RESEARCH BRIEF: SKEW THE SCRIPT AND AP STATISTICS†

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INTRODUCTION

Students often struggle to connect new mathematical ideas to practical applications they find engaging. “When are we going to use this in real life?” is a math class cliché. But that cliché is a reminder that the way we teach math does not always elicit the student motivation and attention required to learn math.

This research brief focuses on Skew The Script (STS), a nonprofit organization working to increase math achievement by creating more engaging curriculum—what STS calls “genuinely relevant math lessons.” STS develops lesson plans, materials, and assignments built around practical applications that match high school students’ interests—like online dating, health care, elections, sports, and social media influencers—and offers those materials for free to teachers. While STS first developed materials for AP Statistics, their efforts have expanded to Algebra I and II more recently.

In this brief, we examine how using STS materials affects student achievement in AP Statistics. To estimate the causal effects of STS, we compare year-over-year changes in AP Statistics test scores before and after schools begin using STS curricular materials. We also measure the same year-over-year changes for a comparison group of schools which do not use STS materials. This comparison group allows us to estimate what would have happened in STS schools if they had not begun using STS. The effect of STS is the difference between what did happen in STS schools and what would have happened without STS. In program evaluation research, our approach is known as a difference-in-differences quasi-experimental design. The results in this brief use publicly-available school-level data on AP test taking and pass rates for schools in Massachusetts and Texas from 2015–2023.

Using Skew The Script materials improved AP Statistics pass rates in Texas high schools. Pass rates increased by about 5–6 percentage points in the first year using STS lesson plans and materials. In subsequent years, pass rates were 10-11 percentage points higher than other Texas high schools not using STS. In Massachusetts high schools, by contrast, using STS materials likely increased the number of students taking AP Statistics, but the pass rate did not change. Enrollment did not change in Texas.

† Ji: saraji@g.harvard.edu. Taylor: eric_taylor@gse.harvard.edu, Gutman Library 469, 6 Appian Way, Cambridge, MA, 02138. We thank Skew The Script, especially Dashiell Young-Saver. We also thank the Massachusetts Department of Elementary and Secondary Education and the Texas Education Agency for making available the data used in this study. This research brief reflects the conclusions of the authors, which may or may not be conclusions shared by Skew The Script.

Our results demonstrate the potential for improvements in achievement, as we found in Texas; or the potential to attract more students to study AP Statistics, without lowering achievement, as we found in Massachusetts. This is encouraging early evidence for the STS strategy. Still, the contrast between the results for Texas and Massachusetts suggests we have much more to understand.

This brief documents the beginning of our research collaboration with Skew The Script. In coming work, we plan to study how STS affects outcomes beyond the AP test, like success in college and the labor market. We will also examine the mechanisms that might explain the difference between Texas and Massachusetts we see in these first results, and why some schools adopt STS while similar schools do not, aided partly by more-detailed administrative data. Our goal is to understand the causal effects of Skew The Script's materials and strategy, and how those effects might differ across the variety of schools and students that use STS.

SKEW THE SCRIPT

Skew The Script (STS) is a nonprofit organization which develops curriculum materials—lesson plans, slides, handouts, videos, data sets, assignments, etc.—for AP Statistics and other high school math courses. Teachers can download STS materials free of charge from https://skewthescript.org/. In this research brief, we study how using STS materials affects student achievement in AP Statistics.

What differentiates Skew The Script from other curriculum materials? The most noticeable feature, for a student, is what STS calls *topic relevance*. This is STS's first design principle: "Topic Relevance: The context is compelling. Lessons explore contexts that are authentically meaningful, compelling, and important to students' lives."[1] In practical terms, this means that STS lessons are structured around applications of math that engage high school students' interests. Those practical applications include topics like:

- How much money do social media influencers actually make? (Lesson 8.1: confidence interval for one mean, t-distribution)
- Does gerrymandering distort your vote? (Lesson 6.1: sampling distributions)
- Who is the NBA's G.O.A.T.: Lebron or Jordan? (Lesson 2.1: percentiles, z-scores)
- Does college really pay off? (Lesson 8.3: confidence interval for two means, quasi-experiments)

Contrast these STS applications with the less-engaging examples often found in AP Statistics curriculum materials: the proportion of rotten watermelons among all watermelons produced by a farm, or the probability of getting different combinations of heads and tails by flipping coins repeatedly.

[1] The description of Skew The Script in this section is based primarily on our conversations with STS, our own review of STS curriculum materials, and the STS website, https://skewthescript.org/, as of March 2025. All direct quotations in this section and all examples of STS materials in this section are from the STS website.

