Do Stricter High School Graduation Requirements Improve College Readiness?

Richard Buddin, Michelle Croft

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Abstract: In recent years, state policymakers have increased high school course requirements—particularly in mathematics and science. This research examines whether stricter requirements have been effective at improving student outcomes. Student-level evidence from a state's recent reform suggests that higher requirements had little effect on trends in course-taking, student performance, and college enrollment. Our evidence suggests that state policies that simply raise math and science graduation requirement may not be effective alone for improving student outcomes. This shortcoming may reflect that the laws primarily affect lower-ability and less-motivated students who often have weaker preparation for advanced coursework. Districts and states may require greater efforts at preparing these students for advanced coursework or redesigning the curriculum to improve student outcomes.

Keywords: graduation requirements, STEM, course taking, high school, college readiness

Introduction

For several decades, policymakers have embraced the goal of preparing students for college and careers, particularly for careers in the area of mathematics and science. The recent emphasis on these STEM (science, technology, engineering, and mathematics) subjects is due to the growth of STEM occupations and the perceived shortage of qualified workers to fill these positions (Economics & Statistics Administration, 2011; National Science Board, 2010). The need for workers with STEM capabilities is not limited to only highly skilled professions such as engineers, but also includes workers for traditionally lower-skilled positions such as workers in manufacturing (National Science Board, 2007; Carnevale, Smith, & Melton, 2011).

Many students do not currently have the level of STEM capabilities necessary for STEM careers. The United States scores below the international average in mathematics and close to the average in science on the Programme for International Student Assessment (PISA), an international assessment of 15 year-olds (OECD, 2013). Likewise, on the National Assessment

[1]The authors are Principal Research Associates at ACT and may be contacted at Dick.Buddin@act.org or Michelle.Croft@act.org.

of Education Progress (NAEP), only 35 percent of eighth-graders are proficient or advanced in math in 2013 and only 32 percent demonstrated proficiency in science in 2011 (National Assessment of Educational Progress Data Explorer, 2013).

To better prepare students for these STEM careers, many states have increased mandated minimum course requirements in math and science. These policies aim to expose more students to sophisticated math and science concepts, and the extra rigor is intended to improve student outcomes in college or the workforce. Twenty-seven states required at least one more year of math instruction for high school graduation class of 2013 than for the class of 2006.[2] Similarly, 19 states required an additional year of science for 2013 high school graduates compared to 2006. In 2013, 42 states required students to take at least three years of math, and 37 states require three years of science. These state minimum requirements, while binding on all students, only affect a minority of students in practice since many college-bound students have traditionally exceeded these minimums and many districts had such requirements already in place.

While stricter graduation requirements have become common legislative tools, there has been little research evidence on the effectiveness of these requirements on student outcomes. Most research used data from the 1980s and 1990s that may not be useful for understanding the recent changes to high school graduation requirements. In addition, most studies have looked at snapshot comparisons of how differences in state-by-state requirements are related to student outcomes. These studies may be distorted by state-to-state differences in curriculum, funding

[2] The graduation requirements for the 2006 graduation class were drawn from Zinth (2006a) and Zinth (2006b). The requirements for the 2013 graduation class are based on author review of state-by-state legislation.

mechanisms, and other factors that may be confounded with differences in statewide graduation requirements.

This project provides a more recent examination of the relationship between high school graduation requirements and student outcomes by using student-level data for nine high school graduation classes to assess how changes in Illinois math and science requirements affect student outcomes. In August 2005, Illinois enacted Public Act 94-0676, aimed at increasing the rigor of high school by mandating more stringent high school graduation requirements. Prior to the reform, most districts allowed high school students to graduate with only two years of math and one year of science. The law set a state minimum graduation requirement of three years of math and two years of science.[3] The law specified that the math requirement must include Algebra I and geometry content. The law was phased in over a four year time period. Each year from 2005 to 2008 entering freshman were responsible for completing more coursework, with the full reform package applicable for the graduating class of 2013. The mandatory state math requirement rose from two years for graduation classes through 2008 to three years for the 2009 graduation class. Two years of science were required by the state for the 2011 graduation class as compared with a one year requirement for earlier classes.

We compare trends in course-taking, achievement, and college enrollment for districts that were affected by the new statewide requirements (treated districts) relative to other districts that already required the mandated levels of math and science coursework (untreated districts).

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[3] This study focuses on the math and science aspects of the reform. The law also increased the language arts requirement from three to four years along with a two-year writing intensive course requirement that might overlap with other coursework. Students were also required to complete two years of social studies coursework that included U.S. history or American government as well as an elective.

The new requirements should expose more students to an advanced curriculum often targeted for college-motivated students.

An advantage of these district-level comparisons within one state is that the districts have common standards and funding mechanisms. In addition, the demographic and background characteristics of students and teachers are unlikely to vary substantially as much across adjacent districts within a state as compared with adjacent states. As a result, we believe that these district-level comparisons provide a stronger basis for isolating the effects of high school graduation requirements than has been possible in earlier studies.

The study addresses three questions:

1. Have the new graduation requirements increased math and science course-taking? The study examines whether the trend in course-taking differed between districts affected by the reform and other districts.
2. Has student achievement improved in math and science because of the policy change? If so, achievement gains should be larger in reform or treated districts than for untreated districts that previously satisfied the new graduation requirements.
3. Have college enrollment trends been affected by the new law? The advanced coursework under the new law will leave some students better prepared for college. In addition, the “extra” math and science courses may peak some students’ interest in postsecondary STEM training.

The study examines reform effects for all students as well as for student subgroups that often take few advanced courses—i.e., students in the bottom half of their graduation class, students with a B- or lower grade point average, or students not enrolled in a college preparatory program.

Students in these subgroups have traditionally taken fewer advanced courses than higher-achieving college-bound students, so the new requirements should have bigger effects on students in the subgroups.

The remainder of the paper is divided into four sections. The next section (section two) examines previous literature on the effectiveness of high school graduation requirements on student outcomes. The third section discusses our research methods for examining the effects of the new Illinois requirements. The fourth section describes how the legislation has affected student course taking, test scores, and college enrollment. The final section discusses the implications of the results for education policy and for future research.

Previous Literature

The 1983 *A Nation at Risk* report served as an impetus for states and districts to increase high school graduation requirements (National Commission on Excellence in Education, 1983). Finding that 25% of the credits earned by general track high school students were in electives (e.g., physical and health education; work experience outside the school; and personal and development courses) and remedial coursework in English and mathematics, the report recommended that states raise graduation requirements in core subject areas. Specifically, students graduating from high school should take: 4 years of English language arts, 3 years of mathematics, 3 years of science, 3 years of social studies, and a half year of computer science.

