1998. With few exceptions, ACT Science Reasoning scores increased with each increase in the

Figure 5. ACT Science Reasoning Test Scores by Participation in Out-of-Class Science Accomplishments: Three Levels of Family Income

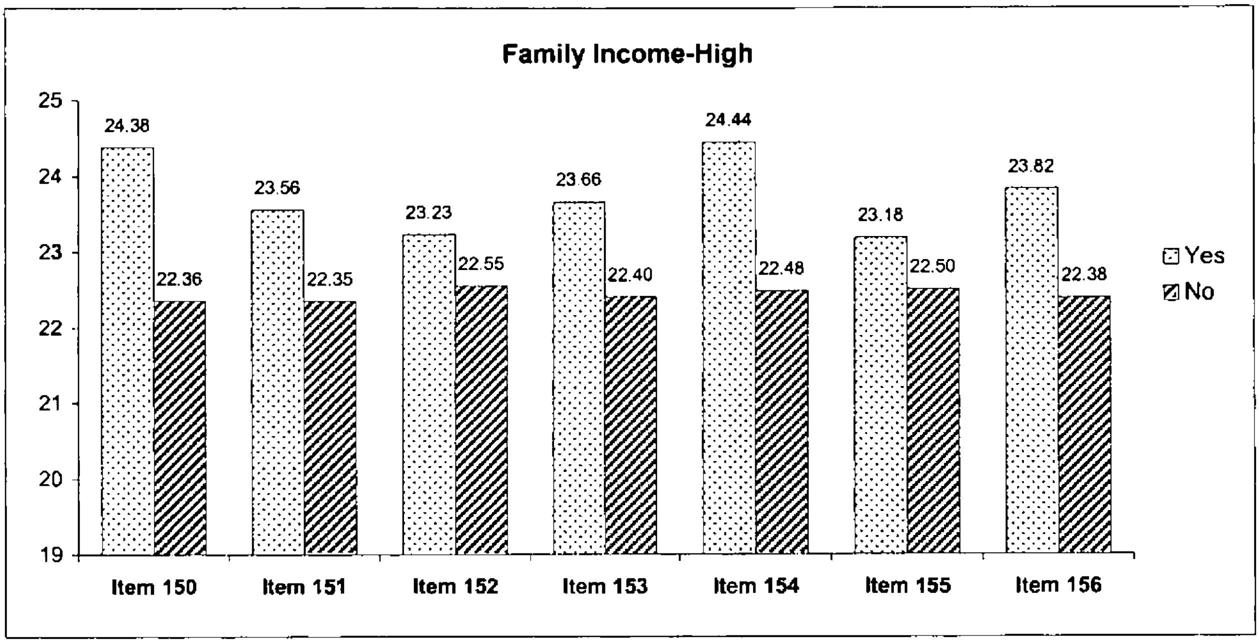




Note. Data for these bar charts appear in Tables 8-14.

SPS Item 150	Wrote an independent paper on a scientific topic which received the highest possible grade given in my school
SPS Item 151	Performed an independent scientific experiment (not as part of a course)
SPS Item 152	Participated in a National Science Foundation summer program for high school students
SPS Item 153	Won a prize or award (of any kind) for scientific work or study
SPS Item 154	Placed first, second, or third in a regional or state science contest
SPS Item 155	Placed first, second, or third in a school science contest
SPS Item 156	Participated in a scientific contest or talent search

Figure 5. (continued) ACT Science Reasoning Test Scores by Participation in Out-of-Class Science Accomplishments: Three Levels of Family Income



Note. Data for these bar charts appear in Tables 8-14.

SPS Item 150	Wrote an independent paper on a scientific topic which received the highest possible grade given my school
SPS Item 151	Performed an independent scientific experiment (not as part of a course)
SPS Item 152	Participated in a National Science Foundation summer program for high school students
SPS Item 153	Won a prize or award (of any kind) for scientific work or study
SPS Item 154	Placed first, second, or third in a regional or state science contest
SPS Item 155	Placed first, second, or third in a school science contest
SPS Item 156	Participated in a scientific contest or talent search

number of out-of-class science accomplishments reported—a pattern that emerged even more clearly as gender, racial/ethnic, and family income subgroup scores were analyzed. Both *t* tests and reviews of effect size confirmed that ACT Science Reasoning scores tended to be higher for students reporting one or more science accomplishment than for those reporting none.