STS's second design principle, perhaps less immediately obvious to students, is *content relevance*: "Content Relevance: The math is essential. The math isn't a side-show or veneer. Rather, the math is central, and it provides genuine insight into the context."

"Lesson 8.1 - Confidence Interval for One Mean" illustrates these and other STS design principles for an AP Statistics lesson. The student-relevant topic is "How much money do influencers actually make?" The lesson reviews or introduces concepts like population (or true) mean and standard deviation, sample mean and standard deviation, sampling distribution, standard error, confidence interval, and the t-distribution. These concepts are taught using actual data on earnings from YouTube, sampled at random from among creators who reported their earnings in videos on their YouTube channel. Figure 1 shows example lecture slides for Lesson 8.1, and the full set of slides and related materials are available on the STS website. These slides have several features that you might also find in a non-STS lesson—like graphical and mathematical representations of statistical concepts. However, the non-STS lesson would likely have a more conventional applied example—like data on the heights of students replacing the data on YouTube earnings.

Lesson 8.1 engages students' interest in social media and influencers. Nearly all students consume and contribute to social media. Some aspire to become influencers, attracted by the potential earnings, but perhaps without systematic information on those potential earnings. Lesson 8.1 provides real data on YouTube earnings. These features make the lesson *topic relevant*, in the STS design criteria. Lesson 8.1 is also *content relevant*. Students learn how the average earnings from a small sample of influencers can be misleading, or at least incomplete, information. The lesson introduces mathematical tools—variance, standard error, confidence interval, etc.—that help students understand variability in YouTube earnings and understand how to make inferences about true earnings based on a sample.[2]

Several other STS design principles complement topic relevance and content relevance. STS lesson plans and other materials are designed to have *instructional relevance* and to respect teacher expertise and agency. "Instructional Relevance: The material is instructionally useful. The lessons fit into teachers' calendars, are aligned to math standards, and prepare students for the assessments they need to take." Further, when creating lessons, STS emphasizes the importance of nonpartisan approaches to civic topics and of choosing topics which will likely be of interest to students for years to come.

Our research, to date, focuses on AP Statistics, the first course where STS developed materials with relevant applications. The course's emphasis on data analysis, probability, and statistical inference aligns strongly with STS's mission to make math relevant, showing students how it can be used to interpret everyday phenomena—from social media trends to election outcomes. STS also provides materials for Algebra I and II, following the same design principles.

[2] Additionally, the lesson ends by returning to a concept from an earlier lesson: sampling bias. The data in Lesson 8.1 are a random sample from among influencers who report their earnings on YouTube. The construction of the sampling frame is subject to sampling bias, even if we draw a random sample from that frame, and thus the earnings estimates in Figure 1 are misleading.

