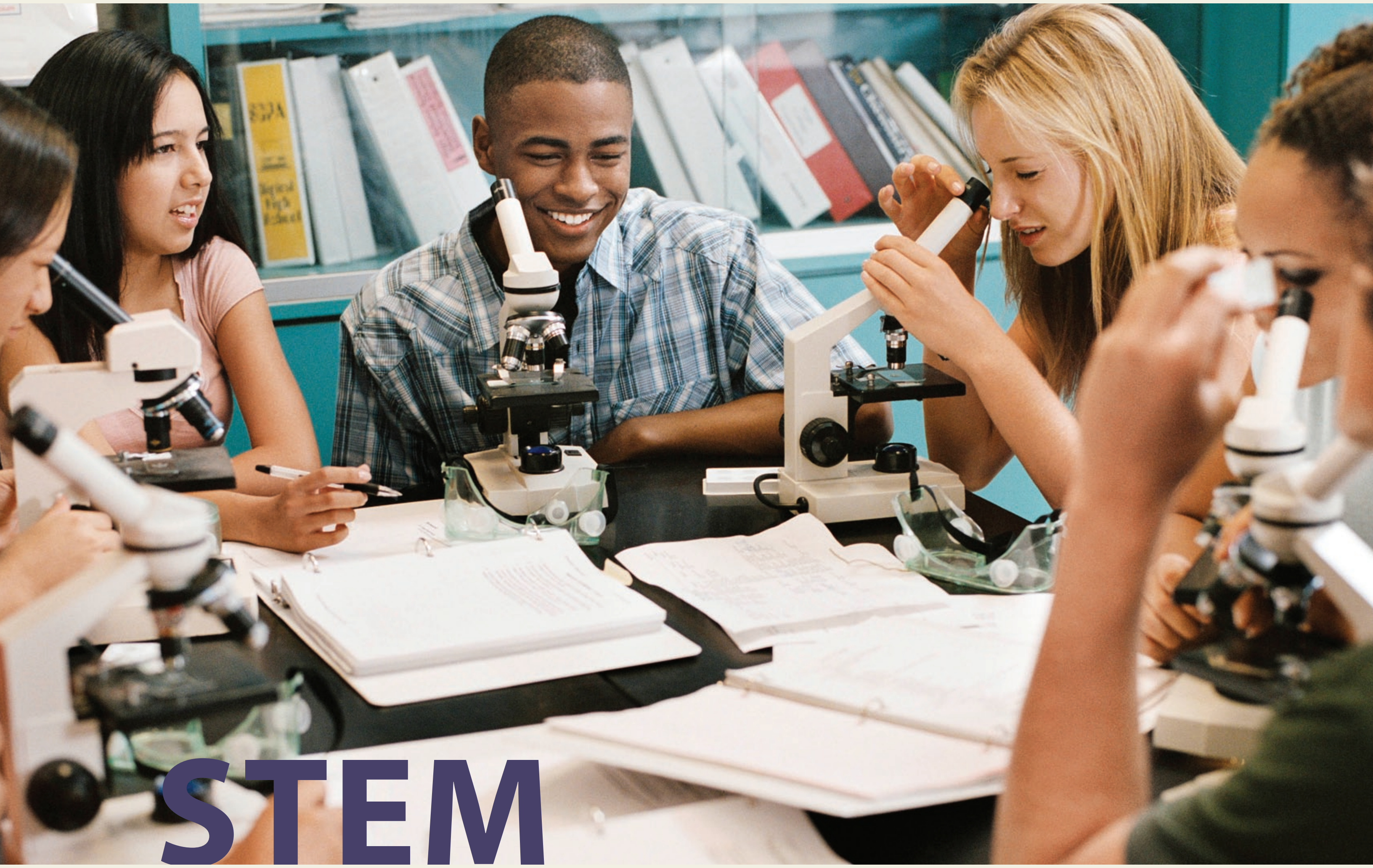
MPR Research Brief
DECEMBER 2009



STEM COURSETAKING
Among High School Graduates, 1990–2005

By Jennifer Laird, Martha Alt, and Joanna Wu

As technical and scientific innovation increasingly drives the global economy, educators and experts in technical fields have expressed concern about the amount of academic preparation of U.S. students in general and in STEM (science, technology, engineering, and mathematics) fields in particular. They contend that shortages of well-qualified STEM graduates could diminish technical innovation at the national level, undermining U.S. living standards, economic growth, and national security (Association of American Universities 2006; Business Roundtable 2005; National Academy of Sciences 2006; National Science Board 2006, 2007).

Further, rapid increases in the number of postsecondary STEM degrees awarded abroad and to foreign students in the United States (National Science Board 2008) have raised questions about our ability to keep pace with the growing technical expertise of other countries. Maintaining a high-quality U.S. labor force is also an issue. Professionals are under pressure to demonstrate advanced skills and high levels of innovation and creativity, since labor costs are lower in many other nations and investment capital is highly mobile. Solid secondary and postsecondary preparation in STEM fields is considered crucial to maintaining a scientific and technical edge for the United States.

Recommendations for addressing these issues generally focus on strengthening education, including increasing student participation in secondary school STEM courses. This MPR Research Brief uses data from the National Assessment of Educational Progress (NAEP) High School Transcript Study (HSTS) to examine student coursetaking in STEM subjects during high school. It compares STEM coursetaking among the 2005 HSTS cohort, the most recent data currently available, with that of the 1990 and 2000 HSTS cohorts. The brief discusses average credits earned in three broad STEM categories and the percentage of graduates who earned credits in 12 specific STEM courses for all graduates and by gender, race/ethnicity, and community type (see "What Are High School STEM Courses?" on page 5 for definitions of STEM categories and courses).

For the 2005 HSTS, transcripts were collected from about 640 public schools and 80 private schools, constituting a nationally representative sample of 26,000 public and private high school graduates (representing approximately 2.7 million graduates). All analyses in this Research Brief include only graduates who earned regular or honors diplomas. Graduates who received a special education diploma or certificate of completion are excluded from this analysis. Course credits are reported as standardized Carnegie units (or Carnegie credits), in which a single unit is equal to 120 hours of classroom time over the course of a year. For more information about the data and analysis methods used in this brief, see the technical notes starting on page 17.

