What's Happening

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Advanced course offerings and completion in science, technology, engineering, and math in Texas public high schools

Marshall Garland
Amie Rapaport
Gibson Consulting Group

Key findings

- The number of advanced courses offered in science, technology, engineering, and math (STEM) rose from 2007/08 to 2013/14 in Texas public high schools in all locales (urban, suburban, town, rural), with large or small proportions of economically disadvantaged students, and with large proportions of minority students.
- Schools with the largest proportion of Black or Hispanic students offered a greater number of advanced STEM courses than did schools with the largest proportion of White students.
- Schools in urban and suburban areas offered a greater number of advanced STEM courses than did schools in rural areas or towns.
- Almost three-quarters of the state's Black and Hispanic students (78 percent of each group) and two-thirds of the state's White students (68 percent) attended high schools offering between 19 and 27 advanced STEM courses.
- A smaller proportion of Black and Hispanic students than White students completed three or more advanced math or science courses, even among students demonstrating comparably high math ability.

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Summary

Taking advanced high school courses predicts such postsecondary outcomes as enrolling in college, persisting in college courses, and completing a degree (see Hinojosa, Rapaport, Jaciw, LiCalsi, & Zacamy, 2016, for a review). In Texas, where Hispanic students make up 51 percent of the student population, their access to and enrollment in advanced courses is an ongoing concern despite recent gains (Aud et al., 2013; Laird, Alt, & Wu, 2009; Texas Education Agency, 2011). In particular, disparities in the proportions of Hispanic adults educated and certified for high-wage jobs in science, technology, engineering, and math (STEM) fields raise questions about Hispanic students' equitable access to advanced STEM courses. In 2009 Hispanic employees accounted for 14 percent of the U.S. workforce but held only 6 percent of STEM jobs (Beede et al., 2011).

Members of the Texas Hispanic STEM Alliance of the Regional Educational Laboratory Southwest, made up of representatives from Regional Education Service Centers, school districts, postsecondary institutions, and state education agencies, asked whether Hispanic students in Texas are taking advanced STEM courses at the same rates as other students or have equitable opportunities to take them. In response, this study examined course offerings and coursetaking in more than 1,500 Texas high schools over 2007/08–2013/14 to identify differences across Black, Hispanic, and White students, using statewide longitudinal student education records for more than 240,000 students a year.

The findings of this study can inform regional and local educators and policymakers who are considering policies, interventions, and reforms to equalize STEM achievement across student groups and support for advanced STEM coursetaking, particularly among Black and Hispanic students. The methodology (in addition to the findings) may help states beyond Texas explore questions of course availability and course completion.

How many advanced science, technology, engineering, and math courses did schools offer?

Texas high school offerings of advanced STEM courses rose from an average of 9 in 2007/08 to 14 in 2013/14. A greater number of advanced courses were offered in science (5.5 on average in 2013/14) than in math (4.8) or in other advanced STEM areas (not math or science), such as information technology (3.6). The largest increase in course offerings was for other advanced STEM courses, which rose from 1.4 in 2007/08 to 3.6 in 2013/14.

Texas high schools enrolling the largest proportions of Black or Hispanic students offered a greater number of advanced STEM courses on average than did schools that enrolled the largest proportions of White students. High schools with the largest proportions of Black students offered about 15 advanced STEM courses on average, those with the largest proportion of Hispanic students offered 17, and those with the largest proportion of White students offered 9 in 2013/14. These differences are closely tied to the schools' locale. Schools in suburban locales offered about 19 advanced STEM courses on average and those in urban locales 18, substantially more than schools in towns, with 13, and in rural locales, with 10.

The economic characteristics of a school's population were associated with even larger differences. Across all school locales, as the percentage of economically disadvantaged students (as proxied by participation in the federal school lunch program) rose, the number

of advanced STEM course offerings declined. In 2013/14 schools enrolling the smallest proportions of economically disadvantaged students averaged 17 advanced STEM courses, while schools enrolling the largest proportions of economically disadvantaged students averaged 14. Schools in rural areas enrolling large proportions of economically disadvantaged students offered an average of 9 advanced STEM courses, fewer than schools in urban areas with large proportions of economically disadvantaged students, which offered 16 courses, or in suburban areas, which offered 17.

Because a majority of Texas high school students reside in urban and suburban areas, a majority (75 percent in 2013/14) attend schools in the top two quintiles of advanced course offerings (between 19 and 27 on average). Approximately 78 percent of Black and Hispanic students are enrolled in these urban and suburban schools, a larger proportion than the 68 percent of White students enrolled there.

How many advanced STEM courses did students complete?

Among students who were continuously enrolled in Texas high schools for four years, White students completed a slightly greater number of advanced STEM courses on average (4.6) than did Hispanic students (4.3) or Black students (4.0). Greater differences by race/ethnicity emerged in analyses of the percentage of students who completed three or more advanced STEM courses in math or in science than in analyses of the mean number of advanced STEM courses completed. Among students demonstrating high math ability in grade 8, approximately 52 percent of White students completed at least three advanced math courses during high school, compared with 41 percent of Hispanic students and 39 percent of Black students. In science the difference was smaller but persistent: 58 percent of White students completed three or more advanced science courses compared with 51 percent of Hispanic students and 51 percent of Black students.

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Why this study?

Taking advanced high school math and science courses is a significant predictor of college success (Klopfenstein & Thomas, 2009) and of such postsecondary science, technology, engineering, and math (STEM) outcomes as majoring in a STEM area in college, persisting in that area, and obtaining a STEM degree (Burge, 2013; Engberg & Wolniak, 2013; Griffith, 2010; Ma, 2011; Maltese & Tai, 2011; Riegle-Crumb & King, 2010; Wang, 2013a, 2013b; You, 2013; see Hinojosa et al., 2016, for a review). Although the percentage of high school students in advanced STEM courses (see box 1 for definitions) has risen steadily in the past two decades across the United States, disparities persist across student subgroups, such as racial/ethnic groups (Aud et al., 2013; Laird, Alt, & Wu, 2009; Texas Education Agency, 2011). Racial/ethnic minority student enrollment in advanced STEM courses in high school continues to lag behind nonminority enrollment, both nationally and in Texas. These gaps are wider for courses such as calculus and physics (Aud et al., 2013; Laird et al., 2009; Texas Education Agency, 2011). (See appendix A for a review of the literature.)

This study examined whether there are important variations in advanced STEM course opportunities in Texas and in the numbers of advanced STEM courses students complete

The Texas Hispanic STEM Alliance, which includes representatives from Education Service Centers, Texas school districts, Texas postsecondary institutions, and Texas state education agencies, expressed concerns about whether Hispanic students in Texas are taking advanced STEM courses at the same rates as other students or have equitable opportunities to take them. This study examined whether there are important variations in advanced STEM course opportunities in Texas and in the numbers of advanced STEM courses students complete. The results can contribute to national understanding of patterns of advanced STEM course offering and coursetaking and may be a first step in identifying opportunities in Texas for minimizing disparities—for example, by increasing offerings of such courses where fewer courses are offered and doing more to encourage students to take them.

What the study examined

This study examined advanced STEM course offerings in all regular-instruction public high schools in Texas, including charter schools, that served students at any time from 2007/08 to 2013/14. The study examined advanced STEM course completion among all students continuously enrolled in public high schools for four years (or five years in public schools when a math performance measure from grade 8 is included) for four cohorts of students in grades 9–12 between the 2007/08 and 2013/14 school years. (More information on the study data, samples, and research methods is in box 2 and appendix B.)

The study addressed three research questions. The first two consider variations in advanced STEM course offerings at the school level (research question 1) and through the lens of variations in student opportunity to access advanced STEM course offerings (research question 2):

1. To what extent did Texas high schools vary in the number of advanced STEM courses offered to students?
    a. To what extent did the number of advanced STEM course offerings vary by schools serving different racial/ethnic subpopulations?
    b. To what extent is this variation explained by other school characteristics, such as school locale or concentration of economically disadvantaged students?

Box 1. Key terms

Advanced STEM courses. Courses identified as "advanced" science, technology, engineering, and math (STEM) by Texas Education Agency data or the High School Transcript Study (Laird et al., 2009; Nord et al., 2011). This report classifies these courses as advanced math, advanced science, and other advanced STEM courses. Engineering courses are classified under advanced science courses. (More information on the process of coding and identifying advanced STEM courses is in appendix B.)

Courses completed. Any course in which a student earned credit for the course. This measure of completion, used for research question 3, focuses on courses completed by students, whereas the measure used for research questions 1 and 2 focuses on courses offered (see below).

Courses offered. Any course in a school that at least one student completed regardless of whether credits were earned. Course offerings were identified indirectly because there is no centralized database of courses offered in schools across Texas. In the analysis, this variable represents the presence or absence of the course at the school. Courses offered were defined in this way for each regular-instructional high school in the state. A course was counted only once regardless of how many times that course was offered in a given school and year.

Economically disadvantaged students. Students who participate in the federal school lunch program, which provides free or reduced-price lunches to students in low-income families, defined as families earning below 185 percent of the federal poverty line ($44,123 for a family of four in 2014, the last year included in the study).

School with the highest proportions of Black, Hispanic, or White students. Schools in the top decile of student populations for each racial/ethnic group examined in 2007/08.

Students demonstrating high math ability. Students who met the Commended Performance standard on the math portion of the Texas Assessment of Knowledge and Skills exam in grade 8. The Texas Education Agency defines Commended Performance as "High academic achievement; considerably above state passing standard; thorough understanding of the math Texas Essential Knowledge and Skills curriculum" (Texas Education Agency, n.d., para. 3). This designation is assigned when a student's score exceeds a scale score of 2400. In this study's final analytic sample, 36 percent of students were classified as high performing.

Other advanced STEM courses. Courses identified by the Texas Education Agency as Advanced Career and Technical (CTE) courses. These include courses in CTE STEM, CTE Health Science, and CTE Information Technology.

School locale. Whether a school was located in an urban, suburban, town, or rural area. Locale was assigned to each school for each study year (school locale was not fixed across years). School locale information was collapsed from the more fine-grained National Center for Education Statistics designations (for example, urban-large, urban-medium, urban-small) into these four categories.

STEM courses. Courses offered by schools that are identified by the Texas Education Agency as science, math, or STEM-related technical courses.

2. To what extent did Texas high school students vary by the number of advanced STEM courses available in their schools?

The third research question considers advanced STEM course completion among important student subpopulations:

3. To what extent did advanced STEM course completion in high school vary for Texas students by student race/ethnicity, grade 8 math performance, and student economic disadvantage?

Box 2. Data sources, study samples, and research methods

Data sources

All data for this study were provided by the Texas Education Agency, except school locale information, which was drawn from the National Center for Education Statistics Common Core of Data (National Center for Education Statistics, 2014). The administrative data from the University of Texas Education Research Center included students' enrollment, demographics, coursetaking, and standardized test scores.

Study samples

Four samples were constructed for this study.

Sample 1: To examine course offerings and opportunities (research questions 1 and 2), the study team constructed a dataset of all schools where students in grades 9 through 12 completed a course during school years 2007/08–2013/14. The number of schools included in each year ranged from 1,367 in 2007/08 to 1,529 in 2013/14.

Sample 2: A subsample of schools was selected for examining differences in course offerings in schools that serve large proportions of White or racial/ethnic minority students (research questions 1 and 2; the method for doing so is described in appendix B). This produced a list of 1,003 nonunique schools with approximately 85 percent or more White students, 1,016 nonunique schools with approximately 30 percent or more Black students, and 1,014 nonunique schools with 90 percent or more Hispanic students (the top decile of schools for each student subgroup). In each year, the number of unique schools ranged from a maximum of 470 in 2007/08 to a minimum of 408 in 2010/11.

Sample 3: To examine course completion (research question 3), the study team constructed a dataset including four cohorts of students—each cohort entering grade 9 and progressing to grade 12 in four years (cohort 1 entered grade 9 in 2007/08 and cohort 4 entered grade 9 in 2010/11), and earning a high school diploma. Cohorts ranged in size from approximately 236,000 to 249,000 students (see table B2 in appendix B). While course completion analyses by school locale and student economic disadvantage included all students, analyses examining course completion by racial/ethnic subgroup were restricted to Black, Hispanic, and White students. Thus, the number of students included in those analyses varies by subquestion.

Sample 4: To examine course completion among students demonstrating high math ability in grade 8 (research question 3), the study team reduced sample 3 to include only students who had a valid score on their grade 8 math state assessment (see table B2 in appendix B). This inclusion rule affected Hispanic, Black, and White students nearly equally. For instance, 92 percent of Black, Hispanic, and White students demonstrating high math ability had four years of high school enrollment records, and practically all of those students graduated.

Research methods

To answer research question 1, the study team examined state and school averages of the number of advanced STEM courses overall and in math, science, and other STEM areas offered across the state from 2007/08 to 2013/14. Each school in the state was weighted equally regardless of the number of students served. Average numbers of courses offered were also examined by school locale and by level of economic disadvantage in the school's student population.