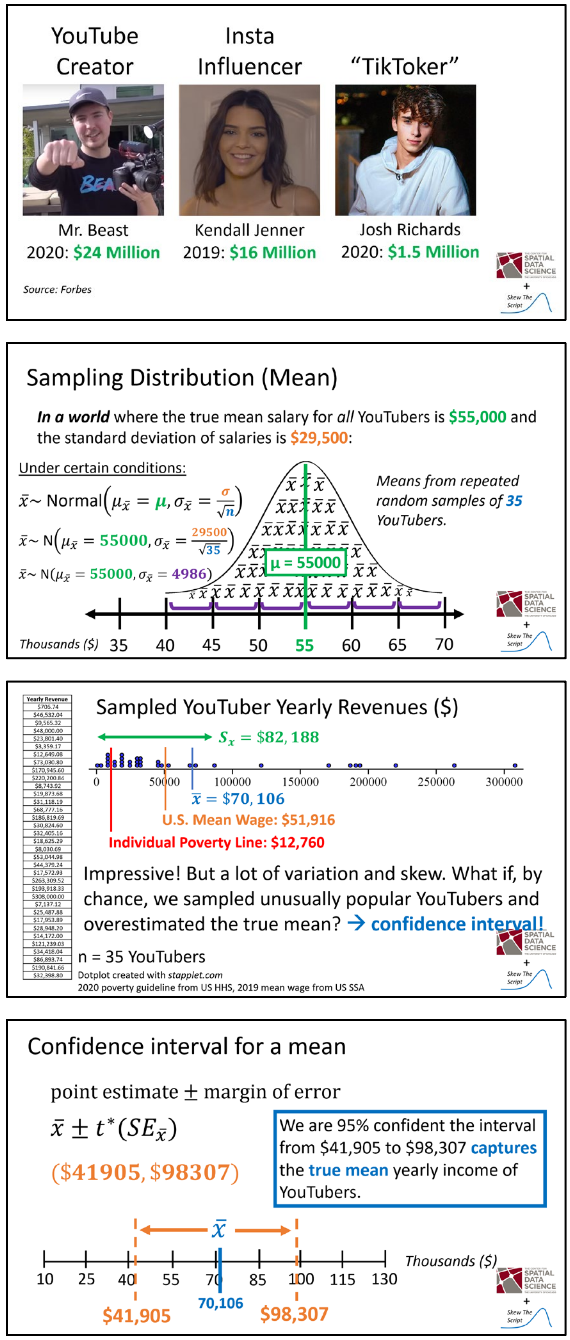


Figure 1—Example Slides from "Lesson 8.1: Confidence Interval for One Mean: How Much Money Do Influencers Actually Make?"

Source: Skew The Script. All materials for Lesson 8.1 are available online at https://skewthescript.org/8-1.

RESEARCH METHODS

Our research question is straightforward: What is the causal effect of using Skew The Script (STS) lesson plans, materials, and assignments on student achievement in AP Statistics?

To answer this question, we use publicly-available data for high schools in Massachusetts and Texas covering seven school years.[3] For each school in each year, we know the number of students who took the AP Statistics exam and the proportion who passed the exam (synonymously, who scored 3 or higher out of 5). Our panel data on high schools include other characteristics and outcomes as described below.

We estimate the effects of STS using a quasi-experimental research method known as difference-in-differences. Using our school panel data, we examine how AP Statistics pass rates change over time at STS schools (synonymously, treated schools). In particular, we compare average pass rates in the years before STS to average pass rates in the years after teachers begin using STS materials. However, this simple "before and after" comparison could be misleading if AP Statistics pass rates were increasing (or decreasing) over time for reasons unrelated to STS. To account for these unrelated changes, we use data for schools which never used STS (synonymously, comparison schools). We calculate the change in AP Statistics pass rate each school year at these comparison schools, and subtract those changes over time from any change in the STS treated schools. The figures in this brief plot, year by year, the difference between pass rates in STS schools and pass rates in comparison schools.

Skew The Script provided us with a list of high schools where one or more teachers have downloaded AP Statistics materials from the STS website. These schools downloaded materials equivalent to roughly weekly use of STS. These schools are the treated schools in our difference-in-differences analysis. STS also provided the date of the first download. We count the school year during which that first download occurred as the first treated year. If the first download happened in the middle of the year only part of that first year was truly treated. Additionally, a teacher may have downloaded materials but not used them in her class. Both of these possibilities would make the estimated effects of STS, reported in this brief, smaller than the true effects of STS. Most comparison schools never downloaded STS materials, but some schools in our comparison sample likely downloaded a few lesson plans. If any comparison schools were using STS, our estimates will understate the benefits of using STS.

[3] Our Massachusetts estimation sample includes 267 schools total, of which 37 were treated, and the school years 2015-16 through 2022-23. Our Texas estimation sample includes 712 schools total, of which 55 were treated, and the school years 2014-15 through 2021-22. Massachusetts data were downloaded from the Department of Elementary and Secondary Education (DESE) public website. Texas data were provided by the Texas Education Agency (TEA) through a public information request. To protect data privacy, school-by-year observations are excluded by TEA when fewer than 10 students took the AP Statistics exam or other exam. DESE follows a similar rule but for 5 of fewer students.

RESULTS

Using Skew The Script (STS) materials improved AP Statistics pass rates in Texas high schools and increased the number of students taking AP Statistics in Massachusetts. Though enrollment in Texas did not change and pass rates in Massachusetts did not change.

Figure 2 shows AP Statistics outcomes over time for Texas high schools. The top graph shows our estimates for exam pass rates. Each blue dot is the difference in outcomes between STS schools and all other high schools in Texas. Specifically, each blue dot is (a) the average pass rate in STS schools, in a given school year, minus (b) the average pass rate in comparison schools the same year. The y-axis measures that difference, (a) minus (b), but scaled so that the difference is set to equal zero in year –1. The x-axis measures time. Year 0 is the first school year during which a teacher downloaded STS materials, and thus the first year a school was treated with Skew The Script. Negative numbers represent years before using STS. The bottom graph in Figure 2 shows the same estimates except the outcome is the number of students who took the AP Statistics exam instead of the pass rate.

AP Statistics pass rates increased after schools began using STS materials. In the first year using STS, year 0 on the graph, pass rates increased by about 5–6 percentage points. In subsequent years, pass rates were 10-11 percentage points higher than other Texas high schools not using STS.