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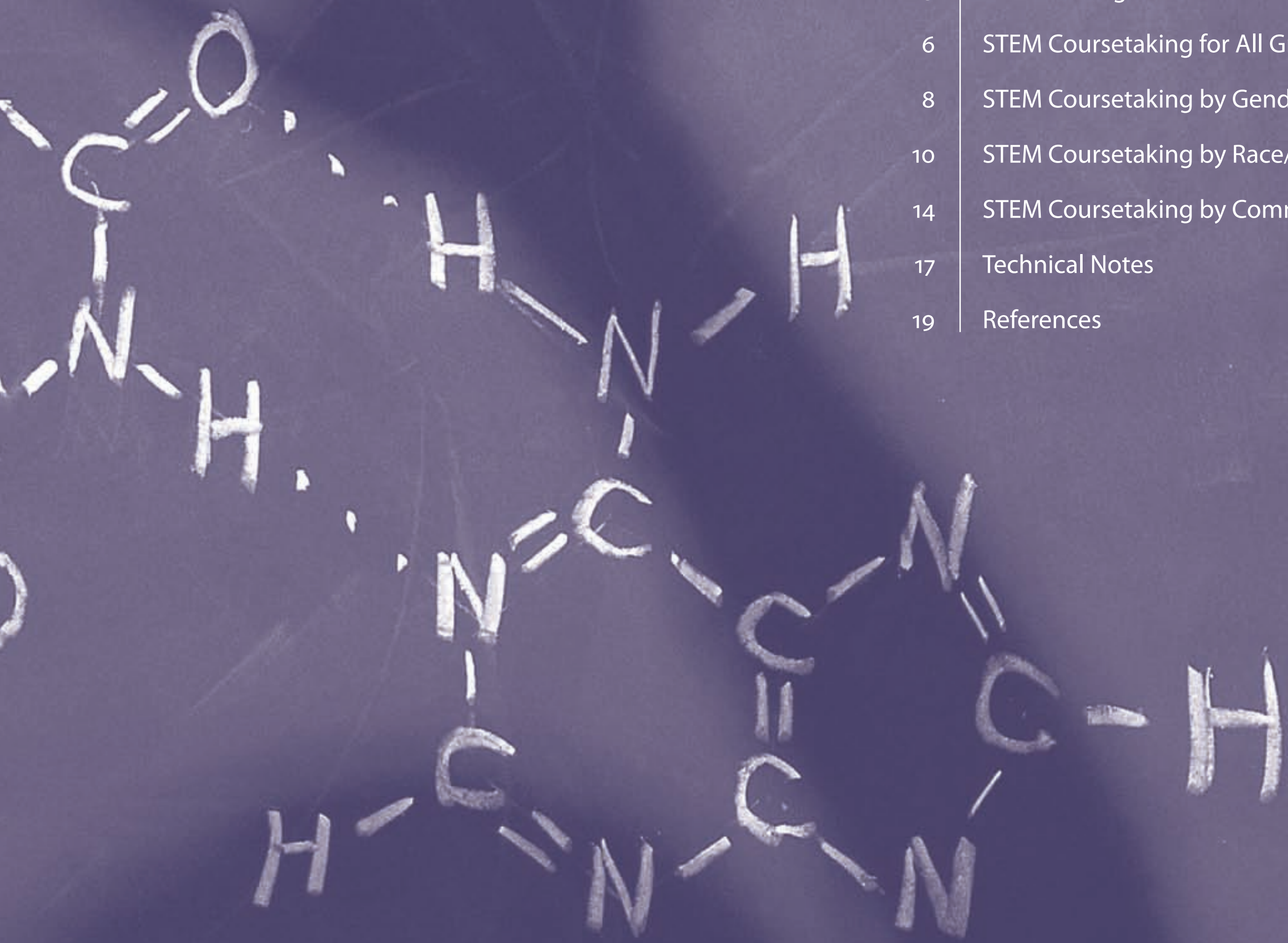


Highlights of Findings

High school graduates earned more STEM credits in 2005 than in 1990.

- Graduates from the class of 2005 earned more credits in each of the three STEM course categories during high school than did 1990 graduates (figure A). In the more recent period of 2000 to 2005, the number of credits earned increased in one of the three categories (advanced mathematics).
- In 10 out of 12 specific STEM courses, the percentage of graduates who earned credits grew from 1990 to 2005.

Both male and female students earned more STEM credits, but there were some gender differences.

- Between 1990 and 2005, both males and females earned more credits in each of the three STEM course categories.
- In 2005, a larger percentage of females than males earned credits in four specific STEM courses: algebra II, advanced biology, chemistry, and health science/technology. A larger percentage of males, on the other hand, earned credits in physics, engineering, engineering/science technologies, and computer/information science.

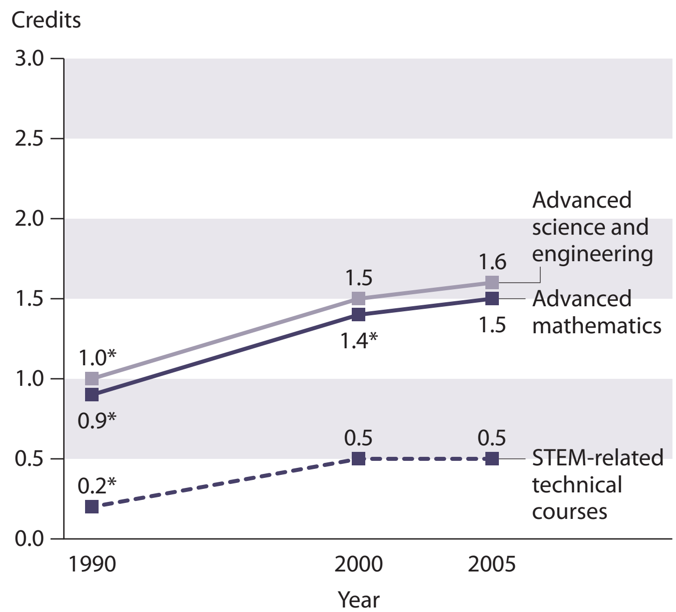
STEM credits increased across racial/ethnic groups, but there were some racial/ethnic gaps.

- White, Black, and Asian high school graduates earned more credits in all three STEM course categories in 2005 than in 1990. Over this period, Hispanic graduates earned more credits in one category (advanced mathematics).
- In 2005, White graduates earned more credits than Black and Hispanic graduates in two STEM course categories (advanced mathematics and advanced science and engineering). There were no statistically significant changes in these gaps from 1990 to 2005.

Students in urban, suburban, and rural communities increased their STEM coursetaking, but there were some differences among community types.

- Graduates from urban, suburban, and rural communities earned more credits in each of the three STEM course categories in 2005 than in 1990.
- Suburban 2005 graduates earned more credits in advanced mathematics and advanced science and engineering than did their rural counterparts.

FIGURE A
Average credits earned by high school graduates in three STEM categories: 1990, 2000, and 2005



* Significantly different (p < .05) from 2005.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

What Are High School STEM Courses?

The STEM courses discussed in this report fall into three broad categories, described below. Advanced courses are defined here as those with higher-level content and/or those designated as "advanced" or "honors" courses.[1]

Advanced mathematics includes algebra II, other advanced mathematics courses, pre-calculus/analysis, and calculus. The "other advanced" category consists primarily of trigonometry and statistics/probability, but also includes algebra III, analytic geometry, International Baccalaureate (IB) mathematics, and discrete mathematics.

Advanced science and engineering includes advanced biology, chemistry, advanced environmental/earth science, physics, and engineering. First-year biology is not included because nearly all graduates complete such a course. Advanced biology consists of second- or third-year courses—such as Advanced Placement or International Baccalaureate (AP/IB) biology—and such specialized courses as anatomy, physiology, and biotechnology. Advanced environmental/earth sciences include AP/IB environmental science, college preparatory and AP earth science, and geology. Engineering includes academic courses applying science and mathematics concepts and skills to engineering problems. Some specialized topics, such as aerospace materials, metallurgy, surveying/mapping sciences, and cartography also are included.

STEM-related technical courses include computer/information science (called "computer science" hereafter), engineering/science technologies, and health science/technology. These course categories in the Career and Technical Education (CTE) curriculum were defined according to the 2007 revision of the Secondary School Taxonomy (Bradby and Hudson 2007). Computer science courses include computer programming, logic, algorithms, and systems administration, but not word processing or other courses that instruct students in using software. Engineering/science technologies courses focus on instrumentation, equipment maintenance, and other technical tasks conducted in engineering and science occupations. Health science includes a spectrum of courses that prepare students for work in the allied health field, from dentistry to veterinary work, community health, epidemiology, nursing, optometry, audiology, mental health, and emergency/disaster science.

