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| Advancing STEM and English AP Program Evaluation—Year 8AP Course Taking and Passing Rates, Analysis ReportFinal Report |
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Advancing STEM and English AP Program Evaluation—Year 8

*AP Course Taking and Passing Rates, Analysis Report*

Prepared by the UMass Donahue Institute’s
Applied Research & Program Evaluation Group

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# Acknowledgments

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# Executive Summary

The Massachusetts Department of Elementary and Secondary Education (DESE) is engaged in numerous initiatives to increase the college and career readiness of students in the Commonwealth, to reduce proficiency gaps and improve academic achievement for all population groups, and to enhance the “STEM pipeline” of students who are interested in and well prepared for postsecondary education and careers in science, technology, engineering, and mathematics (including computer science). One of these initiatives is the AP STEM and English program. As specified by DESE, the goals of the program center on promoting student achievement in Advanced Placement courses and exams, especially among historically underserved populations and school and teacher transformation related to the delivery and sustainment of AP programming.

To meet these program goals and track efforts to improve student achievement, DESE contracted with Mass Insight Education and Research (Mi) as a vendor to implement tasks and responsibilities aligned with the purposes of the program. Mi aims to implement four key tasks in partner schools that participate in the statewide program:

1. Increase participation and improve performance in AP science, mathematics, and ELA courses and on exams, with a focus on historically underserved students.
2. Increase the effectiveness of AP science, mathematics, and ELA teachers.
3. Increase the number of new and/or additional AP science, mathematics, and ELA courses offered by districts and schools in the Commonwealth.
4. Develop collaborations with other existing and/or newly established AP initiatives or organizations to build a robust and collaborative support system for historically underserved students, their parent(s)/guardian(s), and teachers.

In their work to complete these tasks, Mi is responsible for a variety of activities falling in three main tiers of assistance: 1) teacher supports, 2) student supports, and 3) school supports. Considering these three overarching types of support offered by Mi, the Year 8 evaluation study focused on measuring the outcomes that occurred as a result of teachers, students, and/or schools receiving Mi support. More specifically, this year’s evaluation focused on three program outcomes, which note that schools participating in Mi’s program should show increased AP course availability, more students taking AP exams and courses, and more students scoring a 3 or better on AP exams.

To measure these three program outcomes, the Year 8 study will include a series of reports that will provide descriptive information and measure program outcomes on AP course availability, AP course participation and passing rates, and AP exam participation and passing rates for AP STEM and English courses:

* AP Course Availability Report
* AP Course Participation and Passing Rates, Descriptive Report
* AP Course Participation and Passing Rates, Analysis Report
* AP Exam Participation and Passing Rates, Descriptive Report
* AP Exam Participation and Passing Rates, Analysis Report

DESE contracted with the University of Massachusetts Donahue Institute (UMDI) to conduct the multiyear evaluation of the Mi program. UMDI previously submitted interim and final evaluation reports for Years 1–7. This report for the Year 8 evaluation provides a summary of the quasi-experimental analyses conducted to compare AP course participation and passing rates of students at participating schools to those of non-participating schools, and will aim to respond to the following questions:

1. Has there been a change in the percentage of students—particularly underrepresented and economically disadvantaged students—taking AP science, mathematics, and ELA courses at participating schools compared to similar non-participating schools? If change is observed, is it positive (i.e., increased percentage of students taking AP science, mathematics, and ELA courses)?
2. Has there been a change in the percentage of students—particularly underrepresented and economically disadvantaged students—passing AP science, mathematics, and ELA courses at participating schools compared to similar non-participating schools? If change is observed, is it positive (i.e., increased percentage of students passing AP science, mathematics, and ELA courses)?

UMDI collected several secondary data sources from DESE to address these questions.

**Key Findings**

In brief, findings in this report indicate that:

* The AP STEM and English program generally had a positive effect on student AP course taking and passing rates during the first year of participation, though results were mixed by subject and student group. The intervention did not impact the rate of AP course taking or passing after the first year of program participation.
* The AP STEM and English program had a positive effect on AP ELA and math course taking and passing rates during the first year of the intervention.
* The percentage of students *taking* ELA and math courses increased by 3.76 percentage points and 2.03 percentage points (respectively) more at participating schools than at similar non-participating schools during the first year of participation.
* The percentage of students *passing* ELA and math courses increased by 3.33 percentage points and 1.64 percentage points (respectively) more at participating schools than at similar non-participating schools during the first year of participation.
* The AP STEM and English program had no effect on AP science course taking or passing rates.
* The effect of the AP STEM and English program on the AP course taking and passing rates of historically underserved populations was mixed.
* The program had a positive effect on AP course taking and passing rates for ECODIS students, as well as for non-ECODIS students. The rate of taking any AP course increased more for non-ECODIS students (5.62 percentage points) than it did for ECODIS students (3.05 percentage points). Similarly, the rate of passing any AP course increased more for non-ECODIS students (4.75 percentage points) than it did for ECODIS students (2.48 percentage points).
* The program had no effect on AP course taking or passing rates for African American / Black students, Hispanic/Latino students, or English language learners.

# Introduction

The Massachusetts Department of Elementary and Secondary Education (DESE) is engaged in numerous initiatives to increase the college and career readiness of students in the Commonwealth, to reduce proficiency gaps and improve academic achievement for all student groups, and to enhance the “STEM pipeline” of students who are interested in and well prepared for postsecondary education and careers in science, technology, engineering, and mathematics (including computer science).

One of these initiatives is the AP STEM and English program (hereafter, “the program”). As specified by DESE, the goals[[1]](#footnote-1) of the program are to:

1. Increase AP science, mathematics, and ELA course availability, particularly at schools with limited AP science, mathematics, and ELA offerings and high percentages of historically underserved students,
2. Increase historically underserved students’ participation in AP science, mathematics, and ELA courses, such that the demographics of these courses better reflect the diversity of the student population of the school and district,
3. Increase student performance in AP science, mathematics, and ELA courses,
4. Increase the number of students taking AP exams, particularly historically underserved students,
5. Increase the number of students scoring a 3 or higher on AP exams, particularly underrepresented minority students and students who are economically disadvantaged,
6. Increase readiness for college-level study in science, mathematics, and ELA fields, and
7. Improve science, mathematics, and ELA teacher effectiveness, including content knowledge and pedagogical skills.

To meet these program goals and track efforts to improve student achievement, DESE contracted with Mass Insight Education and Research (Mi) as a vendor to implement tasks and responsibilities aligned with the purposes of the program. Mi has administered the program since the initiative’s inception in 2007, including under the program’s previous name, Mass Math + Science Initiative’s (MMSI) “Advanced Placement Training and Awards Program”.

Mi’s first cohort of the program was comprised of eight schools during the 2008–09 academic year. The program welcomed its 12th cohort of schools during the 2019–20 academic year. While Mi has continued to evolve their program over time to continue meeting the needs of participating schools, the key tasks to be implemented by the statewide program have been consistent over time. Namely, Mi aims to do the following in each participating school:

1. Increase participation and improve performance in AP science, mathematics, and ELA courses and on exams, with a focus on historically underserved students.
2. Increase the effectiveness of AP science, mathematics, and ELA teachers.
3. Increase the number of new and/or additional AP science, mathematics, and ELA courses offered by districts and schools in the Commonwealth.
4. Develop collaborations with other existing and/or newly established AP initiatives or organizations to build a robust and collaborative support system for historically underserved students, their parent(s)/guardian(s), and teachers.

In their work to complete these tasks, Mi is responsible for a variety of activities that fall into three main tiers of assistance: 1) teacher supports, 2) student supports, and 3) school supports. Specific examples of these forms of assistance include, but are not limited to, maintaining partnerships with schools with high percentages of minority and economically disadvantaged students, encouraging recruitment of minority and economically disadvantaged students into AP science and mathematics classes, providing exam fee subsidies to economically disadvantaged students, and supporting professional development for STEM AP teachers.

DESE contracted with the University of Massachusetts Donahue Institute (UMDI) to conduct the multiyear evaluation of the Mi program. UMDI previously submitted interim and final evaluation reports for Years 1–7. This report for the Year 8 evaluation provides a summary of the quasi-experimental analyses conducted to compare AP course participation and passing rates of students at participating schools to those of non-participating schools.

This report is organized into five main sections. The first three sections—Evaluation Design, Data and Data Analysis, and Methods for Quasi-Experimental Analysis—provide an overarching description of the Year 8 analysis, and summarize the methods of analysis for the quasi-experimental analysis. The fourth section—Findings—presents the key results from the quasi-experimental analysis. A final section summarizes this part of the Year 8 work.

# Evaluation Design

The Year 8 evaluation was designed to expand upon the work completed during two recent years—to be specific, Year 5 and Year 7. The Year 5 evaluation utilized a quasi-experimental design to assess outcomes for schools participating in the program. This quasi-experimental design was repeated for the Year 8 evaluation with additional years of data—although the design was modified to utilize the most robust statistical analysis possible with the available data. The outcomes measured by the quasi-experimental design were from the program’s logic model (Figure 1), which was updated during Year 7.

**Figure 1. AP STEM and English Program Logic Model**

The Year 8 evaluation study will focus on measuring three of the four outcomes included in the logic model: increased AP course availability, more students take AP exams and courses, and more students score a 3 or better on AP exams. Research questions intended to map on to these three outcomes were developed and finalized by DESE, Mi, and UMDI. These research questions fall into four categories and are as follows:

AP Course Availability

1. How many AP science, mathematics, and ELA courses have been available in participating schools over time, particularly in schools with limited offerings for economically disadvantaged and underrepresented minority students?
2. Has there been a change in the availability of AP science, mathematics, and ELA courses in participating schools compared to similar non-participating schools? If change is observed, is it positive (i.e., increased availability of AP science, mathematics, and ELA courses)?

AP Course Participation and Passing

1. Has there been a change in the percentage of students—particularly underrepresented and economically disadvantaged students—taking AP science, mathematics, and ELA courses at participating schools compared to similar non-participating schools? If change is observed, is it positive (i.e., increased percentage of students taking AP science, mathematics, and ELA courses)?
2. Has there been a change in the percentage of students—particularly underrepresented and economically disadvantaged students—passing AP science, mathematics, and ELA courses at participating schools compared to similar non-participating schools? If change is observed, is it positive (i.e., increased percentage of students passing AP science, mathematics, and ELA courses)?

AP Exam Participation and Passing

1. Has there been a change in the percentage of students—particularly underrepresented and economically disadvantaged students—taking AP science, mathematics, and ELA exams at participating schools compared to similar non-participating schools? If change is observed, is it positive (i.e., increased percentage of students taking AP science, mathematics, and ELA exams)?
2. Has there been a change in the percentage students—particularly underrepresented and economically disadvantaged students—passing AP science, mathematics, and ELA exams at participating schools compared to similar non-participating schools? If change is observed, is it positive (i.e., increased percentage of students passing AP science, mathematics, and ELA exams)?

Summary Questions

1. What can be learned—through descriptive analysis—about trends in AP exam taking?
2. What portion of schools experience marked increases in AP exam participation during their first year of program participation?