To answer research question 2, the study team rank ordered schools by quintiles based on the number of advanced STEM courses offered in a given school year, from the lowest quintile (bottom 20th percentile) to the highest quintile (the top 20th percentile). Then, the number of students enrolled was summed for each quintile and used to calculate the percentage of students in each of these categories, disaggregated by student race/ethnicity. Put another way, this research question describes the percentage of students in the state who were enrolled in a school that offered an above average, below average, or typical number of advanced STEM courses in a given school year.

(continued)

Box 2. Data sources, study samples, and research methods *(continued)*

To answer research question 3, the study team calculated the average number of advanced math, science and other STEM courses completed by each student. Analyses were conducted in two ways: once for courses completed when credit was earned and once regardless of whether credit was earned. Because patterns of results were similar for the two measures, results are reported only for analyses examining course completion with credits earned. Descriptive statistics were used to explore the distribution of students taking at least three advanced math or at least three advanced science courses and to explore these percentages by student race/ethnicity. Three advanced math or three advanced science courses were selected as the cutoff because that number exceeds the requirement for students on the most common graduation plan (the Recommended High School Program), which is one math course and two science courses (classified as advanced in this study). The distributions of course-completion frequencies were examined for students who did and those who did not meet the definition of academically high-performing, by student economic disadvantage status and by school locale. More details about statistical methods are in appendix B.

What the study found

This section discusses the findings for each research question.

Advanced science, technology, engineering, and math course offerings increased statewide from 2007/08 to 2013/14

The number of advanced STEM courses offered at Texas high schools rose from an average of 9 in 2007/08 to 14 in 2013/14 (table 1). A greater number of advanced courses were offered in science than in math: course offerings in science increased from an average of 4.0 to 5.5, while course offerings in math increased from 3.5 to 4.8. The largest increase in course offerings was for other advanced STEM courses (advanced career and technology courses in areas such as health science and information technology), which rose from an average of 1.4 in 2007/08 to 3.6 in 2013/14.[1]

Table 1. Average number of advanced science, technology, engineering, and math courses offered at Texas public high schools, by school year and subject, 2007/08–2013/14

School year	Average number of advanced STEM courses overall	Average number of advanced math courses	Average number of advanced science courses	Average number of other advanced STEM courses
2007/08	8.9	3.5	4.0	1.4
2008/09	9.2	3.6	4.1	1.6
2009/10	9.9	3.7	4.3	1.9
2010/11	11.6	3.9	4.5	3.2
2011/12	13.1	4.4	5.4	3.3
2012/13	13.7	4.7	5.6	3.4
2013/14	13.9	4.8	5.5	3.6

STEM is science, technology, engineering, and math.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

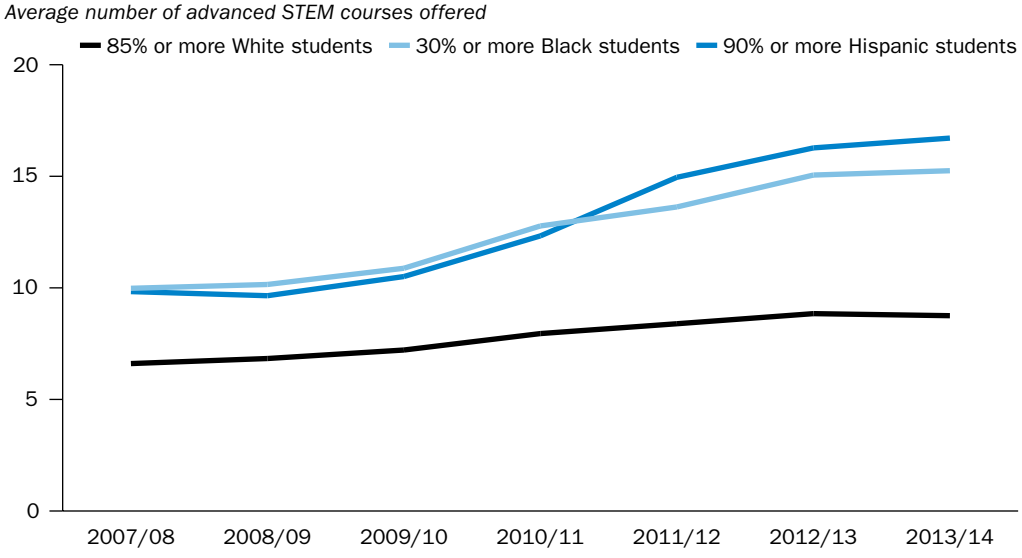
The number of advanced STEM courses offered at Texas high schools rose from an average of 9 in 2007/08 to 14 in 2013/14

Schools enrolling the largest proportion of racial/ethnic minority students offered substantially greater numbers of advanced science, technology, engineering, and math courses than schools enrolling the largest proportion of White students

Schools with more than 90 percent Hispanic students and those with more than 30 percent Black students offered a greater number of advanced STEM courses than schools with more than 85 percent White students. Schools with more than 90 percent Hispanic students offered approximately 10 advanced STEM courses on average in 2007/08 and 17 in 2013/14, schools with more than 30 percent Black students offered approximately 10 in 2007/08 and 15 in 2013/14, and schools with more than 85 percent White students offered approximately 7 in 2007/08 and 9 in 2013/14 (figure 1).

The pattern was similar when math, science, and other advanced STEM course offerings were examined separately. The gap between schools that enrolled the highest proportions of Black and Hispanic students and schools that enrolled the highest proportions of White students was largest for other advanced STEM courses and advanced science courses. The gap was less pronounced for advanced math courses: schools with the highest proportions of Hispanic students offered 5.4 courses on average, schools with the highest proportions of Black students offered 5.0, and schools with the highest proportions of White students offered 3.5 (see figures D1–D3 in appendix D).

Figure 1. Texas public high schools with the largest proportions of Hispanic students had the largest average number of advanced science, technology, engineering, and math courses, followed by schools with the largest proportions of Black students, 2007/08–2013/14



STEM is science, technology, engineering, and math.

Note: Schools are those in the top decile of enrollment for each racial/ethnic subgroup.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

Schools with more than 90 percent Hispanic students offered approximately 10 advanced STEM courses on average in 2007/08 and 17 in 2013/14, schools with more than 30 percent Black students offered approximately 10 in 2007/08 and 15 in 2013/14, and schools with more than 85 percent White students offered approximately 7 in 2007/08 and 9 in 2013/14

A greater number of advanced science, technology, engineering, and math courses were offered in schools with a low percentage of economically disadvantaged students

When schools were organized into quintiles by the proportion of students classified as economically disadvantaged, schools in the bottom quintile (smallest proportion of economically disadvantaged students) offered more advanced STEM courses, and schools in higher quintiles offered fewer advanced STEM courses (table 2). The size of this disparity remained stable between 2007/08 and 2013/14. Advanced STEM course offerings increased across all concentrations of students classified as economically disadvantaged between 2007/08 and 2013/14, though the increases were larger for schools in the top and bottom quintiles (approximately 6 advanced STEM courses in each quintile, on average). This pattern persisted across all types of advanced STEM course categories.

A greater number of advanced science, technology, engineering, and math courses were offered in urban and suburban schools than in rural or town schools

The differences in advanced STEM course offerings by student demographic composition reflect varying concentrations of student racial/ethnic groups by locale. Schools in urban and suburban locales offered a substantially greater number of advanced STEM courses than schools in towns and rural locales (figure 2). Urban schools offered approximately 18 courses on average, suburban schools offered 19, schools in towns offered 13, and rural schools offered 10 in 2013/14. Growth in the average number of advanced STEM courses was largest for schools in urban and suburban locales between 2007/08 and 2013/14. Urban and suburban schools offered a greater number of advanced STEM courses of all types; the difference between locales was most pronounced for advanced science and for other advanced STEM courses[2] (see figures D4–D6 in appendix D).

Table 2. Average number of advanced science, technology, engineering, and math courses offered in Texas public high schools, by quintiles of economically disadvantaged students, 2007/08 and 2013/14

School year	Economically disadvantaged students (quintiles)[a]	Average number of advanced STEM courses overall	Average number of advanced math courses	Average number of advanced science courses	Average number of other advanced STEM courses
2007/08	Bottom	10.8	4.1	5.0	1.8
	Second	8.5	3.5	3.7	1.4
	Third	7.9	3.3	3.5	1.1
	Fourth	8.5	3.4	3.7	1.3
	Top	7.9	3.2	3.4	1.4
2013/14	Bottom	16.8	5.5	6.7	4.5
	Second	12.8	4.6	5.1	3.1
	Third	13.1	4.5	5.1	3.5
	Fourth	13.1	4.6	5.2	3.3
	Top	13.8	4.6	5.6	3.6

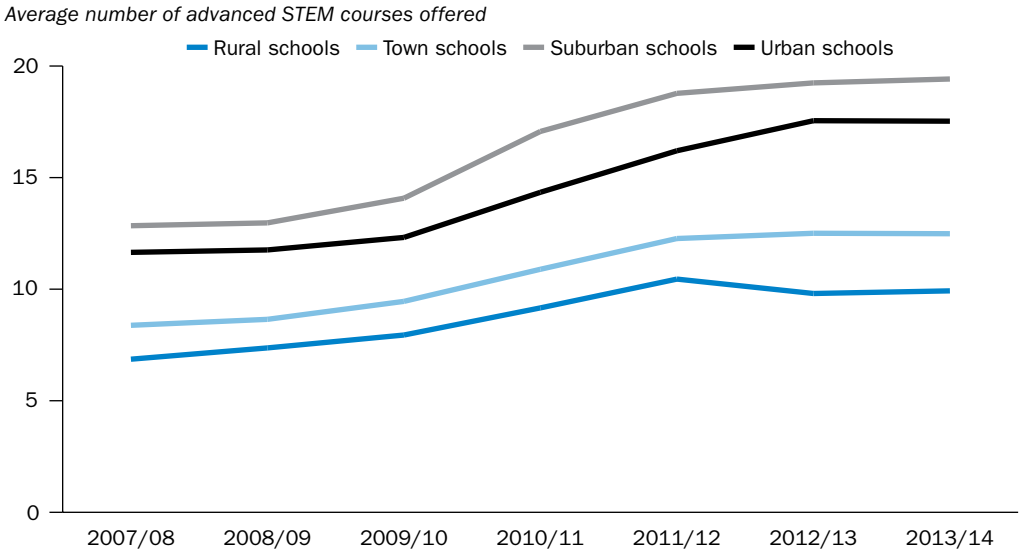
STEM is science, technology, engineering, and math.

a. The bottom quintile has schools with the smallest proportion of economically disadvantaged students.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

Schools with the smallest proportion of economically disadvantaged students offered more advanced STEM courses, and schools with higher proportions offered fewer advanced STEM courses

Figure 2. Urban and suburban public high schools in Texas offered a greater number of advanced science, technology, engineering, and math courses than schools in towns and rural locales, 2007/08–2013/14



Urban schools offered approximately 18 advanced STEM courses on average, suburban schools offered 19, schools in towns offered 13, and rural schools offered 10 in 2013/14

STEM is science, technology, engineering, and math.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

Schools in towns and rural areas that enrolled large proportions of economically disadvantaged students offered the fewest advanced science, technology, engineering and math courses

Rural schools enrolling large proportions of economically disadvantaged students offered the fewest advanced STEM courses: approximately 6 in 2007/08 and 9 in 2013/14 (table 3). Urban schools with large proportions of economically disadvantaged students offered approximately 9 advanced STEM courses in 2007/08 and 16 in 2013/14, and suburban schools offered 11 in 2007/08 and 17 in 2013/14. The increase in the number of advanced STEM course offerings over the study period was smaller, on average, in rural schools than in urban and suburban schools at nearly every concentration of economically disadvantaged students.[3]

Seventy-five percent of the state's student population attended schools in the top two quintiles of advanced science, technology, engineering, and math course offerings

Because students in Texas disproportionately attended schools in densely populated urban areas (the top 10 percent of the state's public high schools enrolled 45 percent of students in 2013/14), the majority of Texas students, including racial/ethnic minority students, attended schools offering high numbers of advanced STEM courses. Some 75 percent of the state's student population attended schools in the top two quintiles of advanced STEM course offerings. For example, the top quintile offered 27 courses, on average, in 2013/14, and the second quintile offered 19 (table 4). Approximately 78 percent of Black and Hispanic students and 68 percent of White students attended schools in these two quintiles.

Table 3. Average number of advanced science, technology, engineering, and math courses offered by Texas public high schools, by school locale and quintiles of economically disadvantaged students, 2007/08 and 2013/14

School locale	Economically disadvantaged students (quintile)[a]	2007/08	2013/14	Change between 2007/08 and 2013/14
Town	Bottom	9.3	12.3	3.0
	Second	8.2	12.4	4.1
	Third	8.4	12.3	3.9
	Fourth	7.5	13.2	5.7
	Top	7.9	11.8	3.8
Rural	Bottom	8.7	12.3	3.6
	Second	6.6	10.0	3.5
	Third	6.5	9.8	3.3
	Fourth	5.7	8.9	3.2
	Top	5.6	8.9	3.4
Suburb	Bottom	14.1	20.5	6.4
	Second	13.7	20.2	6.5
	Third	11.2	21.8	10.7
	Fourth	10.0	18.2	8.2
	Top	10.7	16.8	6.1
Urban	Bottom	12.8	19.2	6.4
	Second	15.2	18.5	3.4
	Third	12.0	20.0	7.9
	Fourth	13.0	17.9	5.0
	Top	8.8	15.8	7.0

a. The bottom quintile has schools with the smallest proportion of economically disadvantaged students.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

Urban schools with large proportions of economically disadvantaged students offered approximately 9 advanced STEM courses in 2007/08 and 16 in 2013/14, and suburban schools offered 11 in 2007/08 and 17 in 2013/14

At the other end of the distribution, approximately 7 percent of students in the state attended schools in the bottom quintile of offering advanced STEM courses (an average of 5 courses) in 2013/14. A somewhat higher percentage of White students attended these schools in 2013/14 (9 percent) than of Black students (7 percent) or of Hispanic (6 percent) students (see tables D1, D2, and D3 in appendix D for distributions of students enrolled in schools with differing offerings of math, science, and other advanced STEM courses).