1 Although the data do not provide details about course quality, as might be gathered from classroom observation, indicators of rigor were incorporated both in the course-coding process and in developing the advanced course categories used in this report, including whether courses were honors or Advanced Placement (AP), or college preparatory; and their position in a sequence of related courses.

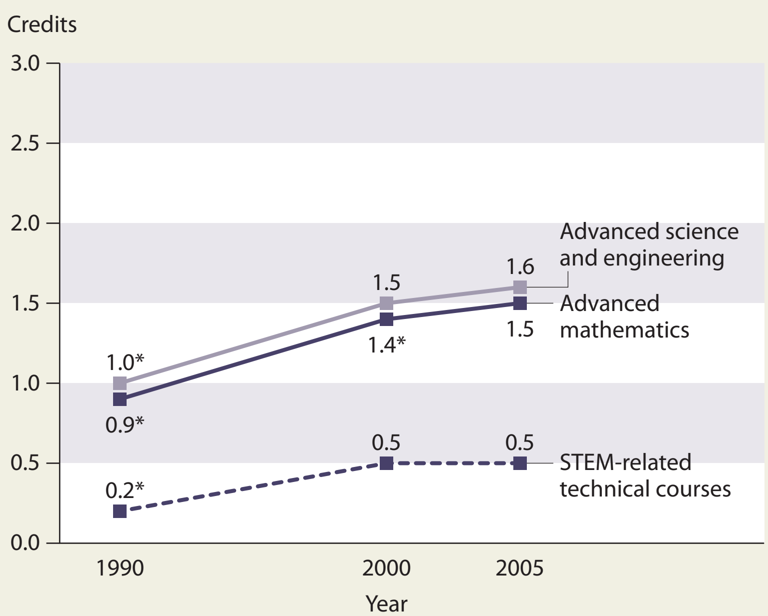
Average number of credits increased in each STEM category from 1990 to 2005

Figure 1 shows the average number of credits earned by 1990, 2000, and 2005 high school graduates in three STEM course categories: advanced mathematics, advanced science and engineering, and STEM-related technical courses. On average, 2005 high school graduates earned 1.5 credits in advanced mathematics courses, an increase from the credits earned in these courses by 1990 and 2000 graduates. The difference in advanced mathematics credits between 1990 and 2000 (0.6 credits) is equivalent to 72 classroom instructional hours.

In advanced science and engineering, 2005 graduates earned an average of 1.6 credits, more than the average credits earned in these courses by 1990 graduates, but not statistically different from those earned by their 2000 counterparts. The average number of credits earned in STEM-related technical courses increased from 1990 to 2005. However, during the shorter period of 2000 to 2005, no statistically significant change was detected.

FIGURE 1

Average credits earned by high school graduates in three STEM categories: 1990, 2000, 2005



* Significantly different (p < .05) from 2005.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

Coursetaking increased in 10 out of 12 specific STEM courses

As shown in table 1, the percentage of graduates who earned credit in specific STEM courses increased from 1990 to 2005 in all but two courses. In 2005, some 6 percent of graduates earned credit in advanced environmental/earth science, a percentage not statistically different from that for 1990 graduates. Coursetaking declined in computer science, from 24 percent in 1990 to 20 percent in 2005. For the remaining 10 courses listed in table 1, coursetaking increased from 1990 to 2005.

From 2000 to 2005, there were fewer increases in STEM coursetaking. In three of the four advanced mathematics courses, a higher percentage of graduates earned credits in 2005 than in 2000, but this pattern was not found for any of the advanced science and engineering courses or the STEM-related technical courses.

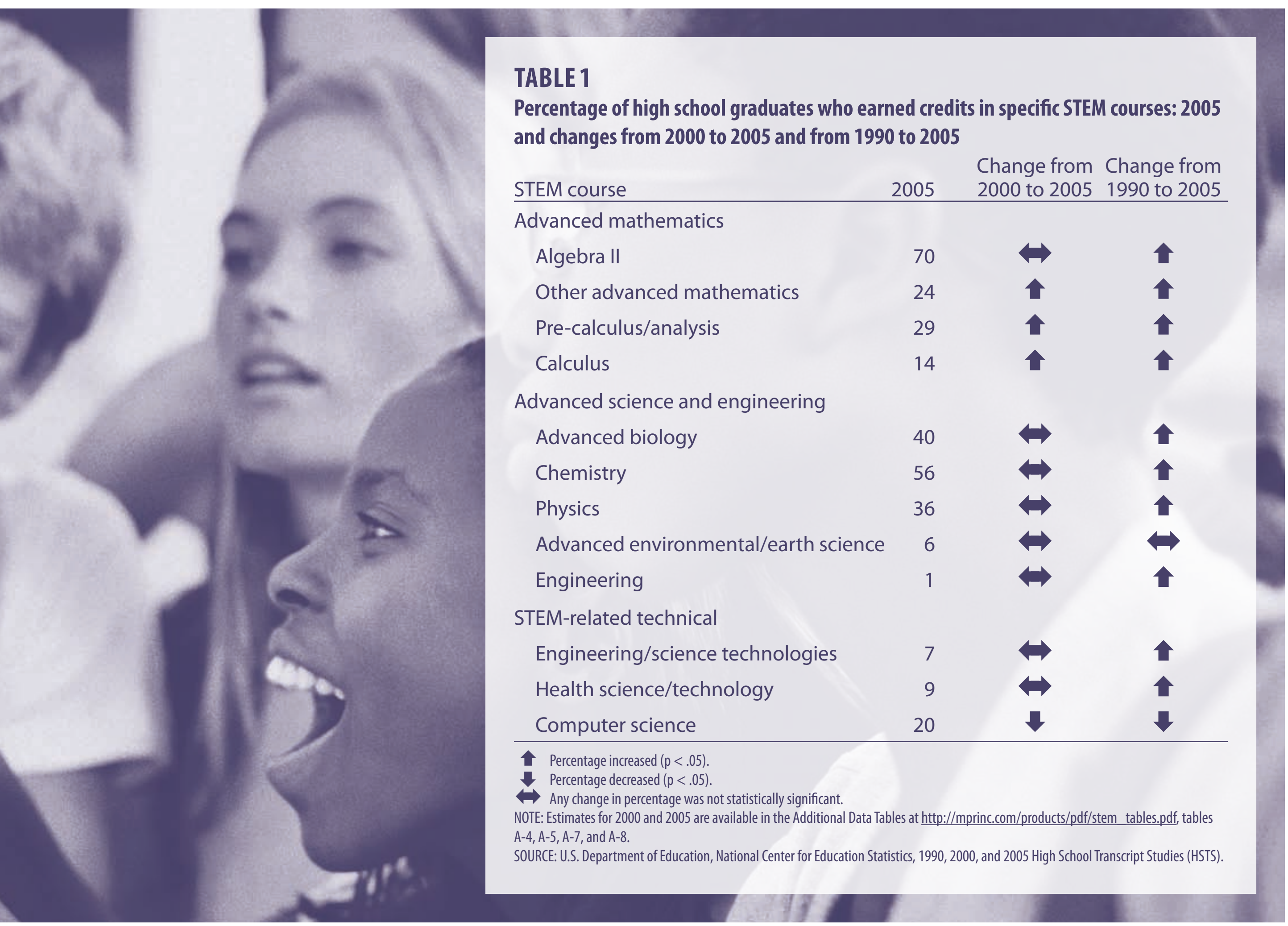


TABLE 1

Percentage of high school graduates who earned credits in specific STEM courses: 2005 and changes from 2000 to 2005 and from 1990 to 2005