Can we interpret these improvements in AP Statistics pass rates as the causal effects of STS? Yes, if we believe that any differences in AP Statistics pass rates, between treated and comparison schools, would have remained constant over time if treated schools had not used STS materials. Put differently, if treated schools never used STS materials, then their AP Statistics pass rates would have increased (or decreased) over time in the same way that scores increased (or decreased) in the comparison schools. The same logic applies to estimates for other student outcomes studied in this brief.

The pattern of results in Figure 2 does support a causal interpretation. Texas high schools which adopted STS are different from schools which do not use STS, but our quasi-experimental methods account for those pre-existing differences. In the school year just before STS, year –1 on the graph, the AP Statistics pass rate in STS schools was about 20 percentage points lower, on average, than the pass rate in other Texas high schools not using STS. Notice, however, that that 20-point gap in pass rates, between STS and other schools, had been stable for several years prior to when treated schools began using STS materials. In Figure 2 there is little to no change in the pass-rate gap for years –1, –2, –3, etc. Only after treated schools begin using STS does that 20-point gap shrinks to 14–15 points and then further to 9–10 points. This pattern of results supports interpreting these improvements as the causal effect of STS: both STS schools and comparison schools were following the same trajectory over time for several years, then STS schools began improving faster at the time they adopted STS materials. This pattern is evidence in support of the assumption described in the previous paragraph.

Could these improvements in AP Statistics pass rates be caused by something other than using STS materials? One potential explanation is that schools which began using STS materials also made some other change at the exact same time, and that other change, not STS, was the true

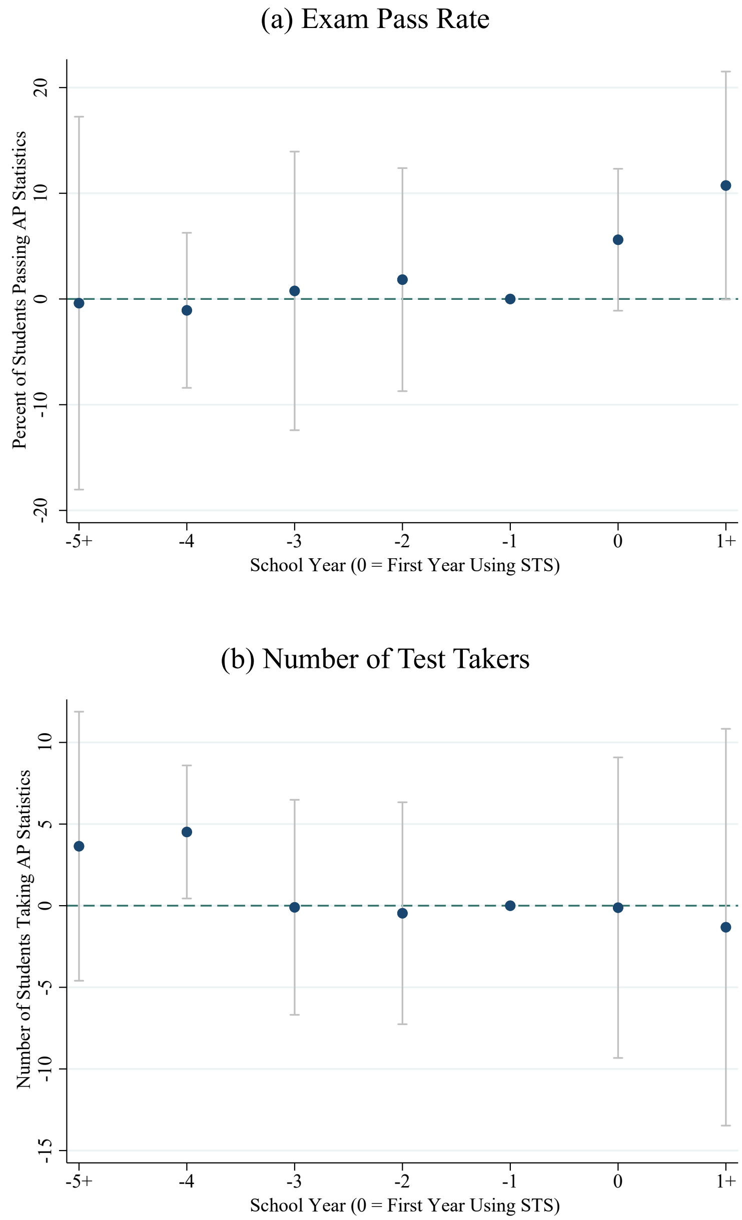


Figure 2—Skew The Script and AP Statistics Exams in Texas High Schools

Note: Each point on the graph is a point estimate obtained by fitting a difference-in-differences event-study style regression specification, with school-by-year observations. In panel (a) the dependent variable is the percentage of students who pass the AP exam, in a given year, among those who take the exam in the school; or in panel (b) the number who took the exam. The estimation sample includes schools observed in all years 2015–2022; schools are not observed in a given year if fewer than 5 students take the AP exam. The vertical lines in the graph represent 95% confidence intervals for each point; standard errors are heteroskedasticity-cluster corrected with schools as clusters.