Small changes from 2007/08 to 2013/14 were found in the percentage of students attending schools that offered the highest or the lowest numbers of advanced STEM courses. For instance, the percentage of students attending a school in the top quintile of offering advanced STEM courses fell nearly 2 percentage points, from 48 to 46 percent (see table 4). However, the change in enrollment in schools in the top quintile of offering advanced STEM courses was not symmetrical across student subgroups. The proportion of White students attending schools in the top quintile fell by 6 percentage points, from 49 percent to 42 percent, while the percentages of Black and Hispanic students were relatively stable.

Table 4. Percentage of students attending Texas public high schools, by quintiles of the numbers of advanced science, technology, engineering, and math courses offered, 2007/08 and 2013/14

Schools ranked in order of total number of advanced STEM courses offered (quintiles)	Average number of advanced STEM courses overall	Number of students attending those schools	Percent of all students	Percent of all Black students	Percent of all Hispanic students	Percent of all White students
2007/08						
Bottom	3.7	99,132	7.8	6.7	6.0	9.9
Second	6.5	104,472	8.2	6.2	7.1	10.4
Third	8.4	147,481	11.5	11.1	12.0	12.0
Fourth	11.4	310,983	24.3	30.1	28.1	19.1
Top	16.8	615,188	48.2	46.0	46.7	48.6
2013/14						
Bottom	5.3	103,403	7.2	6.6	6.2	9.0
Second	8.9	108,293	7.5	5.7	6.2	10.6
Third	12.3	148,612	10.4	10.1	9.8	12.1
Fourth	18.5	410,102	28.6	30.9	29.7	26.0
Top	26.7	663,971	46.3	46.7	48.0	42.4

STEM is science, technology, engineering, and math.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

Schools in the top quintile of advanced STEM course offerings offered 27 courses, on average, in 2013/14, and schools in the second quintile offered 19

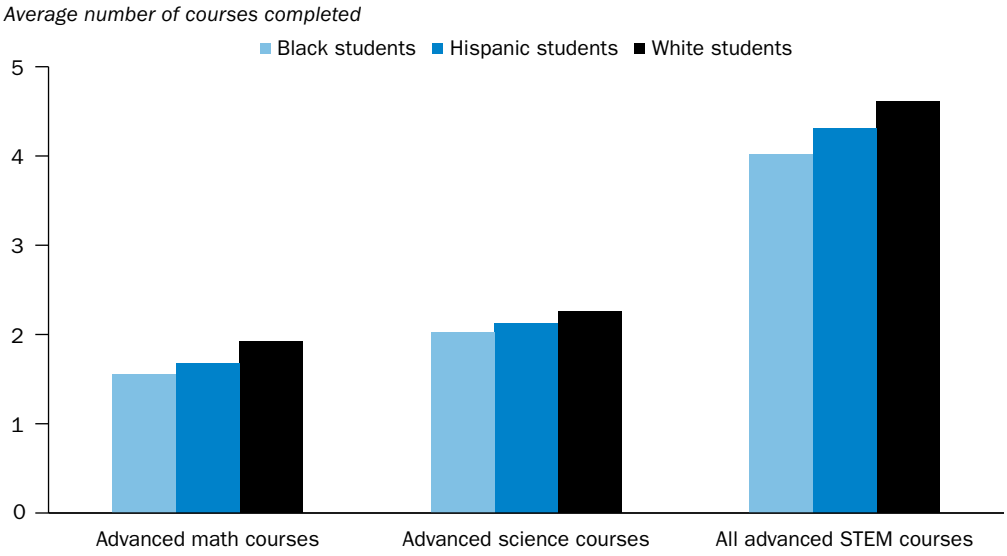
White students completed a slightly greater number of advanced science, technology, engineering, and math courses than Black and Hispanic students on average across the four cohorts examined

Although a greater number of advanced STEM courses were offered in Texas high schools with the largest proportions of Black or Hispanic students, and a larger proportion of Black or Hispanic students who were continuously enrolled in high school for four years attended schools that offered the highest number of advanced STEM courses, White students completed a slightly greater number of advanced STEM courses on average (4.6) than did Hispanic (4.3) or Black students (4.0) across the 2007/08 to 2013/14 student cohorts.[4] This pattern was consistent for math and science courses (figure 3).

Economically disadvantaged students completed, on average, slightly fewer advanced math and advanced science courses than did other students

Economically disadvantaged students across the state completed 1.6 advanced math courses and 1.9 advanced science courses on average, slightly fewer than students not classified as economically disadvantaged, who completed 2.0 courses in math and 2.3 in science (figure 4). This difference is smaller than might be expected considering the larger differences in the number of advanced courses offered by schools enrolling large proportions of economically disadvantaged students and those enrolling small proportions (see table 2).

Figure 3. White students completed a slightly greater number of advanced science, technology, engineering, and math courses in Texas high schools than did Black and Hispanic students, 2007/08–2013/14

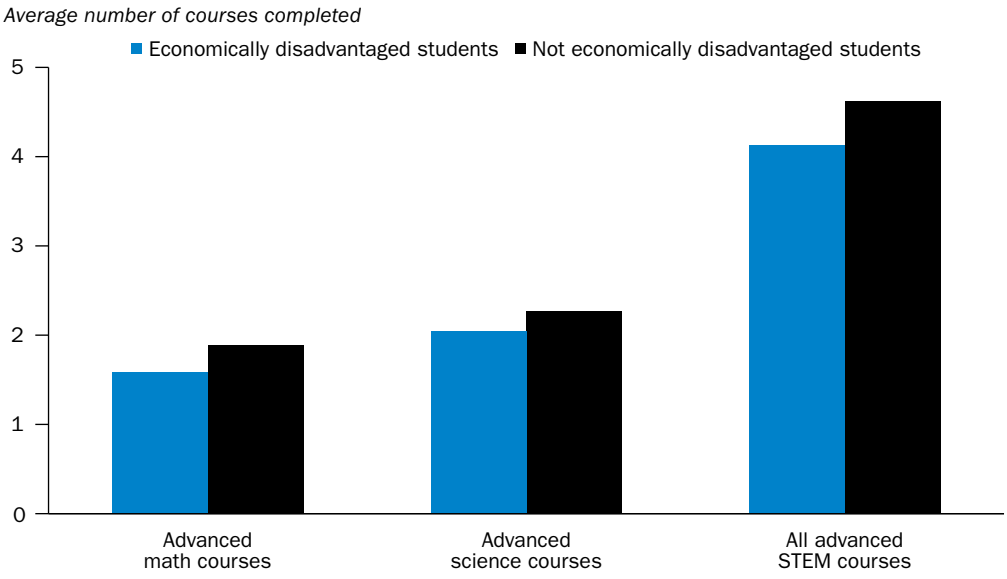


STEM is science, technology, engineering, and math.

Note: Results are not shown for other advanced STEM courses because students took relatively few courses in other advanced STEM subjects.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

Figure 4. Economically disadvantaged students in Texas public high schools completed slightly fewer advanced science, technology, engineering, and math courses than did other students, 2007/08–2013/14



STEM is science, technology, engineering, and math.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

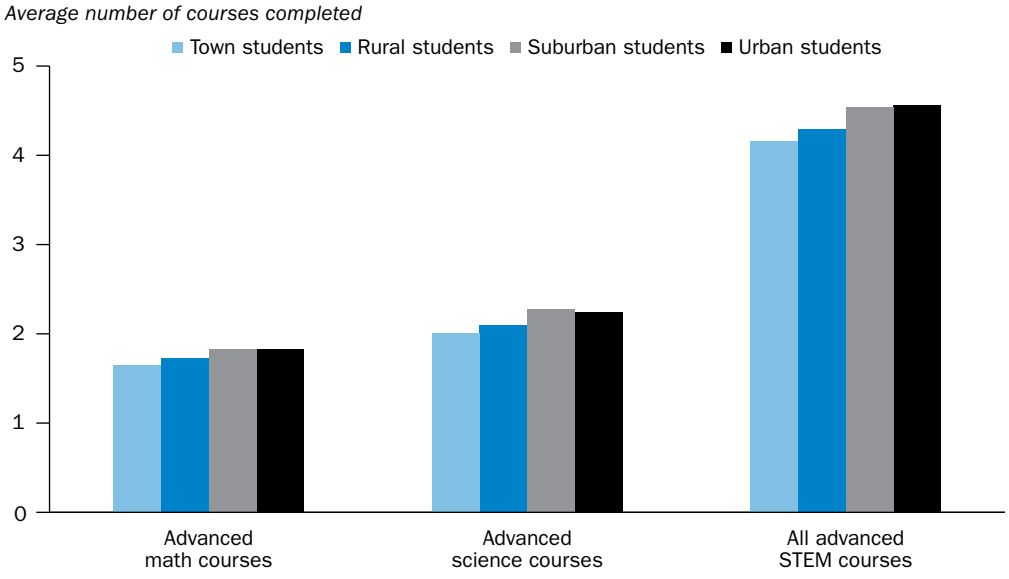
Despite the greater availability of advanced science, technology, engineering, and math courses in urban and suburban schools than in schools in other locales, the average number of courses that students completed did not differ much by locale

Despite large differences by school locale in the number of advanced STEM courses offered (see figure 2), the number of courses students completed did not differ substantially (figure 5). Students completed an average of between 1.6 and 1.8 advanced math courses and between 2.0 and 2.3 advanced science courses, depending upon school locale. For all STEM courses these differences ranged from 4.2 courses completed in towns to 4.6 in urban schools.

A greater proportion of White students than of Black or Hispanic students completed three or more advanced math or advanced science courses, even among students demonstrating high math ability

Differences in course completion across racial/ethnic subgroups are obscured in analyses that consider the mean number of courses students completed. When the analysis looks at the percentage of students who have completed three or more advanced math or three or more advanced science courses, larger differences by race/ethnicity emerge (figure 6). Across the four cohorts included in the study, 25 percent of White students completed three or more advanced math classes, compared with 13 percent of Hispanic students and 10 percent of Black students. And 39 percent of White students completed three or more advanced science classes compared with 32 percent of Hispanic students and 28 percent of Black students.[5]

Figure 5. Students in urban and suburban Texas public high schools completed a slightly greater number of advanced science, technology, engineering, and math classes than did students in town and rural schools, 2007/08–2013/14

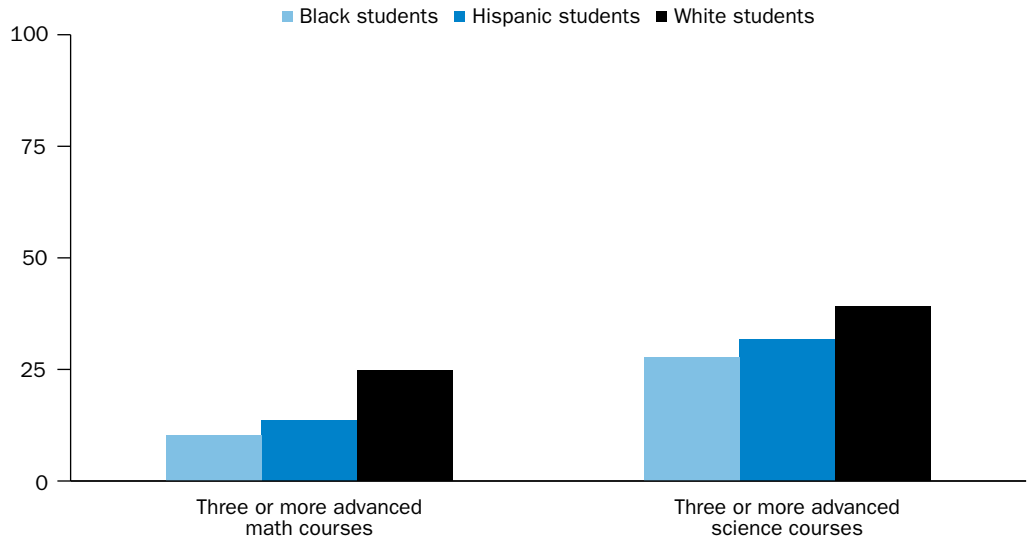


STEM is science, technology, engineering, and math.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

Students completed an average of between 1.6 and 1.8 advanced math courses and between 2.0 and 2.3 advanced science courses, depending upon school locale