STEM course	2005	Change from 2000 to 2005	Change from 1990 to 2005
Advanced mathematics			
Algebra II	70	↔	↑
Other advanced mathematics	24	↑	↑
Pre-calculus/analysis	29	↑	↑
Calculus	14	↑	↑
Advanced science and engineering			
Advanced biology	40	↔	↑
Chemistry	56	↔	↑
Physics	36	↔	↑
Advanced environmental/earth science	6	↔	↔
Engineering	1	↔	↑
STEM-related technical			
Engineering/science technologies	7	↔	↑
Health science/technology	9	↔	↑
Computer science	20	↓	↓

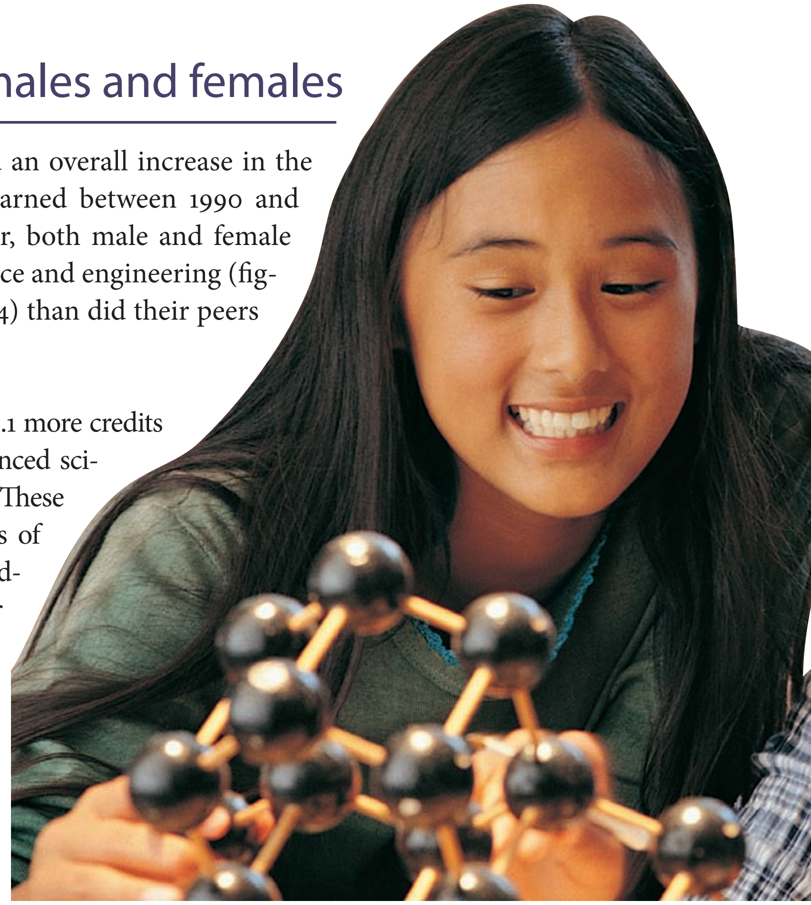
↑ Percentage increased ($p < .05$).
↓ Percentage decreased ($p < .05$).
↔ Any change in percentage was not statistically significant.

NOTE: Estimates for 2000 and 2005 are available in the Additional Data Tables at http://mprinc.com/products/pdf/stem_tables.pdf, tables A-4, A-5, A-7, and A-8.

SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

Gains in STEM credits seen for males and females

Both male and female high school graduates showed an overall increase in the average number of advanced mathematics credits earned between 1990 and 2005 and between 2000 and 2005 (figure 2). Further, both male and female 2005 graduates earned more credits in advanced science and engineering (figure 3) and in STEM-related technical courses (figure 4) than did their peers in 1990, but not more than their peers in 2000.

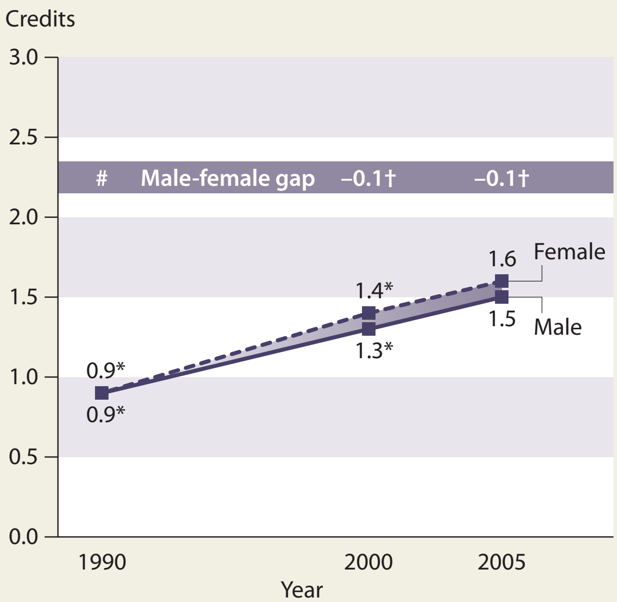


As figures 2 and 3 show, 2005 female graduates earned 0.1 more credits in advanced mathematics and 0.2 more credits in advanced science and engineering than did their male counterparts. These gender gaps are slight, representing 12 additional hours of classroom instruction in advanced mathematics and 24 additional hours in advanced science and engineering for females. Apparent increases in these two gender gaps between 1990 and 2005 were not statistically significant.

In 2005, male graduates earned 0.1 more credits in STEM-related technical courses, on average, than did female graduates, a gender gap that represents an increase from 1990.

FIGURE 2

Average advanced mathematics credits earned, by gender: 1990, 2000, and 2005

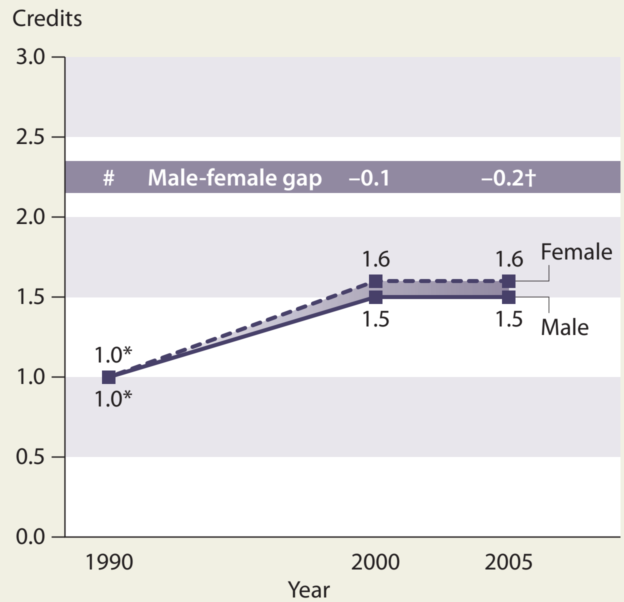


Rounds to zero.
* Significantly different (p < .05) from 2005.
† Gap is statistically significant (p < .05).

NOTE: Gaps were computed using unrounded numbers.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

FIGURE 3

Average advanced science and engineering credits earned, by gender: 1990, 2000, and 2005



Rounds to zero.
* Significantly different (p < .05) from 2005.
† Gap is statistically significant (p < .05).

