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**MA Department of Elementary and Secondary Education**

Evaluation of the Statewide STEM Advanced Placement Program

AP Course Taking and Passing Rates

August 31, 2017

Acknowledgements

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Evaluation of the Statewide STEM Advanced Placement Program: AP Course Taking and Passing Rates

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**Report Information**

This report was prepared by the UMass Donahue Institute, the project evaluator, under contract with the Massachusetts Department of Elementary and Secondary Education.

**About the Donahue Institute**

The University of Massachusetts Donahue Institute is the public service, outreach, and economic development unit of the University of Massachusetts President’s Office. Established in 1971, the Institute strives to connect the Commonwealth with the resources of the University through services that combine theory and innovation with public and private sector applications.

UMDI’s Applied Research and Program Evaluation group specializes in applied social science research, including program evaluation, survey research, policy research, and needs assessment. The group has designed and implemented research and evaluation projects for diverse programs and clients in the areas of education, human services, economic development, and organizational development.

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# Introduction

The Massachusetts Department of Elementary and Secondary Education (ESE) 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, mathematics, and engineering.

One of these initiatives is the Advancing STEM through an Advanced Placement Science and Mathematics program (hereafter “the program” or the “Advancing STEM AP program”). The goals[[1]](#footnote-1) of the program are to:

1. Increase AP science and mathematics course availability, particularly at schools with limited AP science and mathematics offerings and high percentages of economically disadvantaged and minority students;
2. Increase access to and participation in AP science and mathematics courses, particularly for students from ethnic, racial, gender, English proficiency, and socioeconomic groups that have been traditionally underserved, so that the demographics of these courses better reflect the diversity of the student population of the school and district;
3. Increase student achievement in AP science and mathematics courses, particularly to close Massachusetts academic achievement gaps;
4. Increase readiness for college-level study in STEM fields;
5. Improve science and mathematics teacher effectiveness, including content knowledge and pedagogical skills; and
6. Increase student interest in pursuing a STEM degree or a STEM-related career after high school.

In order to meet these program goals and track efforts to improve student achievement, ESE contracted with Mass Insight Education’s (MIE) Massachusetts Math + Science Initiative (MMSI) as a vendor to implement tasks and responsibilities aligned with the purposes of the program. The implementation of the statewide Advancing STEM AP program involves four key tasks to be implemented in partner schools:

1. Increase participation in AP science and mathematics courses, particularly among underserved populations;
2. Increase performance in AP science and mathematics courses, particularly among underserved populations;
3. Increase the number of new and/or additional AP science and mathematics courses offered by the partner districts and schools; and
4. Work in conjunction with statewide Race to the Top (RTTT) pre-AP teacher training program, during the RTTT funding period, which ended in 2016, to align efforts of both programs in those districts participating in both programs.

In their work to complete these tasks, MMSI is responsible for a variety of activities, including:

* 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,
* educating stakeholders about the benefits of the AP program and STEM careers,
* assisting schools in eliminating barriers to STEM AP courses faced by typically underserved students,
* conducting extracurricular study sessions and test preparation sessions, providing exam fee subsidies to economically disadvantaged students,
* supporting professional development for STEM AP teachers, supporting teacher attendance at the College Board’s AP summer institute,
* encouraging curriculum alignment, providing guidance and funds for equipment in new or expanded STEM AP courses,
* monitoring teacher effectiveness and fidelity to the implementation of the program, and
* assisting vertical teams of grade 6–10 pre-AP trained science and mathematics teachers and STEM AP teachers.

ESE contracted the University of Massachusetts Donahue Institute (UMDI) to conduct the multi-year evaluation of the Advancing STEM AP program. This report provides a summary of analyses comparing AP course availability, participation, and passing rates at participating schools to those of similar non-participating schools. It is the final deliverable for evaluation Year 5. Demographic reports overviewing AP exam taking and passing and AP course availability, taking, and passing, were submitted previously.

# Evaluation Design

This report, as part of the fifth year of the evaluation study, provides the results gathered from a quasi-experimental design and analysis comparing the AP course availability, participation, and passing rates at participating schools to those of similar non-participating schools. This information is relevant to the following research question:

* Is the program increasing performance (course taking and passing) on AP courses in participating schools?
* Is the program increasing the availability of AP courses in participating schools?

These research questions are based on the logic model depicted in Figure 1.

Figure 1. Advancing STEM AP Logic Model

*Core Activities Intermediate*

 *Outcomes*

Support district efforts to **offer** **additional** Advanced Placementcourses

 *Overall Outcomes*

**Increased AP course availability**

**More economically disadvantaged and minority students successfully completing AP mathematics, science, and ELA coursework and scoring 3 or higher on**

**AP exams**

**Improved teacher knowledge and skills**

**Provide PD** to current and newly recruited Advanced Placement teachers

**More students interested in pursuing STEM-related career or college major**

**Increased underrepresented student participation in AP courses and AP exams**

**Identify and encourage** underrepresented studentsfor

Advanced Placement courses

# Data and Data Analysis

This analysis is based on AP course data provided by ESE from SY11 to SY16. Data were merged with corresponding SIMS data in order to identify key demographic information for participating students. Participating students were those in grades 9–12 who were enrolled in schools identified as participating in Cohort IVthrough Cohort VI of the Advancing STEM Initiative. Earlier and later cohorts are not included in this analysis because the years of data required to complete a difference-in-difference (DID) model were not available. In total, 31 schools were included in the treatment group, and 208 schools were considered for inclusion in the comparison group. The actual number of schools included in the models varied based on the subject and subgroup of interest.