Figure 6. A greater proportion of White students than of Black or Hispanic students in Texas public high schools completed three or more advanced math courses or three or more advanced science courses, 2007/08–2013/14



Across the four cohorts included in the study, 25 percent of White students completed three or more advanced math classes, compared with 13 percent of Hispanic students and 10 percent of Black students

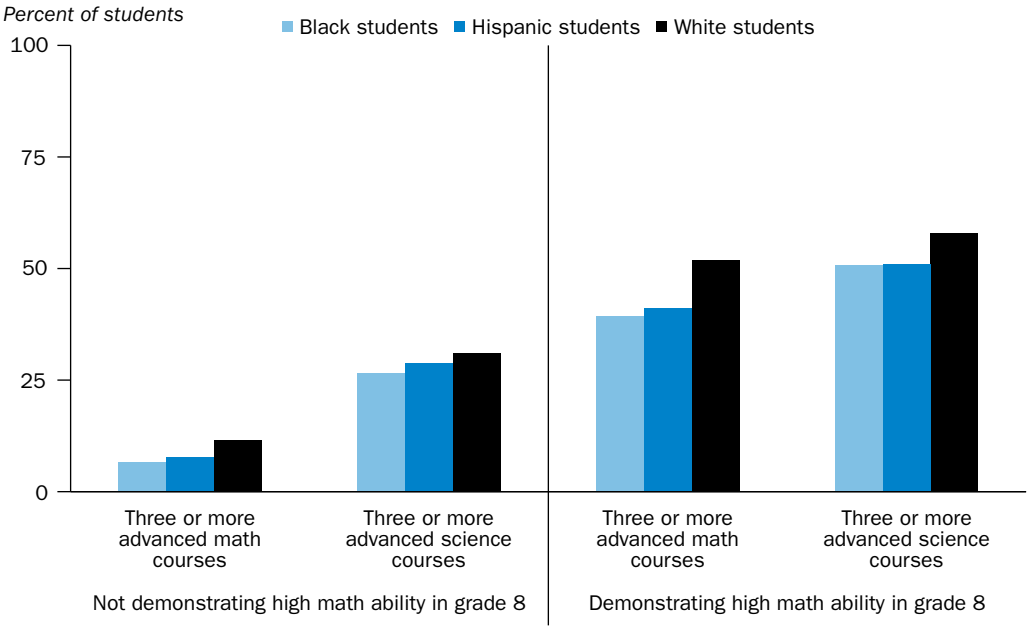
Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

This disparity is slightly smaller among the 36 percent of students demonstrating high math ability in grade 8. Among this group, approximately 52 percent of White students completed three or more advanced math courses during high school, more than 10 percentage points higher than the proportion of Hispanic students (41 percent) and Black students (39 percent; figure 7). While the differences among students demonstrating high math ability are smaller in advanced science courses, the pattern persists: 58 percent of White students completed three or more advanced science courses, compared with 51 percent of Black students and 51 percent of Hispanic students. Considerably fewer students who did not demonstrate high math ability in grade 8 (half to two-thirds fewer) than of students who did demonstrate high ability completed three advanced math or three advanced science courses, but greater proportions of White students than Black or Hispanic students did so.[6]

A substantially smaller proportion of economically disadvantaged students than of other students completed three or more advanced math or three or more advanced science courses, even among students demonstrating high math ability

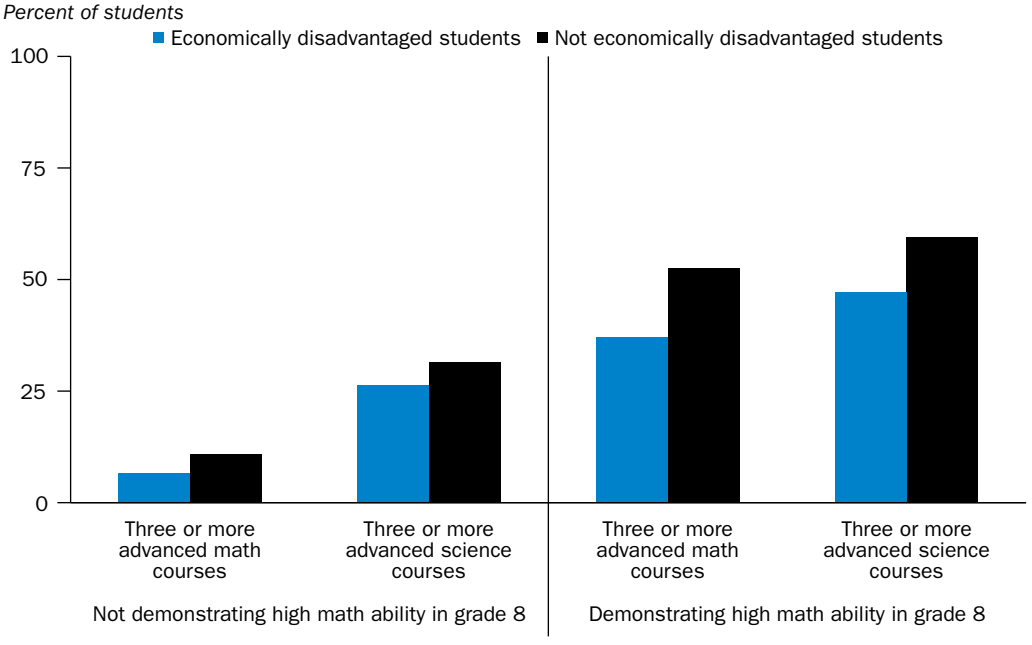
Among both students demonstrating and those not demonstrating high math ability in grade 8, a smaller proportion of economically disadvantaged students completed three or more advanced math courses or three or more advanced science classes (figure 8). The difference was greatest for students demonstrating high math ability: 37 percent of economically disadvantaged students compared with 53 percent of other students completed three or more advanced math courses (16 percentage point difference), and 47 percent of economically disadvantaged students compared with 60 percent of other students completed three or more advanced science courses (12 percentage point difference). These differences were more than double those between economically disadvantaged students and non-economically disadvantaged students who did not demonstrate high math ability in grade 8.

Figure 7. Among Texas public high school students demonstrating high math ability in grade 8, a greater proportion of White students than of Black or Hispanic students completed three or more advanced math or three or more advanced science courses, 2007/08–2013/14



Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

Figure 8. A smaller proportion of economically disadvantaged students than of other students in Texas public high schools completed three or more advanced math or three or more advanced science courses, and the gaps were largest among students demonstrating high math ability in grade 8, 2007/08–2013/14

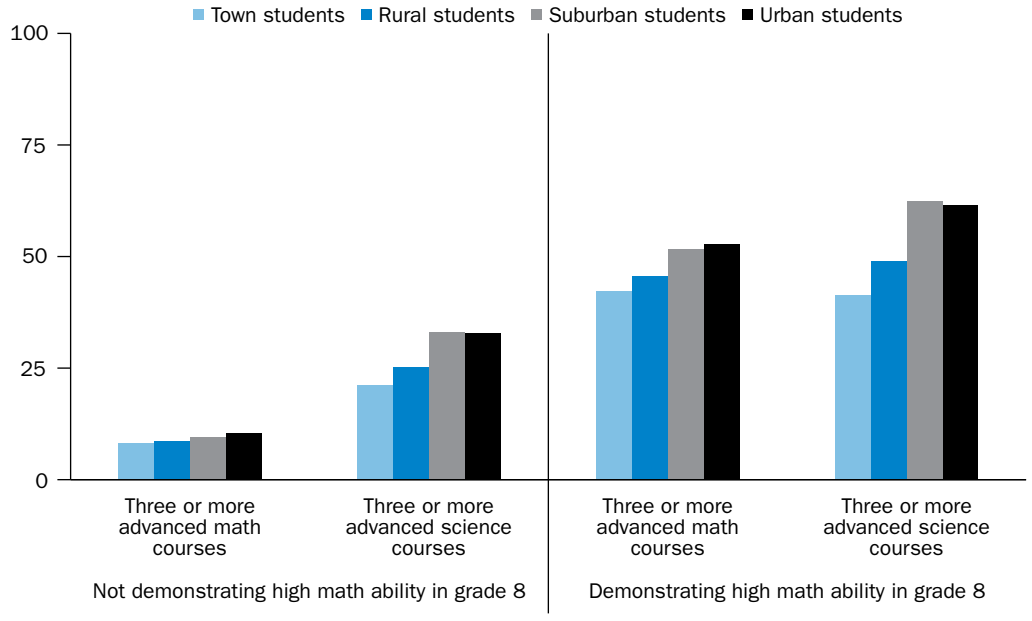


Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

A greater proportion of students in schools in urban and suburban areas than in towns or rural areas completed three or more advanced math or three or more advanced science courses, regardless of whether they demonstrated high math ability in grade 8

Differences in course completion by school locale are also obscured in analyses that examine the mean number of courses that students completed. Larger differences by locale emerge when the analysis focuses on the percentage of students who have completed three or more advanced math or three or more advanced science courses (figure 9). As described earlier, a greater number of advanced STEM courses were available in schools in urban and suburban schools than in towns or rural areas. Among students demonstrating high math ability, approximately 52 percent in urban and suburban schools completed three or more advanced math classes compared with 46 percent in rural areas and 42 percent in towns. Differences in advanced science course completion were even larger: 62 percent in urban and suburban schools completed three or more courses, compared with 49 percent of students in rural areas and 41 percent in towns. Among students who did not demonstrate high math ability in grade 8, the differences remained but were smaller: 33 percent of students in urban and suburban schools completed three or more advanced science classes compared to 25 percent in rural schools (an 8 percentage point difference) and 21 percent in towns (a 12 percentage point difference).

Figure 9. Greater proportions of Texas public high school students in cities and suburbs completed three or more advanced math or three or more advanced science courses than did students in towns or rural areas, with the largest differences in advanced science courses among students demonstrating high math ability in grade 8, 2007/08–2013/14



Among students demonstrating high math ability, approximately 52 percent in urban and suburban schools completed three or more advanced math classes compared with 46 percent in rural areas and 42 percent in towns

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

Implications of the study findings

Many studies have shown a positive and statistically significant association between enrollment in advanced coursework in high school and success in college (see appendix A). Thus, determining whether Hispanic students in Texas have access to advanced STEM courses is a first step toward understanding why Hispanic students lag behind White students in completing STEM degrees and are underrepresented in STEM careers.

This study shows that in Texas, Hispanic students' access to advanced STEM courses is, on average, equal to (if not greater than) that of White students and that a majority of Hispanic students attend schools offering between 19 and 27 advanced STEM courses. In fact, a larger proportion of the state's Black and Hispanic students (78 percent of each group) than White students (68 percent) attend schools offering the highest number of advanced STEM courses.

Yet despite this observed equality of opportunity to take advanced STEM courses, smaller proportions of Black and Hispanic students than of White students completed three or more advanced courses in math or science. This disparity was found even within the subgroup of Black, Hispanic, and White students demonstrating high math ability in grade 8. Although these results do not explain why in that subgroup fewer Black and Hispanic students complete three or more advanced courses in math or science, they point to a need to increase enrollment and perhaps encourage persistence among Black and Hispanic students in those advanced courses. Economic disadvantage also adversely affects the rate of completing a larger number of advanced courses and needs further study.

Although the results do not explain why fewer Black and Hispanic students demonstrating high math ability in grade 8 complete three or more advanced courses in math or science, they point to a need to increase enrollment and perhaps encourage persistence among Black and Hispanic students in those advanced courses

These results may inform state and local efforts to influence advanced STEM course completion among Black and Hispanic students and to understand why the highest achieving Black and Hispanic students take fewer advanced STEM courses than their White student counterparts. Future research might focus on other mechanisms that may contribute to lower course completion rates among racial/ethnic minority students, such as less (or less effective) communication with parents, less involvement by parents, less effort in middle school to spark interest in STEM, insufficient or low quality career advising, or less access to highly qualified teachers.

The results of this study may also guide the expansion of initiatives to boost enrollment in advanced STEM courses, particularly where offerings are already plentiful. For example, one area of state focus might be training counselors and advisors to guide students of all races/ethnicities toward advanced high school STEM coursework, particularly students demonstrating high levels of math and science competency who might not otherwise receive encouragement. Another possibility is an online learning environment to improve counselors' and advisors' skills in postsecondary and career advising, which the University of Texas was tasked with creating under Texas House Bill 18, passed by the Texas Legislature in 2015.

This study did not adjust for the separate contribution of school or student characteristics to differences in advanced STEM course availability or coursetaking in Texas. The study simply presented descriptive comparisons of outcomes between important subgroups of interest. Therefore, the influence of a given student or school attribute in explaining variation in advanced STEM course availability or coursetaking should not be over-interpreted, particularly given the interrelatedness of several of the characteristics examined.

Limitations of the study

An important limitation of this study (and of most research on course offerings) is that it defines a course as being offered only if at least one student completed it (Iatarola, Conger, & Long, 2011; Klopfenstein, 2004). Thus, a course may be announced and a school may have the staff to teach it, but if no student enrolls in and completes the course, it will not be identified as having been offered. Similarly, courses may be announced, but not enough students may enroll to justify giving the course in a particular school year. This issue may arise most often at schools with low enrollment and may appear systematically across a state in areas with high concentrations of small school enrollments. No data are available on these "offered but not taken" courses, so courses offered must be narrowly and specifically interpreted as those that at least one student completed. Furthermore, teacher turnover can affect which courses are offered from year to year—this phenomenon, too, is expected to arise most at schools with small enrollments but may occur even at large comprehensive high schools for highly specialized advanced courses with low student demand.