cause of the improvements. That kind of "other change" might affect the school broadly, for example, a change in the school leadership, a new investment in professional development for teachers, a new school accountability program, or a change in the school's attendance zone. If a school-wide change were the "other change," we would expect to see improvements not just in AP Statistics outcomes but in other student outcomes as well. We do not see changes in other outcomes. Figure 3 shows estimates, using the same methods as Figure 2, but for pass rates in AP English Language and AP Calculus A/B. The English and Calculus pass rates do not change in the years before or after STS adoption.

The potential "other changes" could be specific to AP Statistics not school wide. For example, there may have been a change in the faculty member who was teaching AP Statistics, and that new teacher sought out resources from STS. In that scenario, perhaps that new teacher would have caused an improvement in pass rates with or without STS materials. The publicly-available school-level data we use in this research brief do not include information about teachers; we will soon be examining this empirically with administrative data. Likely there were teacher changes coinciding with STS in some schools, but teacher changes seem unlikely to completely explain the improvements after STS adoption in the average school.

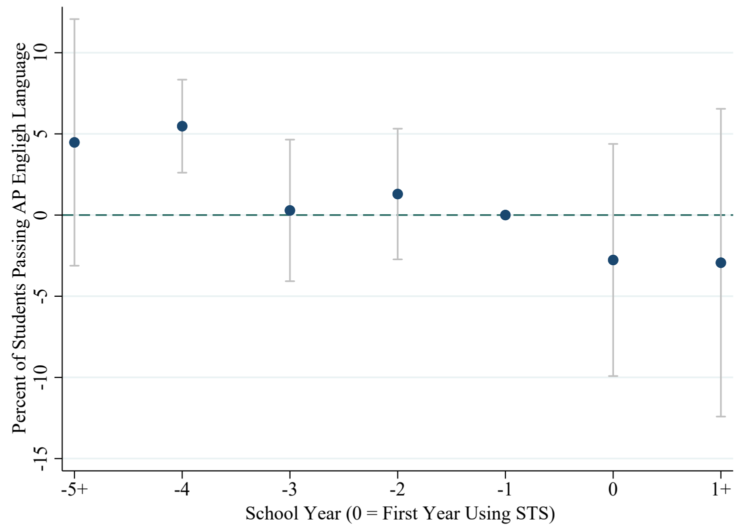
One additional consideration is the number of students taking the AP Statistics exam. The bottom graph in Figure 2 shows that STS did not affect the number of students who took the AP Statistics exam in Texas.[4] One possible "other change" is that a school or teacher began encouraging more students to take AP Statistics and simultaneously sought out resources from STS. A change in the students taking AP Statistics might explain changes in AP test outcomes, with or without STS. As shown in Figure 2, we do not find a change in the number of students taking AP Statistics; in future work with student-level data we will study whether the characteristics of students are changing, e.g., students' prior success in math.

However, a change in the number or characteristics of students who take AP Statistics is not necessarily a threat to our goal of estimating the causal effects of STS. A change in students might occur *because of* STS, not just happen coincidentally at the same time. For example, new students might enroll in AP Statistics because they hear from peers that the course is now more engaging. In other words, changes in students that occur because of STS are part of the causal effects of STS we want to understand.

In summary, in Texas high schools, Figure 2 shows improvements in AP Statistics exam pass rates when teachers use STS materials. These improvements are likely caused by STS use, not by other changes that happened to occur in STS schools concurrently. Pass rates for other AP exams were unaffected, and we see no evidence of changes in students taking the exams in Texas.

[4] There is some suggestion in the graph that the number of students taking AP Statistics was, in general, declining over time. But these apparent differences are not statistically significant at conventional levels.