To answer these research questions, the Year 8 study will deliver a series of reports that will provide descriptive information and measure program outcomes on (1) AP course availability, (2) AP course participation and passing rates, and (3) AP exam participation and passing rates for AP STEM and English courses. With the exception of the report on AP Course Availability, one report with descriptive statistics and one report with the results from the quasi-experimental analysis will be written for each of these outcome areas, for a total of five reports:

* AP Course Availability Report
* AP Course Participation and Passing Rates, Descriptive Report
* AP Course Participation and Passing Rates, Analysis Report
* AP Exam Participation and Passing Rates, Descriptive Report
* AP Exam Participation and Passing Rates, Analysis Report

This third report presents results from quasi-experimental analyses completed to address research questions 2 and 3 on AP course participation and passing:

1. Has there been a change in the percentage of students—particularly underrepresented and economically disadvantaged students—taking AP science, mathematics, and ELA courses at participating schools compared to similar non-participating schools? If change is observed, is it positive (i.e., increased percentage of students taking AP science, mathematics, and ELA courses)?
2. Has there been a change in the percentage of students—particularly underrepresented and economically disadvantaged students—passing AP science, mathematics, and ELA courses at participating schools compared to similar non-participating schools? If change is observed, is it positive (i.e., increased percentage of students passing AP science, mathematics, and ELA courses)?

Information on the data included in these analyses, and how the data was analyzed follows in the next section.

# Data and Data Analysis

This report includes a summary of analyses comparing (1) the rates with which students *take* AP ELA, math, and/or science courses at participating schools to those of similar non-participating schools, and (2) the rates with which students *pass* AP ELA, math, and/or science courses at participating schools to those of similar non-participating schools.

These analyses are based on AP course data, from the Student Course Schedule (SCS) data file, provided by DESE from SY11 to SY19.[[2]](#footnote-2) Data were merged with corresponding SIMS data in order to identify key demographic information for participating students—where participating students were those in grades 9–12, and were enrolled in schools that are part of the AP STEM and English program. The newly merged data file included key information on which students were taking AP ELA, math, and science courses takers and which students were considered AP course passers. In order to be considered a course passer a student must have (1) completed the AP course, (2) earned credit, and (3) received a passing letter or numeric grade within the AP course. Student-level data on taking and passing rates were used to conduct the quasi-experimental analyses.

The quasi-experimental analyses conducted to compare AP course taking and passing rates at participating schools to those of similar non-participating schools were comparative interrupted time series (CITS) analyses and difference-in-difference (DID) analyses. The CITS analyses conducted—which are described in further detail in the next section—were completed with schools that started the intervention during SY15, SY16, or SY17 (Cohorts VII–IX). Earlier and later cohorts are not included in this analysis because the years of data required to complete a CITS model were not available. In total, 32 schools were included in the treatment group (participating schools) and 225 schools were considered for inclusion in the comparison group (non-participating schools).[[3]](#footnote-3) The actual number of schools included in the models varied by subject and by outcome (taking/passing).

Additionally, DID analyses—which are described in further detail in the next section—were conducted with schools that started the intervention during SY12 (Cohort IV) and during SY16 and SY17 (Cohorts VIII–IX). The DID analyses examined the change in the percentage of students—that qualify for free or reduced-price lunch and/or are economically disadvantaged—taking and passing AP ELA, math, and science courses. Additionally, DID analyses were conducted to assess the impact of the program on course taking and passing rates for all students. Free or reduced-price lunch (FRL) was used as a proxy for measure low-income for schools that started the program during SY12 , economically disadvantaged (ECODIS) was used for schools that started the program during SY16 and SY17. Earlier and later cohorts for the DID analyses are not included because the years of data required to complete DID analyses were not available for either FRL or ECODIS. In total, nine schools were included in the treatment group, and 225 schools were considered for inclusion in the comparison group when including the FRL covariate. When conducting the including the ECODIS covariate in the DID analysis, 18 schools were included in the treatment group, and 222 schools were considered for inclusion in the comparison group. The actual number of schools included in the models varied based on the subject and student group of interest for both outcome measures: taking and passing.

This report summarizes the results of quasi-experimental analyses that compared the AP course taking and passing rates at participating AP STEM and English schools to those at non-participating schools. Quantitative results are presented by subject and student group, and examine the impact of the program on the following:

* the percentage of students taking and passing at least one AP ELA, math, or science course the year participation began;
* the annual change in the percentage of students taking and passing at least one AP ELA, math, or science course; as well as,
* the percentage of students taking and passing at least one AP ELA, math, or science course two years after participation began when FRL and ECODIS metrics are used as proxies for low-income students.

A summary of results is presented in the “Findings” section. Full model results for all CITS and DID analyses are provided in Appendices C and D.

# Methods for Quasi-Experimental Analysis

The AP STEM and English program is a school-level intervention. As such, analyses to assess the program’s impact on AP course taking and course passing rates were conducted at the school level, comparing participating AP STEM and English program schools (treatment schools) to similar schools that did not participate in the program (comparison schools).

The impacts of the AP STEM and English program were assessed for both AP course taking rates and for AP course passing rates. Rates were calculated as the number of students taking/passing an AP ELA, math, or science course divided by the total number of enrolled high school students in a school.[[4]](#footnote-4),[[5]](#footnote-5)

Program impact on AP course taking and passing was assessed using both comparative interrupted time series (CITS) analysis and difference-in-difference (DID) analysis. The CITS analysis was the primary method of analysis conducted, whenever possible, because of its robustness. CITS analyses allowed for a comparison of treatment and control schools, and accounted for baseline trends in the outcomes of interest and other covariates of interest.

## CITS Analysis

Differences in treatment and comparison schools were assessed using a comparative interrupted time series design. In this design, AP course taking/passing rates in treatment and comparison schools are observed across multiple school years before and after the introduction of the AP STEM and English program. The AP STEM and English program is intended to “interrupt” the level of AP course taking/passing rates—and/or the trend (i.e., the change over time) in AP course taking/passing rates—that would have been observed in the absence of the intervention. Using both AP STEM and English program schools and comparison schools is what makes the interrupted time series “comparative,” and this enables stronger inferences about what AP course taking/passing rates, and trends, would have been observed in absence of the AP STEM and English program.

The CITS models assessed the effects of the AP STEM and English program on four academic groupings: (1) taking/passing rates for any AP ELA, math, or science course, (2) taking/passing rates for AP ELA courses, (3) taking/passing rates for AP math courses, and (4) taking/passing rates for AP science courses. For each of these four academic groupings, program impact on AP course taking/passing rates were assessed as an aggregate—across all students in AP STEM and English schools—and individually by various student groups. Finally, for each set of analyses previously mentioned, two sets of models were conducted; one to assess the impact of the program on AP course taking rates and the other assessing program impact on AP course passing rates. Each set of analyses included 12 models for each of the four academic groupings, yielding 48 models for each of the outcome measures; for a total of 96 CITS models.

1. CITS analyses on all students: Impacts on all students in all AP STEM and English schools. (Four academic discipline groupings and two outcomes measured yielded eight CITS models.)
2. CITS analyses on student groups: Impacts on groups of students in all AP STEM and English schools. Student groups that were assessed were female, male, Asian, African American / Black, Hispanic/Latino, Multi-Race and Non-Hispanic/Latino, White, English language learners (ELL), non-English language learners (non-ELL), students with disabilities (SWD), students without disabilities (non-SWD).[[6]](#footnote-6) (Eleven student groups, four academic discipline groupings, and two outcomes yielded 88 CITS models.)

## DID Analysis

Differences in treatment and comparison schools were also assessed using a difference-in-difference (DID) design. This model calculates the effect of a treatment on an outcome by comparing the average change over time in the outcome variable for the treatment group, compared to the average change over time for the control group. For this study, AP course taking and passing rates were observed one school year before and two school years after the introduction of the AP STEM and English program to see if the differences in AP course taking and passing rates, two years after participation, were significantly different from differences in the same rates at similar comparison schools. Using both AP STEM and English and comparison schools enables stronger inferences about what AP course taking and passing rates would have been observed in the absence of the AP STEM and English program.

The DID models assessed the effects of the AP STEM and English program on four academic groupings: (1) taking/passing rates for any ELA, math, or science AP course, (2) taking/passing rates for ELA AP courses, (3) taking/passing rates for math AP courses, and (4) taking/passing rates for science AP courses. For each of these four academic groupings, program impact on AP course taking and passing rates were assessed for two low-income measures: (1) free or reduced-price lunch, which was available SY14 and prior, and (2) economically disadvantaged, which was available SY15 and later. Both of these measures were assessed as an aggregate—across all students in AP STEM and English schools—and individually by the following student groups: free or reduced-price lunch, non-free or reduced-price lunch, economically disadvantaged, and non-economically disadvantaged. Finally, for each of the analyses previously mentioned, two sets of models were conducted; one to assess the impact of the program on AP course taking rates and the other assessing program impact on AP course passing rates. Each set of analysis, for both measures of low-income (FRL and ECODIS), included three models for each of the four academic groupings, yielding 24 models for each of the outcome measures; for a total of 48 DID models.

1. DID analyses on all students: Impacts on all students in all AP STEM and English schools. (Two measures of low income—free and reduced-price lunch and economically disadvantaged—for four academic discipline groupings on two outcomes measured yielded 16 DID models.)
2. DID analyses on student groups: Impacts on groups of students in all AP STEM and English schools. The student groups assessed were free and reduced-price lunch, non-free and reduced-price lunch, economically disadvantaged, and non-economically disadvantaged. (Four student groups, four academic discipline groupings, and two outcomes yielded 32 DID models.)

Program impact on AP course taking/passing rates was determined through a procedure called propensity score weighting.

## Propensity Score Weighting for CITS and DID Models

The AP STEM and English program did not utilize random assignment because each school was selected by Mi to participate based on school characteristics. Therefore, it is likely that there were differences between treatment and comparison schools prior to intervention. These differences could have represented a significant threat to the validity of the study’s findings. To reduce these differences substantially, propensity score weighting procedures were used, thereby improving the validity of the estimates of program impacts.[[7]](#footnote-7)

In essence, propensity score weighting is used to approximate the results of random assignment by reducing multiple covariates (e.g., race/ethnicity, gender, AP course taking/passing rates prior to the AP STEM and English program) to a single score called a propensity score. A propensity score was calculated for each treatment and comparison school that described the likelihood of that school participating in the AP STEM and English program. Weighting procedures were then applied to balance propensity scores for treatment and comparison schools. Propensity scores allowed the research team to generate estimates of the average treatment effect for the treated (ATT) population. This approach is typical for quasi-experimental studies that try to assess the impact of a particular program, such as the AP STEM and English program.

Covariates used in the propensity score weighting procedure included pre-intervention rates of AP course taking/passing (from the four school years prior to intervention for CITS analyses and one year prior to intervention for DID analyses), gender, race/ethnicity, ELL status, special education status, and average school MCAS CPI (by subject, as appropriate for each analysis). In addition, for DID analyses, the propensity score weighting procedure also included the percentage of FRL students or the percentage of ECODIS students one year prior to intervention, as applicable. Once weights were assigned, the balance of the covariate distributions between treatment and comparison schools was assessed in terms of standardized bias. For this study, we considered a covariate to be balanced if the standardized bias was less than 0.25. Although there is no universal criterion for assessing precisely when balance has been achieved, 0.25 is commonly used.[[8]](#footnote-8)

To assess each CITS and DID model’s potential for producing findings with a high likelihood of validity, the balance of covariates after weighting was considered. When propensity score weighting was completely successful, it yielded a comparison group that met the balance criteria (i.e., standardized bias less than 0.25) for all covariates. Models in which all covariates met this criterion after weighting were designated as “fully balanced.” Models that were not fully balanced were assessed to see if more than half of the covariates used in the weighting procedure achieved a standardized bias of less than 0.25 after weighting. Models that achieved this criterion were designated as “partially balanced.” Results are not reported for models that did not achieve full or partial balance because no adequately matched comparison group could be identified. Of the 96 CITS models assessed, 69 were fully balanced after weighting, and 16 were partially balanced. Of the 48 DID models assessed, 41 were fully balanced after weighting, and seven were partially balanced.