This study does not address the quality of instruction or the rigor of the courses offered across schools, districts, and regions, creating an interpretive challenge, even in courses with an ostensibly standardized curriculum and assessment instruments

This study does not address the quality of instruction or the rigor of the courses offered across schools, districts, and regions, creating an interpretive challenge, even in courses with an ostensibly standardized curriculum and assessment instruments.[7] In this study a course was either offered or it was not; a course was either completed or not. There was no measure of the quality of a course and no consideration of how course quality might change the meaning of the findings.

This study does not reflect the changes to the graduation requirements introduced for students entering grade 9 in 2014/15. Consequently, these results may not be representative of current Texas high schools and current cohorts of high school students.

The student cohorts included in the analyses are restricted to students who were continuously enrolled for four years in a regular-instruction Texas public high school who earned a high school diploma or, for the analyses using grade 8 standardized math test performance, students who were continuously enrolled for five years and earned a diploma. Therefore, the results on student coursetaking can be generalized only to students who meet these criteria. Furthermore, these criteria have different effects on students from different subgroups because, for instance, successful grade transition rates and four-year graduation rates are higher among White students (Cameron & Heckman, 2001).

Online course delivery through the Texas Virtual School Network (TxVSN) may have affected whether a school was counted as offering a particular course. TxVSN is a clearinghouse of courses approved by the Texas Education Agency, and the number of students enrolling in them has been small—fewer than 3,000 in fall 2013/14 (Texas Education Agency, 2016). If a student in a school completed a TxVSN advanced STEM course, then that school was identified as having offered an advanced STEM course. It is unclear how many schools participate in the TxVSN because data were not available to identify whether individual courses were delivered through the TxVSN or through a brick-and-mortar school.

Finally, no multivariate statistical adjustments were made to account for the correlations among different characteristics. This was intentional, because the study team wanted to highlight the unadjusted differences across school and student characteristics and not to

conceal revealing differences across various subpopulations. For instance, in a multivariate model with several statistical controls, differences in advanced STEM course availability between schools with different racial/ethnic group concentrations may mask differences that are actually due to school locale.[8]

Appendix A. Literature review

Access to and enrollment in rigorous high school coursework is an important component of preparing students for postsecondary and career success. Enrollment in advanced coursework in high school has a positive and statistically significant association with success in college and beyond (Adelman, 1999; Attewell & Domina, 2008; Joensen & Nielsen, 2009; Klopfenstein & Thomas, 2009; Long, Conger, & Iatarola, 2012; Rose & Betts, 2001). Specifically in Texas, students who took advanced math or science courses, regardless of whether the courses were Advanced Placement (AP), were more successful in college than students who took less rigorous coursework (Klopfenstein and Thomas, 2009).

For science, technology, engineering, and math (STEM)–related outcomes, greater exposure in high school to advanced coursework and enrollment in more math and science courses is related to an increased likelihood of majoring in a STEM field and ultimately obtaining a STEM degree (Engberg & Wolniak, 2013; Ma, 2011; You, 2013). In a literature review examining high school math or science coursetaking and postsecondary STEM outcomes, 14 of 15 studies found a significant positive relationship: students who took more math and science courses, especially more rigorous ones, demonstrated more positive postsecondary STEM outcomes such as attempting and completing STEM degrees (Hinojosa et al., 2016). In studies of multiple predictors of STEM outcomes, taking high school math and science courses—in particular taking the highest levels of courses—emerged as most predictive of STEM postsecondary outcomes. These results held up across studies that followed students longitudinally and studies of nationally representative samples of students (Burge, 2013; Engberg & Wolniak, 2013; Griffith, 2010; Ma, 2011; Maltese & Tai, 2011; Miller & Kimmel, 2012; Riegle-Crumb & King, 2010; Wang, 2013b; You, 2013), as well as retrospective studies of students already at postsecondary institutions (Ackerman, Kanfer, & Calderwood, 2013; Kokkelenberg & Sinha, 2010; Shaw & Barbuti, 2010; Tyson, Lee, Borman, & Hanson, 2007).

Of the 23 studies in the Hinojosa et al. (2016) literature review, and among the 15 that included a measure of high school coursetaking, only 4 examined whether the relationship between high school advanced coursetaking and postsecondary STEM outcomes differed for students of different races/ethnicities. Wang (2013a) found that the number of math and science credits taken during high school was the strongest predictor of choosing a STEM major in college (that is, the standardized coefficient was statistically significantly larger than all other predictors in the model), but this indicator performed most strongly for White students and least strongly for underrepresented minority students (including Hispanic students). However, the relationship between level of high school math and science coursework and STEM success was strong for all race/ethnicity-based groups (Riegle-Crumb & King, 2010; You, 2013). In particular, taking calculus in high school was predictive of majoring in a STEM area for students of all races/ethnicities and genders (You, 2013).

Differences in advanced STEM course availability and coursetaking

Only 50 percent of high schools in a national sample in 2011/12 offered at least one calculus course, whereas 63 percent offered a physics course (U.S. Department of Education Office for Civil Rights, 2014). And there were disparities in course availability by student racial/ethnic subgroups: nearly 71 percent of White students had access to Algebra I,

geometry, Algebra II, calculus, biology, chemistry, and physics courses, but only 57 percent of Black students and 67 percent of Hispanic students had access. Schools with large enrollments of racial/ethnic minority students were less likely to offer either an Algebra II course (74 percent compared with 83 percent of other schools) or a chemistry course (66 percent compared with 78 percent of other schools). But in general, few studies have examined advanced STEM course availability by race/ethnicity.

In Texas the proportion of high schools that offered any type of Advanced Placement (AP) course grew from 21 percent to 53 percent between 1994 and 2000, and the average number of AP math and science courses grew from 1.4 to 3.3 (Klopfenstein, 2004). However, differences among schools with different enrollment profiles remained. Although schools with predominantly racial/ethnic minority and predominantly White student populations differed little in the average number of AP math and science courses offered, nonrural and rural schools had large differences, as did schools with small and large populations of low-income students (Klopfenstein, 2004).[9]

School size was strongly associated with the likelihood of offering AP/International Baccalaureate (IB) courses between 2001/02 and 2005/06 in a study in Florida: less than 10 percent of schools in the lowest decile of student enrollment (fewer than 366 students) offered at least one AP/IB math or science course, compared with nearly 100 percent of schools in the top three enrollment deciles (more than 2,224 students; Iatorola et al., 2011). In addition, the academic makeup of a school's student body was a strong correlate of AP/IB course offering: the more students a school had whose state assessment score was greater than one standard deviation above the median, the more likely the school was to offer an AP/IB course in any subject (Iatorola et al., 2011).

Rates of advanced coursetaking

Although the percentage of students enrolling in advanced STEM courses has risen steadily in the past two decades across both the United States and Texas, disparities by student subgroup persist (Aud et al., 2013; Laird et al., 2009; Texas Education Agency, 2011).

Gains in advanced coursetaking. Among all U.S. high school graduates, the proportion who completed Algebra II or a trigonometry course rose from 54 percent to 76 percent between 1990 and 2009, and the proportion who completed a physics course rose from 21 percent to 36 percent during the same period (Aud et al., 2013). Similarly, the proportion of students in Texas who took Algebra II rose between 1996 and 2006 by nearly 19 percentage points, while the proportion of students who took at least one higher level science course (chemistry, physics, or any other advanced science course) rose by 33 percentage points (Blank, Langesen, & Petermann, 2007). The proportion of students in Texas who took at least one advanced course rose between 1999/2000 and 2012/13 by 13 percentage points, and the proportion who took at least one AP/IB test rose by 9 percentage points (these results are not disaggregated by course type: the list of advanced courses included is available at https://rptsvr1.tea.texas.gov/perfreport/tapr/2015/glossary.pdf). These gains in advanced coursetaking in Texas occurred during a period in which legislatively mandated changes strengthened graduation requirements to include a greater number of advanced math and science courses.[10]

Disparities in advanced STEM coursetaking by student subgroup. Despite these overall gains, minority student enrollment in high school advanced STEM courses continues to lag behind nonminority enrollment, both nationally and in Texas. These gaps are wider for courses such as calculus and physics (Aud et al., 2013; Laird et al., 2009; Texas Education Agency, 2011). In a nationally representative sample 77 percent of White students enrolled in Algebra II or trigonometry compared with approximately 71 percent of Black and Hispanic students, a statistically significant difference (Aud et al., 2013). Even greater disparities emerged in calculus: White students were approximately three times as likely as Black students to enroll (18 percent compared with 6 percent) and twice as likely as Hispanic students (18 percent compared with 9 percent); these differences were also statistically significant. In 2005 Black and Hispanic students earned fewer advanced mathematics and science and engineering credits than White students. The gap in math was 0.4–0.5 credit hours, with Black students earning about 75 percent as many credit hours as White students and Hispanic students earning about 69 percent as many. In science the gap was 0.2–0.5, with Black students earning 88 percent as many credit hours as Whites and Hispanic students earning 69 percent as many advanced math and advanced science and engineering credits as White students, although the gap was larger between White and Hispanic students in both course groupings than between White and Black students (Laird et al., 2009); these differences were statistically significant. There were no statistically significant changes between 1990 and 2005 in the gaps in advanced STEM credit acquisition among White, Black, or Hispanic high school graduates (Laird et al. 2009).

Appendix B. Data sources and analytic methods

This appendix provides additional details about the data sources and analytic methods used in this study.

Data sources

All student-level data used in this study were accessed at the University of Texas Education Research Center, which contains student-level administrative accountability and state assessment data collected by the Texas Education Agency from school districts throughout Texas. For the study the data are de-identified, with a synthetic identification number replacing students' state-assigned identification number. The study used these administrative and state assessment data for all students in Texas public high schools:

- Annual student enrollment records reflecting students enrolled in a Texas public school the last Friday in October. This file contained students' demographic, grade level, and school of enrollment information.
- Annual course enrollment and completion records, including a unique course identifier and a variable capturing whether the student completed the course with or without credit.
- Texas Assessment of Knowledge and Skills grade 8 math assessment scores and the Commended Performance (score of 2400 or higher) indicator provided by the vendor.

In addition, data on school locale were obtained from annual files of the National Center for Education Statistics Common Core of Data, Local Education Agency, Universe Survey Data (National Center for Education Statistics 2014). These files were linked to schools in the analysis file using the unique nine-digit county-district-school number assigned to all schools in Texas by the Texas Education Agency in each school year of the study. School locale information was not fixed for a school across years, but assigned within each study year.

School-level student enrollment and racial composition data used for all research questions came from annual school-level performance reporting data produced by the Texas Education Agency.[11] These data provided demographic information for all students enrolled at a school, since they were not restricted to students who met the inclusion criteria or who completed at least one advanced science, technology, engineering, or math (STEM) course.

Description of the study population. The primary unit of analysis varied by research question. For research questions 1 and 2 (examining course offerings and opportunities) the unit of analysis was regular-instruction high schools in Texas. Schools were included if a student in grades 9 through 12 completed at least one course. Schools were included in the data once for each school year, though schools could be included multiple times in the data across multiple school years. The number of unique schools per school year ranged from 1,367 in 2007/08 to 1,529 in 2013/14 (table B1).

For examining differences in course offerings in schools that enrolled large proportions of minority students, subsamples of schools were selected that enrolled the largest proportions of Black, Hispanic, or White students in the state. This included 1,003 nonunique

Table B1. Unique count of regular-instruction public high schools in Texas included in the analysis dataset, 2007/08–2013/14

School year	Number of schools
2007/08	1,367
2008/09	1,395
2009/10	1,424
2010/11	1,463
2011/12	1,486
2012/13	1,503
2013/14	1,529

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

schools with approximately 85 percent or more White students, 1,016 nonunique schools with approximately 30 percent or more Black students, and 1,014 nonunique schools with 90 percent or more Hispanic students. (How the schools were selected is discussed in the methodology section below.)

For the research question pertaining to student course completion (research question 3), students were the primary unit of analysis. For inclusion in the study, students had to meet three criteria:

1. Enrolled in grade 12 in one of the following years: 2010/11, 2011/12, 2012/13, or 2013/14.

2. Enrolled in a regular-instruction Texas public high school in each of the preceding three school years. In other words, students must have been enrolled in grades 9–12 in a regular-instruction Texas public high school for four years.

3. Graduated from a regular-instruction high school in Texas.

To examine course completion by students' grade 8 math achievement level for research question 3, the student sample was reduced to students who had a valid score on their grade 8 math state assessment.

Counts for students who met these requirements are presented in table B2.