(a) English Exam Pass Rates



(b) Calculus Exam Pass Rates

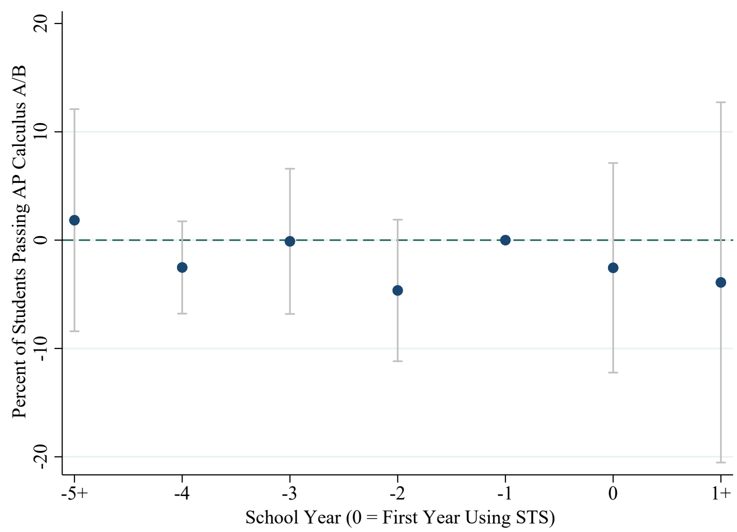


Figure 3—AP English and AP Calculus Exams in Texas High Schools

Note: Each point on the graph is a point estimate obtained by fitting a difference-in-differences event-study style regression specification, with school-by-year observations. The dependent variable is the percentage of students who pass the AP exam, in a given year, among those who take the exam in the school. The estimation sample includes schools observed in all years 2015–2022; schools are not observed in a given year if fewer than 5 students take the AP exam. The vertical lines in the graph represent 95% confidence intervals for each point; standard errors are heteroskedasticity-cluster corrected with schools as clusters.

We now shift focus to Massachusetts. For Massachusetts high schools, the relationship between STS and AP Statistics pass rates is not clear. Figure 4 provides results for Massachusetts paralleling Figure 2 for Texas. In the years after teachers begin using STS materials, the pass rates are sometimes higher and sometimes no different from Massachusetts schools which never used STS. However, the estimates showing increases in pass rates are not statistically significantly different from zero. Moreover, the variation over time in post-STS years is similar to the variation in pre-STS years. For these reasons we advise readers to not draw strong conclusions about AP Statistics pass rates, positive or negative, from the quasi-experimental results in Massachusetts. In future work, we expect to sharpen our analysis with administrative data.

Our current results are clearer regarding changes in the number of students taking AP Statistics in Massachusetts. Those results are shown in the bottom graph in Figure 4. In the first year using STS, year 0 on the graph, the number of students does not change substantially. However, in subsequent years, our estimates suggest 8–9 additional students are taking the AP Statistics exam each year in schools using STS. The differences are not statistically significant, but the pattern of results is much more consistent with STS having a causal effect on the number of students (in contrast with the top graph in Figure 4 for pass rates).

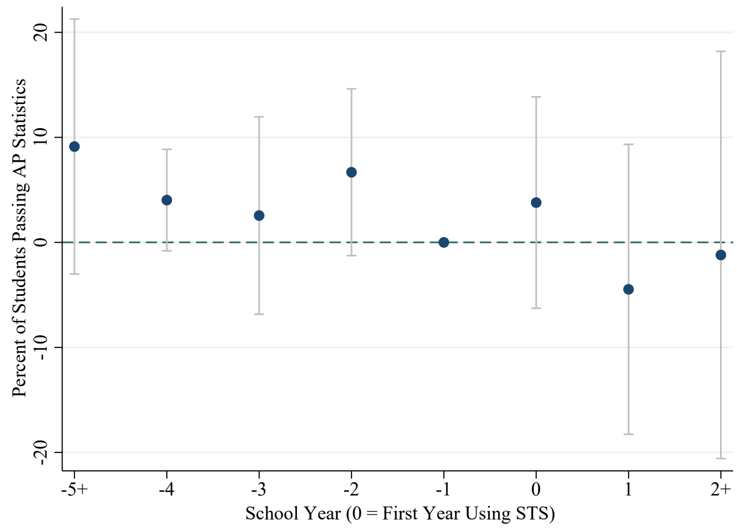
As mentioned already, a change in the number or characteristics of students who take AP Statistics is a potential benefit of using STS materials. The results in Figure 4 suggest more students took AP Statistics in Massachusetts high schools because of STS. As we continue to study STS and its effects, we plan to examine these potential benefits further. Understanding the change in students is also important to understanding the change in pass rates. Enrolling new students, who are potentially less prepared, may benefit those new students but reduce the average pass rate in the school. The increase in enrollment in Massachusetts may partly explain the lack of clear effects on exam pass rates.