Data summarized in this report include quantitative results of a quasi-experimental design that compares the AP course taking and passing rates at participating Advancing STEM AP schools to those at non-participating schools. Additionally, analyses compare the number of unique AP courses offered at participating Advancing STEM AP schools to those at non-participating schools. Quantitative results are presented by subject and subgroup and examine the impact of the program on the following: the percentage of students taking and passing at least one ELA, math, or science AP course two years after their school’s participation in the Advancing STEM AP program began, as well as the number of unique AP courses offered two years after participation in the Advancing STEM AP program began. Summaries of significant results are found in the text below. Full model results for all analyses are provided in Appendix B, Appendix C, and Appendix D. A summary of key results for all models is provided in Appendix E.

Separate analyses were conducted by race/ethnicity, gender, and for special populations, including English language learner (ELL) status and disability status.

# Methods

Advancing STEM AP is a school-level intervention. As such, analyses to assess the program’s impact on AP course taking and course passing rates, as well as the number of unique AP courses offered (i.e., unique section count), were conducted at the school level, comparing participating Advancing STEM AP schools to similar schools that did not participate in the program.

Differences in treatment and comparison schools were 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. In this design, AP course taking and passing rates were observed one school year before and two school years after the introduction of the Advancing STEM AP program to see if the differences in AP course taking and passing rates two years after participation are significantly different from differences in the same rates at similar comparison schools. The same method was applied for comparing the number of unique courses offered at a given school. Using both Advancing STEM AP schools and comparison schools enables stronger inferences about what AP course taking and passing levels and trends, as well as the number of unique course offerings, would have been observed in the absence of the Advancing STEM AP program.

The impacts of the Advancing STEM AP 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 course divided by the total number of enrolled high school students in a school.[[2]](#footnote-2),[[3]](#footnote-3) Models assessed the effects of the Advancing STEM AP program on four groupings: AP course taking/passing rates for any ELA, math, or science AP course; taking/passing rates for any ELA AP course; taking/passing rates for any math AP course; and taking/passing rates for any science AP course. For each of these groupings, assessment of impacts on AP course taking/passing rates fell into the two categories below, corresponding to the study’s outcome evaluation questions. In total, two sets of models were conducted: one to assess the impact of the program on taking rates and the other assessing impacts on passing rates. Each set of analyses included 11 models for each of the four groupings, yielding 44 models per outcome measure, for a total of 88 models.

1. All students – Impacts on all students in all Advancing STEM AP schools. (Four academic discipline groupings and two measured outcomes yielded eight difference-in-difference models.)
2. Subgroups – Impacts on subgroups of students in all Advancing STEM AP schools. Subgroups assessed were female, male, ELL, non-ELL, students with disabilities (SWD), non-SWD, Asian, African American/Black, Hispanic/Latino, and White. (Ten subgroups, four academic discipline groupings, and two outcomes yielded 80 difference-in-difference models.)

An additional set of four models were conducted to assess the impact of the Advancing STEM AP program on unique course offerings. Models assessed the effects of the Advancing STEM AP program on four groupings: the number of unique ELA, math, or science AP courses; ELA courses; math courses; and science courses.

The Advancing STEM AP program did not utilize random assignment because each school was selected by MIE to participate based on school characteristics. Therefore, it is likely that there were differences between Advancing STEM AP 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.

In essence, propensity score weighting is used to approximate the results of random assignment by reducing multiple covariates (e.g., race, gender, and AP course taking and passing rates prior to the Advancing STEM AP program) to a single score called a propensity score. A propensity score was calculated for each Advancing STEM AP participating and comparison school that described the likelihood of that school participating in the Advancing STEM AP program. Weighting procedures were then applied to balance propensity scores for Advancing STEM AP and comparison schools. Propensity scores generated 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 Advancing STEM AP program.

Covariates used in the propensity score weighting procedure included gender, race/ethnicity, low income status, English Language Learner (ELL) status, special education status, average school MCAS CPI (by subject, as appropriate for each analysis), and pre-intervention AP course taking and passing rates from the year prior to intervention. Once weights were assigned, the balance of the covariate distributions between Advancing STEM AP 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.[[4]](#footnote-4)

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 that achieved this criterion were designated as “fully balanced.” Models that could not be fully balanced were assessed to see if more than half of the variables used in the weighting equation achieved a standardized bias of less than 0.25 after weighting. Models that achieved this criterion were designated as “partially balanced.” The tables in the findings section below indicate which models were only partially balanced. For models that did not achieve full or partial balance, findings are not reported, due to the lack of an adequately matched comparison group. Of the 92 models assessed, 43 were balanced after weighting, and 36 were considered partially balanced.

Even if individual covariates met the criteria just described for full balance or partial balance, the difference-in-difference analysis may determine that the baseline year of AP course taking/passing data, or the baseline year of unique AP course offerings data, when considered together, differed in terms of their initial level (corresponding to the participant value; see Appendix A). While such differences raise some concerns about the ability to draw causal inferences about the relationship between the Advancing STEM AP program, AP course taking/passing rates, and unique AP course offerings, the full or partial balance achieved via the propensity score weighting provides evidence of substantial similarity between the Advancing STEM AP participants and comparison schools.