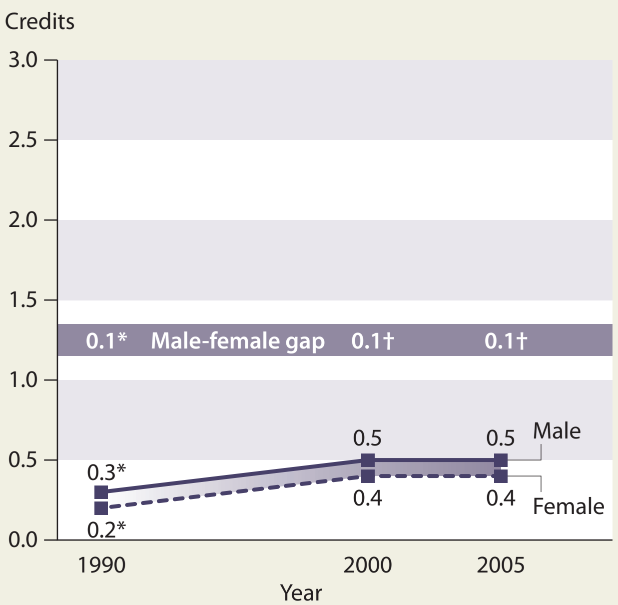
NOTE: Gaps were computed using unrounded numbers.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

TABLE 2
Percentage who earned credits in specific STEM courses, by gender: 2005

STEM course	Male	Female	Male-female gap
Advanced mathematics			
Algebra II	67	73	-6*
Other advanced mathematics	24	24	0
Pre-calculus/analysis	28	31	-3
Calculus	15	14	1
Advanced science and engineering			
Advanced biology	35	46	-11*
Chemistry	52	59	-7*
Physics	37	34	4*
Advanced environmental/earth science	6	6	0
Engineering	2	1	2*
STEM-related technical			
Engineering/science technologies	12	3	9*
Health science/technology	6	12	-6*
Computer science	25	15	10*

* Statistically significant ($p < .05$).
NOTE: Gaps were computed using unrounded numbers.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 2005 High School Transcript Study (HSTS).

FIGURE 4
Average STEM-related technical credits earned, by gender: 1990, 2000, and 2005



* Significantly different ($p < .05$) from 2005.
† Gap is statistically significant ($p < .05$).
NOTE: Gaps were computed using unrounded numbers.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

For specific STEM courses, gender gaps varied

Gender gaps in the percentage of graduates earning credits in specific STEM courses varied by course (table 2). In 2005, a larger percentage of female than male graduates earned credits in the following four courses: algebra II, advanced biology, chemistry, and health science/technology. A larger percentage of males than females, on the other hand, earned credits in physics, engineering, engineering/science technologies, and computer science.

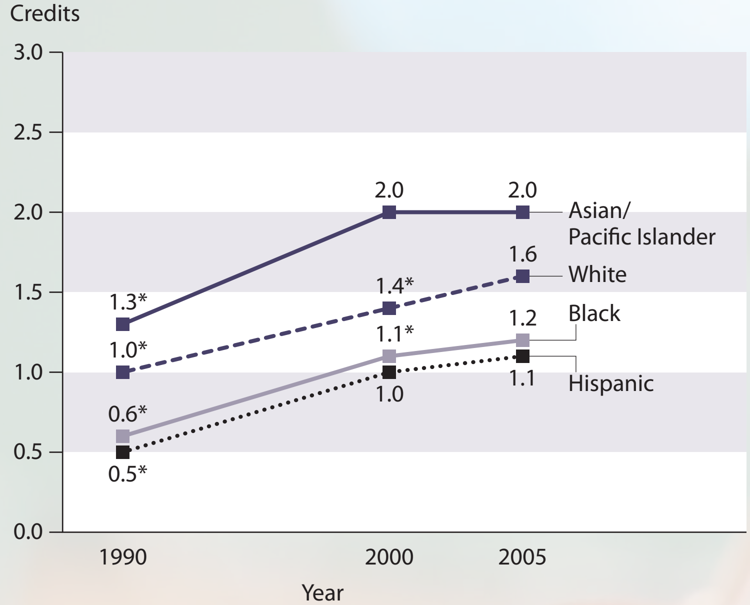
Increases in STEM credits seen across all racial/ethnic groups, but Hispanics experienced fewer gains

From 1990 to 2005, White, Black, and Asian high school graduates earned more credits in all three STEM course categories (figures 5–7). Over this period, Hispanic graduates earned more credits in advanced mathematics, but not in advanced science and engineering or STEM-related technical courses.

During the more recent period of 2000 to 2005, both White and Black graduates increased the number of advanced mathematics credits they earned. There were no other statistically significant changes in STEM credits earned by racial/ethnic groups during that period.

FIGURE 5

Average advanced mathematics credits earned, by race/ethnicity: 1990, 2000, and 2005



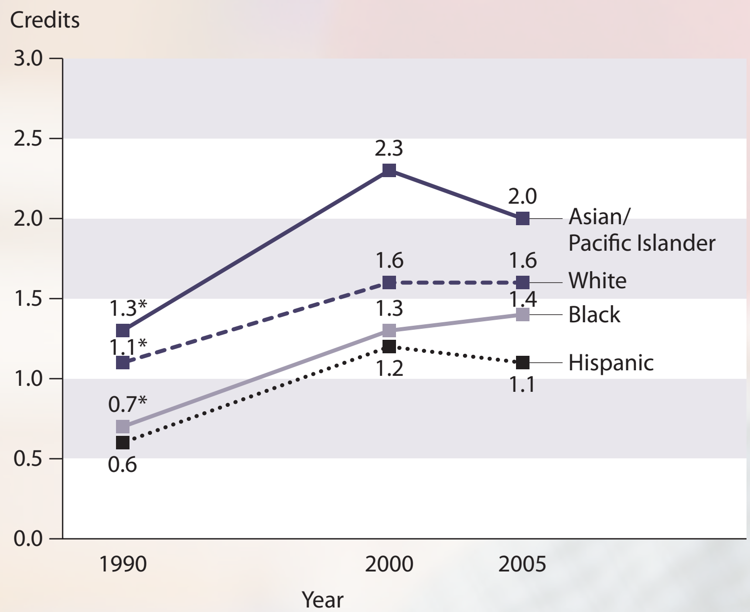
* Significantly different (p < .05) from 2005.

NOTE: Race categories exclude persons of Hispanic ethnicity.

SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

FIGURE 6

Average advanced science and engineering credits earned, by race/ethnicity: 1990, 2000, and 2005



* Significantly different (p < .05) from 2005.

NOTE: Race categories exclude persons of Hispanic ethnicity.

SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

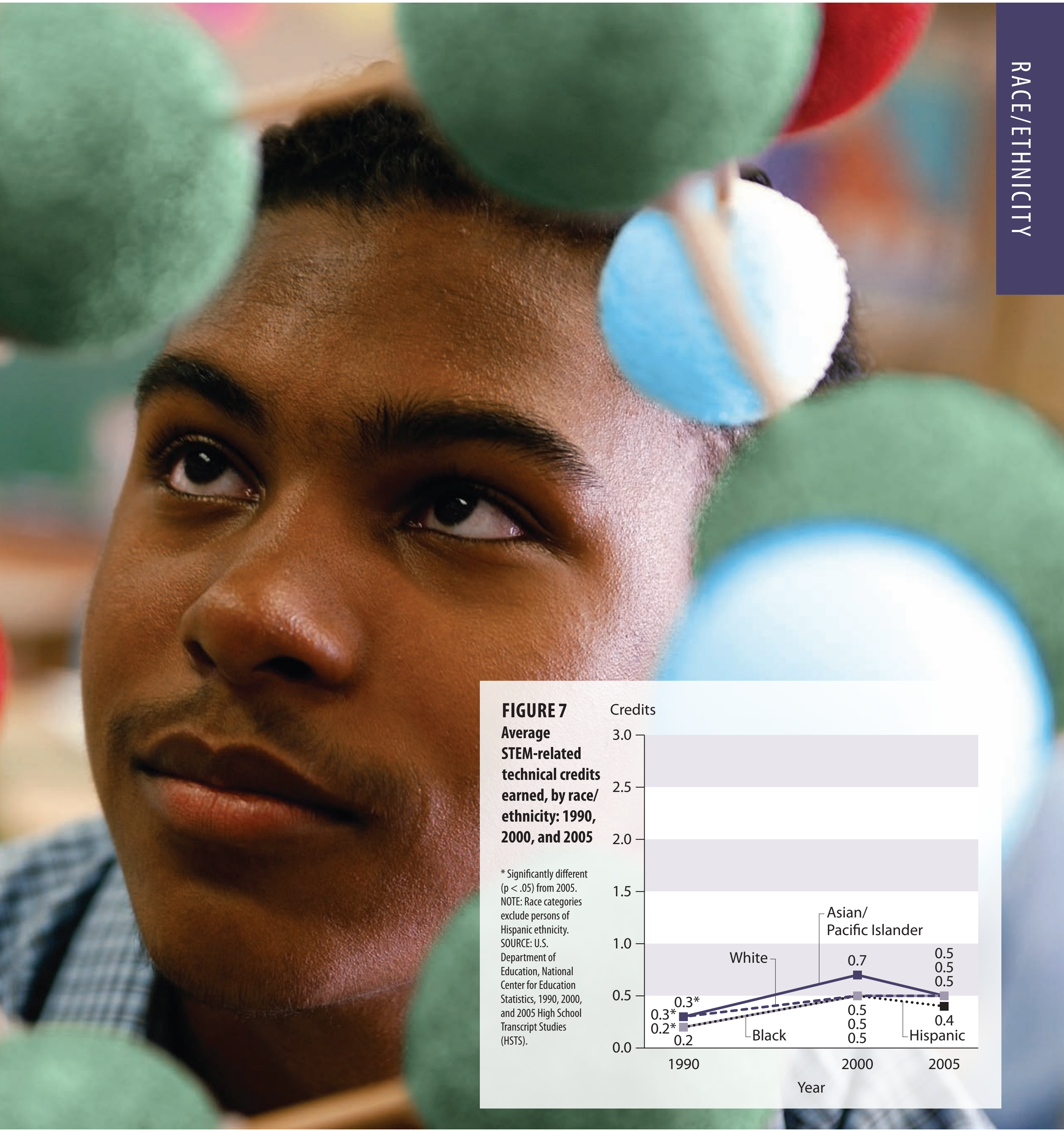


FIGURE 7
Average STEM-related technical credits earned, by race/ethnicity: 1990, 2000, and 2005

* Significantly different (p < .05) from 2005.
NOTE: Race categories exclude persons of Hispanic ethnicity.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

Whites earned more credits than Blacks and Hispanics in two STEM course categories

Table 3 summarizes the gaps between White and Black graduates and between White and Hispanic graduates in the average number of STEM credits earned. In 2005, White graduates earned more credits in advanced mathematics and advanced science and engineering than did Black and Hispanic graduates. These racial/ethnic gaps ranged from 0.3 (or 38 instructional hours) to 0.5 (or 60 instructional hours). There were no statistically significant differences between White and Black graduates, or between White and Hispanic graduates, in the number of STEM-related technical credits earned.

TABLE 3

Racial/ethnic gaps in average STEM credits: 2005 and changes from 2000 to 2005 and from 1990 to 2005

STEM credits	2005	Change from 2000 to 2005	Change from 1990 to 2005
Advanced mathematics			
White-Black gap	0.4*	↔	↔
White-Hispanic gap	0.5*	↔	↔
Advanced science and engineering			
White-Black gap	0.3*	↔	↔
White-Hispanic gap	0.5*	↔	↔
STEM-related technical			
White-Black gap	–0.1	↔	↔
White-Hispanic gap	#	↔	↔

Rounds to zero.
* Statistically significant (p < .05) gap in 2005.
↔ Any change in percentage was not statistically significant.
NOTE: Race categories exclude persons of Hispanic ethnicity.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

No measurable change in White-Black and White-Hispanic STEM credits gaps

There were no statistically significant changes between 1990 and 2005, or between 2000 and 2005, in the White-Black or White-Hispanic gaps in the average number of credits earned in advanced mathematics or in advanced science and engineering (table 3).

Racial/ethnic gaps in STEM credits earned varied by specific STEM courses

In 2005, a greater percentage of White than Black graduates earned credits in five specific STEM courses: other advanced mathematics, pre-calculus/analysis, calculus, advanced biology, and physics (table 4). In one specific STEM course, health science/technology, a greater percentage of Black than White 2005 graduates earned credits.

There were gaps between Whites and Hispanics in the percentage of graduates who earned credits in 9 of the 12 specific STEM-related courses in 2005, with higher proportions of White students earning credit in these courses. There were no statistically significant White-Hispanic gaps in three STEM courses: engineering, health science/technology, and computer science.

TABLE 4

Percentage who earned credits in specific STEM courses, by race/ethnicity: 2005

STEM course	White	Black	Hispanic	Asian/ Pacific Islander	White-Black gap	White-Hispanic gap
Advanced mathematics						
Algebra II	71	69	62	78	2	9*
Other advanced mathematics	27	17	15	30	11*	12*
Pre-calculus/analysis	32	18	20	49	14*	12*
Calculus	16	6	7	31	10*	9*
Advanced science and engineering						
Advanced biology	43	36	27	44	7*	16*
Chemistry	56	55	49	68	1	7*
Physics	38	28	26	53	10*	12*
Advanced environmental/earth science	7	6	4	5	0	3*
Engineering	1	1	1	3	0	0
STEM-related technical						
Engineering/science technologies	8	6	5	7	1	2*
Health science/technology	9	12	9	7	-3*	0
Computer science	19	19	20	28	0	0

* Statistically significant ($p < .05$).

NOTE: Race categories exclude persons of Hispanic ethnicity. Gaps were computed using unrounded numbers.

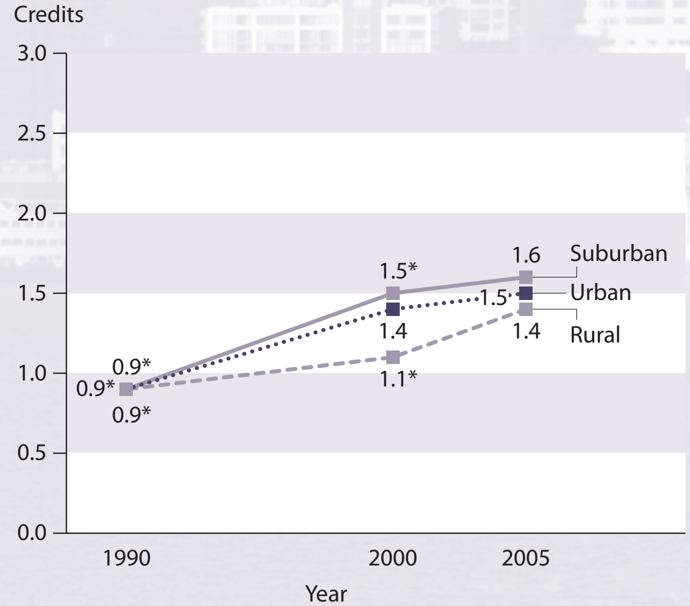
SOURCE: U.S. Department of Education, National Center for Education Statistics, 2005 High School Transcript Study (HSTS).