Even if samples met the criteria just described for full balance or partial balance, it may be determined from CITS or DID analysis that baseline pre-intervention course taking/passing rates—or trends in rates—differed for AP ELA, math, and science courses.[[9]](#footnote-9) While such differences raise some concerns about the ability to draw causal inferences about the relationship between the AP STEM and English program and AP course taking/passing rates, the full or partial balance achieved via the propensity score weighting provides evidence of substantial similarity between AP STEM and English participant schools and comparison schools.

## Time Intervals for CITS and DID Models

It is important to note that both CITS and DID analyses were dependent on the number of years for which data on AP course taking and passing rates were available. The time intervals for assessing impacts were based on the number of years between a given AP course taking rate or AP course passing rate being available and when a school joined the AP STEM and English program. For CITS analyses, only cohorts for which four years of pre-intervention data and two years of post-intervention data (seven total years of data) were available were eligible for inclusion in this analysis. The cohorts for which the necessary data was available for CITS analyses in this report included Cohort VII through Cohort IX. Cohort VII joined the AP STEM and English program in SY15, Cohort VIII in SY16, and Cohort IX in SY17. For DID analyses, only cohorts for which one year of pre-intervention data and two years post-intervention data (two total years of data) were available were eligible for inclusion in this analysis. The cohorts for which the necessary data were available for DID analyses in this report included Cohort IV for the free or reduced-price lunch analyses, and Cohorts VIII and IX for the economically disadvantaged analyses. Cohort IV joined the AP STEM and English program in SY12 and, again, Cohort VIII joined in SY16 and Cohort IX in SY17.

## Limitations

In order for a school to be included in CITS analyses, we required that the school have seven years of relevant data; four years of baseline data, and three years of data after program implementation. Importantly, the way in which students from low-income familes were identified changed in SY15 from identifying students eligible to receive free or reduced-price lunch (FRL) to identifying students from families that were economically distadvantaged (ECODIS). While both FRL and ECODIS are proxies for low-income status, they are not equivalent proxies and therefore, cannot be combined. Because of the CITS data requirements, and because the measure used to identify students from low-income families changed during the study period, the research team could not include a single variable that accounted for differences in schools based on the proportion of students who were from low-income families in CITS analyses. The research team understands that level of income is an important predictor of student success, and that students from low-income families are a student group of interest for this intervention. In order to assess the impact of the intervention on students from low-income familes—and to account for income status in the overall assessement of program impact—the research team completed a series of DID analyses. While DID does not account for baseline trends in outcomes of interst, the data requirements allowed for the inclusion of both the FRL and ECODIS covariates, identifying the proportion of schools’ students that were from low-income familes―prior to, and after the start of SY15, respectively.

This split of the time interval available for analysis at SY15, combined with the data requirements for DID analysis, the number of eligible cohorts and hence sample size of schools included in the DID being relatively small. As such, the results of all DID analyses should be interpreted with caution. Moreover, the inclusion of FRL covariates resulted in only one cohort (Cohort IV) being eligible for DID analyses. For this reason, the results for Cohort IV―FRL DID analyses are included in the appendices but not discussed in the findings.

The “Findings” section below summarizes program impact analysis results, indicating which models were fully or partially balanced, and which models showed a significant difference in the rates for AP course taking and AP course passing. Additionally, the CITS analyses also indicate which models showed a significant change in the trend (i.e., change over time) of AP course taking and passing rates after joining the program.

# Findings

This section presents the findings related to the percentage of students—particularly those typically underrepresented in advanced placement courses—taking AP courses and passing AP courses (research questions 2 and 3). Findings are organized in two subsections. The first subsection summarizes the results of the quasi-experimental analysis comparing AP course taking and passing rates of all students at schools participating in the AP STEM and English program to similar non-participating schools. The second subsection summarizes the results of the quasi-experimental analysis comparing AP course taking and passing rates of student groups of interest at schools participating in the AP STEM and English program to similar non-participating schools.

When interpreting the findings presented within this section, it is important to consider several notes about AP course taking and passing rates, including the following:

1. Students at participating schools were considered an AP course taker if they were enrolled in one or more AP ELA, math, or science course. As the AP STEM and English program aims to increase the proportion of students enrolling in AP courses, the percentage of AP STEM and English course takers was calculated using the total number of students enrolled in 9th–12th grade at the school as the denominator—as opposed to using the total number of students enrolled in AP courses.
2. Students at participating schools were considered an AP course passer if they (1) completed the course, (2) earned credit, and (3) received a passing letter or numeric grade within at least one of the AP STEM and English courses they were enrolled in. The percentage of AP STEM and English course passers is defined as the number of students passing one or more AP course divided by the total number of students enrolled in 9th–12th grade at the school.

To see full results from all course taking and passing models, please see Appendices C and D.

|  |
| --- |
| **Summary of Key Findings** |
| * The AP STEM and English program generally had a positive effect on student AP course taking and passing rates during the first year of participation, though results were mixed by subject and student group. The intervention did not impact the rate of AP course taking or passing after the first year of program participation.
* The AP STEM and English program had a positive effect on AP ELA and math course taking and passing rates during the first year of the intervention.
* The percentage of students *taking* ELA and math courses increased by 3.76 percentage points and 2.03 percentage points (respectively) more at participating schools than at similar non-participating schools during the first year of participation.
* The percentage of students *passing* ELA and math courses increased by 3.33 percentage points and 1.64 percentage points (respectively) more at participating schools than at similar non-participating schools during the first year of participation.
* The AP STEM and English program had no effect on AP science course taking or passing rates.
* The effect of the AP STEM and English program on the AP course taking and passing rates of historically underserved populations was mixed.
* The program had a positive effect on AP course taking and passing rates for ECODIS students, as well as for non-ECODIS students. The rate of *taking* any AP course increased more for non-ECODIS students (5.62 percentage points) than it did for ECODIS students (3.05 percentage points). Similarly, the rate of *passing* any AP course increased more for non-ECODIS students (4.75 percentage points) than it did for ECODIS students (2.48 percentage points).
	+ The program had no effect on AP course taking or passing rates for African American / Black students, Hispanic/Latino students, or English language learners.
 |

## Impacts on AP Course Taking and Passing Rates

Impacts on AP course taking and passing rates were assessed in relation to all students and student groups of interest for each of the four AP STEM and English program academic discipline groupings: ELA, math, or science; ELA; math; and science. The rate with which students took AP courses at participating schools was compared to the rate with which students took AP courses at similar schools that did not participate in the program (comparison schools). In total, 48 CITS models were analyzed for each of AP course taking and AP course passing, with 12 models for each of the four academic discipline groupings. Additionally, impacts on AP course taking and passing rates were assessed in relation to all students and student groups of interest, related to low-income status, for each of the four AP STEM and English academic discipline groupings. In total, 24 DID models were analyzed for each of AP course taking and AP course passing, with three models conducted (one for each student group) for each of the four academic discipline groupings, for each of the two proxies of low-income (FRL and ECODIS).

Results showing the significance of the impact, if any, are presented in the body of the report. Results for full models are presented in the appendices.

Statistically significant and positive program impacts were identified for 36 of the 96 CITS models overall, as summarized in the tables below. The tables indicate significance in relation to two aspects of AP course taking rates. The first notes the significance of any differences—between AP STEM and English participant schools and comparison schools—in the percentage of students taking/passing an AP ELA, math, and/or science course one year after schools began participating in the AP STEM and English program. These differences are presented in the “AP Course Taking/Passing Rate Change after One Year” column. The second aspect of change in the tables is the “Annual Change in Percent Taking Rate” column. This column indicates the significance of any differences—between AP STEM and English participant schools and comparison schools—in the annual rate of change in students’ AP course taking/passing rate during the three years after schools began participating in the program. These changes are presented as the percentage of students taking/passing an AP course, with a positive number indicating that participating schools had an increase in taking/passing rates.

Statistically significant and positive program impacts were identified for 36 of the 48 DID models overall, as summarized in the tables below and in the appendices. The tables indicate the level of significance in relation to the AP course taking/passing rate change two years after participation for AP STEM and English schools when compared to similar non-participating schools. The changes are presented as the percentage of students taking/passing an AP course, with a positive number indicating an increase in taking/passing rates.

**Table 1a: Summary of AP STEM and English Impacts by Subject Percentage Point Change—CITS for All Students**

| **Student Group** | **Subject2** | **Course Taking1** | **Course Passing1** |
| --- | --- | --- | --- |
|  **AP Course Taking Rate Change after One Year** | **Annual Change in Percent Taking Rate** | **AP Course Passing Rate Change after One Year** | **Annual Change in Percent Passing Rate** |
| **All students** | Any | n.s. | n.s. | n.s. | n.s. |
| ELA | 3.76\*\*\* | n.s. | 3.33\*\*\* | n.s. |
| Math | 2.03\*\*\* | n.s. | 1.64\*\* | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results are presented.+ *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .0011 Change in percentage points of students taking/passing an AP course at a school. A positive number indicates an increase in the percentage taking/passing.2 “Any" refers to any AP ELA, math, or science course. |

**Table 1b: Summary of AP STEM and English Impacts by Subject Percentage Point Change—DID for All Students (Cohorts VIII and IX)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Student group** | **Subject2** | **Difference in Percentage Point Change in Taking Between Treatment and Control Groups Two Years After Participation1** | **Difference in Percentage Point Change in Passing Between Treatment and Control Groups Two Years After Participation** |
| **All students** | Any | 4.58\*\*\* | 3.89\*\*\* |
| ELA | 3.47\*\*\* | 3.16\*\*\* |
| Math | 2.72\*\*\* | 2.57\*\*\* |
| Science | n.s. | n.s. |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results are presented. + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .0011Change in percentage points of students taking/passing an AP course at a school compared to change for control group. A positive number indicates a greater increase in the percentage taking/passing for participating schools.2 “Any" refers to any AP ELA, math, or science course. |

**Impacts on AP course taking and passing rates for all students.** The percentage of both students taking and students passing an AP ELA course, an AP math course, an AP science course, or any AP course (ELA, math, or science) increased for both participant and comparison schools during the intervention period.

Results for CITS and DID analyses completed to assess impacts of the intervention on taking and passing any AP course (ELA, math, or science) varied by method. CITS results indicate that the intervention did not have a statistically significant effect on the percentage of students taking or passing any AP course. However, DID analysis indicate that the program did have a statistically significant effect on the percentage of students taking and passing any AP course. Specifically, DID analysis shows that participating schools had an additional 4.58 percent of students take, and an additional 3.89 percent of students pass any AP ELA, math or science course compared to non-participating schools. These inconsistent results indicate that additional data and analyses are necessary to determine if the intervention has an effect on the percentage of students taking or passing any AP ELA, math, or science course.