The time intervals for assessing impacts were based on the number of years between a given offering of an AP course and when a school began its Advancing STEM AP program. Only cohorts for which the data were available and complete the year prior to intervention and two years post-intervention were eligible for inclusion in this model. Cohort IV schools began their Advancing STEM AP program in SY12, Cohort V in SY13, and Cohort IV in SY14.

# Findings

Findings drawn from quantitative analyses of AP Course takers and passers and unique course are summarized below. To see full results from all course taking and passing models, please see Appendix B and Appendix C. A summary of key results for models of all unique AP course offerings is provided in Appendix D.

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| **Summary of Key Findings** |
| * Participating schools experienced significant additional increases in the number of unique course sections offered when compared to similar non-participating schools.
* Advancing STEM AP programs had a positive effect on ELA, math, and science AP course taking and passing rates two years after participation began.
* On average, the percentage of students taking and the percentage of students passing one or more ELA, math, or science AP courses increased by 5 percentage points more at participating schools than at similar non-participating schools the year participation began.
* ELA course taking and passing rates generally improved more than math or science course taking and passing rates.
* Increases in the percentage of female students taking or passing any AP course were almost double the increases seen for male students at participating schools.
 |

**Impacts on Unique AP Course Availability**

For each of the four Advancing STEM AP academic discipline groupings, impacts on unique AP course offerings (i.e., sections) were assessed in relation to all students. In total, four models were run to assess this impact. Statistically significant program impacts were identified for 3 of the 4 models. The fourth model (math) did not achieve balance, indicating that the model did not fully account for the differences between schools prior to intervention. As a result, this model is not presented.

The table indicates significance in relation to the additional change in the number of unique AP course sections offered two years after participation. The coefficient represents the additional increase in unique AP course sections offered at participating schools when compared to similar non-participating schools.

Overall, the number of all ELA, math, and science unique AP course sections offered increased for both treatment and control schools during the intervention period. An additional 4 unique AP course sections were offered at schools participating in intervention when compared to similar control schools. The number of ELA and science course sections offered also increased more at participating schools than control schools, by about 1 and 2 course sections respectively.

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| **Impacts of Advancing STEM AP on AP Course Offering,** **Summary of Significant Findings for ELA, Math, or Science Courses** |
| Model Description(Subgroup) | Difference in Change in Unique Course Sections Offered Between Treatment and Control Groups Two Years After Participation |
| Any° | 3.8 |
| ELA° | 2.2 |
| Science° | 1.0 |
| °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced. |

**Impacts on AP Course Taking Rates**

Impacts on AP course taking rates were assessed in relation to all students and student subgroups for each of the four Advancing STEM AP academic discipline groupings. In total, 44 difference-in-difference models were analyzed, with 11 for each of the four academic discipline groupings.

Statistically significant program impacts were identified for 28 of these 44 models, as summarized in the tables below. The tables indicate significance in relation to the AP course taking rate change two years after participation for Advancing STEM AP schools when compared to similar non-participating schools. The changes are presented as the percentage of students taking an AP course, with a positive number indicating an increase in taking rates.

**Impacts on ELA, Math, or Science AP Course Taking** **Rates.** The percentage of students taking an AP course increased for both treatment and control schools during the intervention period. AP course taking rates among schools participating in the intervention increased an additional 5 percentage points when compared to similar control schools. Eight subgroups at schools participating in the intervention saw significant additional increases in the percentage of students taking any ELA, math, or science AP course when compared to similar control schools.

The percentage of male students taking an AP course at participating schools increased an additional 4 percentage points, while female students saw an increase of 8 more percentage points when compared to similar non-participating schools. Across racial/ethnic groups, the change in course taking rate for White and Hipsanic/Latino students in Advancing STEM schools was 4–5 percentage points higher than the change in course taking rate for White and Hispanic/Latino students in the control schools. The change in course taking rate for African American/Black students in Advancing STEM schools was 7 percentage points higher than the change in course taking rate for African American/Black students in the control schools. The change in course taking rate for ELL students in Advancing STEM schools was 4 percentage points higher than the change in course taking rate for ELL students in the control schools

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| **Impacts of Advancing STEM AP on AP Course Taking,** **Summary of Significant Findings for ELA, Math, or Science Courses** |
| Model Description(Subgroup) | Difference in Percentage Point Change in Taking Between Treatment and Control Groups Two Years After Participation |
| All° | 4.7 |
| Female | 7.5 |
| Male | 3.8 |
| African American/Black° | 7.0 |
| Hispanic/Latino | 4.1 |
| White° | 4.9 |
| English Language Learner | 4.3 |
| Student Without Disabilities° | 6.3 |
| °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced.Note: Results for the following subgroups are not displayed because they were not statistically significant: Asian and students with disabilities.. Results for non-English language learners are not displayed because the model was not balanced for that subgroup. |

**Impacts on ELA AP Course Taking Rates.** The percentage of students taking an ELA AP course increased for both treatment and control schools during the intervention period. AP course taking rates among schools participating in intervention increased an additional 5 percentage points when compared to similar control schools. Eight subgroups at schools participating in the intervention saw significant additional increases in the percentage of students taking any ELA AP course when compared to similar control schools.