COMMUNITY TYPE

Graduates from urban, suburban, and rural communities earned more STEM credits in 2005 than in 1990

Figures 8–10 present the average number of credits earned in the three STEM course categories by high school graduates from urban, suburban, and rural communities. In all three types of communities, 2005 graduates earned more credits, on average, in each STEM course category than did 1990 graduates. Between 2000 and 2005, the average number of advanced mathematics credits earned increased among graduates in suburban and rural communities, but not among those in urban communities. No statistically significant changes were observed between 2000 and 2005 in the advanced science and engineering credits or STEM-related technical credits earned by graduates in the three types of communities.

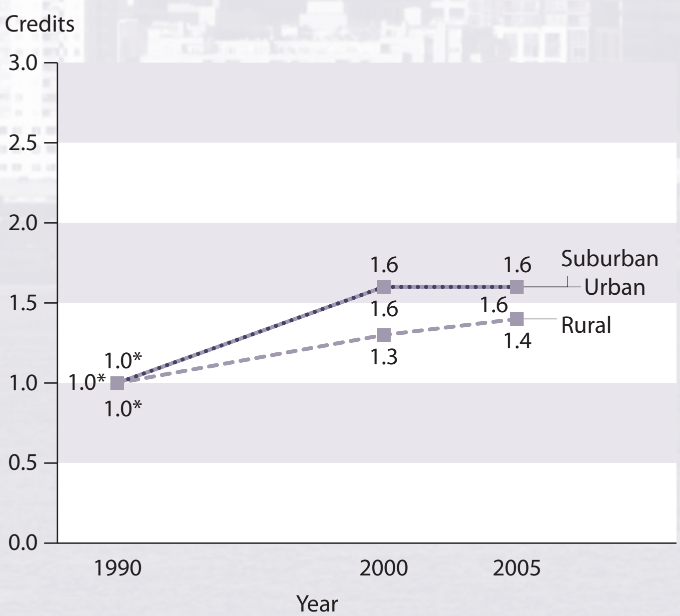
FIGURE 8
Average advanced mathematics credits earned, by community type: 1990, 2000, and 2005



* Significantly different ($p < .05$) from 2005.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

FIGURE 9

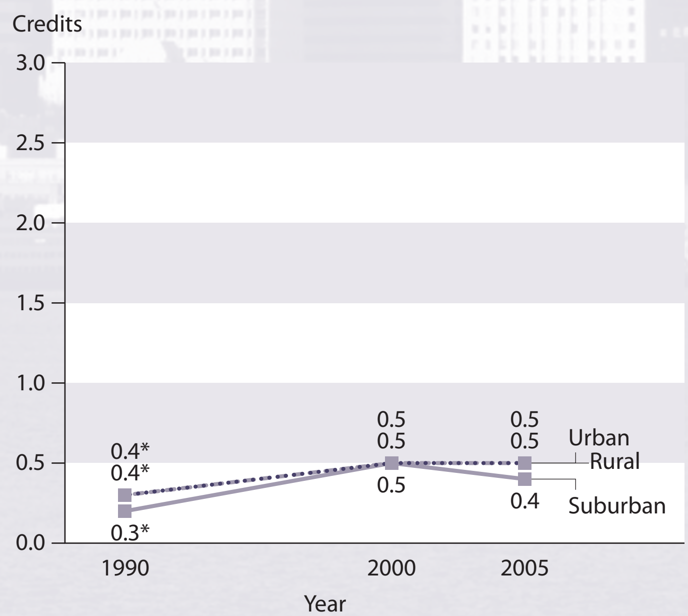
Average advanced science and engineering credits earned, by community type: 1990, 2000, and 2005



* Significantly different (p < .05) from 2005.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

FIGURE 10

Average STEM-related technical credits earned, by community type: 1990, 2000, and 2005



* Significantly different (p < .05) from 2005.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

Suburban graduates earned more advanced mathematics and advanced science and engineering credits than rural graduates

In 2005, suburban graduates earned more advanced mathematics credits and advanced science and engineering credits, on average, than did their rural peers (table 5). There was no statistically significant difference between suburban and rural graduates in the average number of STEM-related technical credits earned, nor was there any difference between suburban and urban graduates for any of the three STEM course categories.

Table 6 presents the percentage of 2005 graduates who earned credits in specific STEM-related technical courses by community type. Compared with urban graduates, a greater percentage of suburban graduates earned credits in other advanced mathematics and advanced environmental/earth science. In 7 of the 12 specific STEM courses, a greater proportion of suburban graduates than rural graduates earned credits.

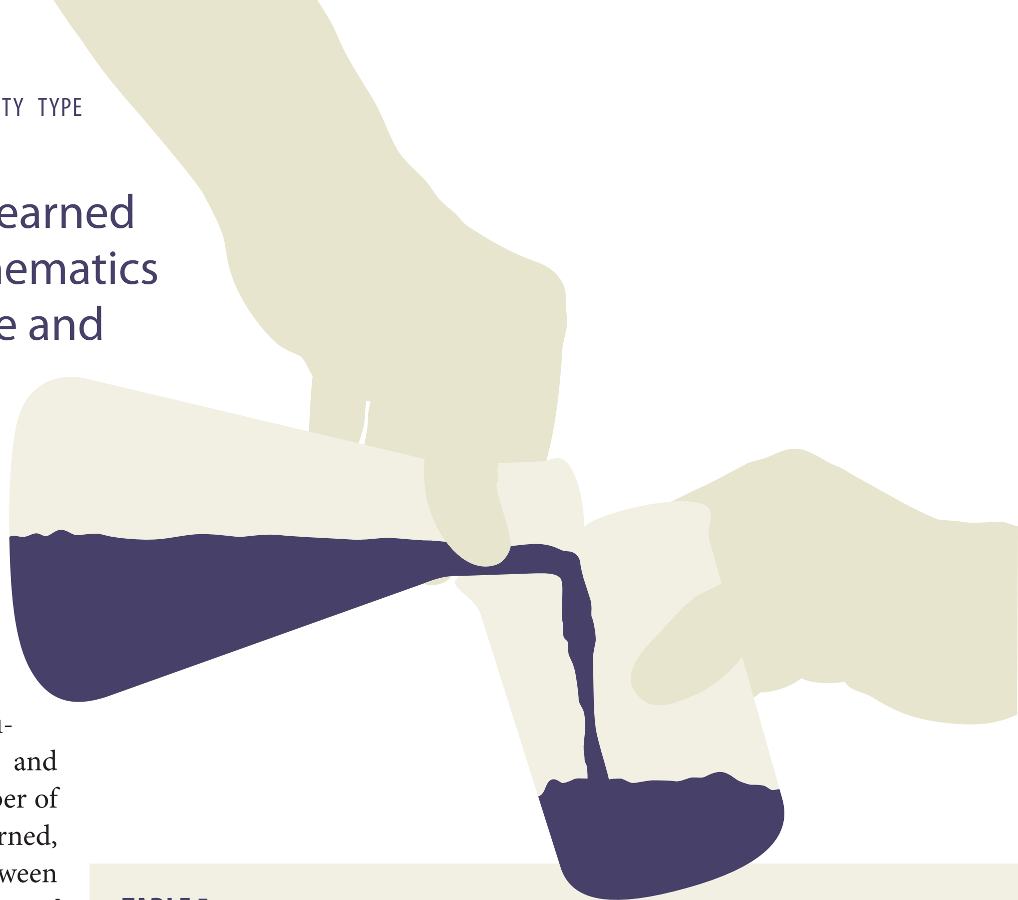


TABLE 5
Community type gaps in average STEM credits: 2005 and changes from 2000 to 2005 and from 1990 to 2005

STEM credits	2005	Change from 2000 to 2005	Change from 1990 to 2005
Advanced mathematics			
Suburban-urban	0.1	↔	↔
Suburban-rural	0.2 *	↔	↔
Advanced science and engineering			
Suburban-urban	0.1	↔	↔
Suburban-rural	0.2 *	↔	↔
STEM-related technical			
Suburban-urban	#	↔	↔
Suburban-rural	–0.1	↔	↔

Rounds to zero.
* Statistically significant ($p < .05$) gap in 2005.
↔ Any change in percentage was not statistically significant.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 1990, 2000, and 2005 High School Transcript Studies (HSTS).