CITS analyses indicate that AP ELA course taking rates among schools in the intervention increased and additional 3.76 percentage points and AP ELA course passing rates increased an additional 3.33 percentage points during the first year of the intervention, when compared to similar control schools. Similarly, CITS analyses indicate that AP math course taking rates among schools in the intervention increased an additional 2.03 percentage points and AP math course passing rates increased an additional 1.64 percentage points during the first year of the intervention, when compared to similar control schools. CITS analyses results indicate that there was no significant change in the trend in AP ELA or AP math course taking or passing rates after the first year of the intervention. Results of DID analyses were similar to the results described above, and provide additional evidence that the intervention had a positive effect on AP ELA and AP math course taking and passing rates.

Both CITS and DID results indicate that the AP STEM and English program did not have a statistically significant effect on the percentage of students either taking or passing an AP science course.

**Table 2a: Summary of AP STEM and English Impacts by Student Group Percentage Point Change—CITS for Student Groups**

| **Student Group** | **Subject2** | **Course Taking1** | **Course Passing1** |
| --- | --- | --- | --- |
|  **AP Course Taking Rate Change after One Year** | **Annual Change in Percent Taking Rate** | **AP Course Passing Rate Change after One Year** | **Annual Change in Percent Passing Rate** |
| **Female students** | Any | 5.75\*\*\* | n.s. | 5.08\*\*\* | n.s. |
| ELA | 5.15\*\*\* | n.s. | 4.58\*\*\* | n.s. |
| Math | 2.58\*\*\* | n.s. | 2.15\*\* | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |
| **Male students** | Any | n.s. | n.s. | n.s. | 1.51+ |
| ELA | 2.29\*\*\* | n.s. | 2.00\*\* | n.s. |
| Math | 1.42\* | n.s. | 1.09+ | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |
| **African American / Black students** | Any | n.s. | n.s. | n.s. | n.s. |
| ELA | n.r. | n.r. | n.r. | n.r. |
| Math | n.s. | n.s. | n.s. | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |
| **Asian students** | Any | n.r. | n.r. | n.r. | n.r. |
| ELA | n.r. | n.r. | n.r. | n.r. |
| Math | n.r. | n.r. | n.r. | n.r. |
| Science | n.r. | n.r. | n.r. | n.r. |
| **Hispanic/Latino students** | Any | n.s. | n.s. | n.s. | n.s. |
| ELA | n.s. | n.s. | n.s. | n.s. |
| Math | n.s. | n.s. | n.s. | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |
| **Multi-Race and Non-Hispanic/Latino students** | Any | 5.32+ | n.s. | 5.16+ | n.s. |
| ELA | 3.63+ | n.s. | 3.64\* | n.s. |
| Math | n.s. | n.s. | n.s. | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |
| **White students** | Any | 4.73\*\*\* | n.s. | 4.50\*\*\* | 1.25+ |
| ELA | 4.36\*\*\* | n.s. | 3.87\*\*\* | n.s. |
| Math | 2.16\*\* | n.s. | 1.93\*\* | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |
| **English Language Learner students** | Any | n.s. | 1.82+ | n.s. | n.s. |
| ELA | n.r. | n.r. | n.s. | n.s. |
| Math | n.s. | n.s. | n.s. | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |
| **Non-English Language Learner students** | Any | n.s. | n.s. | n.s. | n.s. |
| ELA | 3.88\*\*\* | n.s. | 3.32\*\*\* | n.s. |
| Math | 2.14\*\*\* | n.s. | 1.84\*\* | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |
| **Students with Disabilities** | Any | n.s. | n.s. | n.s. | n.s. |
| ELA | 0.63\*\*\* | n.s. | 0.40\*\* | n.s. |
| Math | n.s. | n.s. | n.s. | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |
| **Students without Disabilities** | Any | n.s. | n.s. | n.s. | n.s. |
| ELA | 4.37\*\*\* | n.s. | 3.90\*\*\* | n.s. |
| Math | 2.29\*\*\* | n.s. | 1.86\*\* | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results are presented.+ *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .001“n.r.” means “not reported.” Findings are not reported because either the models did not converge and therefore produced no results or the samples of participating and non-participating schools were not balanced or partially balanced.1 Change in percentage points of students taking/passing an AP course at a school. A positive number indicates an increase in the percentage taking/passing.2 “Any" refers to any AP ELA, math, or science course. |

**Table 2b: Summary of AP STEM and English Impacts by Student Group Percentage Point Change—DID for Student Groups (Cohorts VIII and IX)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Student group** | **Subject2** | **Difference in Percentage Point Change in Taking Between Treatment and Control Groups Two Years After Participation1** | **Difference in Percentage Point Change in Passing Between Treatment and Control Groups Two Years After Participation** |
| **Economically Disadvantaged** | Any | 3.05\*\* | 2.48\* |
| ELA | 2.91\*\*\* | 2.59\*\*\* |
| Math | 1.87\*\*\* | 1.74\*\*\* |
| Science | n.s. | n.s. |
| **Non-Economically Disadvantaged** | Any | 5.62\*\*\* | 4.75\*\*\* |
| ELA | 3.85\*\*\* | 3.48\*\*\* |
| Math | 2.94\*\*\* | 2.79\*\*\* |
| Science | n.s. | n.s. |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results are presented. + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .0011Change in percentage points of students taking/passing an AP course at a school compared to change for control group. A positive number indicates a greater increase in the percentage taking/passing for participating schools.2 “Any" refers to any AP ELA, math, or science course. |

**Impacts on AP course taking and passing rates for student groups of interest.** One goal of the AP STEM and English program is to increase AP ELA, math, and science course taking and passing rates for students from traditionally underserved groups. Though results varied by student group, results for all groups indicate that the intervention either had a statistically significant and positive impact, or no impact on course taking and passing rates in AP ELA, AP math, or any AP (ELA, math, or science) course during the first year of intervention. When differences were detected, they ranged in magnitude from small (0.40 percentage points for AP ELA for students with disabilities) to large (5.75 percentage points for female students taking any AP—ELA, math or science—course).

Across all student groups, analyses indicate that the intervention had no effect on the percentage of students taking or passing at least one AP science course. Also, CITS analyses indicate that the intervention did not impact the rate of AP course taking or passing after the initial year of program participation. In the three cases where possible impacts on the rate of taking or passing AP courses after the intial year of program participation were detected, the results were only marginally significant (.05 < *p* < .1).

The impact of the intervention on AP course taking and passing in AP ELA, math, or any AP course varied by student group.

Results indicate that the intervention had a statistically significant and positive impact on the percentage of students taking and passing AP ELA, math, and any AP (ELA, math, or science) course for female, White, ECODIS, and non-ECODIS students.

Similarly, results indicate that the intervention had a statistically significant and positive impact on the percentage of students taking and passing at least one AP ELA and AP math course for male students, non-ELL, and non-SWD. For these groups the intervention did not have a statistically significant impact on the percentage of students taking or the percentage of students passing any AP (ELA, math, or science) course.

The intervention did have a statistically significant and positive impact on the percentage of Multi-Race and Non-Hispanic/Latino students passing at least one AP ELA course.

The intervention also had a statistically significant and small positive impact on the percentage of students with disabilities taking and passing at least one AP ELA course, but did not have a statistically significant effect on their rate of taking or passing one or more AP math course or any AP (ELA, math, or science) course.

Notably, results of CITS analyses indicate that the intervention did not have a statistically significant effect on the percentage of African American / Black students, Hispanic/Latino students, EELL taking or passing AP ELA, math, science, or any AP course.[[10]](#footnote-10)

# Summary

A primary goal of the AP STEM and English program is to increase student enrollment and performance in AP STEM and English courses, particularly among historically underserved populations.

Results of CITS and DID analyses completed to assess impacts of the intervention on taking and passing any AP (ELA, math, or science) course varied by method. CITS results indicate that the intervention did not have a statistically significant effect on the percentage of students taking or passing any AP course. However, DID results indicate that the program did have a statistically significant effect on the percentage of students taking and passing any AP course. Specifically, DID analysis showed that participating schools had an additional 4.58 percent of students take, and an additional 3.89 percent of students pass any AP course compared to non-participating schools. These inconsistent results indicate that additional data and analyses are necessary to determine if the intervention has an effect on the percentage of students taking or passing any AP ELA, math, or science course.

Results indicate that the program did have a positive effect on course taking and passing rates in AP ELA and math during the first year of intervention. Both CITS and DID results indicate that the AP STEM and English program did not have a statistically significant effect on the percentage of students taking or passing an AP science course. Also, CITS analyses indicate that the intervention did not impact the rate of AP course taking or passing after the initial year of program participation.

Results varied by student group. For example, results indicate that the intervention had a statistically significant and positive impact on the percentage of students taking and passing AP ELA, math, and any AP (ELA, math, or science) course for female, White, ECODIS, and non-ECODIS students. However, results also indicate that the intervention did not have a statistically significant effect on the percentage of African American / Black students, Hispanic/Latino students, or ELL students taking or passing AP ELA, math, science, or any AP course.[[11]](#footnote-11)

Though results varied by student group, results for all groups indicate that the intervention either had a statistically significant and positive impact, or no impact on course taking and passing rates in AP ELA, math, or any AP (ELA, math, or science) course during the first year of intervention. When differences were detected, they ranged in magnitude from small (0.40 percentage points for AP ELA for students with disabilities) to large (5.75 percentage points for female students taking any AP—ELA, math or science—course).

Overall, findings indicate that the AP STEM and English program had a positive impact on AP course taking and passing rates in the first year of intervention for AP ELA and AP math courses. Schools participating in the AP STEM and English program experienced larger increases in the taking and passing of AP ELA courses than in math or science. Similarly, some evidence of progress being made toward the goal of increasing AP course taking and passing rates among historically underserved populations was detected. Across the Commonwealth, more support may be needed to improve AP course taking and passing rates for AP ELA, math, and—most notably—science courses for all student groups, and particularly among those that are underserved.

# Appendices

# Appendix A

**Modeling Procedures for Comparative Interrupted Time Series (CITS) Analyses**

For each academic discipline (i.e., ELA, math, and science), a CITS model was developed to assess the impact of the AP STEM and English program on (1) a school’s AP course taking/passing rate one year after the program began, and (2) the trend (i.e., the slope) of the AP course taking/passing rate during the three year period after the program began.

This procedure was used for all 96 CITS models. The following equation represents the CITS model:

*Yit = β0 + β1Timet, + β2Interventiont + β3TimetInterventiont* ***+*** *β4Participanti + β5ParticipantiTimet + β6ParticipantiInterventiont + β7ParticipantiTimetInterventiont + ui +eit*

In this model, Yit is the outcome measure for a school *i* at time *t*. *Timet* is the time in years since the start of the study. *Interventiont* is an indicator of whether or not a school was participating in the intervention at time *t*. *TimetInterventiont* is an interaction between *Timet* and *Interventiont*. *Participanti* is an indicator for a school *i* that participated in the AP STEM and English program (by academic discipline). *ParticipantiTimet* , *ParticipantiInterventiont* , and *ParticipantiTimetInterventiont* are interaction terms used in comparisons of multiple groups. Random effects were included to account for school and individual observation effects by adding a random error term for each school (ui), and individual observations (eit).

The *β0* to *β3* coefficients represent the control group. The *β4* to *β7* coefficients represent differences between the treatment and control groups. *β1* represents the slope, or trajectory of the outcome variable until the introduction of the intervention. *β2*represents the change in the level of the outcome variable that occurs in the period immediately following the introduction of the intervention. *β3*represents the difference between pre- and post-intervention slopes of the outcome. *β4* represents the difference in the level (intercept) between treatment and control prior to intervention. *β5* represents the difference in the slope between treatment and control prior to intervention. *β6* represents the impact of the AP STEM and English program on AP course taking/passing rates at each school. *β7* represents the impact of the AP STEM and English program on the trend (i.e., the slope) of AP course taking/passing rates at each school during the three-year period after the program began.