The program appears to have the largest impact on ELA course taking for Female, Asian, and White students. Smaller—but statistically significant—impacts were observed for Male, African American/Black, and Hispanic/Latino students. The percentage of male students taking an ELA AP course at treatment schools increased an additional 2 percentage points compared to male students in control schools, while female students in treatment schools saw an additional increase of 7 percentage points when compared to similar non-participating schools. Across racial/ethnic groups, the largest increase in percentage taking an ELA course was seen for Asian students, with an additional increase of 7 percentage points. Hispanic/Latino students saw the smallest increase, with an additional 4 percentage-point increase in course taking. The percentage of non-ELL and non-SWD taking an ELA AP course increased by an additional 5–6 percentage points when compared to similar non-participating schools.

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| **Impacts of Advancing STEM AP on AP Course Taking,** **Summary of Significant Findings for ELA Courses** |
| Model Description(Subgroup) | Difference in Percentage Point Change in Taking Between Treatment and Control Groups Two Years After Participation |
| All° | 5.0 |
| Female | 6.8 |
| Male | 2.5 |
| African American/Black | 4.5 |
| Asian | 7.3 |
| Hispanic/Latino | 3.9 |
| White | 6.5 |
| Non-English Language Learner° | 5.4 |
| Student Without Disabilities° | 5.7 |
| °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced.Note: Results for the following subgroups are not displayed because they were not statistically significant: ELL and students with disabilities.  |

**Impacts on AP Math Course Taking Rates.** No conclusions can be made about the impact of participation on math taking rates for all students due to a lack of balance between treatment and control schools prior to intervention. After propensity score weighting, schools were not statistically equivalent, indicating that models would be unable to account for differences between schools that existed prior to intervention. However, impacts that were detected for AP course taking rates among subgroups of interest were lower for math than for ELA.

Many subgroup models, however, were balanced and a few subgroups saw significant positive impacts. The percentage of male students taking an AP course at participating schools increased an additional 1 percentage point, while female students saw an additional increase of 3 percentage points when compared to similar non-participating schools. Turning to race/ethnicity categories, African American/Black and Hispanic/Latino students saw an additional increase in the percentage of students taking a math course of between 1 and 2 percentage points when compared to the results for those subgroups in similar non-participating schools.

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| **Impacts of Advancing STEM AP on AP Course Taking,** **Summary of Significant Findings for Math Courses** |
| Model Description(Subgroup) | Difference in Percentage Point Change in Taking Between Treatment and Control Groups Two Years After Participation |
| Female | 2.5 |
| Male° | 1.4 |
| African American/Black | 1.9 |
| Hispanic/Latino° | 1.4 |
| °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced.Note: Results for the following subgroups are not displayed because they were not significant: Asian, students with disabilities, and ELL. Results for the following subgroups are not displayed because the model was not balanced: All students, White, non-ELL, and students without disabilities. |

**Impacts on AP Science Course Taking Rates.** The percentage of students taking a science AP course increased for both treatment and control schools during the intervention period. AP course taking rates among schools participating in intervention increased an additional 2 percentage points when compared to similar control schools. Four subgroups at schools participating in the intervention saw significant additional increases in the percentage of students taking any science AP course when compared to similar non-participating schools. Impacts that were detected for AP course taking rates among subgroups of interest were generally similar for science and math, and both were lower than the impacts observed for ELA.

The percentage of male students taking a science AP course at participating schools increased an additional percentage point, while course-taking rates for female students increased an additional 2 percentage points when compared to similar non-participating schools. Across racial/ethnic groups, only African American/Black students saw a significant increase in the percentage of students taking a science course, with an additional increase of about 2 percentage points. The percentage of non-SWD increased by an additional 2 percentage points.

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| **Impacts of Advancing STEM AP on AP Course Taking,** **Summary of Significant Findings for Science Courses** |
| Model Description(Subgroup) | Difference in Percentage Point Change in Taking Between Treatment and Control Groups Two Years After Participation |
| All° | 1.5 |
| Female | 2.1 |
| Male | 1.1 |
| African American/Black | 2.2 |
| Student Without Disabilities° | 1.6 |
| °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced.Note: Results for the following subgroups are not displayed because they were not significant: Asian, Hispanic/Latino, White, and students with disabilities. Results for the non-ELL subgroup is not displayed because the model was not balanced.  |

**Impacts on AP Course Passing Rates**

Impacts on AP course passing rates were assessed in relation to all students and student subgroups for each of the four Advancing STEM AP academic discipline groupings. In total, 44 difference-in-difference models were analyzed, with 11 for each of the four academic discipline groupings.

Statistically significant program impacts were identified for 29 of these 44 models, as summarized in the tables below. The tables indicate significance in relation to the AP course passing rate change two years after participation for Advancing STEM AP schools when compared to similar non-participating schools. The changes are presented as the percentage of students passing an AP course (among all enrolled students—whether or not they took an AP course), with a positive number indicating an increase in passing rates.

**Impacts on ELA, Math, or Science Course Passing Rates**. The percentage of students passing an AP course increased for both treatment and control schools during the intervention period. AP course passing rates among schools participating in intervention increased an additional 5 percentage points when compared to similar control schools. Six subgroups at schools participating in the intervention saw significant additional increases in the percentage of students passing any ELA, math, or science AP course when compared to similar control schools.