DISCUSSION

The results summarized in this brief are encouraging evidence for Skew The Script's strategy—develop lesson plans, materials, and assignments for math instruction built around practical applications that match high school students' interests. Our results demonstrate the potential for improvements in achievement, as we found in Texas, and the potential to attract more students to study AP Statistics, as we found in Massachusetts. These results are not conclusive; notably, we do not find improved exam pass rates in Massachusetts. We do believe these results are encouraging and should motivate further study of STS and its strategy more generally.

Greater achievement in AP Statistics during high school will likely benefit students in college and beyond. A small collection of empirical research studies, over the past decade or so, have documented the benefits of taking AP courses and passing AP exams. Students who pass AP exams are more likely to attend and graduate from college, and students who pass AP Statistics (or other STEM-focused AP exams) are more likely to major in a STEM field in college. Success on AP exams in high school also predicts higher earnings in the future labor market as an adult. Still,

(a) Exam Pass Rate



(b) Number of Test Takers

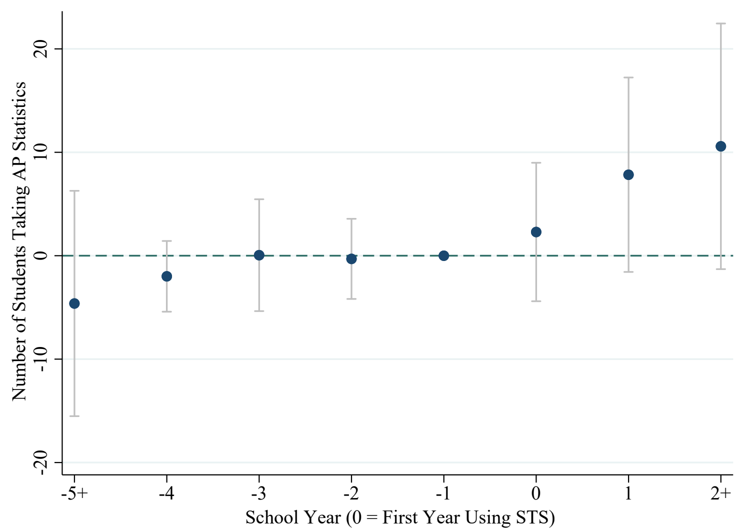


Figure 4—Skew The Script and AP Statistics Exams in Massachusetts High Schools

Note: Each point on the graph is a point estimate obtained by fitting a difference-in-differences event-study style regression specification, with school-by-year observations. In panel (a) the dependent variable is the percentage of students who pass the AP exam, in a given year, among those who take the exam in the school; or in panel (b) the number who took the exam. The estimation sample includes schools observed in all years 2016–2023; schools are not observed in a given year if fewer than 10 students take the AP exam. The vertical lines in the graph represent 95% confidence intervals for each point; standard errors are heteroskedasticity-cluster corrected with schools as clusters.

AP curriculum can be challenging, and students who take AP courses may have more stress and lower course grades during high school.[5]

If achievement in AP courses benefits students, the natural follow-up questions are: What strategies can we use to *increase* achievement among students taking AP courses? What strategies would get *more* students to take AP courses? Very little research evidence exists today that would help parents, educators, or policymakers answer these questions. Our analysis of Skew The Script is important new evidence.

Still, while evidence is scarce, our findings for STS are not without some precedent. First, a different AP-focused strategy—the Advanced Placement Incentive Program (APIP)—also increased AP course enrollment and exam pass rates. APIP provides cash rewards to students and teachers for AP success, some additional training for teachers, and middle school curriculum to help students prepare for future AP coursework.[6] Both STS and APIP demonstrate the potential to improve achievement in AP-level material, especially among students already taking AP courses. Second, with parallels to Skew The Script's strategy, CitizenMath (formerly Mathalicious) creates math lesson plans and other materials which emphasize practical applications which engage students' interests. In a field experiment, grade 6–8 math test scores improved meaningfully when teachers were given CitizenMath lesson plans.[7] Compared to other alternatives, STS has a relatively low marginal cost for schools and teachers. STS materials are free and readily available online. The time a teacher invests in new lesson plans in one year will have returns in future years. By contrast, incentive programs, like APIP, require annual expenditures for each participating school.

This brief documents the beginning of our research collaboration with Skew The Script. While these preliminary results are encouraging, we plan to examine a variety of additional questions and expand our data sources. Achievement in AP Statistics predicts future success, but in coming work we plan to directly measure STS effects on those future outcomes—high school completion; college applications, admission, and attendance; and success in the labor market. We also plan to study how changes in a school's student body or teachers influence the adoption of STS materials, aided by student-level administrative data. Answering these additional questions will, in part, help clarify when a causal interpretation of our estimates is warranted and when it may not be. Our broader research agenda and collaboration will also help answer the practical questions stated above: What strategies can we use to *increase* achievement in high school math? What strategies would get *more* students to take advanced math courses?