The remainder of this section examines research literature on high school course-taking, test scores, and college enrollment. The studies examine how stricter graduation requirements have affected these student outcomes.

High School Course-Taking

After the publication of *A Nation at Risk*, 42 states increased their graduation requirements (Clune, White, & Patterson, 1989), but few adopted the number of courses recommended. By 1990, only three states had adopted the *A Nation at Risk* recommendation of three years of both math and science (Medrich, Brown, Henke, & Ross, 1992). Further, in practice, the requirements only affected the course-taking of a minority of students. A study using the 1990 National Assessment of Educational Progress (NAEP) and the 1990 High School Transcript Study examined the effects on school-level graduation requirements on student course-taking and achievement (Chaney, Burgdorf, & Atash, 1997). The study found that the majority of students (64% for mathematics and 56% for science) completed more courses than required, so the minimum graduation requirements did not affect the majority of students.

Although the graduation requirements do not affect the course-taking of all students, studies have found effects on particular subgroups of students. For instance, Clune and White (1992) reviewed student transcripts in four states (California, Florida, Missouri, and Pennsylvania) at three points of time (two before and one after the implementation of new graduation requirements) to examine the effect of changing graduation requirements on student course-taking.[4] The study found a slight increase in core course-taking for schools serving predominately low-achieving students. Likewise, Goodman (2009) also found large increases in completed math coursework for blacks, particularly for black males, when using the High School and Beyond Survey for the classes of 1982, 1987, 1991, and 1994.

[4] Although all four states had increased their graduation requirements, only Florida was deemed a "high-change" state. All schools within the four states were in the lowest quartile of average student achievement within their state, did not undergo major changes in population or demographic shifts from 1980 to 1988, and included at least one urban and one rural or suburban area.

The types of courses taken, however, tended to be mostly basic and middle-level courses instead of advanced courses. For instance, Finn et al., (2002) using high school transcripts from approximately 22,000 graduates from 305 public high schools who participated in the 1994 High School Transcript Study (HSTS) found that graduation requirements increased the number of mathematics courses taken, but did not increase the number of advanced courses taken. Likewise, Schiller and Mueller (2003) using the National Education Longitudinal Study of 1988 (NELS: 88) evaluated the relationship between graduation requirements and course-taking. The researchers found that in states with higher graduation requirements, students who were placed in lower level mathematics courses as freshman were less likely than those in other states with lower graduation requirements to take advanced level courses in mathematics. A more recent survey of Michigan principals following the implementation of the Michigan Merit Curriculum[5] found that 14.3% reported seeing no change in course-taking and 45% reported that some additional students were taking more challenging courses (Byrd & Langer, 2010). Thus, increases to high school graduation requirements have tended to only affect the course-taking of low-skilled students instead of high-skilled students.

Teitelbaum (2003) used data from NELS:88 to show that many schools did not strictly enforce high school graduation requirements in math and science. About 15 percent of students graduated without satisfying a 3-year math requirement at their school, and about 20 percent failed to meet a 3-year science requirement. The survey did not address why these requirements were weakly enforced by high schools. Teitelbaum (2003) found that vocational/general track

[5] The Michigan Merit Curriculum required students graduating in 2011 and beyond to earn four credits in English, four in math (including Algebra I, Algebra II, and geometry), three credits in science, three credits in social studies, and one each in physical education, visual or performing arts, and an online learning experience. Previously, graduation requirements were within the discretion of the individual school district. (Bryd & Langer, 2010).

students were much less likely to meet the requirements while students with higher 8^{th} grade test scores were much more likely to meet the requirement.

Student Achievement

Students who complete core coursework typically have much higher achievement scores than other students (Jones, Davenport, Bryson, Bekhuis, & Zwick, 1986; ACT, Inc., 2012). Well-prepared students with strong motivation for college often take advanced math and science courses as preparation for college work. If new requirements pressure less motivated or prepared students to take advanced coursework, these student may not perform as well as students enrolled in those courses on a voluntary basis.

Limited evidence suggests that mandated course requirements may have only a small effect on student achievement. Teitelbaum (2003) used transcript and test score information from NELS:88 to examine the effects of graduation requirements. When controlling for demographic characteristics, prior achievement, and high school path (general or vocational), Teitelbaum did not find a statistically significant effect of higher graduation standards on student test scores.

Researchers have found two exceptions. The first is if students complete progressively advanced coursework (Chaney, Burgdorf, & Atash, 1997). The second is if they are otherwise motivated (Montgomery, Allensworth, & Correa, 2010). Montgomery, Allensworth, and Correa (2010) described the relationship between course-taking and student achievement as: "Simply requiring students to be exposed to specific coursework is not enough to substantially improve learning in science. Course content matters only when students are engaged in learning content and are earning strong grades."

College Enrollment

Research shows that students who voluntarily take more rigorous high school coursework are more likely to enroll and persist in college. Radunzel and Noble (2012) using data from 24,850 ACT-tested high school graduates found that students who completed a core curriculum were more likely to enroll in college and ultimately be successful in obtaining a college degree. Similarly, Adelman (2006) found a relationship between the highest level of high school mathematics completed and bachelor's degree completion.

The results from voluntary course-taking may not translate to increased college enrollment under the mandated requirements, however. The new requirements target students that may have weaker preparation and motivation for college than the group currently choosing more advanced math and science courses. Policymakers hope that increased graduation requirements would improve college and workforce outcomes for a broader class of students, but this claim has not yet been verified by researchers.

Research Methods

Data

The primary data source for this analysis is high school graduation information collected as part of ACT testing administration. All public school students in Illinois participate in ACT testing in the spring of their junior year. Student standardized achievement scores are collected in English, math, reading, and science and are on a scale from 1 to 36. The average ACT math score on a nationally representative norming sample was 17.93, with a standard deviation of 4.54 and a standard error of measurement of 1.41 (ACT, Inc., 2007). In science, the average score was 17.08, with a standard deviation of 4.72 and a standard error of measurement 1.84.

As part of the test administration, students identify college preparatory (i.e., Algebra I but not general math) courses that they either have taken or plan to complete prior to graduating from high school. Students also provide detailed demographic and family background information. Therefore, we are able to examine the effect of the law on different subgroups of students including students in the bottom half of their graduation class (*low class rank*), students with a B- or lower grade point average (*low GPA*), and students not enrolled in a college preparatory program (*non-college prep*).