Two parameters, *β4* and *β5*, play a role in establishing whether the treatment and control groups are balanced on both the level and trajectory of the outcome variable in the pre-intervention period. If these data were from a randomized controlled trial, we would expect similar levels and slopes prior to the intervention. However, in an observational study where equivalence between groups cannot be assumed, any observed differences will likely raise concerns about the ability to draw causal inferences about the relationship between the intervention and the outcomes (Linden and Adams, 2011).[[12]](#footnote-12) When the value for *β4* and/or *β5* is statistically significant, it indicates that, despite propensity score weighting, significant pre-intervention differences in AP STEM and English schools’ and comparison schools’ AP course taking/passing rates remained.

# Appendix B

**Modeling Procedures for Difference-in-Difference (DID) Analyses**

DID is a quasi-experimental design that makes use of longitudinal data from treatment and control groups to estimate a causal effect. It calculates the effect of a treatment on an outcome by comparing the average change over time in the outcome variable for the treatment group, compared to the average change over time for the control group.

DID is used in observational settings where exchangeability cannot be assumed between the treatment and control groups. DID relies on a less strict exchangeability assumption (i.e., in absence of treatment, the unobserved differences between treatment and control groups are the same overtime). Hence, difference-in-difference is a useful technique to use when randomization at the level of the unit of measurement—in this case, the school level—is not possible. DID requires data from pre-/post-intervention, such as cohort or panel data or repeated cross-sectional data (individual or group level). The approach removes biases in post-intervention period comparisons between the treatment and control group that could be the result from permanent differences between those groups, as well as biases from comparisons over time in the treatment group that could be the result of trends due to other causes of the outcome. This method may still be subject to certain biases (e.g. mean regression, reverse causality and omitted variable bias), so results should be interpreted with caution.

**Modeling Procedure**

For each student group (all students, gender student groups, racial/ethnic student groups, special populations, by subject) a DID model was developed to assess the impact of the AP STEM and English intervention on (a) school AP course taking rate and (b) school AP course passing rate at each school one year after the program began.

This procedure was used for all 48 of the DID analysis models developed for this report. The following equation represents the procedure:

*Yit = β0 + β1Timet + β2Participantit + β3TimetParticipantit + β4Covariatesi + eit*

In this model, Yit is the outcome measure for a school *i* at time *t*. *Timet* indicates if the measure occurred before or after the intervention began. *Participantit* is an indicator of whether or not a school was participating in the intervention at time *t*. *TimetParticipantit* is an interaction between *Timet* and *Participantit*. *Covariatesi* represents the vector of covariates included in the model for each school. Covariates considered for inclusion in the model included gender, race/ethnicity, English language learner status, and student disability status, with *eit* is the error term. In a DID model, the statistical significance of the interaction term (*TimetParticipantit*) is assessed to determine if there was a significant difference between treatment and control groups after treatment occurred.

The *β0* coefficient represents the baseline average in the outcome of interest; *β1* represents the change over time in the control group. *β2*represents the difference between the treatment and control groups prior to the intervention. *β3*represents the interaction between *Timet* and *Participantit* (i.e., the difference-in-differencebetween the treatment and control groups). *β4* represents the vector of covariates included in the model.

# Appendix C

**AP Course Taking, Full Model Results**

**Table 3a: Impacts of AP STEM and English Program on AP Course Taking, Any ELA, Math, or Science Courses—CITS**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All°** | **Female** | **Male** | **Afr. Amer. / Black°** | **Hispanic/ Latino** | **Multi-race** | **White** | **ELL** | **Non-ELL°** | **SWD** | **Non-SWD** |
| Intercept (β0) | 3.27+  | 6.69\*\*\*  | 3.57\*\*\*  | 6.01\*\*  | 2.74\*\*\*  | 3.70\*  | 6.27\*\*\*  | 1.69 | 3.78+  | 0.29+  | 4.30\*  |
| (1.85) | (0.83) | (0.78) | (2.12) | (0.78) | (1.49) | (0.62) | (1.08) | (1.98) | (0.17) | (1.82) |
| Time (β1) | 1.72+  | 1.23\*\*  | 0.94\*\*  | -0.26 | 1.03\*\*  | 0.81\*  | 1.18\*\*\*  | 0.06 | 1.98+  | 0.07 | 1.83\*  |
| (0.94) | (0.39) | (0.33) | (0.71) | (0.31) | (0.41) | (0.29) | (0.46) | (1.04) | (0.06) | (0.90) |
| Intervention Period (β2) | 2.57 | 0.65 | 1.17 | 1.01 | -0.83 | 1.12 | 0.36 | -0.07 | 3.08 | 0.20 | 2.14 |
| (2.25) | (0.71) | (1.13) | (1.08) | (0.61) | (1.40) | (0.76) | (0.87) | (2.66) | (0.22) | (2.01) |
| Time by Intervention (β3) | -2.25 | -0.91 | -0.88 | 1.61 | -0.62 | -1.08 | -1.03+  | -0.41 | -2.78 | 0.03 | -2.22 |
| (1.99) | (0.77) | (0.75) | (1.32) | (0.51) | (0.83) | (0.60) | (0.79) | (2.22) | (0.12) | (1.90) |
| Participant (β4) | 1.94 | 0.39 | 0.20 | -1.30 | 0.98 | 3.31 | 0.05 | 0.11 | 1.71 | 0.06 | 1.68 |
| (1.98) | (1.17) | (1.03) | (2.33) | (1.49) | (3.58) | (1.01) | (1.44) | (2.09) | (0.31) | (1.98) |
| Participant by Time (β5) | -0.73 | -0.11 | -0.11 | 0.50 | -0.06 | -0.61 | -0.08 | -0.33 | -0.91 | 0.02 | -0.65 |
| (0.97) | (0.47) | (0.39) | (0.77) | (0.48) | (1.06) | (0.38) | (0.55) | (1.06) | (0.12) | (0.93) |
| Participation by Intervention (β6) | 2.15 | 5.75\*\*\*  | 1.91 | 2.88 | 1.10 | 5.32+  | 4.73\*\*\*  | -0.19 | 1.78 | 0.66 | 3.20 |
| (2.42) | (1.32) | (1.47) | (2.06) | (1.74) | (3.03) | (1.34) | (1.43) | (2.80) | (0.42) | (2.24) |
| Participation by Time by Intervention (β7) | 2.20 | 0.55 | 1.26 | -0.32 | 0.19 | 3.09 | 1.17 | 1.82+  | 2.58 | -0.03 | 2.23 |
| (2.06) | (1.02) | (0.91) | (1.94) | (1.03) | (2.17) | (0.87) | (1.09) | (2.29) | (0.26) | (2.00) |
| + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .001°After propensity score weighting, treatment and comparison schools were only partially balanced.β6 represents the difference in the level between AP STEM and English schools and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between AP STEM and English schools and comparison schools in the slope from the years before the AP STEM and English intervention (i.e., SY07–SY10 for Cohort III) to the three years after the AP STEM and English intervention began (i.e., SY12–SY13 for Cohort III). |

**Table 3b: Impacts of AP STEM and English Program on AP Course Taking, Any ELA, Math, or Science Courses—DID**

|  |  |  |  |
| --- | --- | --- | --- |
| **Model Description****(Student group)** | **Participant** | **Time** | **Percent Taking Change Two Years After Participation1** |
| **Cohort IV—FRL** |
| All | -0.16(0.69) | 3.73\*\*\*(0.68) | 4.34\*\*\*(0.97) |
| Free and Reduced-Price Lunch | -0.13(0.64) | 2.96\*\*\*(0.63) | 1.15(0.91) |
| Non-Free and Reduced-Price Lunch | -0.30(0.78) | 4.17\*\*\*(0.78) | 7.24\*\*\*(1.10) |
| **Cohorts VIII and IX —ECODIS** |
| All | 0.07(0.82) | 1.07(0.81) | 4.58\*\*\*(1.15) |
| Economically Disadvantaged | 0.06(0.78) | 0.02(0.78) | 3.05\*\*(1.10) |
| Non-Economically Disadvantaged | -0.07(0.88) | 1.72\*(0.87) | 5.62\*\*\*(1.24) |
| \**p* < .05, \*\**p* < .01, \*\*\**p* < .0011Change in percentage points of students taking an AP course at a school. A positive number indicates an increase in the percent taking for treatment schools. |

**Table 4a: Impacts of AP STEM and English Program on AP Course Taking, ELA Courses—CITS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All** | **Female** | **Male** | **Hispanic/ Latino** | **Multi-race°** | **White** | **Non-ELL** | **SWD** | **Non-SWD** |
| Intercept (β0) | 2.46\*\*\*  | 3.91\*\*\*  | 1.28\*\*\*  | 2.69\*\*  | 2.06 | 3.29\*\*\*  | 2.65\*\*\*  | 0.05 | 2.80\*\*\*  |
| (0.41) | (0.45) | (0.34) | (0.85) | (1.27) | (0.35) | (0.43) | (0.10) | (0.47) |
| Time (β1) | 0.75\*\*\*  | 0.88\*\*\*  | 0.54\*\*\*  | 0.26 | 0.46 | 0.66\*\*\*  | 0.79\*\*\*  | 0.05 | 0.86\*\*\*  |
| (0.16) | (0.16) | (0.13) | (0.24) | (0.45) | (0.12) | (0.17) | (0.03) | (0.18) |
| Intervention Period (β2) | -0.39+  | -0.24 | -0.39 | -0.52 | 0.70 | -0.50\*  | -0.44\*  | 0.00 | -0.52\*  |
| (0.20) | (0.30) | (0.25) | (0.61) | (1.39) | (0.19) | (0.21) | (0.08) | (0.25) |
| Time by Intervention (β3) | -0.71\*  | -0.89\*  | -0.42+  | -0.15 | -0.76 | -0.64\*  | -0.79\*  | 0.09 | -0.80\*  |
| (0.33) | (0.37) | (0.22) | (0.32) | (0.74) | (0.26) | (0.36) | (0.10) | (0.37) |
| Participant (β4) | 0.28 | 0.27 | 0.19 | -0.16 | 1.75 | 0.13 | 0.26 | 0.02 | 0.38 |
| (0.64) | (0.85) | (0.48) | (1.42) | (2.33) | (0.68) | (0.68) | (0.12) | (0.73) |
| Participant by Time (β5) | -0.06 | -0.04 | -0.01 | 0.06 | -0.30 | -0.01 | -0.06 | 0.01 | -0.03 |
| (0.23) | (0.30) | (0.19) | (0.42) | (0.63) | (0.23) | (0.24) | (0.04) | (0.27) |
| Participation by Intervention (β6) | 3.76\*\*\*  | 5.15\*\*\*  | 2.29\*\*\*  | 1.54 | 3.63+  | 4.36\*\*\*  | 3.88\*\*\*  | 0.63\*\*\*  | 4.37\*\*\*  |
| (0.61) | (1.07) | (0.61) | (1.53) | (1.99) | (0.67) | (0.62) | (0.18) | (0.72) |
| Participation by Time by Intervention (β7) | 0.29 | 0.18 | 0.37 | 0.36 | 0.67 | 0.54 | 0.31 | -0.13 | 0.33 |
| (0.59) | (0.72) | (0.49) | (0.92) | (1.66) | (0.69) | (0.62) | (0.21) | (0.69) |
| + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .001°After propensity score weighting, treatment and comparison schools were only partially balanced.β6 represents the difference in the level between AP STEM and English schools and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between AP STEM and English schools and comparison schools in the slope from the years before the AP STEM and English intervention (i.e., SY07–SY10 for Cohort III) to the three years after the AP STEM and English intervention began (i.e., SY12–SY13 for Cohort III). |