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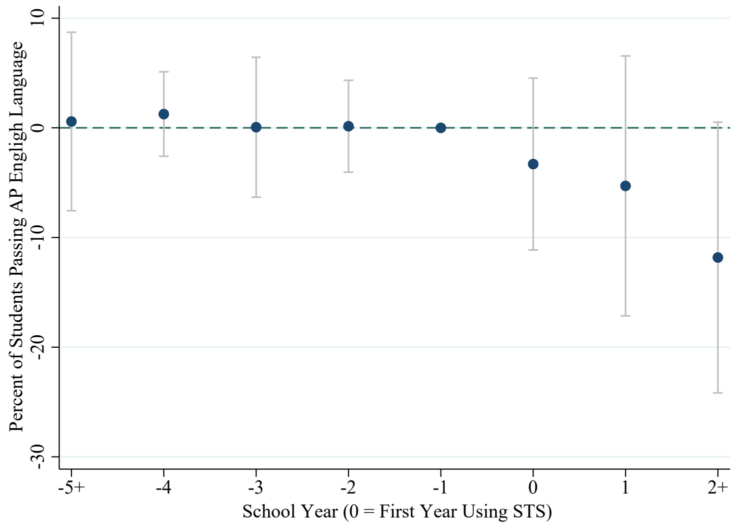
[5] Avery, C., Gurantz, O., Hurwitz, M., & Smith, J. (2018). Shifting college majors in response to advanced placement exam scores. *Journal of Human Resources, 53*(4), 918-956.
Conger, D., Kennedy, A. I., Long, M. C., & McGhee, R. (2021). The effect of Advanced Placement science on students' skills, confidence, and stress. *Journal of Human Resources*, *56*(1), 93-124.
Jackson, C. K. (2010). A little now for a lot later: A look at a Texas advanced placement incentive program. *Journal of Human Resources, 45*(3), 591-639.
Jackson, C. K. (2014). Do college-preparatory programs improve long-term outcomes? *Economic Inquiry*, *52*(1), 72-99.
Smith, J., Hurwitz, M., & Avery, C. (2017). Giving college credit where it is due: Advanced Placement exam scores and college outcomes. *Journal of Labor Economics, 35*(1), 67-147.

[6] Jackson (2010), Jackson (2014).

[7] Jackson, K., & Makarin, A. (2018). Can online off-the-shelf lessons improve student outcomes? Evidence from a field experiment. *American Economic Journal: Economic Policy*, *10*(3), 226-254.

(a) English Exam Pass Rates



(b) Calculus Exam Pass Rates

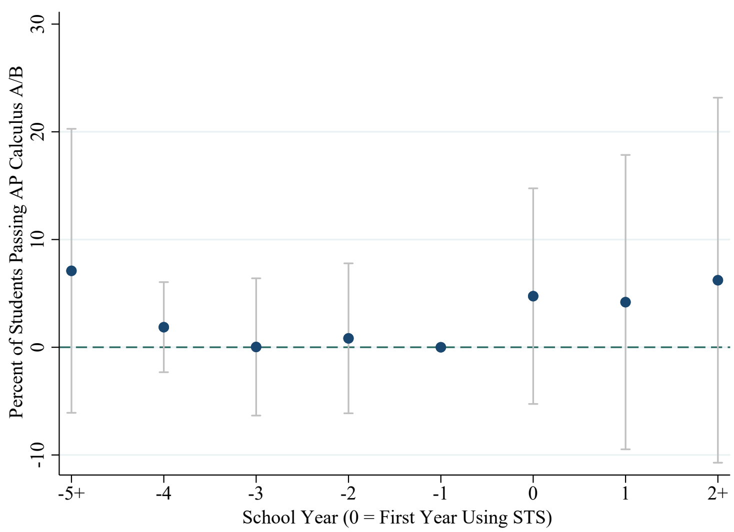


Figure 5—AP English and AP Calculus Exams in Massachusetts High Schools

Note: Each point on the graph is a point estimate obtained by fitting a difference-in-differences event-study style regression specification, with school-by-year observations. The dependent variable is the percentage of students who pass the AP exam, in a given year, among those who take the exam in the school. The estimation sample includes schools observed in all years 2016–2023; schools are not observed in a given year if fewer than 10 students take the AP exam. The vertical lines in the graph represent 95% confidence intervals for each point; standard errors are heteroskedasticity-cluster corrected with schools as clusters.