The analysis relies on information for the 2005 through 2013 public high school graduation classes for all districts except for the Chicago Public School (CPS) district. CPS was omitted due to its size, as there were 27,000 freshman in CPS compared to 3,000 in the next largest district. The nine-year time span provides information on cohorts before the policy change, during the phase-in period, and after the implementation of the law.

Information on public school district graduation requirements was drawn from an Illinois State Board of Education Survey in 2005. The survey asked whether districts met the overall requirements, the requirements in each subject area (English, math, and science), and if students in the districts take specific math courses proposed as part of the math requirement. About 87% of districts responded to the survey. Based on the survey results, districts were categorized into treated and untreated districts for each subject area (i.e., a district could be categorized as a "treated district" in science but not as a "treated district" in math). Treated districts were those that were affected by the law. Untreated districts were those that had met the graduation requirements prior to the law's enactment.

Data on college enrollment was provided by the National Student Clearinghouse (NSC), which has enrollment information for over 96% of all students in public and private U.S. postsecondary institutions.

ACT test records include students enrolled in private schools, but these students are omitted from our analysis for two reasons. First, private school students in the state take the ACT on a voluntary basis. This group may be unrepresentative of private school students in the state overall, as college enrollment is likely the primary motivation of private school test takers. Second, the state school board survey was restricted to public school districts, so we have no information about private school graduation requirements in the baseline year of 2005.

Multiple imputation techniques were used to fill missing data on student demographics and background (Little and Rubin, 2002). These techniques were particularly useful for adjusting family income for differences in the cost of living over the nine cohorts. The ACT survey asks students to report family income by categories. These categories are fixed from year to year, but inflation over the nine years was about 25 percent. As a result, a family income of $50,000 in 2013 was roughly equivalent to an income of $40,000 in 2005. As part of the imputation, family income intervals were recoded to 2013 dollars, and income was imputed for each interval. Our analysis is based on 20 datasets with alternative imputations to preserve the variability in family income and other factors in the statistical model.

Missing values were imputed for all variables using multiple chain techniques, but the analysis is conducted on the subset of observations with complete data on the dependent variables in the statistical models. Several studies have argued that the dependent variables should be included as part of the imputation procedure but then excluded from the analysis of particular dependent variables (Little and Rubin, 2002; Allison, 2001; Von Hippel, 2007; and White et al., 2011).

The ACT test data consists of 818,611 math and science scores from the high school graduation classes of 2005 through 2013. Of these about 24 percent claimed they were in the lowest half of their graduation class, about 37 percent reported a grade point average of less than 3.0 (a B), and about 40 percent were not enrolled in a college preparatory curriculum. About 10 percent of students did not report information on math or science courses taken. The college enrollment sample is 643,935. This smaller sample reflects enrollments through 2012 (2013 enrollments are not yet available from NSC) and about 8 percent of students that we were unable to match with NSC records (primarily due to missing Social Security Numbers).

Students in the subgroups traditionally take fewer math and science classes than other students, so these groups might benefit the most from the higher graduation requirements. At baseline in 2005, about 20 percent of students took less than 3 years of math as compared with 37 percent of student in the bottom half of their class, 34 percent of students with less than a 3.0 grade point average, and 31 percent of students enrolled in a non-college preparatory curriculum. About 7 percent of all students took fewer than 2 years of science in 2005 as compared with 13 percent of students in the bottom half of their class, 12 percent of students with less than a 3.0 grade point average, and 12 percent of students enrolled in a non-college preparatory program.

Districts meeting the math requirements in 2005 had higher proportions of African American and Asian/Pacific Islander students than the districts affected by the legislation (see Table 1). In addition, the untreated districts had average family income about $7,000 less than the treated districts. The treated sample included over twice as many students as the untreated sample in 2005 when the higher graduation requirement was enacted.

Table 1
Means and Standard Deviations of Student Background and Academic Variables at Baseline (2005) by Math Treatment Status

	Treated Districts		Untreated Districts	
	Mean	Standard Deviation	Mean	Standard Deviation
African American	0.04	0.21	0.12	0.32
Hispanic	0.06	0.25	0.06	0.25
Asian or Pacific Islander	0.04	0.19	0.02	0.14
Female	0.50	0.50	0.51	0.50
Age at HS graduation	18.35	0.41	18.35	0.43
US citizen	0.86	0.35	0.85	0.35
Family Income	69.90	39.01	63.30	37.06
Less than 3 years of math	0.20	0.40	0.20	0.40
Math score	20.75	5.71	19.59	5.32
College enrollment	0.65	0.48	0.60	0.49
Number of Students	58,210		23,577	
Number of Districts	247		170	

Note: Treated districts required less than 3 years of math for 2005 graduates. Untreated districts already required 3 or more years of math in 2005, so the new math requirement did not affect these districts. Age at HS graduation, family income, and test scores are continuous variables. The other factors are indicator variables where the omitted groups are white non-Hispanic, male, not US citizen, 3 or more years of math, 2 or more years of science, and not enrolled in college immediately following high school (i.e., the fall of high school graduation year). Family income is measured in 1000s of 2013 dollars.

Table 1 also shows that about 20 percent of students in both the treated and untreated districts had less than 3 years of math in 2005. The percentage should be lower in the untreated districts that ostensibly had a requirement of 3 years of math in 2005. Two reasons explain the disparity. First, the districts may be lax in enforcing their graduation requirement as Teitlebaum (2003) found in his NELS:88 analysis. Second, the ACT test data omit information on foundational and applied math classes such as general math, pre-algebra, or business math. As a result, many students may satisfy the district requirements with courses that are not counted as part of ACT test administration. ACT specifically asks about pure math course work that is expected in college-level preparation, i.e., algebra I and II, geometry, trigonometry, and calculus.

Finally, Table 1 shows that the districts affected by the higher graduation requirements already had higher math scores and college enrollment rates than the other districts. Students' math scores in the treated districts average were about 1 point higher than those for comparable students in the untreated districts. About 65 percent of students in treated districts went immediately on to college in the fall of their high school graduation year as compared with about 60 percent of students in untreated districts.

Table 2 shows small differences in student demographics for districts affected by the increased science requirement. About 83 percent of students in the untreated districts are white non-Hispanics, compared with about 13 percent in the treated districts.