**Table 4b: Impacts of AP STEM and English Program on AP Course Taking, ELA Courses—DID**

|  |  |  |  |
| --- | --- | --- | --- |
| **Model Description****(Student group)** | **Participant** | **Time** | **Percent Taking Change Two Years After Participation1** |
| **Cohort IV—FRL** |
| All | -0.16(0.60) | 2.35\*\*\*(0.59) | 2.88\*\*\*(0.84) |
| Free and Reduced-Price Lunch | 0.06(0.49) | 1.94\*\*\*(0.48) | 0.70(0.69) |
| Non-Free and Reduced-Price Lunch | 0.00(0.64) | 2.48\*\*\*(0.63) | 5.77\*\*\*(0.90) |
| **Cohorts VIII and IX—ECODIS** |
| All | -0.01(0.63) | 0.13(0.63) | 3.47\*\*\*(0.89) |
| Economically Disadvantaged | -0.01(0.62) | -0.40(0.62) | 2.91\*\*\*(0.88) |
| Non-Economically Disadvantaged | -0.09(0.68) | 0.45(0.67) | 3.85\*\*\*(0.96) |
| \*\*\**p* < .0011Change in percentage points of students taking an AP course at a school. A positive number indicates an increase in the percent taking for treatment schools. |

**Table 5a: Impacts of AP STEM and English Program on AP Course Taking, Math Courses—CITS**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All** | **Female** | **Male** | **Afr. Amer. / Black** | **Hispanic/ Latino** | **Multi-race** | **White** | **ELL°** | **Non-ELL** | **SWD** | **Non-SWD°** |
| Intercept (β0) | 2.08\*\*\*  | 2.22\*\*\*  | 1.94\*\*\*  | 1.94\*\*\*  | 1.15\*\*\*  | 2.85\*\*  | 1.88\*\*\*  | 0.94\*  | 1.80\*\*\*  | 0.34\*\*  | 2.31\*\*\*  |
| (0.31) | (0.30) | (0.30) | (0.43) | (0.30) | (1.00) | (0.22) | (0.45) | (0.27) | (0.12) | (0.35) |
| Time (β1) | 0.14\*  | 0.09 | 0.20\*\*  | -0.08 | 0.23\*  | -0.41+  | 0.25\*\*\*  | -0.23+  | 0.21\*\*\*  | -0.09\*  | 0.19\*  |
| (0.07) | (0.07) | (0.07) | (0.11) | (0.09) | (0.21) | (0.04) | (0.13) | (0.05) | (0.05) | (0.09) |
| Intervention Period (β2) | 0.27+  | 0.39\*  | 0.14 | 0.58 | -0.22 | 2.32\*  | 0.02 | 0.45\*  | 0.19 | 0.41\*  | 0.29 |
| (0.16) | (0.20) | (0.17) | (0.39) | (0.34) | (0.97) | (0.12) | (0.22) | (0.12) | (0.20) | (0.19) |
| Time by Intervention (β3) | 0.19+  | 0.29\*  | 0.16 | 0.66\*  | -0.07 | 0.37+  | 0.04 | 0.38 | 0.15 | 0.10\*  | 0.22 |
| (0.11) | (0.12) | (0.12) | (0.26) | (0.22) | (0.22) | (0.07) | (0.27) | (0.10) | (0.04) | (0.14) |
| Participant (β4) | 0.19 | 0.15 | 0.05 | 0.00 | 0.41 | 1.64 | 0.28 | 0.59 | 0.44 | -0.02 | 0.27 |
| (0.50) | (0.50) | (0.54) | (0.74) | (0.87) | (2.09) | (0.52) | (0.89) | (0.48) | (0.18) | (0.56) |
| Participant by Time (β5) | 0.03 | 0.02 | 0.05 | 0.06 | 0.00 | -0.17 | 0.03 | -0.13 | 0.00 | 0.02 | 0.04 |
| (0.11) | (0.13) | (0.13) | (0.21) | (0.22) | (0.42) | (0.13) | (0.26) | (0.10) | (0.06) | (0.14) |
| Participation by Intervention (β6) | 2.03\*\*\*  | 2.58\*\*\*  | 1.42\*  | 0.74 | 0.87 | 2.53 | 2.16\*\*  | 0.07 | 2.14\*\*\*  | 0.04 | 2.29\*\*\*  |
| (0.56) | (0.68) | (0.58) | (0.86) | (0.77) | (1.86) | (0.68) | (0.38) | (0.57) | (0.26) | (0.65) |
| Participation by Time by Intervention (β7) | 0.09 | -0.20 | 0.34 | 0.36 | -0.25 | 0.31 | 0.32 | 0.34 | 0.03 | 0.02 | 0.11 |
| (0.44) | (0.50) | (0.44) | (1.14) | (0.67) | (1.37) | (0.43) | (0.72) | (0.45) | (0.12) | (0.52) |
| + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .001°After propensity score weighting, treatment and comparison schools were only partially balanced.β6 represents the difference in the level between AP STEM and English schools and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between AP STEM and English schools and comparison schools in the slope from the years before the AP STEM and English intervention (i.e., SY07–SY10 for Cohort III) to the three years after the AP STEM and English intervention began (i.e., SY12–SY13 for Cohort III). |

**Table 5b: Impacts of AP STEM and English Program on AP Course Taking, Math Courses—DID**

|  |  |  |  |
| --- | --- | --- | --- |
| **Model Description****(Student group)** | **Participant** | **Time** | **Percent Taking Change Two Years After Participation1** |
| **Cohort IV—FRL** |
| All | 0.04(0.42) | 1.80\*\*\*(0.42) | 1.56\*\*(0.59) |
| Free and Reduced-Price Lunch° | -0.08(0.35) | 0.89\*\*(0.34) | 0.24(0.49) |
| Non-Free and Reduced-Price Lunch | 0.17(0.47) | 2.52\*\*\*(0.46) | 2.14\*\*(0.66) |
| **Cohorts VIII and IX—ECODIS** |
| All° | 0.07(0.42) | 0.76+(0.42) | 2.72\*\*\*(0.60) |
| Economically Disadvantaged | 0.05(0.33) | 0.31(0.33) | 1.87\*\*\*(0.47) |
| Non-Economically Disadvantaged | 0.04(0.48) | 1.14\*(0.48) | 2.94\*\*\*(0.68) |
| + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .0011Change in percentage points of students taking an AP course at a school. A positive number indicates an increase in the percent taking for treatment schools. |

**Table 6a: Impacts of AP STEM and English Program on AP Course Taking, Science Courses—CITS**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All** | **Female** | **Male** | **Afr. Amer. / Black°** | **Hispanic/ Latino** | **Multi-race** | **White** | **ELL** | **Non-ELL** | **SWD** | **Non-SWD** |
| Intercept (β0) | 1.47+  | 1.96\*  | 1.29\*\*  | 1.35\*\*\*  | -0.47 | 2.13\* | 1.89\*\*\*  | 0.81 | 1.54+  | 0.02 | 1.87\* |
| (0.85) | (0.79) | (0.39) | (0.36) | (0.67) | (0.98) | (0.39) | (0.68) | (0.87) | (0.15) | (0.92) |
| Time (β1) | 0.78\*  | 0.76\*  | 0.59\*\*\*  | 0.31\*  | 0.88\*\* | 0.44 | 0.76\*\*\*  | 0.02 | 0.86\*  | 0.09 | 0.89\* |
| (0.35) | (0.32) | (0.16) | (0.15) | (0.26) | (0.32) | (0.17) | (0.17) | (0.37) | (0.06) | (0.38) |
| Intervention Period (β2) | 1.17 | 1.12 | 0.44 | -0.02 | -0.67 | 1.28 | 0.30 | -0.20 | 1.24 | 0.01 | 1.20 |
| (1.01) | (0.92) | (0.49) | (0.47) | (0.59) | (1.37) | (0.56) | (0.28) | (1.14) | (0.26) | (1.02) |
| Time by Intervention (β3) | -0.91 | -0.72 | -0.60 | 0.36+  | -0.75\*\* | -0.29 | -0.59 | -0.20 | -1.04 | 0.07 | -1.06 |
| (0.79) | (0.72) | (0.37) | (0.21) | (0.28) | (1.00) | (0.39) | (0.28) | (0.86) | (0.11) | (0.87) |
| Participant (β4) | 0.67 | 0.75 | 0.42 | 0.13 | 1.10 | 1.08 | 0.18 | -0.13 | 0.64 | 0.09 | 0.64 |
| (1.03) | (1.04) | (0.68) | (0.78) | (1.01) | (2.48) | (0.73) | (0.75) | (1.05) | (0.26) | (1.14) |
| Participant by Time (β5) | -0.16 | -0.10 | -0.03 | 0.03 | 0.02 | -0.13 | 0.01 | -0.03 | -0.18 | -0.01 | -0.14 |
| (0.41) | (0.40) | (0.25) | (0.30) | (0.42) | (0.84) | (0.30) | (0.20) | (0.43) | (0.10) | (0.45) |
| Participation by Intervention (β6) | 0.33 | 0.87 | 0.62 | 1.77 | -0.98 | -1.02 | 1.01 | -0.22 | 0.31 | 0.01 | 0.47 |
| (1.26) | (1.25) | (0.93) | (1.62) | (1.54) | (2.68) | (1.11) | (0.70) | (1.37) | (0.39) | (1.33) |
| Participation by Time by Intervention (β7) | 0.74 | 0.51 | 0.49 | -0.38 | 0.13 | 2.25 | 0.55 | 0.87 | 0.77 | -0.08 | 0.91 |
| (0.85) | (0.83) | (0.48) | (0.83) | (0.55) | (1.90) | (0.55) | (0.57) | (0.92) | (0.18) | (0.95) |
| + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .001°After propensity score weighting, treatment and comparison schools were only partially balanced.β6 represents the difference in the level between AP STEM and English schools and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between AP STEM and English schools and comparison schools in the slope from the years before the AP STEM and English intervention (i.e., SY07–SY10 for Cohort III) to the three years after the AP STEM and English intervention began (i.e., SY12–SY13 for Cohort III). |

**Table 6b: Impacts of AP STEM and English Program on AP Course Taking, Science Courses—DID**

|  |  |  |  |
| --- | --- | --- | --- |
| **Model Description****(Student group)** | **Participant** | **Time** | **Percent Taking Change Two Years After Participation1** |
| **Cohort IV—FRL** |
| All° | -0.08(0.41) | 1.33\*\*(0.41) | 1.72\*\*(0.59) |
| Free and Reduced-Price Lunch | -0.07(0.32) | 0.82\*(0.32) | 0.87+(0.46) |
| Non-Free and Reduced-Price Lunch | 0.00(0.51) | 1.72\*\*\*(0.51) | 3.23\*\*\*(0.72) |
| **Cohorts VIII and IX—ECODIS** |
| All | -0.07(0.55) | 0.79(0.55) | 0.28(0.78) |
| Economically Disadvantaged° | -1.00(0.62) | -2.24\*\*\*(0.62) | 1.36(0.88) |
| Non-Economically Disadvantaged | -0.15(0.61) | 0.83(0.61) | 1.35(0.87) |
| + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .0011Change in percentage points of students taking an AP course at a school. A positive number indicates an increase in the percent taking for treatment schools. |