The largest statistically significant changes in the percentage of students passing an AP course at participating schools—when compared to the performance of students at similar non-participating schools—was found for female students and for African-American/Black students. The smallest statistically significant change was observed for Hispanic/Latino students. The percentage of male students passing an AP course at participating schools increased 4 percentage points more at participating schools than at similar non-participating schools. The percentage of female students passing an AP course at participating schools increased 8 percentage points more at participating schools than at similar non-participating schools. Across racial/ethnic groups, the percentage of White students passing an AP course increased by 4 percentage points more at participating schools than at similar non-participating schools, while the percentage of African American/Black students increased by 7 percentage points more at participating schools than similar non-participating schools. The change in the percentage of Hispanic/Latino students passing any course was 1 percentage point lower at participating schools than at similar non-participating schools, but this change was statistically significant. Lastly, the percentage of students without disabilities passing any course significantly increased at participating schools by 7 percentage points more at participating schools than at similar non-participating schools.

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| **Impacts of Advancing STEM AP on AP Course Passing,** **Summary of Significant Findings for ELA, Math, or Science Courses** |
| Model Description(Subgroup) | Difference in Percentage Point Change in Passing Between Treatment and Control Groups Two Years After Participation |
| All° | 5.1 |
| Female | 7.7 |
| Male | 3.5 |
| African American/Black° | 6.9 |
| Hispanic/Latino° | 0.6 |
| White° | 4.2 |
| Student Without Disabilities | 6.5 |
| °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced.Note: Results for the following subgroups are not displayed because they were not significant: Asian and students with disabilities.. Results for the non-ELL subgroup is not displayed because the model was not balanced. |

**Impacts on ELA Course Passing Rates.** The percentage of students passing an ELA AP course increased for both treatment and control schools during the intervention period. AP course passing rates among schools participating in intervention increased an additional 5 percentage points when compared to similar control schools. Six subgroups at schools participating in the intervention saw significant additional increases in the percentage of students passing any ELA AP course when compared to similar control schools.

The percentage of male students passing an AP course at participating schools increased an additional 4 percentage points, while female students saw an additional increase of 7 percentage points when compared to similar non-participating schools. Across racial/ethnic groups, the largest increase in percentage passing an ELA course was seen for Asian students, with an additional increase of 6 percentage points. The percentage of non-English Language Learner and students without disabilities each increased by an additional 5 percentage points when compared to similar non-participating schools.

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| **Impacts of Advancing STEM AP on AP Course Passing,** **Summary of Significant Findings for ELA Courses** |
| Model Description(Subgroup) | Difference in Percentage Point Change in Passing Between Treatment and Control Groups Two Years After Participation |
| All° | 4.8 |
| Female | 6.6 |
| Male | 3.6 |
| Asian | 6.2 |
| White | 5.5 |
| Non-English Language Learner° | 5.1 |
| Student Without Disabilities° | 5.5 |
| °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced.Note: Results for the following subgroups are not displayed because they were not statistically significant: African American/Black, Hispanic/Latino, ELL, and students with disabilities.  |

**Impacts on AP Math Course Passing Rates.** No conclusions can be made about the impact of participation on math passing rates for all students due to a lack of balance between treatment and control schools prior to intervention. After propensity score weighting, schools were not statistically equivalent, indicating that models would be unable to account for difference between schools prior to intervention. However, impacts that were detected for AP course passing rates among subgroups of interest were lower for math than for ELA.

Three subgroup models, however, were balanced and all three saw statistically significant positive impacts. The percentage of male students taking an AP course at participating schools increased an additional 1 percentage point, while female students saw an additional increase of 3 percentage points when compared to similar non-participating schools. African American/Black students saw an additional increase in the percentage of students taking a math course of 2 percentage points.

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| **Impacts of Advancing STEM AP on AP Course Passing,** **Summary of Significant Findings for Math Courses** |
| Model Description(Subgroup) | Difference in Percentage Point Change in Passing Between Treatment and Control Groups Two Years After Participation |
| Female | 2.6 |
| Male° | 1.3 |
| African American/Black | 1.5 |
| °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced.Note: Results for the following subgroups are not displayed because they were not significant: Asian, Hispanic/Latino, ELL, and students with disabilities. Results for the following subgroups are not displayed because the model was not balanced: All students, White, non-ELL, and students without disabilities. |

**Impacts on AP Science Course Passing Rates.** There was no statistically significant difference in the percentage of students passing a science AP course between treatment and control schools during the intervention period. Five subgroups at schools participating in the intervention saw significant additional increases in the percentage of students passing any science AP course when compared to similar control schools. Impacts that were detected for AP course passing rates among subgroups of interest were generally similar for science and math, and both were lower than the impacts observed for ELA.

The percentage of male students passing a science AP course at participating schools increased an additional percentage point, while female students increased an additional 3 percentage points when compared to similar non-participating schools. Across racial/ethnic groups, only African American/Black students saw a significant increase in the percentage of students passing a science course, with an additional increase of about 2 percentage points. While full results (see Appendix C) suggest a general increase in science passing rates over time for students with disabilities at both participating and non-participating schools, results above indicate that students with disabilities in Advancing STEM schools passed at a slightly lower rate than students at comparison schools. This is the only instance where passing rates were lower for the participating schools than for the comparison schools.