The 2-year science requirement only affected about 15 percent of the districts, since the others already required 2 or more years of science in 2005. As with the math requirement, however, about 6 percent of students in untreated districts did not satisfy the existing district science requirement in 2005. High school science classes are somewhat more standardized than math classes (physical science, earth science, general science, biology, chemistry, and physics), so some untreated districts would seem lax in enforcing their science requirements.

Table 2 shows that science test scores and college enrollment rates were very similar between treated and non-treated districts in 2005.

Table 2
Means and Standard Deviations of Student Background and Academic Variables at Baseline (2005) by Science Treatment Status

	Treated Districts		Untreated Districts	
	Mean	Standard Deviation	Mean	Standard Deviation
African American	0.05	0.22	0.07	0.25
Hispanic	0.05	0.21	0.07	0.25
Asian or Pacific Islander	0.03	0.16	0.03	0.18
Female	0.50	0.50	0.50	0.50
Age at HS graduation	18.37	0.42	18.34	0.41
US citizen	0.91	0.29	0.85	0.36
Family Income	66.52	37.78	68.27	38.70
Less than 2 years of science	0.12	0.33	0.06	0.25
Science score	20.37	5.62	20.42	5.62
College enrollment	0.63	0.48	0.64	0.48
Number of Students	13,589		68,198	
Number of Districts	64		353	

Note: Treated districts required less than 2 years of science for 2005 graduates. Untreated districts already required 2 or more years of science in 2005, so the new science requirement did not affect these districts. Age at HS graduation, family income, and test scores are continuous variables. The other factors are indicator variables where the omitted groups are white non-Hispanic, male, not US citizen, 3 or more years of math, 2 or more years of science, and not enrolled in college immediately following high school (i.e., the fall of high school graduation year). Family income is measured in 1000s of 2013 dollars.

A cursory examination of the data suggested that the reform might have large effects on test scores and college enrollment. Consider the pattern in scores and enrollments in 2005 for districts that were not affected by the new reform. Students with 2 years of pure math courses had math test scores of 16.4 as compared with scores of 18.3 for students that voluntarily took a 3rd year of math. About 48 percent of the students with 3 years of math enrolled in college as compared with 33 percent of students with 2 years of math. The pattern is similar in science where test scores were 22.1 for students with 2 years of science as compared to 18.6 for students with 1 year of science. College enrollments were 64 percent for the group with a second year of science as compared with 45 percent for students with on 1 year of science.

The problem with these cursory comparisons is that they are plagued by the self-selection of students into "extra" math and science, so these gains may not be representative of actual gains for students required to take extra coursework. For example, students that voluntarily take an extra year of math or science might be more proficient or interested in those subjects than students choosing to take fewer courses. In addition, students may choose to take the extra math and science classes because they plan to attend college and recognize that this coursework is important for college admission. These factors suggest that the measured gains may substantially overstate the benefits of legislation that requires students to take additional math and science coursework.

Statistical Model

The analysis focuses on three outcomes for each student: meeting mandated course requirements in math and science, the ACT test score in each subject, and the immediate transition to college for the student. The model allows for different intercepts for treated and untreated districts for 2005 when the stricter requirements were adopted and for different time trends for treated and untreated districts after the statewide mandate. For each outcome in each subject,

$$y_{ijt} = \alpha + \gamma_5 I_5 + \delta_5 I_5 Z_5 + \gamma T_{ijt} + \delta T_{ijt} Z_{ijt} + \boldsymbol{X}_{ijt}\beta + \tau_{ij} + \varepsilon_{ijt} \qquad \text{Equation. 1}$$

where the outcome for the i^{th} student in the j^{th} district in the t^{th} year is an indicator variable for the base year of 2005 (*I*), a time trend (*T*), an indicator for whether the state graduation requirements would affect the district (*Z*), and a row vector of student demographic and background characteristics (***X***). The model includes district-level fixed effects (*τ)* to adjust for possible unobserved district factors that are time invariant. The standard errors of regression parameters are adjusted to account for the fact that students are drawn from separate high schools each year using the Huber/White sandwich estimator.

The policy effects of the legislation are indicated by the model parameters are γ_5 and δ in Equation 1. Treated districts may differ from untreated districts on some of the outcomes even before the new legislation. For example, the mathematics test score in treated district might be lower than those in untreated districts in 2005, and this difference would be reflected in γ_5. The more important policy parameter is δ that indicates whether the trend in student outcomes was differentially affected by the legislation. Proponents of stricter requirements hope that the legislation will increase math and science course taking, test scores, and postsecondary enrollments. If students take more advanced courses, they would be better prepared for college and perhaps more motivated to continue their education in a 2- or 4-year college.

The college enrollment equations for changes in math and science requirements are similar but not identical. The set of districts affected by the new math requirement is different than the set of districts affected by the new science requirement. This occurs because some districts were affected by the new law in one subject but were not affected by the law in the other.

In preliminary analysis, we explored a more complex relationship that tracked year-by-year comparisons of treated and untreated districts. The marginal or incremental effect of the law was decomposed into four components. First, the districts "treated" or newly-affected by the law may have outcomes higher or lower than the control group. Second, treated districts have a pre-implementation period as the district transitions to the new requirements. During this period, district may need to expand offerings in math and science or encourage more students to enroll in more of these classes. Third, the new requirements constrain eligibility for graduation in the "treated" districts. Finally, student outcomes may continue to improve in treated districts after the new requirements take effect as school refine their course offerings and staff become acclimated to the stricter guidelines. The results of this more complicated analysis were similar to those reported here, and so we report herein on the statistical model presented.

In a separate analysis, we also explored whether the high graduation requirements had positive effects on at-risk minority students. The results for African American and Hispanic students showed that trends in course taking, test scores, and college enrollment did not vary between treated and untreated districts in either math or science. These educational outcomes for at-risk minority students did not improve as a result of the higher graduation requirements.

Results

Math Course Taking

At the time of the reform legislation in 2005, comparable shares of students in both the treated and untreated districts had taken fewer than 3 years of math (see Table 3). The stricter requirements in districts that already met the legislative mandate were either not enforced or the requirement was satisfied with foundational or business math classes. The statistical model holds constant student demographic and background factors that may contribute to differences in course taking patterns across districts.

Math course taking increased from 2005 to 2013 with fewer students taking less than three years of pure math classes (i.e., college-preparatory math) in 2013 than before the reform. The percentage of students taking fewer than 3 years of math fell by 11 percentage points between 2005 and 2013. The decline was about 18 percentage points for the various subgroups that generally take fewer math classes.