# Appendix D

**AP Course Passing, Full Model Results**

**Table 7a: Impacts of AP STEM and English Program on AP Course Passing, Any ELA, Math, or Science Courses—CITS**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All°** | **Female** | **Male** | **Afr. Amer. / Black** | **Hispanic/ Latino** | **Multi-race** | **White** | **ELL°** | **Non-ELL°** | **SWD** | **Non-SWD** |
| Intercept (β0) | 2.41+ | 5.62\*\*\* | 2.65\*\*\* | 4.93\*\* | 2.18\*\*\* | 2.73\* | 5.50\*\*\* | 2.02+ | 3.52\*\* | 0.31\* | 3.31\* |
| (1.45) | (0.67) | (0.74) | (1.77) | (0.59) | (1.26) | (0.51) | (1.10) | (1.33) | (0.12) | (1.50) |
| Time (β1) | 1.49\* | 1.18\*\*\* | 1.00\*\* | -0.28 | 0.97\*\*\* | 0.91\* | 1.11\*\*\* | -0.10 | 1.61\* | 0.03 | 1.70\* |
| (0.71) | (0.33) | (0.35) | (0.55) | (0.22) | (0.36) | (0.21) | (0.45) | (0.68) | (0.04) | (0.74) |
| Intervention Period (β2) | 2.12 | 0.40 | 1.45 | 1.32 | -1.09+ | 0.25 | -0.01 | -0.06 | 2.01 | 0.18 | 1.82 |
| (1.93) | (0.66) | (1.44) | (0.87) | (0.64) | (1.06) | (0.55) | (0.78) | (1.94) | (0.17) | (1.84) |
| Time by Intervention (β3) | -1.80 | -0.79 | -1.06 | 1.53 | -0.50 | -0.68 | -0.96\* | -0.06 | -2.03 | 0.09 | -1.96 |
| (1.49) | (0.65) | (0.81) | (1.10) | (0.38) | (0.79) | (0.45) | (0.74) | (1.44) | (0.09) | (1.54) |
| Participant (β4) | 1.57 | 0.31 | 0.27 | -0.80 | 0.79 | 3.18 | 0.07 | -0.06 | 0.81 | 0.04 | 1.27 |
| (1.61) | (1.10) | (0.98) | (1.99) | (1.32) | (3.54) | (0.98) | (1.48) | (1.50) | (0.25) | (1.69) |
| Participant by Time (β5) | -0.47 | -0.03 | -0.14 | 0.40 | -0.01 | -0.49 | -0.07 | -0.22 | -0.51 | 0.02 | -0.47 |
| (0.74) | (0.43) | (0.40) | (0.63) | (0.41) | (1.04) | (0.31) | (0.55) | (0.71) | (0.09) | (0.77) |
| Participation by Intervention (β6) | 1.81 | 5.08\*\*\* | 0.97 | 1.85 | 0.48 | 5.16+ | 4.50\*\*\* | 0.10 | 1.92 | 0.54 | 2.58 |
| (2.13) | (1.32) | (1.71) | (1.91) | (1.74) | (2.69) | (1.13) | (1.34) | (2.15) | (0.33) | (2.11) |
| Participation by Time by Intervention (β7) | 1.73 | 0.32 | 1.51+ | -0.22 | 0.37 | 2.68 | 1.25+ | 1.00 | 1.87 | 0.04 | 1.91 |
| (1.55) | (0.87) | (0.91) | (1.71) | (1.01) | (2.33) | (0.72) | (0.92) | (1.51) | (0.22) | (1.63) |
| + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .001°After propensity score weighting, treatment and comparison schools were only partially balanced.β6 represents the difference in the level between AP STEM and English schools and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between AP STEM and English schools and comparison schools in the slope from the years before the AP STEM and English intervention (i.e., SY07–SY10 for Cohort III) to the three years after the AP STEM and English intervention began (i.e., SY12–SY13 for Cohort III). |

**Table 7b: Impacts of AP STEM and English Program on AP Course Passing, Any ELA, Math, or Science Courses—DID**

|  |  |  |  |
| --- | --- | --- | --- |
| **Model Description****(Student group)** | **Participant** | **Time** | **Percent Passing Change Two Years After Participation1** |
| **Cohort IV—FRL** |
| All | -0.19(0.67) | 3.64\*\*\*(0.66) | 4.19\*\*\*(0.94) |
| Free and Reduced-Price Lunch | -0.13(0.58) | 2.40\*\*\*(0.57) | 1.31(0.82) |
| Non-Free and Reduced-Price Lunch | -0.38(0.75) | 4.34\*\*\*(0.75) | 6.59\*\*\*(1.06) |
| **Cohorts VIII and IX—ECODIS** |
| All° | 0.05(0.75) | 1.08(0.75) | 3.89\*\*\*(1.06) |
| Economically Disadvantaged | -0.01(0.71) | -0.16(0.71) | 2.48\*(1.00) |
| Non-Economically Disadvantaged | -0.09(0.81) | 1.77\*(0.80) | 4.75\*\*\*(1.14) |
| \**p* < .05, \*\*\**p* < .0011Change in percentage points of students passing an AP course at a school. A positive number indicates an increase in the percent passing for treatment schools. |

**Table 8a: Impacts of AP STEM and English Program on AP Course Passing, ELA Courses—CITS**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All** | **Female** | **Male** | **Hispanic/ Latino** | **Multi-race°** | **White** | **ELL°** | **Non-ELL** | **SWD** | **Non-SWD** |
| Intercept (β0) | 2.26\*\*\* | 3.50\*\*\* | 1.24\*\*\* | 1.78\*\* | 1.45 | 3.12\*\*\* | 0.04 | 2.40\*\*\* | 0.09 | 2.53\*\*\* |
| (0.32) | (0.39) | (0.28) | (0.58) | (0.93) | (0.34) | (0.06) | (0.36) | (0.07) | (0.40) |
| Time (β1) | 0.68\*\*\* | 0.83\*\*\* | 0.49\*\*\* | 0.33+ | 0.54+ | 0.60\*\*\* | 0.06+ | 0.74\*\*\* | 0.02 | 0.83\*\*\* |
| (0.15) | (0.16) | (0.13) | (0.19) | (0.29) | (0.13) | (0.03) | (0.18) | (0.02) | (0.19) |
| Intervention Period (β2) | -0.41\* | -0.25 | -0.44+ | -0.55 | 0.17 | -0.46+ | -0.11\* | -0.40+ | 0.04 | -0.55\* |
| (0.21) | (0.29) | (0.25) | (0.55) | (0.90) | (0.24) | (0.05) | (0.23) | (0.08) | (0.27) |
| Time by Intervention (β3) | -0.67+ | -0.80\* | -0.43\* | -0.30 | -0.43 | -0.71\* | -0.18\* | -0.78+ | 0.07 | -0.81+ |
| (0.35) | (0.39) | (0.22) | (0.21) | (0.58) | (0.35) | (0.07) | (0.42) | (0.06) | (0.43) |
| Participant (β4) | 0.13 | 0.19 | 0.07 | 0.25 | 1.87 | 0.12 | -0.11 | 0.14 | 0.05 | 0.23 |
| (0.62) | (0.86) | (0.47) | (1.31) | (2.31) | (0.73) | (0.43) | (0.66) | (0.10) | (0.73) |
| Participant by Time (β5) | -0.04 | -0.03 | 0.00 | 0.00 | -0.22 | -0.04 | 0.09 | -0.06 | 0.01 | -0.05 |
| (0.23) | (0.30) | (0.18) | (0.42) | (0.59) | (0.24) | (0.22) | (0.25) | (0.03) | (0.27) |
| Participation by Intervention (β6) | 3.33\*\*\* | 4.58\*\*\* | 2.00\*\* | 1.11 | 3.64\* | 3.87\*\*\* | -0.42 | 3.32\*\*\* | 0.40\*\* | 3.90\*\*\* |
| (0.65) | (1.07) | (0.63) | (1.49) | (1.69) | (0.68) | (0.76) | (0.67) | (0.15) | (0.76) |
| Participation by Time by Intervention (β7) | 0.35 | 0.18 | 0.50 | 0.65 | 0.31 | 0.73 | 0.22 | 0.46 | -0.02 | 0.43 |
| (0.53) | (0.67) | (0.41) | (0.83) | (1.64) | (0.62) | (0.35) | (0.58) | (0.14) | (0.64) |
| + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .001°After propensity score weighting, treatment and comparison schools were only partially balanced.β6 represents the difference in the level between AP STEM and English schools and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between AP STEM and English schools and comparison schools in the slope from the years before the AP STEM and English intervention (i.e., SY07–SY10 for Cohort III) to the three years after the AP STEM and English intervention began (i.e., SY12–SY13 for Cohort III). |

**Table 8b: Impacts of AP STEM and English Program on AP Course Passing, ELA Courses—DID**

|  |  |  |  |
| --- | --- | --- | --- |
| **Model Description****(Student group)** | **Participant** | **Time** | **Percent Passing Change Two Years After Participation1** |
| **Cohort IV—FRL** |
| All | -0.15(0.58) | 2.24\*\*\*(0.57) | 2.87\*\*\*(0.81) |
| Free and Reduced-Price Lunch | 0.07(0.44) | 1.55\*\*\*(0.44) | 0.90(0.62) |
| Non-Free and Reduced-Price Lunch | -0.06(0.59) | 2.58\*\*\*(0.59) | 5.27\*\*\*(0.84) |
| **Cohorts VIII and IX—ECODIS** |
| All | -0.01(0.55) | 0.15(0.55) | 3.16\*\*\*(0.78) |
| Economically Disadvantaged | -0.04(0.54) | -0.49(0.54) | 2.59\*\*\*(0.77) |
| Non-Economically Disadvantaged | -0.07(0.61) | 0.50(0.61) | 3.48\*\*\*(0.87) |
| \*\*\**p* < .0011Change in percentage points of students passing an AP course at a school. A positive number indicates an increase in the percent passing for treatment schools. |