TABLE 6

Percentage who earned credits in specific STEM courses, by community type: 2005

STEM course	Urban	Suburban	Rural	Suburban-urban gap	Suburban-rural gap
Advanced mathematics					
Algebra II	73	70	68	-3	1
Other advanced mathematics	22	28	21	6*	6*
Pre-calculus/analysis	31	33	23	2	9*
Calculus	15	15	12	0	3*
Advanced science and engineering					
Advanced biology	38	41	42	3	-2
Chemistry	61	56	50	-5	6*
Physics	36	38	30	2	8*
Advanced environmental/earth science	5	8	5	3*	3*
Engineering	2	1	1	-1	1*
STEM-related technical					
Engineering/science technologies	6	7	7	2	0
Health science/technology	8	9	10	1	0
Computer science	21	19	19	-2	-1

* Statistically significant ($p < .05$).
NOTE: Gaps were computed using unrounded numbers.
SOURCE: U.S. Department of Education, National Center for Education Statistics, 2005 High School Transcript Study (HSTS).

Technical Notes

Additional Data Tables

Additional Data Tables for this report, including standard error tables, are available at http://mprinc.com/products/pdf/stem_tables.pdf.

The High School Transcript Study

The High School Transcript Study (HSTS) is conducted by the National Center for Education Statistics, U.S. Department of Education. For this report, the HSTS of 1990, 2000, and 2005 were used to examine STEM coursetaking. The HSTS periodically collects information about courses completed and credits and grades earned during high school by high school graduates, including 12th-graders sampled for the National Assessment of Educational Progress (NAEP). A brief summary of the HSTS survey methodology is provided below, with particular attention given to the 2005 HSTS because it is the focus of this report. Similar procedures were followed for the 1990 and 2000 studies. Further information is available at http://nces.ed.gov/nationsreportcard/hsts. Also available through that website are the technical guides for the 2000 (Roey et al. 2005) and 2005 (Shettle et al. 2008) studies. The technical guide for the 1990 report is not available online, but information about obtaining a copy is available on the website.

NAEP HSTS data are being collected for the class of 2009 and are expected to be available in early 2011.

Classifying Courses and Credits

The HSTS applies consistent methods for classifying courses. High school courses vary by content and level, even among those with similar titles. Therefore, to compare the thousands of transcripts collected from schools in the HSTS sample and to ensure that each course is uniquely identified, a common course coding system, the Classification of Secondary School Courses (CSSC), was used.

Course credits were converted to standardized Carnegie units or credits, in which a single unit equals 120 hours of classroom time over the course of a year. Schools provided information on how many course credits represent a Carnegie unit at their school. Course credits recorded on the transcript were then converted (standardized) into Carnegie units for the data analysis for this report.

Sampling, Participation Rates, and Weighting

The target population for HSTS 2005 included all students in public and private schools in the United States who were enrolled in 12th grade in 2004–05 and who graduated in 2005. The HSTS collected a nationally representative sample of more than 26,000 transcripts (from more than 29,000 students in the original sample), representing approximately 2.7 million 2005 high school graduates. Students excluded from the study included nongraduates, and students with incomplete transcripts. For each graduate, transcript information was collected for 9th through 12th grades. Transcripts were collected from about 640 public schools and 80 private schools. Although the weighted graduate within-school response rate was about 99.7 percent, the NAEP HSTS school response rate (84.2 percent) fell slightly below the National Center for Education Statistics standard of 85 percent for both schools and graduates.

All estimates were weighted using sampling weights (HSTS sample weights or NAEP-linked weights) to provide unbiased estimates of the national population. HSTS sample weights were used for all aggregations that did not rely on NAEP assessment score data; all graduates with complete transcripts were included in these estimates. Some results shown in the Additional Data Tables used NAEP-linked weights for analyses involving both NAEP assessment scores and transcript data. These analyses included only graduates with complete transcripts and scores from the 2005 NAEP mathematics or science assessment.

Analytical Sample

The analyses in this report include only graduates with regular or honors diplomas and those with 16 or more earned Carnegie credits and a nonzero number of Carnegie credits in English/language arts. These inclusion criteria were established to ensure that the transcripts were complete and valid. Analyses that link coursetaking with NAEP assessment performance were conducted on subsets of the sample: graduates from the HSTS who had also participated in the NAEP 12th-grade mathematics or science assessments (approximately 17,000 of the graduates in the HSTS sample).

Variance Estimation and Nonsampling Error

Estimates using HSTS data are subject to sampling error because they were derived from a sample, rather than the whole population. Sampling error was measured by the sampling variance, which indicated how much the population estimate for a given statistic was likely to change if it had been based on another equivalent sample of individuals drawn in exactly the same manner as the actual sample. Since the HSTS used a complex sample design with two-stage sampling and unequal selection probabilities, along with complex weighting procedures, standard textbook formulas could not be used for estimating variances. Instead, variances were estimated using jackknife replication methods (Krewski and Rao 1981). This estimation involved constructing a number of subsamples (replicates) from the full sample and computing the statistic of interest for each replicate. Measuring the variability among the replicates leads to an accurate estimate of variance for the full sample.

As in any statistical study, the HSTS estimates are subject to nonsampling errors as well as sampling errors. For example, the appropriate CSSC code for classifying courses is not always clear because of insufficient or inaccurate information provided by schools, thus leading to measurement error.

Interpreting Statistical Significance

Comparisons over time or between groups were based on *t*-tests, statistical tests that consider both the size of the differences and the standard errors of the two estimates being compared. When estimates—such as average scores—have large standard errors, a numerical difference that seems large may not be statistically significant (i.e., the null hypothesis of no difference cannot be rejected with sufficient confidence). Differences of the same size may or may not be statistically significant for various comparisons, depending on the size of standard errors involved. Any differences between scores or percentages discussed in this report are statistically significant at the 0.05 level. No adjustments were made for multiple comparisons.

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This Research Brief, along with additional data tables to support the findings in this report, can be found on MPR Associates' website at **www.mprinc.com.**

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The authors wish to thank Janis Brown and her colleagues at the National Center for Education Statistics (U.S. Department of Education), along with members of the NAEP High School Transcript Studies Technical Panel for their guidance and helpful review comments. The authors also thank Westat and the NAEP Education Statistics Services Institute for their contributions to the High School Transcript Studies.

This publication was prepared with support from the NAEP Education Statistics Services Institute (Contract No. ED-05CO-0053). The views expressed do not necessarily represent any official positions of the U.S. Department of Education.