Table 3
Regression Estimates for Less than 3 Years of Math by Student Group

	All b/se	Low Rank b/se	Low Grades b/se	Not Coll Prep b/se
Year 2005	-0.01073	-0.01823	-0.01569	-0.01368
	(0.00736)	(0.01452)	(0.01212)	(0.01080)
Year 2005 & Math Treated	-0.00837	-0.01394	-0.00548	-0.00506
	(0.00910)	(0.01743)	(0.01479)	(0.01373)
Trend	-0.01364*	-0.02647*	-0.02241*	-0.02075*
	(0.00086)	(0.00152)	(0.00135)	(0.00118)
Trend & Math Treated	-0.00161	-0.00238	-0.00294	-0.00345*
	(0.00105)	(0.00187)	(0.00164)	(0.00152)
African American	0.05624*	0.02516*	0.03325*	0.05725*
	(0.00257)	(0.00421)	(0.00334)	(0.00381)
Hispanic	0.02565*	0.00650	0.01476*	0.01684*
	(0.00217)	(0.00379)	(0.00313)	(0.00297)
Asian or Pacific Islander	-0.04954*	-0.06618*	-0.06446*	-0.06521*
	(0.00202)	(0.00539)	(0.00462)	(0.00353)
Female	-0.04654*	-0.03844*	-0.02467*	-0.04202*
	(0.00111)	(0.00211)	(0.00174)	(0.00165)
Age at HS graduation	0.08403*	0.08424*	0.08788*	0.09123*
	(0.00162)	(0.00260)	(0.00225)	(0.00215)
US Citizen	-0.02075*	-0.02218*	-0.02190*	-0.01391*
	(0.00266)	(0.00459)	(0.00391)	(0.00369)
Family Income	-0.00278*	-0.00194*	-0.00232*	-0.00281*
	(0.00006)	(0.00010)	(0.00009)	(0.00008)
Family income squared	0.00001*	0.00001*	0.00001*	0.00001*
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Constant	-1.16990*	-1.05351*	-1.14961*	-1.21837*
	(0.02965)	(0.04921)	(0.04266)	(0.04058)
Adjusted R-Square	0.1011	0.1469	0.1230	0.1379
Number of Students	730,873	189,932	284,249	309,269

Note: Entries are regression coefficients with standard errors in parentheses. Asterisk indicates statistical significance at 0.05 level. Omitted reference categories are white non-Hispanic, male, and not US citizen. Family income is measured in 1000s of 2013 dollars.
Source: ACT Test Records for Illinois

Although there were gains in math course taking, these gains were spread evenly across districts that were affected by the new law and districts that were not. The only statistically significant difference in math course taking was for non-college preparatory students, where the percentage taking fewer than 3 years of math fell over the entire period by 19 percentage points in treated districts as compared with 17 percentage points in untreated districts.

The evidence suggests that the new law had little effect on course takings. While more students were taking at least 3 pure math courses than before, the trend differed little if, at all, by whether districts were affected by the high math graduation requirement.

The results also showed differences in course taking by student demographic and background. African American and Hispanic students took fewer pure math classes than white non-Hispanic students, but Asian/Pacific Islander students took more math classes than all other groups. Girls took more math classes than boys. Older students that may have repeated a grade in school took fewer math classes than others. Other things equal, math course taking was positively related to family income. About 22 percent of students at the 25th percentile of family income ($34K in $2013) took fewer than 3 years of high school math as compared with only 14 percent of students at the 75th percentile of family income ($88K in $2013).

Science Course Taking

In 2005, science course taking was quite similar across districts irrespective of whether those districts were affected by the requirement that students take 2 years of high school science (see Table 4). Science course taking was not statistically different between treated and untreated districts overall, after controlling for differences in student demographics and background. In addition, the baseline differences were insignificant across each of the subgroups of students that typically take fewer science classes.

The science requirement did have a differential effect on the trend in course taking between treated and untreated districts. Over the nine year period, the percentage of students taking fewer than 2 science classes fell by about 3 percentage points in the untreated districts. At the same time, the percentage of students taking fewer than 2 science classes fell by about 6 percentage points in the treated districts.

Table 4
Regression Estimates for Less than 2 Years of Science by Student Group

	All b/se	Low Rank b/se	Low Grades b/se	Not Coll Prep b/se
Year 2005	0.00226	0.01224*	0.01123*	0.01062*
	(0.00266)	(0.00518)	(0.00452)	(0.00430)
Year 2005 & Science Treated	-0.00984	-0.01829	-0.01501	-0.01300
	(0.00907)	(0.01738)	(0.01504)	(0.01534)
Trend	-0.00334*	-0.00570*	-0.00505*	-0.00519*
	(0.00027)	(0.00051)	(0.00046)	(0.00042)
Trend & Science Treated	-0.00419*	-0.00823*	-0.00649*	-0.00700*
	(0.00093)	(0.00180)	(0.00151)	(0.00153)
African American	0.02261*	0.01117*	0.01676*	0.02656*
	(0.00158)	(0.00266)	(0.00215)	(0.00230)
Hispanic	0.01024*	0.00690*	0.01035*	0.00871*
	(0.00117)	(0.00210)	(0.00178)	(0.00172)
Asian or Pacific Islander	-0.01520*	-0.01753*	-0.01702*	-0.01900*
	(0.00107)	(0.00322)	(0.00273)	(0.00193)
Female	-0.02479*	-0.03156*	-0.02522*	-0.02800*
	(0.00078)	(0.00153)	(0.00123)	(0.00117)
Age at HS graduation	0.03843*	0.03958*	0.03935*	0.04203*
	(0.00110)	(0.00180)	(0.00153)	(0.00151)
US Citizen	-0.01658*	-0.01609*	-0.01837*	-0.01412*
	(0.00159)	(0.00290)	(0.00241)	(0.00223)
Family Income	-0.00107*	-0.00094*	-0.00103*	-0.00112*
	(0.00004)	(0.00007)	(0.00006)	(0.00006)
Family income squared	0.00000*	0.00000*	0.00000*	0.00000*
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Constant	-0.57443*	-0.56995*	-0.57233*	-0.62159*
	(0.01959)	(0.03328)	(0.02806)	(0.02760)
Adjusted R-Square	0.07189	0.1095	0.09302	0.1092
Number of Students	736,930	193,462	288,573	314,088

Note: Entries are regression coefficients with standard errors in parentheses. Asterisk indicates statistical significance at 0.05 level. Omitted reference categories are white non-Hispanic, male, and not US citizen. Family income is measured in 1000s of 2013 dollars.
Source: ACT Test Records for Illinois

The science results were larger for the subgroups than for the overall student population, but the course taking trend did differ between treated and untreated districts. In general, the downward trend in students taking fewer than 2 years of high school science was about twice as large in the treated districts as in the untreated districts.