The study samples were restricted to students with four years of data from public high schools (including charter schools). Restricting the study samples to students who were continuously enrolled for four years ensures that differences in STEM course enrollment rates are not confounded with students' duration of enrollment in a Texas public school because these students' records will not contain credits earned out of state or from private schools. This restriction is particularly important for comparing course enrollment rates across student racial/ethnic groups because students' enrollment continuity varies by student race/ethnicity. For instance, in the 2011/12 school year the statewide average dropout rate in grades 9–12 was 2.4 percent. However, the rate was approximately two and a half to three times higher for Black students (3.8 percent) and Hispanic students (3.1 percent) than for White students (1.2 percent; Texas Education Agency, 2013).

Table B2. Student cohorts constructed for examining course completion in Texas public high schools, 2010/11–2013/14

Cohort	Year entered grade 12	Number of students	Number of students with grade 8 math score
Cohort 1	2010/11	235,977	190,820
Cohort 2	2011/12	236,696	191,400
Cohort 3	2012/13	245,608	193,766
Cohort 4	2013/14	248,841	196,783

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

Identifying advanced science, technology, engineering, and math courses in Texas public schools

The study team constructed indicators to flag whether a course was offered in a school, categorized as advanced, categorized as STEM, and counted as an "advanced STEM course." Six primary sources were used to create a rubric containing inclusion and exclusion rules for identifying STEM courses:

1. The inventory of approved courses in each year between 2007/08 and 2013/14 (P_SERVICE). In addition to providing the universe of courses approved by the Texas Education Agency in each school year, this source provided four vital pieces of information: the content area or content cluster of each course; a stable, unique course identifier; the grade levels of the course; and a friendly course label (for example, Computer Science III).

2. The Texas Education Code. The Texas Education Code provides detailed descriptions of each approved course, including the grades for which the course is recommended, the prerequisites, and the knowledge and skills students are expected to acquire by course completion.

3. High school transcript studies. Classifications of advanced STEM courses from other studies that employed coursetaking data from the High School Transcript Study are a useful guide. These include Laird et al. (2009), Nord et al. (2011), and Cunningham, Hoyer, and Sparks (2015). Each of these studies established three broad groups of STEM courses: advanced math, advanced science and engineering, and STEM-related technical. In addition, they provide specific examples of courses within each category. The labels and descriptions for these courses were used to winnow the universe of STEM courses offered in Texas to only those that are advanced STEM.

4. Student-level course completion records (P_COMPLETE). Student coursetaking records were accessed at the University of Texas Education Research Center to identify all courses, in each year of the study, attempted by students at eligible Texas public high schools.

5. Texas Education Agency list of advanced courses. The Texas Education Agency publishes a roster of courses and course identification numbers that are considered advanced for Texas students.

6. Members of the Hispanic STEM Alliance. Several members of the Hispanic STEM Alliance provided valuable input on the sources of information available for identifying the advanced courses included in this study.

Flagging advanced STEM courses included three primary steps, in this order:

Step 1: Defining courses offered by schools. Student-level coursetaking records from the University of Texas Education Research Center were aggregated to the school level to create a list of courses completed by at least one student (regardless of whether credits were earned) in grades 9–12 from 2007/08 to 2013/14 for each regular-instruction school in the state. Use of student completion rather than credits earned ensured that schools were considered to have offered the course even if the only students who completed it did not earn a passing grade.

Step 2: Identifying STEM courses. The Texas Education Agency does not publish a consolidated list of approved STEM courses that can be offered by local education agencies in Texas nor, beyond math and science courses within the STEM content area, does the agency identify courses that deliver advanced content to students. However, the P_SERVICE table, stored at the University of Texas Education Research Center, provides an inventory of all approved courses that can be taught by local education agencies in a given year. The courses are organized into clusters, which are defined by the grade level and content area of each course. The study team developed a rubric for winnowing the universe of courses to STEM courses available to students in grades 9–12 in each school year:

1. Place complete roster of courses, for each school year, into a database. The annual roster of courses was obtained from the P_SERVICE table stored at the University of Texas Education Research Center.

2. Remove courses offered to grades below 9–12. These are courses not under the heading "grade 9–12."

3. Science and math.
   a. Retain all courses offered under the "math" cluster. These are identified in the data element SUBJAREA with a value of "3."
   b. Retain all courses offered under the "science" cluster. These are identified in the data element SUBJAREA with a value of "4."

4. STEM-related courses.[12]
   a. Retain all courses in the following three career and technical education course clusters defined by the Texas Education Agency:
      (1) Science, technology, engineering, and math.
      (2) Health science.
      (3) Information technology (which includes the information technology cluster and the "grades 9–12, technology applications" cluster).

      These courses were identified in the data element SUBJAREA with values of "9" and "11."

Step 3: Identifying advanced courses in STEM. To identify advanced STEM courses, the study team flagged any STEM courses that appeared on the Texas Education Agency's taxonomy of advanced courses (table B3) as an advanced STEM course. However, this list omitted a number of courses that are commonly classified as advanced math (such as Algebra II, Multivariate Calculus, and AP Statistics) and advanced science (such as AP Biology and AP Physics). To ensure that advanced courses are not under-identified, the

study team supplemented the Texas Education Agency's advanced course list (see table B3) with additional courses (tables B4 and B5). To do so, the study team cross-referenced courses identified as advanced from the High School Transcript Study (Laird et al., 2009; Nord et al., 2011; table B4) to the Texas Education Agency's course listings, and the courses that matched and were not already included in the Texas Education Agency's taxonomy were flagged as "advanced." For career and technical courses the Texas Education Agency designates which are advanced career and technical courses (classified as other advanced STEM in this study) and categorizes them into three clusters: STEM, health sciences, and information technology. Table B5 includes a sampling of other advanced STEM courses in each of the three clusters.

Table B3. Texas Education Agency's taxonomy of advanced courses (science and math only), 2007/08–2013/14

Service ID	Course name
Advanced math	
3101100	Pre-Calculus
3102500	Independent study in mathematics (first time taken)
3102501	Independent study in mathematics (second time taken)
A3100101	*AP Calculus AB*
A3100102	*AP Calculus BC*
A3100200	*AP Statistics*
I3100100	IB Mathematical studies standard level
I3100200	IB Mathematics standard level
I3100300	IB Mathematics higher level
I3100400	IB Further Mathematics standard level
Advanced science	
A3010200	*AP Biology*
A3020000	*AP Environmental Science*
A3040000	*AP Chemistry*
A3050001	*AP Physics B*
A3050002	*AP Physics C*
I3010200	IB Biology
I3010201	IB Biology II
I3020000	IB Environmental Systems and Societies
I3030001	IB Design Technology standard level
I3030002	IB Design Technology higher level
I3040001	IB Chemistry I
I3040002	IB Chemistry II
I3050001	IB Physics I
I3050002	IB Physics II

AP is Advanced Placement. IB is International Baccalaureate.

Note: Advanced Placement courses are italicized and are denoted by an "A" as the first character in the unique course identifier.

Source: Texas Education Agency, 2012.

Table B4. Supplemental list of advanced science, technology, engineering, and math courses in Texas public high schools, 2007/08–2013/14

Service ID	Course name
Advanced math	
Algebra II	
3100600	Algebra II
3100605	Algebra II
3100607	Algebra II
Calculus	
3101100	Pre-Calculus
A3100101	*AP Calculus AB*
A3100102	*AP Calculus BC*
N1110018	Multivariable Calculus
Other advanced math	
13016900	Statistics and Risk Management
13036700	Engineering Mathematics
3102510	Advanced Quantitative Reasoning (1 Unit) (ADQUANR)
A3100200	*AP Statistics*
3102500	Independent study in mathematics (first time taken)
3102501	Independent study in mathematics (second time taken)
I3100100	IB Mathematical Studies standard level
I3100200	IB Mathematics standard level
I3100300	IB Mathematics higher level
I3100400	IB Further Mathematics standard level
Advanced science and engineering	
A3010200	*AP Biology*
A3020000	*AP Environmental Science*
A3040000	*AP Chemistry*
A3050001	*AP Physics B*
A3050002	*AP Physics C*
I3010200	IB Biology
I3010201	IB Biology II
I3020000	IB Environmental Systems and Societies
I3030001	IB Design Technology standard level
I3030002	IB Design Technology higher level

AP is Advanced Placement. IB is International Baccalaureate.

Note: Advanced Placement courses are italicized and are denoted by an "A" as the first character in the unique course identifier.

Source: Laird et al., 2009; Nord et al., 2011.

Table B5. Sample of other advanced science, technology, engineering, and math courses in Texas public high schools, by cluster, 2007/08–2013/14

Service ID	Course name
STEM	
13037200	Scientific Research and Design 1
N1303745	Aerospace Engineering
N1303750	Data Acquisition and Analysis
Health sciences	
13020500	Practicum in Health Science
13020700	Medical Microbiology
13020900	World Health Research
Information technology	
13027700	Advanced Computer Programming
N1302802	Database Programming (Oracle)
N1302803	Internetworking Technologies I (Cisco)

STEM is science, technology, engineering, and math.

Source: Texas Education Agency List of Career and Technology Education Advanced Courses and author's calculation based on applying the advanced STEM course identification rubric to the inventory of unique courses authorized in Texas (P_SERVICE).

Cross-referencing was performed independently by two coders. After coding was complete, the two coders convened to discuss conflicting classifications to reconcile the discrepancies. Reconciliation of discrepant classifications relied on two primary sources: the Texas Education Code, which provides information on content and prerequisites for most courses offered in Texas public schools, and publicly available local education agency student handbooks, which also provided detailed information on content and prerequisites for courses offered in the district. After the two coders reached consensus, this list of advanced STEM courses was merged back to the student-level coursetaking records contained at the University of Texas Education Research Center.

After creating all advanced STEM course flags, the study team identified advanced course offerings based on whether, in any given year, at least one student in a school *completed* the course. These flags were created separately by subject area (for example, math, science, and other advanced STEM; table B6).

Table B6. Number of unique advanced science, technology, engineering, and math courses in Texas public high schools identified by the course selection rubric, 2007/08 to 2013/14

Subject area	Number of unique courses
Math	32
Science	46
Other advanced STEM	67
Total	145

STEM is science, technology, engineering, and math.

Source: Author's calculation based on applying the advanced STEM course identification rubric to the inventory of unique courses authorized in Texas (P_SERVICE).

To answer research questions 1 and 2, the study team created an analytic file that distilled the courses by school year file to a single record layout file, where the unit of analysis was the school and school year. This was done by summing the total number of unique advanced STEM courses offered at a school each year by subject area and discarding any extraneous rows that represented detailed course-specific data.

To answer research question 3, the study team restricted the file to students who met the study inclusion rules. Then, student–year–course level records were distilled to the student level by counting the total number of advanced STEM courses by subject area that were completed by eligible students during high school. Next, summary statistics were calculated for the mean number of advanced STEM courses, as well as the percentage of students who took these courses, for all the subpopulations examined in the study.

Analytic methods

Once advanced STEM courses were defined and the data files were created, the study team used various analytic methods to answer the three research questions.

Research question 1: Calculating the average number of advanced science, technology, engineering, and math courses offered in schools. School-level course offerings were counted and state and school averages were examined, including the number of advanced STEM courses (overall, in math, in science, and in other advanced STEM areas) offered across the state from 2007/08 to 2013/14. For these analyses each school in the state is weighted equally regardless of the number of students served. That is, each school, in each year, is represented once in the analytic file.

To examine how advanced STEM course offerings varied based on the demographic composition of students attending schools, schools were rank ordered based on the proportion of Black, Hispanic, or White students enrolled in each school. Next, the top 10 percent of schools within each measure of racial/ethnic composition were selected. As such, for exploration of differences in course offerings by student enrollment composition, only schools that served the largest proportion of White students, or the largest proportion of Black students, or the largest proportion of Hispanic students during the study period were included. It is important to note that a single high school could not be included in multiple race/ethnicity categories (that is, a school enrolling the largest proportion of Black students could not also be a school enrolling the largest proportion of Hispanic students).

Course offerings were also examined by school locale and by concentration of economically disadvantaged students. For the concentration of economically disadvantaged students, a ranking method like that for race/ethnicity was used, but in this case schools were divided into quintiles. The classification was performed for each year. In that way, schools could change quintile groups when there were changes in the overall distribution of the percentage of economically disadvantaged students during a school year or when there were school-level changes in the percentage of students classified as economically disadvantaged during a school year. For this analysis, economically disadvantaged students are defined as those who participate in the federal school lunch program, which provides free or reduced-price lunches to students from families with incomes below 185 percent of the federal poverty level ($45,510 for a family of four in 2017).

Research question 2: Describing course availability/opportunity for students across the state. To answer research question 2, the study team created a percentile ranking of schools according to the average number of advanced STEM courses, by school year and by subject area. For each year schools were then split into quintile groups. Schools could move into a different quintile across school years, depending on the number of advanced STEM courses offered in a school year. Next, for each year the study team computed the total number of students from each subgroup (for example race/ethnicity or locale) who were enrolled in schools in each of the advanced STEM course quintiles. Last, the percentage of students enrolled in schools in each quintile, in each school year, was calculated by dividing the number of students in each quintile group and subgroup by the total number of students from the respective subgroup. Thus, while research question 1 describes the number of advanced STEM courses offered at schools across Texas, the computed statistic for research question 2 represents the percentage of all subgroup students who were enrolled in schools whose advanced STEM course offerings rank them in each of the quintile groups.