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| **Impacts of Advancing STEM AP on AP Course Passing,** **Summary of Significant Findings for Science Courses** |
| Model Description(Subgroup) | Difference in Percentage Point Change in Passing Between Treatment and Control Groups Two Years After Participation |
| Female | 2.8 |
| Male | 1.1 |
| African American/Black° | 2.2 |
| Student with Disabilities° | -0.5 |
| Student Without Disabilities° | 1.5 |
| °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced.Note: Results for the following subgroups are not displayed because they were not significant: All students, Asian, Hispanic/Latino, White, ELL, and non-ELL.  |

**Summary**

A primary goal of the Advancing STEM AP program is to increase participation and performance in ELA, mathematics, and science AP courses, particularly for students from underrepresented groups. In line with this goal, UMDI’s evaluation of the program found that observed impacts on AP course taking and passing rates for all students were generally positive. Results varied by subject and subgroup. Additionally, results suggest the Advancing STEM AP program has positive impacts on the number of unique AP course sections offered.

Results were reported for all academic subjects (ELA, math, and science) combined, as well as for individual subjects. Results indicate that the Advancing STEM AP program increased the percentage of all students taking any ELA, math, or science AP course by 4.7 percentage points and increased the percentage of all studentspassing any ELA, math, or science AP course by 5.1 percentage points.

When looking across subjects, increases in the percentage of students taking an ELA AP course were markedly higher than increases in science AP course taking rates (5.0 for ELA compared to 1.5 for science). ELA passing rates were similarly impacted, with an additional 5 percent of students passing an ELA AP course. There was no significant impact on science passing rates for all students. Models assessing the impacts of the Advancing STEM AP program on AP math course taking and passing cannot be interpreted due to the insufficient balance between participating and non-participating schools after propensity score weighting. However available subgroup analyses suggest that the Advancing STEM

AP intervention may have had less impact on Math course taking and passing than on ELA course taking and passing. As additional data become available, further analysis may be warranted to assess this hypothesis.

Inconsistent impacts were detected for some subgroups across course taking and passing models or subject-specific models. Generally, across subjects, course taking and passing rates increased by an additional 1 to 7 percentage points among subgroups two years after school participation. For most subgroups, students had larger increases in ELA taking and passing rates and smaller increases in math and science taking and passing rates.

Female students saw significantly higher increases in AP taking and passing when compared to male students. On average, female students tended to have an impact nearly double that of male students. Additionally, all racial/ethnic subgroups saw significant impacts on the percentage of students taking and passing any ELA, math, or science AP course. This effect was inconsistent when broken down by subject. Specifically, Asian and White students experienced large gains in ELA AP course taking and passing (about 7 and 6 percentage point increases respectively), but no significant impacts were detected for math or science taking and passing rates. African American/Black students had significant gains in every subject, showing an approximate additional gain of 2 percentage points in math and science taking and passing rates. While the AP course taking rate for Hispanic/Latino students increased by 1 percentage point for math and 4 percentage points for ELA, there were no increases in passing rates.

Overall, the number of ELA, math, and science unique AP course offerings increased for both treatment and control schools during the intervention period. An additional 4 unique AP course sections were offered at schools participating in intervention when compared to similar non-participating schools. ELA and science course offerings also increased at participating schools by about 1 and 2 course offerings respectively.

Overall, findings indicate that the Advancing STEM AP program had largely positive impacts on AP course taking and passing rates two years after programming began. By and large, schools participating in the Advancing STEM AP initiative experienced larger increases in the taking and passing of ELA AP courses than in math and science, the focus of the program. Similarly, while some progress was made towards the goal of increasing the AP course taking rate among students from underrepresented racial/ethnic groups, more support may be needed to further improve AP course taking and passing rates, especially in science.

# Appendices

**Appendix A: Modeling Procedures for Difference-in-Difference 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 subgroup (All students, racial/ethnic subgroups, by subject) a DID model was developed to assess the impact of the Pre-AP intervention on (a) school AP course taking rate, (b) school AP course passing rate, and (c) the number of sections of AP offered at each school one year after the program began.

This procedure was used for all 92 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-difference*between the treatment and control groups). β4 represents the vector of covariates included in the model.

**Appendix B: Unique AP Course Offerings, Full Model Results**

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| **Impacts of Advancing STEM AP on Unique AP Course Offering,** **Summary of Significant Findings for ELA, Math, or Science Courses** |
| Model Description(Subgroup) | Participant | Time | Unique Courses Two Years After Participation1 |
| Any◦ | 0.36(0.70) | 1.42\*(0.63) | 3.84\*\*\*(0.96) |
| ELA◦ | 0.12(0.29) | 0.61\*(0.28) | 2.16\*\*\*(0.41) |
| Science◦ | 0.20(0.32) | 0.39(0.03) | 1.03\*(0.44) |
| \*p < .05, \*\* p < .01, \*\*\* p < .001. Note: “NS” means “no significant findings.” Only statistically significant results are presented.1Change in number of AP courses at a school. A positive number indicates an increase in the unique course offerings for treatment schools. |