Student demographics and background had a similar effect on science course taking as on math course taking. African American and Hispanic students took fewer science courses than white non-Hispanic or Asian/Pacific Islander students. Girls and US citizens took more science classes than boys and non-citizens. Other things equal, older students took fewer science courses than average aged students. Students whose family income was at the 25th percentile were about 3 times as likely to take fewer than 2 high school science classes as were students at the 75th percentile (9 versus 3 percent).

Math Test Scores

Baseline math scores were similar for treated and untreated districts (see Table 5). Both types of districts had insignificant differences in math scores in 2005 overall as well as for each of the subgroups.

Math scores have risen since 2005, but there was not a statistically significant difference in the trends between treated and untreated districts. The results indicate that comparable students in terms of demographic characteristics and family income would score about 0.94 points higher in 2013 as compared with 2005. The gains were shared across low ranking students, students with low grades, and students not in college preparatory programs.

These test score gains were not tied to the new mandated math course requirements, since the gains were not significantly different in treated and untreated districts. The higher scores may reflect the increased math course load that was the trend over this period. The higher scores could also be related to other changes in education policy and practices in the state or unmeasured changes in the student composition over this period.

Math scores differed substantially across many student demographic groups. African American and Hispanic students averaged about 2.6 and 1.6 points lower, respectively, than comparable white non-Hispanic students. Asian/Pacific Islander students typically scored 2.6 points higher in math than comparable white non-Hispanic students. Girls had math scores about 0.3 points lower than boys. The math score for a 19-year-old graduate was about 1.5 points lower than for an 18-year-old graduate. Finally, US citizens had math scores about 0.8 points higher than non-citizens.

Table 5
Regression Estimates for ACT Math Score by Student Group

	All b/se	Low Rank b/se	Low Grades b/se	Not Coll Prep b/se
Year 2005	-0.03061	-0.02785	-0.07634	-0.05541
	(0.08834)	(0.07840)	(0.07154)	(0.07809)
Year 2005 & Math Treated	0.09775	-0.01735	0.00692	0.04300
	(0.10939)	(0.09570)	(0.08873)	(0.09981)
Trend	0.11791*	0.12854*	0.11105*	0.13404*
	(0.01086)	(0.00922)	(0.00857)	(0.01021)
Trend & Math Treated	-0.00853	-0.01243	-0.00247	0.01237
	(0.01346)	(0.01127)	(0.01070)	(0.01281)
African American	-2.62584*	-1.25862*	-1.53808*	-2.17836*
	(0.04501)	(0.03111)	(0.02870)	(0.04078)
Hispanic	-1.60371*	-0.62829*	-0.85035*	-1.25639*
	(0.04016)	(0.02909)	(0.02669)	(0.03646)
Asian or Pacific Islander	2.64650*	0.80258*	0.79791*	1.99378*
	(0.06916)	(0.07543)	(0.06699)	(0.08120)
Female	-0.31953*	-0.64641*	-0.84394*	-0.53160*
	(0.01322)	(0.01582)	(0.01380)	(0.01601)
Age at HS graduation	-1.49230*	-0.89913*	-1.03798*	-1.26793*
	(0.01480)	(0.01536)	(0.01419)	(0.01622)
US Citizen	0.84225*	0.39074*	0.52057*	0.42182*
	(0.05001)	(0.03560)	(0.03018)	(0.03925)
Family Income	0.04125*	0.01521*	0.02130*	0.03264*
	(0.00081)	(0.00080)	(0.00075)	(0.00086)
Family income squared	-0.00003*	-0.00001*	-0.00004*	-0.00004*
	(0.00000)	(0.00001)	(0.00001)	(0.00001)
Constant	45.62194*	33.30686*	35.95672*	40.75560*
	(0.31571)	(0.31072)	(0.28169)	(0.33091)
Adjusted R-Square	0.2877	0.2149	0.1893	0.2710
Number of Students	818,611	200,950	300,038	325,612

Note: Entries are regression coefficients with standard errors in parentheses. Asterisk indicates statistical significance at 0.05 level. Omitted reference categories are white non-Hispanic, male, and not US citizen. Family income is measured in 1000s of 2013 dollars.
Source: ACT Test Records for Illinois

Math scores varied considerably with family income even after controlling for these demographic factors. Each ten thousand dollar increase in family income was associated with about a 0.04 increase in math score. The model results mean that a typical student at the 25^{th} percentile of family income would have a math score of 19.4 as compared with 21.4 for a student at the 75^{th} percentile.

Science Test Scores

Science test scores were comparable across treated and untreated districts in 2005 (see Table 6). Similarly, there were no significant differences in the science test scores for the student subgroups in districts affected by the 2-year science requirement compared to those in districts that already mandated at least a 2-year requirement in 2005.

Science scores rose overall and for each subgroup between 2005 and 2013. The overall science score rose by about 0.7 points over the period. This overall trend was consistent across treated and untreated districts. In two of the subgroups (low ranking students and non-college preparatory), the trend was statistically smaller for the treated group than for the untreated group. The science scores still rose for these subgroups in the treated districts, but their science scores were rising at a slower pace than those of the untreated group.

This evidence suggests that the 2-year science requirement in the education reform had little effect on science achievement. If effective, the overall trend should have been steeper in districts affected by the requirement. This was not the case, however, and achievement growth was actually lower for some subgroups in the treated districts than in the untreated districts. If effective, the reform should have increased science test scores especially for the subgroups where students had traditionally taken fewer science courses.