Research question 3: Describing variation in student course completion. To answer research question 3, the study team used the compiled student-level longitudinal dataset to calculate the average number of advanced math, advanced science, and other advanced STEM courses completed, overall, by student race/ethnicity, student economic disadvantage, and locale of the school. Also, descriptive statistics were used to explore the distribution in the frequencies of students taking at least three advanced math or at least three advanced science courses and to explore these percentages by student race/ethnicity. Further, course counts and the distribution of course-completion frequencies were compared for students who demonstrated high math ability in grade 8 and for those who did not.

The analyses in this section were performed using student-level data. Thus, student-level characteristics collected in annual administrative and assessment files available at the University of Texas Education Research Center were used to disaggregate the descriptive analysis by selected student attributes. The longitudinal student enrollment and course-taking records were distilled to a single record per student for each cohort. Cohort membership was mutually exclusive. Because longitudinal details were collapsed to the student level, student race/ethnicity data and economic disadvantage data were obtained from students' first enrollment year (for example their grade 9 enrollment record), while school and locale assignment were selected from students' grade 12 enrollment year. The different selection rules for school and locale were intended to avoid undercounting advanced STEM course completion, since students typically enroll in advanced courses later in high school.

Appendix C. Texas graduation requirements

The State Board of Education has authority over graduation requirements for Texas public school students. Courses required for graduation in Texas did not change for students who entered grade 9 from 2007/08 to 2013/14.[13] For both sets of research questions, the years included in the study are restricted to those in which graduation requirements were stable for students entering grade 9, so that the number of math and science courses required for graduation did not change.

The math and science courses required for the Minimum High School Program and those required for the Recommended High School Program for entering grade 9 students during the years examined in this study are shown in table C1.

For a full list of the courses that will satisfy the additional credits required for each graduation plan, see Texas Education Code § 74.61.

More information about state graduation requirements in Texas is available from Texas Education Agency (Texas Education Agency, n.d., State Graduation Requirements, retrieved April 5, 2017).

Table C1. High school graduation requirements in math and science for Texas public high school students entering grade 9 from 2007/08 to 2013/14

Study area	Minimum High School Program	Recommended High School Program
Math	*Three credits, two of which must be:*	*Four credits, three of which must be:*
	Algebra I	Algebra I
	Geometry	Geometry
		Algebra II
Science	*Three credits, two of which must be:*	*Four credits, three of which must be:*
	Biology	Biology
	Integrated physics and chemistry	**Chemistry**
		Physics

Note: The courses in boldface are categorized as advanced science, technology, engineering, and math in this study.

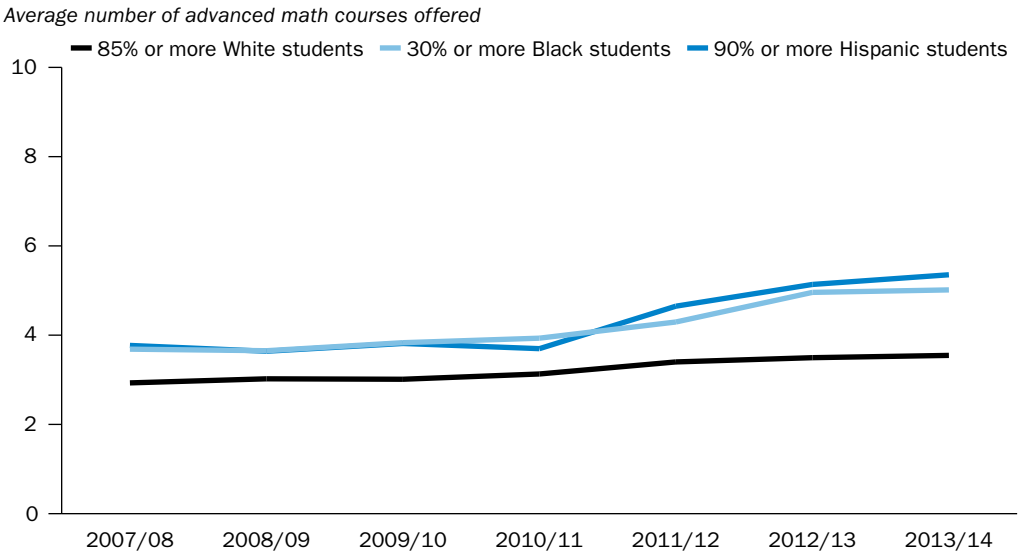
Source: Texas Education Agency, 2014.

Appendix D. Supplementary figures and tables

This appendix includes additional figures and tables for the results on science, technology, engineering, and math (STEM) course offerings and completion discussed in the main text of the report. Results are presented separately for advanced math, advanced science, and advanced other STEM courses

The average number of advanced math courses offered at schools with the largest Hispanic, Black, and White student enrollments, by school year, is shown in figure D1.

Figure D1. The average number of advanced math courses was highest at Texas public high schools with the largest Hispanic student enrollment, followed by those with the largest Black student enrollment, 2007/08–2013/14

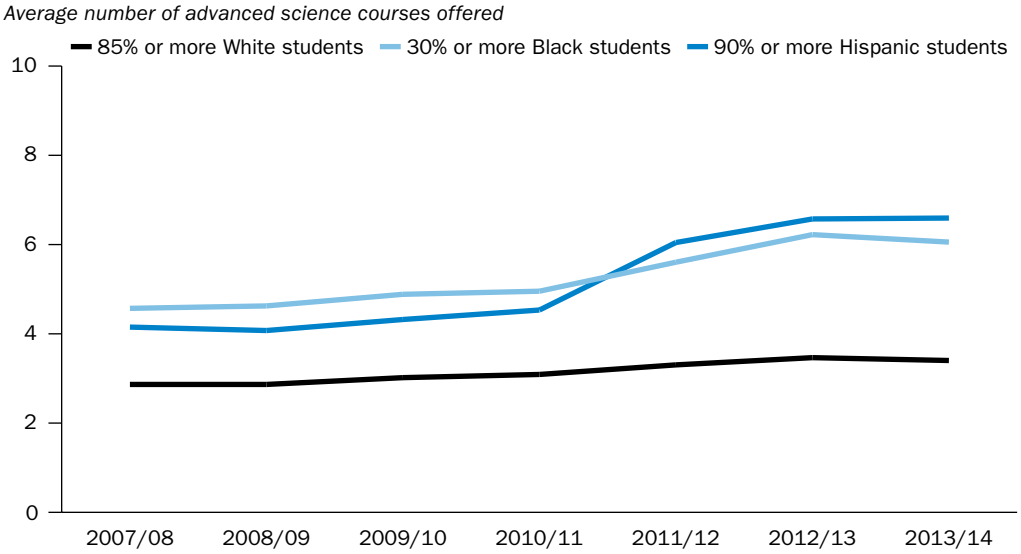


Note: Schools are those in the top decile of enrollment for each racial/ethnic subgroup.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

The average number of advanced science courses offered at schools with the largest Hispanic, Black, and White student enrollments, by school year, is shown in figure D2.

Figure D2. The average number of advanced science courses was highest at Texas public high schools with the largest Hispanic student enrollment, followed by those with the largest Black student enrollment, 2007/08–2013/14

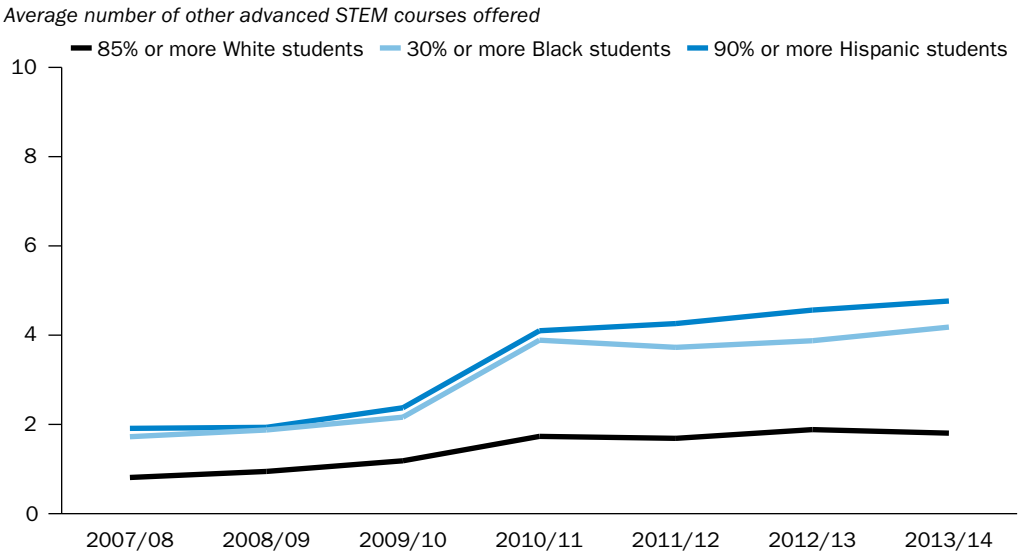


Note: Schools are those in the top decile of enrollment for each racial/ethnic subgroup.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

The average number of other advanced STEM courses offered at schools with the largest Hispanic, Black, and White student enrollments, by school year, is shown in figure D3.

Figure D3. The average number of other advanced science, technology, engineering, and math courses was highest at Texas public high schools with the largest Hispanic student enrollment, followed by those with the largest Black student enrollment, 2007/08–2013/14



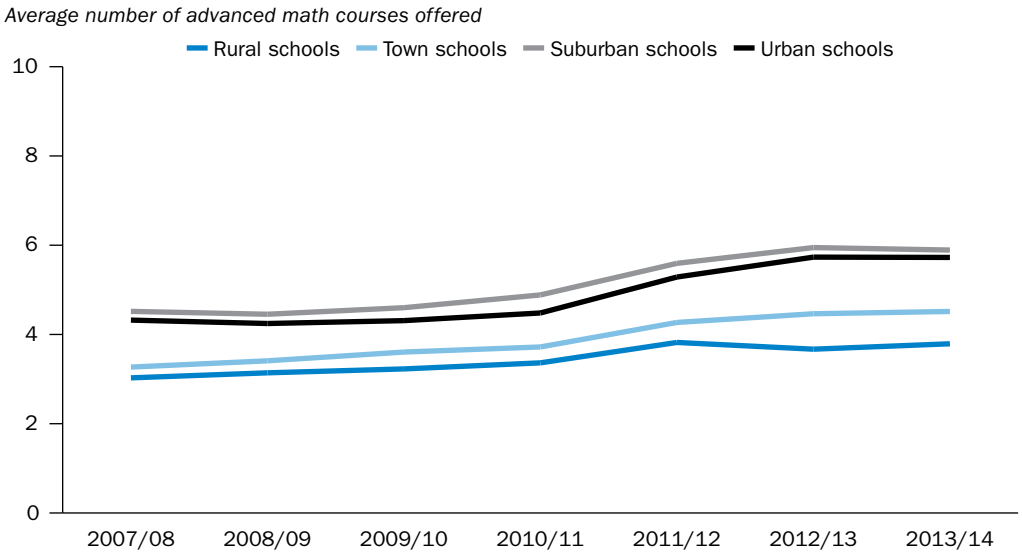
STEM is science, technology, engineering, and math.

Note: Schools are those in the top decile of enrollment for each racial/ethnic subgroup.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

The average number of advanced math courses offered at schools, by locale and school year, is presented in figure D4.

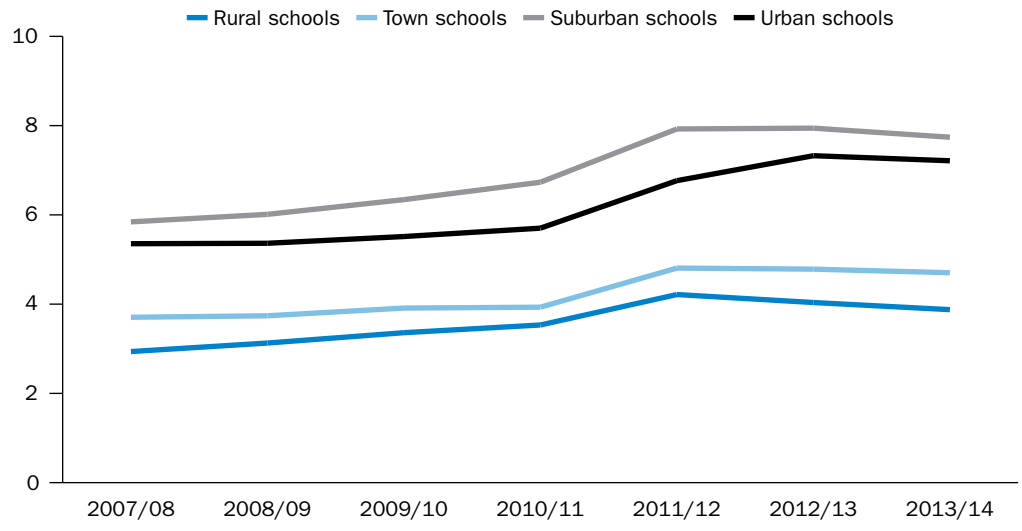
Figure D4. Urban and suburban public high schools in Texas offered a greater number of advanced math courses than schools in towns and rural locales, 2007/08–2013/14



Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

The average number of advanced science courses offered at schools, by locale and school year, is presented in figure D5.