**Appendix C: AP Course Taking, Full Model Results**

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| **Impacts of Advancing STEM AP on AP Course Taking,** **Summary of Significant Findings for ELA, Math, or Science Course** |
| Model Description(Subgroup) | Participant | Time | Percent Taking Change Two Years After Participation1 |
| All◦ | 0.08(0.73) | 3.53\*\*\*(0.65) | 4.7\*\*\*(1.00) |
| Female | 0.28(0.92) | 3.14\*\*\*(0.89) | 7.53\*\*\*(1.28) |
| Male | -0.15(0.73) | 2.05\*\*(0.72) | 3.81\*\*\*(1.02) |
| African American/Black◦ | -0.16(1.18) | 0.09(1.15) | 7.04\*\*\*(1.66) |
| Asian | 0.60(1.79) | 5.16\*\*(1.77) | 4.95+(2.52) |
| Hispanic/Latino | 0.03(0.79) | 1.59\*(0.77) | 4.14\*\*\*(1.11) |
| White◦ | 1.07(0.80) | 4.46\*\*\*(0.78) | 4.89\*\*\*(1.12) |
| English Language Learner | -0.09(1.39) | -2.56+(1.37) | 4.25\*(1.96) |
| Student with Disabilities | 0.13(0.31) | 1.08\*\*\*(0.31) | 0.23(0.43) |
| Student Without Disabilities◦ | -0.29(0.90) | 2.97\*\*(0.85) | 6.33\*\*\*(1.25) |
| +p<.10, \*p < .05, \*\* p < .01, \*\*\* p < .001. 1Change 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. |

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| **Impacts of Advancing STEM AP on AP Course Taking,** **Summary of Significant Findings for ELA Course** |
| Model Description(Subgroup) | Participant | Time | Percent Taking Change Two Years After Participation1 |
| All | 0.26(0.68) | 1.88\*\*(0.66) | 5.04\*\*\*(0.95) |
| Female | 0.18(0.85) | 2.28\*\*(0.83) | 6.84\*\*\*(1.20) |
| Male | 0.22(0.59) | 0.56(0.57) | 2.48\*\*(0.82) |
| African American/Black | 0.25(1.06) | 1.17(1.05) | 4.47\*\*(1.49) |
| Asian | 0.16(1.48) | 0.13(1.47) | 7.33\*\*\*(2.08) |
| Hispanic/Latino | 0.12(0.69) | 1.18+(0.69) | 3.89\*\*\*(0.97) |
| White | 0.23(0.76) | 1.39+(0.75) | 6.46\*\*\*(1.07) |
| English Language Learner◦ | 0.47(1.02) | -1.22(1.00) | 0.50(1.43) |
| Non-English Language Learner | 0.36(0.73) | 1.80\*(0.70) | 5.35\*\*\*(1.02) |
| Student with Disabilities | 0.10(0.24) | 0.66\*\*(0.24) | 0.10(0.34) |
| Student without Disabilities◦ | 0.37(0.82) | 2.22\*\*(0.79) | 5.67\*\*\*(1.15) |
| +p<.10, \*p < .05, \*\* p < .01, \*\*\* p < .001. 1Change 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. |

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| **Impacts of Advancing STEM AP on AP Course Taking,** **Summary of Significant Findings for Math Course** |
| Model Description(Subgroup) | Participant | Time | Percent Taking Change Two Years After Participation1 |
| Female | 0.02(0.44) | 1.03\*(0.43) | 2.54\*\*\*(0.62) |
| Male◦ | 0.12(0.37) | 0.90\*(0.36) | 1.40\*\*(0.52) |
| African American/Black | 0.33(0.52) | 0.45(0.51) | 1.87\*(0.73) |
| Asian | 0.06(1.21) | 3.88\*\*(1.20) | 2.45(1.71) |
| Hispanic/Latino◦ | -0.14(0.37) | 0.11(0.36) | 1.39\*\*(0.52) |
| English Language Learner | 0.52(0.49) | -0.75(0.49) | 0.71(0.68) |
| Student with Disabilities◦ | -0.20(0.16) | -0.28+(0.16) | 0.31(0.23) |
| \*p < .05, \*\* p < .01, \*\*\* p < .001. 1Change 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. |

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| **Impacts of Advancing STEM AP on AP Course Taking,** **Summary of Significant Findings for Science Course** |
| Model Description(Subgroup) | Participant | Time | Percent Taking Change Two Years After Participation1 |
| All | 0.12(0.37) | 1.31\*\*\*(0.36) | 1.51\*\*(0.52) |
| Female | 0.11(0.47) | 1.47\*\*(0.46) | 2.09\*\*(0.66) |
| Male | 0.05(0.36) | 1.01\*\*(0.36) | 1.08\*(0.50) |
| African American/Black | 0.10(0.63) | 0.90(0.62) | 2.23\*(0.88) |
| Asian | -0.11(1.15) | 3.74\*\*(1.14) | 1.72(1.62) |
| Hispanic/Latino | 0.16(0.43) | 1.84\*\*\*(0.43) | 0.00(0.61) |
| White | 0.13(0.46) | 2.33\*\*\*(0.45) | 0.71(0.65) |
| English Language Learner◦ | 0.35(0.71) | 0.34(0.71) | 1.67+(1.00) |
| Student with Disabilities◦ | 0.21(0.16) | 0.87\*\*\*(0.15) | -0.27(0.22) |
| Student Without Disabilities◦ | 0.17(0.43) | 1.62\*\*\*(0.41) | 1.58\*\*(0.60) |
| +p<.10, \*p < .05, \*\* p < .01, \*\*\* p < .001. 1Change 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**