Effect sizes for male students ranged as high as .38; for female students as high as .41; for some racial/ethnic groups as high as .46, .50, and .58; and for family income groups as high as .45, .42, and .31. The average number of *years* and the average number of *courses* in science varied less by gender than by race/ethnicity and family income. Male students reported more out-of-class science accomplishments than did female students—an average of 0.74 versus 0.55.

Many but not all of the outcomes of this study are positive: some are noteworthy because they are worrisome. For example, although female students had taken approximately the same *number* of years of science, they had not taken the same *type of science* courses—at least with respect to physics. Five in ten male students had taken physics, but only four in ten female students had done so. Another noteworthy aspect of this study was the sizeable difference in the percentages of male and female students responding *Yes* to Item 151, *Performed an independent scientific experiment (not as part of a course).* Two in ten male students reported this accomplishment, but only one in ten female students did so (21.6% versus 12.8%). With respect to each of the seven accomplishments, slightly higher percentages of male students than of female students responded *Yes*.

For racial/ethnic groups, the average number of out-of-class accomplishments ranged from 0.57 for Hispanic students to 0.77 for both Native American and Asian students. Effect size differences in the Science Reasoning score means of *Yes* and *No* responders to the various accomplishments tended to be smaller for Black students than for others, except for Item 152, *Participated in a National Science Foundation summer program for high school students.*

The greatest difference in the Science Reasoning means for the *Yes* and *No* responses for the total group occurred with respect to Item 150, *Wrote an independent paper on a scientific topic which received the highest possible grade given in school* (effect size = .41) and Item 154, *Placed first, second, or third in a regional or state science contest* (effect size = .37).

The study's examination of science accomplishments is limited to the seven listed in the ACT SPS. Because the list represents only a few of the many out-of-class science activities and accomplishments in the experience of high school students, these findings are not comprehensive. Nevertheless, these seven accomplishments are sufficient to suggest a positive relationship exists between out-of-class science accomplishments and achievement and a tendency for male students to surpass female students in their participation in out-of-class science accomplishments.

Although not the primary focus of the study, another result deserves mention: We observed that four of the seven out-of-class science accomplishments were reported by fewer than 10% of students. Even for the remaining three accomplishments, the percentages of students reporting them were relatively small—never more than 16.5% for any one accomplishment. Even though we recognize that the seven accomplishments represent only a small sample of extracurricular science activities, this low level of involvement is not encouraging.

A student's interest in an area of knowledge may affect and be affected by attitudes early in life. Positive attitudes toward science may help students discover opportunities to participate in science-related activities and to develop competence that accrues from such experiential learning. With greater competence, even more opportunities open up as others take note of that competence and reinforce it by means of suggestions, support, and enrichment activities. Interest in science is apt to stimulate academic course work in science, which in turn can lead to acquisition of greater knowledge, skills, and even greater interest. Students who have experience with or an interest in an extracurricular activity may cause others to select them for additional similar activities. Oakes (1990) has referred to this spiraling effect, pointing out that it tends to benefit those who are already ahead.

Other researchers have observed the beneficial effects of extracurricular activities. For example, Gerber (1996) analyzed data from the *National Educational Longitudinal Study*: 88 and found a positive relationship between the amount of participation in extracurricular activities and academic achievement. Camp (1990) used data from the *High School and Beyond* sophomore cohort and found that student activities appear to enhance academic achievement. Modi, Kostantopoulos, and Hedges (1998) studied predictors of academic giftedness and found that extracurricular activities increase the likelihood of talent development. Holloway (1999/2000) reviewed several studies that suggest "extracurricular activities provide all students—including at-risk and gifted students—an academic safety net" (pp. 87-88). The present study has reaffirmed that increased course taking in science goes hand in hand with higher science test scores and has suggested that another key to better science performance may be related to increases in out-of-class science accomplishments and activities.

However, higher academic performance on tests is not all that is at stake. In today's information age with its technology revolution, scientific savvy is not just for scientists. Students entering the scientific pipeline are not the only ones needing to develop science-related talents and interests. Individually and collectively, we need basic knowledge and proactive attitudes toward science for coping in a fast changing world. We need it for being responsible householders and family members, for performing civic duties, for maintaining career skills and competence, and for making informed decisions about everything from labels on consumer products to public policy affecting our very existence. The same kinds of efforts are needed to help students who do not plan to become professional scientists as are needed for those who do. Out-of-class science accomplishments may be an important means of helping students achieve in science.

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