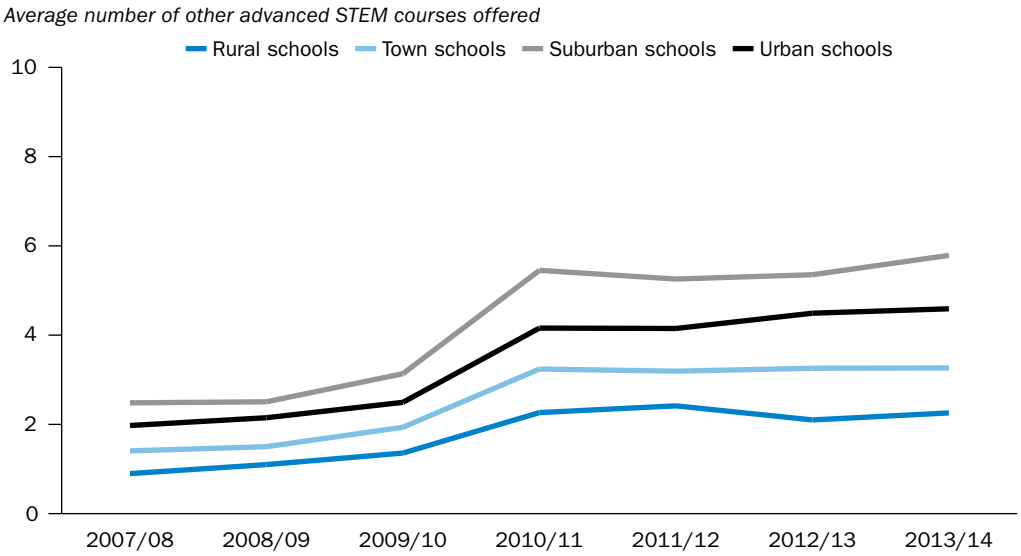
Figure D5. Urban and suburban public high schools in Texas offered a greater number of advanced science courses than schools in towns and rural locales in Texas, 2007/08–2013/14



Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

The average number of other advanced STEM courses offered at schools, by locale and school year, is presented in figure D6.

Figure D6. Urban and suburban public high schools in Texas offered a greater number of other advanced science, technology, engineering, and math courses than schools in towns and rural locales, 2007/08–2013/14



STEM is science, technology, engineering, and math.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

The number and percentage of students attending Texas high schools with different groupings of advanced math courses are shown in table D1.

Table D1. Number and percentage of students attending Texas public high schools, by quintile of the number of advanced math courses offered, 2007/08 and 2013/14

School ranking by total number of advanced math courses offered (quintiles)	Average number of advanced math courses offered	Number of students attending those schools	Percent of all students	Percent of all Black students	Percent of all Hispanic students	Percent of all White students
2007/08						
Bottom	1.6	94,656	7.4	7.5	6.3	8.6
Second	3.0	221,839	17.4	17.6	15.8	19.9
Third	4.0	259,048	20.3	21.0	23.0	18.1
Fourth	5.0	318,963	25.0	23.7	28.5	21.2
Top	6.4	382,750	30.0	30.2	26.5	32.2
2013/14						
Bottom	2.4	169,871	11.8	10.5	10.3	14.7
Second	4.0	124,569	8.7	8.1	7.4	11.4
Third	5.0	170,801	11.9	12.0	12.3	11.9
Fourth	6.5	503,001	35.1	36.4	35.6	33.1
Top	8.7	466,139	32.5	33.0	34.3	28.8

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

The number and percentage of students attending Texas high schools with different groupings of advanced science courses are shown in table D2.

Table D2. Number and percentage of students attending Texas public high schools, by quintile of the number of advanced science courses offered, 2007/08 and 2013/14

School ranking by total number of advanced science courses offered (quintiles)	Average number of advanced science courses offered	Number of students attending those schools	Percent of all students in Texas	Percent of all Black students in Texas	Percent of all Hispanic students in Texas	Percent of all White students in Texas
2007/08						
Bottom	1.6	143,053	11.2	9.2	9.6	13.7
Second	3.0	132,068	10.3	6.7	11.6	10.9
Third	4.0	135,170	10.6	9.7	12.1	9.8
Fourth	5.5	327,650	25.7	30.8	28.0	21.9
Top	8.2	539,315	42.2	43.5	38.7	43.7
2013/14						
Bottom	2.4	175,620	12.2	9.7	9.8	17.0
Second	4.0	80,461	5.6	5.2	5.3	6.7
Third	5.4	188,223	13.1	12.0	13.9	13.3
Fourth	8.1	429,909	30.0	33.3	30.0	28.4
Top	11.2	560,168	39.1	39.7	40.9	34.7

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

The number and percentage of students attending Texas high schools with different groupings of other advanced STEM courses are shown in table D3.

Table D3. Number and percentage of students attending Texas public high schools, by quintile of the number of other advanced science, technology, engineering, and math courses offered, 2007/08 and 2013/14

School ranking by total number of other advanced STEM courses offered (quintiles)	Average number of other advanced STEM courses offered	Number of students attending those schools	Percent of all students	Percent of all Black students	Percent of all Hispanic students	Percent of all White students
2007/08						
Bottom	0.0	175,583	13.7	15.2	12.0	15.4
Second	1.0	283,440	22.2	20.9	19.1	26.1
Third	2.4	524,180	41.0	40.2	44.4	37.7
Fourth	—	—	—	—	—	—
Top	4.9	294,053	23.0	23.7	24.5	20.8
2013/14						
Bottom	0.6	164,765	11.5	10.9	11.0	13.0
Second	2.0	126,542	8.8	8.4	7.5	11.1
Third	3.5	256,850	17.9	19.0	17.9	17.8
Fourth	5.5	277,110	19.3	19.2	19.6	18.8
Top	9.0	609,114	42.5	42.6	44.0	39.2

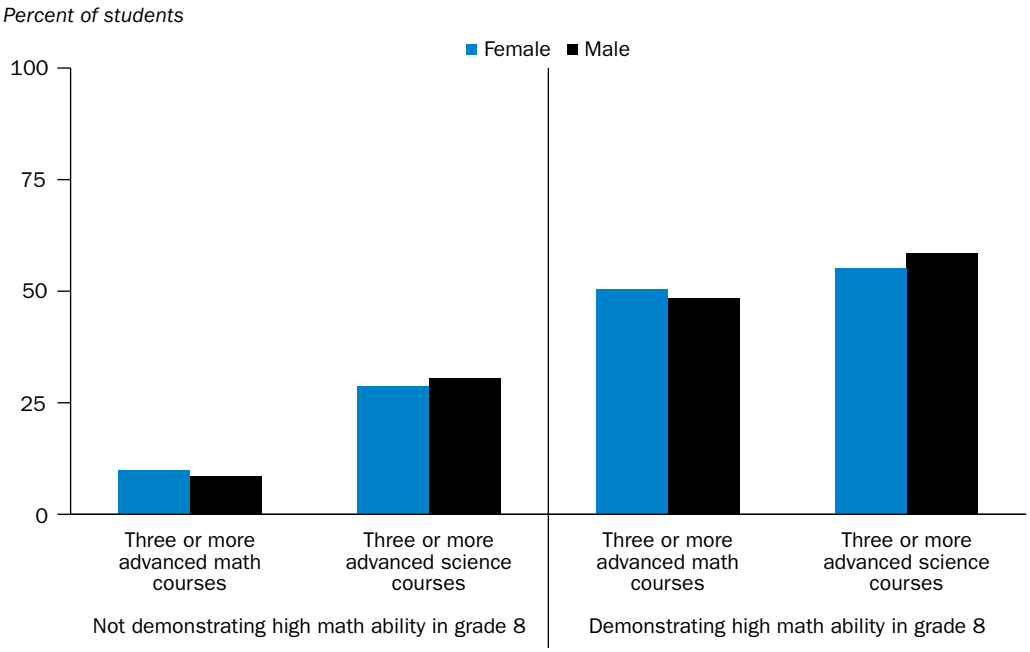
STEM is science, technology, engineering, and math.

— Denotes no records in that quintile. The distribution of other advanced STEM courses in 2007/08 was severely right skewed, with nearly 64 percent of schools offering either no or one other advanced STEM course and approximately 10 percent offering four or more. Because of this skewness, the percentile cutoffs for the third and fourth quintile were identical (one) and separate quintile categories could not be created.

Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at the University of Texas Education Research Center.

The percentages of students who took three or more advanced math or science courses, by sex, are shown in figure D7 for students who did and for those who did not meet the Commended Performance threshold on the grade 8 standardized math test for demonstrating high math ability.

Figure D7. There was little difference in the percentages of male and female Texas high school students completing three or more advanced math or advanced science courses, regardless of whether they demonstrated high math ability in grade 8, 2007/08–2013/14



Source: Authors' analysis of student-level data from the Texas Education Agency and the Texas Higher Education Coordinating Board stored at The University of Texas Education Research Center.

Notes

1. The 2009 76th Texas Legislature, Regular Session, expanded the number of other advanced STEM courses (in the career and technology area such as health and information technology) that could be used to substitute for upper-level math and science courses to meet graduation requirements. This policy went into effect beginning in the 2009/10 school year. This expanded from 75 to 117 the universe of STEM courses that could be classified as other advanced STEM courses in this study. From 2009/10 to 2010/11, the average number of other advanced STEM courses schools offered increased by 1.3. This was the largest single-year increase in average advanced STEM course offerings across all subject categories during the period in this study. This increase may be a combination of schools continuing to offer courses that became classified as advanced STEM in 2009/10 and schools offering new other advanced STEM courses.
2. The expansion in the number of advanced STEM courses that could substitute for upper-level math and science courses to meet graduation requirements pursuant to 2009 changes in Texas policy (see note 1) differentially affected schools based on their locale. The sharpest jump in the number of other advanced STEM courses offered between 2009/10 and 2010/11 occurred at suburban schools, where the average number of unique courses increased by approximately 2.4. Across all schools, the increase was 1.3 (see figure D6 in appendix D).
3. The study also examined differences in course offerings by a school's racial/ethnic composition and by a school's locale. However, there were too few schools in some combinations to provide meaningful results. Fewer than 10 schools were in the top decile of Black student population or top decile of White student population in towns or in the top decile of White student population in suburban or urban locales. Very few schools were in the combination of the bottom quintile of economically disadvantaged students and in the top decile of Hispanic student population or in the top quintile of economically disadvantaged students and in the top decile of White student population, even when the bottom or top two student racial/ethnic minority population deciles were collapsed. For these reasons, these results are not included.
4. Analyses performed separately by cohort showed the average number of advanced STEM courses completed rising by approximately 0.5 courses. The increase was consistent across White, Black, and Hispanic students.
5. The study also examined differences by student sex. Average differences between male and female students were small in the number of advanced STEM courses taken and in the proportion of students taking three or more advanced math or science courses (see figure D7 in appendix D).
6. Even among students demonstrating high math ability in grade 8, Black students were less likely than White or Hispanic students to enroll in a calculus or precalculus course. Among students demonstrating high math ability in grade 8, 28 percent of Black students enrolled in a calculus course, compared with 36 percent of White and 32 percent of Hispanic students. Nearly 86 percent of White students enrolled in a precalculus course, compared with 83 percent of Black and 85 percent of Hispanic students.
7. See, for example, Dougherty, Mellor, and Jian (2006) for a description of the problem, and consequences, of credit inflation in Texas.
8. See Loeb et al. (2017) for a discussion of how regression-based statistical adjustments can mask differences across groups that reflect deeper, more complicated social or economic phenomena.

9. A search of the literature yielded no more recent studies of this issue using Texas data.
10. House Bill (HB1) passed by the 79th Texas Legislature in 2006 introduced the "4×4" curriculum, which required four credits in math, science, English language arts, and social studies for the Recommended High School Plan. This affected students who began ninth grade in 2007/08. For a comprehensive review of the history of graduation requirements in Texas since 1996, see Mellor, Stoker, and Reese (2015).
11. This includes the Academic Excellence Indicator System data between 2007/08 and 2011/12, and the Texas Academic Performance Report data for 2012/13 and 2013/14.
12. The 2009 76th Texas Legislature, Regular Session, expanded the number of advanced STEM courses that could be used to substitute for upper-level math and science courses to meet graduation requirements. This policy, which went into effect beginning in the 2009/10 school year, expanded the number of STEM courses designated as advanced. In this study, the expanded definition of advanced courses was applied to courses across all years.
13. Although the statement is true for students who entered grade 9 during this period, it is not true for students who entered grade 9 prior to 2007/08 and who were in grades 10–12 in school years 2007/08, 2008/09, or 2009/10. Thus, the course offerings available to students may have changed during the period under study because of the more rigorous course requirements associated with revised graduation plans that were implemented for students entering grade 9 in 2007/08 and later. House Bill 5, which was passed in 2013 by the 83rd Texas Legislature, Regular Session, modified the graduation requirements of students who entered grade 9 in 2014/15 or later. This cohort of students is not included in this study.

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