Table 6
Regression Estimates for ACT Science Score by Student Group

	All b/se	Low Rank b/se	Low Grades b/se	Not Coll Prep b/se
Year 2005	0.15529*	0.04317	0.00804	0.04361
	(0.05523)	(0.05503)	(0.05026)	(0.05503)
Year 2005 & Science Treated	-0.05244	-0.24595	-0.18736	-0.13825
	(0.10696)	(0.12572)	(0.10683)	(0.10796)
Trend	0.08934*	0.06159*	0.04579*	0.09470*
	(0.00683)	(0.00683)	(0.00615)	(0.00708)
Trend & Science Treated	-0.02080	-0.04903*	-0.02142	-0.03112*
	(0.01310)	(0.01522)	(0.01400)	(0.01472)
African American	-2.61977*	-1.43855*	-1.70007*	-2.30561*
	(0.04254)	(0.03745)	(0.03329)	(0.04299)
Hispanic	-1.72016*	-0.91085*	-1.12455*	-1.42016*
	(0.03952)	(0.03525)	(0.03202)	(0.03695)
Asian or Pacific Islander	1.41514*	0.16854*	0.20256*	0.97456*
	(0.05436)	(0.07073)	(0.06362)	(0.06610)
Female	-0.15378*	-0.40534*	-0.59294*	-0.36010*
	(0.01318)	(0.01895)	(0.01599)	(0.01668)
Age at HS graduation	-1.59204*	-1.09937*	-1.22966*	-1.41067*
	(0.01482)	(0.01855)	(0.01677)	(0.01756)
US Citizen	1.05659*	0.67729*	0.76956*	0.74027*
	(0.04658)	(0.04126)	(0.03671)	(0.04032)
Family Income	0.03888*	0.01931*	0.02524*	0.03332*
	(0.00077)	(0.00096)	(0.00085)	(0.00090)
Family income squared	-0.00005*	-0.00005*	-0.00007*	-0.00007*
	(0.00000)	(0.00001)	(0.00001)	(0.00001)
Constant	46.90920*	37.02193*	39.55417*	43.07238*
	(0.31036)	(0.36153)	(0.32312)	(0.34713)
Adjusted R-Square	0.2421	0.1496	0.1420	0.2124
Number of Students	818,611	200,950	300,038	325,612

Note: Entries are regression coefficients with standard errors in parentheses. Asterisk indicates statistical significance at 0.05 level. Omitted reference categories are white non-Hispanic, male, and not US citizen. Family income is measured in 1000s of 2013 dollars.
Source: ACT Test Records for Illinois

Science test scores also varied substantially across demographic groups. Typical African American and Hispanic students had scores 2.6 and 1.7 points lower than comparable white non-Hispanic students, respectively. Asian/Pacific Islander students had science scores 1.4 points higher than white non-Hispanics. US citizens had science scores 1.1 points higher than non-citizens. Graduation age was inversely related to the student science scores, with an extra year of age translating into a 1.6 reduction in average science score.

Family income had nearly as large of an effect on science achievement as on math achievement. The typical student from a family at the 25th percentile of family income would score 19.3 as compared with a comparable student from a family at the 75th percentile that would score 21.0.

College Enrollment for Math Treatment Districts

Conditional on student demographics and background, college enrollments at baseline were about 3 percentage points higher in treated than in untreated districts (see Table 7). The primary reason for this difference was that there were more non-college preparatory students from treated districts than from untreated districts.

College enrollment rose faster in districts affected by the higher math requirement than in other districts. Between 2005 and 2013, the enrollment rate rose 2 percentage points in untreated districts (this trend is insignificantly different from zero) as compared with a 5 percentage point increase in treated districts. The higher requirement was associated with a higher overall enrollment rate; the rate did not change for any of the lower-ability and less college motivated subgroups.

These gains in the enrollment rate were small relative to demographic differences in the enrollment rate. African American and Hispanic students had enrollment rates 4 and 11 percentage points lower, respectively, than comparable white non-Hispanic students. Asian/Pacific Islander students had college enrollment rates 8 percentage points higher than white non-Hispanics. The enrollment rate for girls was 8 percentage points higher than for boys. Students that were a year older than their graduation classmates had enrollment rates about 10 percentage points lower the average graduate. The enrollment rate for US citizens was 11 percentage points higher than for non-citizens.

Table 7
Regression Estimates for Immediate College Enrollment by Student Group (Math Treatment Districts)

	All b/se	Low Rank b/se	Low Grades b/se	Not Coll Prep b/se
Year 2005	-0.03018*	-0.02453	-0.03009*	-0.03253*
	(0.00872)	(0.01300)	(0.01263)	(0.00997)
Year 2005 & Math Treated	0.02902*	0.01093	0.01246	0.02630*
	(0.00999)	(0.01477)	(0.01410)	(0.01162)
Trend	0.00258	0.00545*	0.00302	0.00477*
	(0.00135)	(0.00185)	(0.00174)	(0.00169)
Trend & Math Treated	0.00383*	0.00040	0.00117	0.00374
	(0.00154)	(0.00215)	(0.00197)	(0.00192)
African American	-0.04367*	0.02739*	0.01409*	-0.02685*
	(0.00390)	(0.00532)	(0.00469)	(0.00505)
Hispanic	-0.11391*	-0.06686*	-0.07762*	-0.09966*
	(0.00415)	(0.00559)	(0.00477)	(0.00493)
Asian or Pacific Islander	0.07679*	0.09307*	0.09553*	0.08579*
	(0.00381)	(0.00865)	(0.00756)	(0.00608)
Female	0.08255*	0.08033*	0.05936*	0.08025*
	(0.00145)	(0.00261)	(0.00214)	(0.00210)
Age at HS graduation	-0.09985*	-0.08673*	-0.09631*	-0.09472*
	(0.00184)	(0.00273)	(0.00236)	(0.00236)
US Citizen	0.10928*	0.11286*	0.12118*	0.12561*
	(0.00462)	(0.00644)	(0.00567)	(0.00566)
Family Income	0.00414*	0.00308*	0.00350*	0.00407*
	(0.00007)	(0.00014)	(0.00011)	(0.00010)
Family income squared	-0.00001*	-0.00001*	-0.00001*	-0.00001*
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Constant	2.17797*	1.85602*	2.04300*	1.99384*
	(0.03603)	(0.05436)	(0.04690)	(0.04668)
Adjusted R-Square	0.1052	0.09761	0.08305	0.1077
Number of Students	643,935	151,893	230,716	250,810

Note: Entries are regression coefficients with standard errors in parentheses. Asterisk indicates statistical significance at 0.05 level. Omitted reference categories are white non-Hispanic, male, and not US citizen. Family income is measured in 1000s of 2013 dollars. Data is for 2005-2012, since 2013 college enrollments are not yet available.
Source: ACT Test Records for Illinois

Socioeconomic status had a large effect on whether high school graduates enrolled in college. About 72 percent of students with family incomes at the 75th percentile of their class enrolled as compared with only 56 percent of students at the 25th percentile.