**Table 9a: Impacts of AP STEM and English Program on AP Course Passing, Math Courses—CITS**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All°** | **Female** | **Male** | **Afr. Amer. / Black** | **Hispanic/ Latino** | **Multi-race** | **White** | **ELL°** | **Non-ELL** | **SWD** | **Non-SWD°** |
| Intercept (β0) | 1.87\*\*\* | 2.08\*\*\* | 1.59\*\*\* | 1.63\*\* | 1.03\*\* | 2.31\*\* | 1.83\*\*\* | 0.99+ | 1.56\*\*\* | 0.30\*\*\* | 2.08\*\*\* |
| (0.36) | (0.34) | (0.31) | (0.58) | (0.34) | (0.73) | (0.22) | (0.57) | (0.26) | (0.07) | (0.41) |
| Time (β1) | 0.12 | 0.05 | 0.21\* | -0.13 | 0.24+ | -0.26+ | 0.18\*\*\* | -0.26 | 0.23\*\*\* | -0.08\*\*\* | 0.17 |
| (0.11) | (0.10) | (0.10) | (0.18) | (0.14) | (0.14) | (0.04) | (0.18) | (0.05) | (0.02) | (0.14) |
| Intervention Period (β2) | 0.33 | 0.49 | 0.14 | 0.98 | -0.29 | 1.55\* | 0.15 | 0.52\* | 0.10 | 0.30\*\*\* | 0.33 |
| (0.27) | (0.30) | (0.24) | (0.61) | (0.47) | (0.65) | (0.13) | (0.24) | (0.13) | (0.08) | (0.33) |
| Time by Intervention (β3) | 0.26 | 0.35\* | 0.18 | 0.67+ | -0.06 | 0.49\* | 0.11 | 0.47 | 0.17+ | 0.11\*\*\* | 0.31 |
| (0.16) | (0.15) | (0.16) | (0.36) | (0.21) | (0.22) | (0.07) | (0.40) | (0.10) | (0.03) | (0.20) |
| Participant (β4) | 0.07 | 0.11 | -0.01 | 0.05 | 0.40 | 1.61 | 0.25 | 0.58 | 0.38 | 0.03 | 0.13 |
| (0.52) | (0.53) | (0.52) | (0.78) | (0.88) | (2.06) | (0.49) | (0.94) | (0.45) | (0.16) | (0.58) |
| Participant by Time (β5) | 0.06 | 0.04 | 0.06 | 0.09 | -0.01 | -0.16 | 0.00 | -0.13 | 0.00 | -0.01 | 0.07 |
| (0.14) | (0.15) | (0.15) | (0.25) | (0.24) | (0.43) | (0.11) | (0.28) | (0.10) | (0.05) | (0.17) |
| Participation by Intervention (β6) | 1.64\*\* | 2.15\*\* | 1.09+ | 0.08 | 0.42 | 2.49 | 1.93\*\* | 0.15 | 1.84\*\* | 0.14 | 1.86\*\* |
| (0.59) | (0.71) | (0.58) | (1.01) | (0.78) | (1.58) | (0.60) | (0.54) | (0.56) | (0.19) | (0.69) |
| Participation by Time by Intervention (β7) | 0.05 | -0.24 | 0.34 | 0.36 | -0.04 | 0.30 | 0.43 | 0.20 | 0.05 | 0.04 | 0.05 |
| (0.42) | (0.47) | (0.42) | (1.16) | (0.71) | (1.33) | (0.38) | (0.71) | (0.42) | (0.11) | (0.50) |
| + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .001°After propensity score weighting, treatment and comparison schools were only partially balanced.β6 represents the difference in the level between AP STEM and English schools and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between AP STEM and English schools and comparison schools in the slope from the years before the AP STEM and English intervention (i.e., SY07–SY10 for Cohort III) to the three years after the AP STEM and English intervention began (i.e., SY12–SY13 for Cohort III). |

**Table 9b: Impacts of AP STEM and English Program on AP Course Passing, Math Courses—DID**

|  |  |  |  |
| --- | --- | --- | --- |
| **Model Description****(Student group)** | **Participant** | **Time** | **Percent Passing Change Two Years After Participation1** |
| **Cohort IV—FRL** |
| All | 0.03(0.40) | 1.82\*\*\*(0.40) | 1.56\*\*(0.56) |
| Free and Reduced-Price Lunch° | -0.02(0.27) | 0.94\*\*\*(0.27) | 0.10(0.38) |
| Non-Free and Reduced-Price Lunch | 0.14(0.46) | 2.65\*\*\*(0.45) | 2.06\*\*(0.64) |
| **Cohorts VIII and IX—ECODIS** |
| All | 0.07(0.40) | 0.87\*(0.39) | 2.57\*\*\*(0.56) |
| Economically Disadvantaged | 0.04(0.32) | 0.30(0.32) | 1.74\*\*\*(0.45) |
| Non-Economically Disadvantaged | 0.03(0.45) | 1.25\*\*(0.45) | 2.79\*\*\*(0.64) |
| \**p* < .05, \*\**p* < .01, \*\*\**p* < .0011Change in percentage points of students passing an AP course at a school. A positive number indicates an increase in the percent passing for treatment schools. |

**Table 10a: Impacts of AP STEM and English Program on AP Course Passing, Science Courses—CITS**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | **All** | **Female** | **Male** | **Afr. Amer. / Black** | **Hispanic/ Latino** | **Multi-race** | **White** | **ELL°** | **Non-ELL** | **SWD** | **Non-SWD** |
| Intercept (β0) | 0.35 | 0.83 | 0.69+ | 1.41\*\* | -0.20 | 1.23+ | 1.39\*\*\* | 0.45 | 0.54 | 0.01 | 0.63 |
| (1.04) | (0.99) | (0.40) | (0.49) | (0.41) | (0.67) | (0.37) | (0.63) | (1.13) | (0.10) | (1.20) |
| Time (β1) | 0.90\* | 0.89\* | 0.63\*\*\* | 0.16 | 0.71\*\*\* | 0.61\* | 0.80\*\*\* | 0.00 | 1.01\* | 0.06+ | 1.07\* |
| (0.41) | (0.39) | (0.17) | (0.14) | (0.16) | (0.28) | (0.18) | (0.28) | (0.47) | (0.03) | (0.49) |
| Intervention Period (β2) | 1.43 | 1.31 | 0.46 | 0.48 | -0.72 | 0.16 | 0.25 | 0.14 | 1.64 | 0.00 | 1.52 |
| (1.37) | (1.28) | (0.55) | (0.45) | (0.47) | (0.97) | (0.63) | (0.45) | (1.58) | (0.16) | (1.46) |
| Time by Intervention (β3) | -1.15 | -0.96 | -0.68+ | 0.61\* | -0.47+ | -0.33 | -0.68 | -0.17 | -1.34 | 0.09 | -1.41 |
| (0.95) | (0.91) | (0.38) | (0.27) | (0.24) | (0.82) | (0.43) | (0.48) | (1.08) | (0.09) | (1.11) |
| Participant (β4) | 0.99 | 1.01 | 0.43 | -0.05 | 0.76 | 1.00 | 0.17 | 0.18 | 0.69 | 0.05 | 0.79 |
| (1.17) | (1.17) | (0.64) | (0.79) | (0.78) | (2.34) | (0.68) | (0.72) | (1.26) | (0.16) | (1.35) |
| Participant by Time (β5) | -0.25 | -0.19 | -0.04 | 0.04 | 0.06 | -0.08 | -0.03 | -0.07 | -0.30 | 0.01 | -0.27 |
| (0.46) | (0.46) | (0.25) | (0.27) | (0.35) | (0.81) | (0.29) | (0.30) | (0.51) | (0.06) | (0.54) |
| Participation by Intervention (β6) | -0.31 | 0.20 | 0.30 | 1.17 | -0.84 | -0.74 | 0.89 | -0.41 | -0.53 | 0.01 | -0.33 |
| (1.54) | (1.50) | (0.92) | (1.40) | (1.36) | (2.64) | (1.03) | (0.62) | (1.74) | (0.25) | (1.67) |
| Participation by Time by Intervention (β7) | 0.92 | 0.68 | 0.50 | -0.52 | -0.01 | 2.10 | 0.55 | 0.55 | 1.04 | -0.08 | 1.16 |
| (0.99) | (0.98) | (0.48) | (0.82) | (0.51) | (1.80) | (0.59) | (0.55) | (1.12) | (0.16) | (1.17) |
| + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .001°After propensity score weighting, treatment and comparison schools were only partially balanced.β6 represents the difference in the level between AP STEM and English schools and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between AP STEM and English schools and comparison schools in the slope from the years before the AP STEM and English intervention (i.e., SY07–SY10 for Cohort III) to the three years after the AP STEM and English intervention began (i.e., SY12–SY13 for Cohort III). |

**Table 10b: Impacts of AP STEM and English Program on AP Course Passing, Science Courses—DID**

|  |  |  |  |
| --- | --- | --- | --- |
| **Model Description****(Student group)** | **Participant** | **Time** | **Percent Passing Change Two Years After Participation1** |
| **Cohort IV—FRL** |
| All | -0.10(0.40) | 1.18\*\*(0.40) | 1.69\*\*(0.57) |
| Free and Reduced-Price Lunch | -0.07(0.31) | 0.65\*(0.31) | 0.91\*(0.44) |
| Non-Free and Reduced-Price Lunch | -0.02(0.46) | 1.64\*\*\*(0.46) | 2.69\*\*\*(0.65) |
| **Cohorts VIII and IX—ECODIS** |
| All | -0.07(0.51) | 0.68(0.51) | -0.02(0.73) |
| Economically Disadvantaged° | -1.09+(0.61) | -2.47\*\*\*(0.61) | 1.13(0.87) |
| Non-Economically Disadvantaged | -0.14(0.57) | 0.76(0.56) | 0.96(0.80) |
| + *p* < .1, \**p* < .05, \*\**p* < .01, \*\*\**p* < .0011Change in percentage points of students passing an AP course at a school. A positive number indicates an increase in the percent passing for treatment schools. |

1. Increasing participation and performance in English Laguage Arts (ELA) AP courses and AP exams is not a stated goal of the project. However, increasing participation and performance in ELA AP courses and exams is frequently reflected as a goal of the program in practice. [↑](#footnote-ref-1)
2. Data from the 2019–20 school year were not included because the necessary data was not available. [↑](#footnote-ref-2)
3. Five participating schools from Cohort VII through Cohort IX were not included in the treatment group because they were identified as not having fully implemented the program by DESE and Mi. These schools included Hoosac Valley Middle and High School, Rockland Senior High School, Weymouth High School, William J. Dean Technical High School, and KIPP Academy Lynn Collegiate High School. [↑](#footnote-ref-3)
4. To be considered a course passer, a student must have (1) completed the course, (2) earned credit, and (3) received a passing letter or numeric grade within the course. [↑](#footnote-ref-4)
5. AP course passing rates are calculated based on the number of students enrolled in the school rather than the number of students enrolled in the AP course, since the objective of the analysis was to determine if the *overall rate of AP course passing* had changed more at participating schools than at similar non-participating schools, and not to determine if the *rate of passing among course takers* had changed more at participating schools than at similar non-participating schools. [↑](#footnote-ref-5)
6. CITS analyses for other student groups—such as non-binary students—were not conducted because the amount of data necessary to conduct the analysis was not available. [↑](#footnote-ref-6)
7. It is important to note that propensity score *weighting* is a separate and different procedure than propensity score *matching*. While there are advantages and disadvantages of both procedures, ultimately, propensity score weighting was used because it resulted in low standardized bias and a high number of balanced models. [↑](#footnote-ref-7)
8. Rubin, D. B. (2001). Using propensity scores to help design observational studies: Application to the tobacco litigation. *Health Services and Outcomes Research Methodology*, *2*(3–4), 169–188. [↑](#footnote-ref-8)
9. Corresponding to *β4* and *β5* coefficients for the CITS analysis, see Appendix A, and *β*2 coefficient for the DID analysis, see Appendix B. [↑](#footnote-ref-9)
10. Results for CITS analyses on Asian students were not reported since the samples were not balanced. CITS results for African American / Black students were not completed for ELA because the sample was not balanced. [↑](#footnote-ref-10)
11. Results for CITS analyses on Asian students were not reported since the samples were not balanced. CITS results for African American / Black students were not completed for ELA because the sample was not balanced. [↑](#footnote-ref-11)
12. Linden, A., & Adams, J. L. (2011). Applying a propensity score‐based weighting model to interrupted time series data: Improving causal inference in programme evaluation. *Journal of Evaluation in Clinical Practice*, *17*(6), 1231–1238. [↑](#footnote-ref-12)