College Enrollment for Science Treatment Group

The 2005 college enrollment rate was similar in districts that had already met the 2-year science requirement compared to districts that not, after controlling for student characteristics (see Table 8). Even before the higher state requirement took effect, treated districts had college enrollment rates for non-college preparatory students that were about 2 percentage points higher than those for untreated districts.

The overall level of college enrollment rose by about 4 percentage points between 2005 and 2014, but the trend was similar for treated and untreated districts. Enrollment growth was 5 percentage points for low ranking students, 4 percentage points for students with low grades, and 6 percentage points for non-college preparatory students. Under the higher science requirement, students in treated districts took more science classes than in untreated districts, but this did not lead to higher college enrollment either overall or for any of the subgroups.

The enrollment effects for student demographics and family income were similar to those for districts affected by the math reform. Enrollment rates were lowest for Hispanics, followed by African Americans, white non-Hispanics, and Asian/Pacific Islander. Girls were more likely to start college than boys. US citizens were more likely to enroll than non-citizens, and older graduates were less likely to enroll than younger graduates. Family income had a large effect on college enrollment with 56 percent of students at the 25th percentile starting college as compared with 72 percent of students at the 75th percentile of family income.

Table 8
Regression Estimates for Immediate College Enrollment by Student Group

	All b/se	Low Rank b/se	Low Grades b/se	Not Coll Prep b/se
Year 2005	-0.01227*	-0.01928*	-0.02442*	-0.01809*
	(0.00476)	(0.00701)	(0.00659)	(0.00584)
Year 2005 & Science Treated	0.01516	0.01367	0.01677	0.02266*
	(0.01045)	(0.01399)	(0.01234)	(0.01110)
Trend	0.00541*	0.00646*	0.00443*	0.00762*
	(0.00070)	(0.00103)	(0.00093)	(0.00090)
Trend & Science Treated	-0.00089	-0.00478	-0.00381	-0.00176
	(0.00168)	(0.00246)	(0.00206)	(0.00210)
African American	-0.04388*	0.02733*	0.01410*	-0.02679*
	(0.00390)	(0.00532)	(0.00468)	(0.00504)
Hispanic	-0.11404*	-0.06703*	-0.07778*	-0.09974*
	(0.00414)	(0.00558)	(0.00476)	(0.00493)
Asian or Pacific Islander	0.07662*	0.09298*	0.09544*	0.08578*
	(0.00382)	(0.00865)	(0.00756)	(0.00608)
Female	0.08255*	0.08033*	0.05935*	0.08022*
	(0.00145)	(0.00261)	(0.00214)	(0.00210)
Age at HS graduation	-0.09993*	-0.08672*	-0.09635*	-0.09479*
	(0.00184)	(0.00273)	(0.00236)	(0.00236)
US Citizen	0.10882*	0.11288*	0.12110*	0.12550*
	(0.00466)	(0.00643)	(0.00567)	(0.00566)
Family Income	0.00414*	0.00308*	0.00350*	0.00407*
	(0.00007)	(0.00014)	(0.00011)	(0.00010)
Family income squared	-0.00001*	-0.00001*	-0.00001*	-0.00001*
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Constant	2.18994*	1.85128*	2.04280*	2.00425*
	(0.03586)	(0.05383)	(0.04642)	(0.04672)
Adjusted R-Square	0.1051	0.09770	0.08313	0.1077
Number of Students	643,935	151,893	230,716	250,810

Note: Entries are regression coefficients with standard errors in parentheses. Asterisk indicates statistical significance at 0.05 level. Omitted reference categories are white non-Hispanic, male, and not US citizen. Family income is measured in 1000s of 2013 dollars. Data is for 2005-2012, since 2013 college enrollments are not yet available.
Source: ACT Test Records for Illinois

Discussion

State policymakers may be unrealistic in expecting that simply raising math and science graduation requirements alone through state policy will improve student outcomes. Despite the introduction of higher graduation requirements in math and science, there was little effect on student course-taking, achievement, or college enrollment. The reform even had little effect on students with low class rank, grades, or taking non-college preparatory curriculum. These groups traditionally have taken fewer math and science classes and should have benefitted the most from the reform.

From 2005 to 2013, students took more math courses, but the increase was the same for all students regardless of whether the students were in districts newly subjected to higher graduation requirements or were in districts already requiring the courses. Science course taking did increase for more for students in treated than in untreated districts, but this disproportionate increase in science course taking did not translate into high science achievement scores or an increase in college enrollment.

The findings are consistent with the "algebra for all" policies requiring students to complete algebra by ninth grade or earlier. Although algebra completion generally is related to student achievement such that students taking advanced courses have higher student achievement (Gamoran & Hannigan, 2000), the relationship changes once algebra is required instead of optional. A study in Chicago examining the district's algebra for all ninth graders policy found no improvement in student achievement, a drop in grades, and no change in college going (Allensworth, Nomi, Montgomery, & Lee, 2009). Likewise, states that have algebra requirements have not seen increases in student achievement (Dougherty, 2010; Loveless, 2008).

The research related to high school graduation requirements and "algebra for all" illustrates that requiring certain courses alone will do little to change student learning and behavior. The shortcoming may reflect that the laws primarily affect lower-ability and less-motivated students that often have weaker preparation for advanced coursework. For students to succeed in these courses, they must possess the necessary prerequisite skills to then take advantage of the advanced material. Efforts should be focused on early preparation to ensure that students have the skills by the time they reach high school. For students already in high school, targeted remediation efforts are necessary, and the remediation efforts may need to be differentiated by ability level distinguishing students with very weak ability to those only slightly behind (Nomi & Allensworth, 2009).

Another difficulty is ensuring that the courses remain challenging to best prepare students for college and career. An unintended side effect of increasing high school graduation requirements is that students may be completing more coursework that is less advanced (e.g., a watered-down algebra II course). As schools must expand course offerings, there may be "course credit inflation" which is where "the level of content mastery by the median students receiving credit for a course with a given title declines over time" (Dougherty, Mellor, & Jian, 2006). Thus, as more students are required to take algebra II, the content covered becomes lessened or easier to accommodate the various skill levels of incoming students in the course.

Overall, as states try to increase the preparedness of students for college and career, course requirements alone are not an effective mechanism for change. Exposing students to advanced material is an important first step, but we must recognize that better preparation, better instruction, better student commitment, better parental support, and a host of other factors are needed for students to master these advanced skills. New research is needed to identify what policies and practices will allow a broader cross section of students to embrace and succeed at learning advanced concepts.

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