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| **Impacts of Advancing STEM AP on AP Course Passing,** **Summary of Significant Findings for ELA, Math, or Science Courses** |
| Model Description(Subgroup) | Participant | Time | Percent Passing Change Two Years After Participation1 |
| All◦ | 0.02(0.67) | 2.79\*\*\*(0.60) | 5.07\*\*\*(0.91) |
| Female | 0.38(0.84) | 2.32\*\*(0.82) | 7.70\*\*\*(1.17) |
| Male | 0.13(0.69) | 2.28\*\*(0.68) | 3.48\*\*\*(0.96) |
| African American/Black◦ | 0.13(1.01) | 0.76(0.98) | 6.90\*\*\*(1.42) |
| Asian | 0.54(1.6) | 4.85\*\*(1.59) | 3.94+(2.25) |
| Hispanic/Latino◦ | 0.17(0.19) | 0.46\*(0.18) | 0.56\*(0.26) |
| White◦ | 0.80(0.78) | 4.35\*\*\*(0.77) | 4.23\*\*\*(1.10) |
| English Language Learner◦ | 1.36+(0.76) | -0.88(0.77) | 1.83+(1.07) |
| Student with Disabilities | 0.12(0.29) | 0.99\*\*(0.28) | -0.21(0.40) |
| Student Without Disabilities◦ | -0.31(0.81) | 2.43\*\*(0.76) | 6.54\*\*\*(1.12) |
| +p<.10, \*p < .05, \*\* p < .01, \*\*\* p < .001. 1Change 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. |

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| **Impacts of Advancing STEM AP on AP Course Passing,** **Summary of Significant Findings for ELA Courses** |
| Model Description(Subgroup) | Participant | Time | Percent Taking Change Two Years After Participation1 |
| All◦ | 0.24(0.63) | 1.78\*\*(0.60) | 4.84\*\*\*(0.88) |
| Female | 0.13(0.79) | 2.02\*\*(0.78) | 6.61\*\*\*(1.11) |
| Male | 0.28(0.57) | 1.07+(0.55) | 3.56\*\*\*(0.80) |
| African American/Black◦ | 0.12(0.95) | 0.12(0.95) | 0.12(0.95) |
| Asian | 0.02(1.38) | 0.15(1.37) | 6.23\*\*(1.94) |
| Hispanic/Latino | 0.12(0.14) | 0.38\*\*(0.14) | 0.34+(0.2) |
| White | 0.24(0.70) | 1.63\*(0.69) | 5.50\*\*\*(0.99) |
| English Language Learner◦ | 1.30\*(0.56) | -0.32(0.57) | -0.55(0.79) |
| Non-English Language Learner◦ | 0.39(0.66) | 1.76\*\*(0.63) | 5.14\*\*\*(0.92) |
| Student with Disabilities | 0.09(0.24) | 0.60\*(0.23) | -0.04(0.33) |
| Student Without Disabilities◦ | 0.32(0.73) | 2.12\*\*(0.70) | 5.46\*\*\*(1.02) |
| +p<.10, \*p < .05, \*\* p < .01, \*\*\* p < .001. 1Change 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. |

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| **Impacts of Advancing STEM AP on AP Course Passing,** **Summary of Significant Findings for Math Courses** |
| Model Description(Subgroup) | Participant | Time | Percent Taking Change Two Years After Participation1 |
| Female | 0.01(0.41) | 0.85\*(0.40) | 2.64\*\*\*(0.57) |
| Male◦ | 0.06(0.35) | 0.94\*\*(0.34) | 1.28\*\*(0.49) |
| African American/Black | 0.26(0.45) | 0.39(0.44) | 1.52\*(0.63) |
| Asian | -0.04(1.14) | 3.71\*\*(1.13) | 2.53(1.61) |
| Hispanic/Latino | 0.02(0.09) | 0.09(0.08) | 0.22+(0.12) |
| English Language Learner | 0.47(0.47) | -0.95\*(0.47) | 0.96(0.65) |
| Student with Disabilities | 0.09(0.24) | 0.6\*(0.23) | -0.04(0.33) |
| +p<.10, \*p < .05, \*\* p < .01, \*\*\* p < .001. 1Change 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. |

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| **Impacts of Advancing STEM AP on AP Course Passing,** **Summary of Significant Findings for Science Courses** |
| Model Description(Subgroup) | Participant | Time | Percent Taking Change Two Years After Participation1 |
| All◦ | 0.11(0.35) | 0.11(0.35) | 0.11(0.35) |
| Female | 0.28(0.63) | 1.36\*(0.62) | 2.83\*\*(0.89) |
| Male | 0.05(0.35) | 0.92\*\*(0.35) | 1.10\*(0.49) |
| African American/Black◦ | 0.14(0.53) | 0.95+(0.52) | 2.24\*\*(0.75) |
| Asian | -0.22(1.13) | 3.15\*\*(1.12) | 2.28(1.60) |
| Hispanic/Latino | 0.06(0.09) | 0.41\*\*\*(0.09) | 0.00(0.13) |
| White◦ | 0.10(0.44) | 2.26\*\*\*(0.43) | 0.43(0.62) |
| English Language Learner◦ | 0.34(0.51) | 0.25(0.51) | 1.11(0.71) |
| Non-English Language Learner | 0.08(0.36) | 1.15\*\*(0.34) | 1.41\*\*(0.50) |
| Student with Disabilities◦ | 0.22(0.14) | 0.81\*\*\*(0.13) | -0.49\*(0.19) |
| Student Without Disabilities◦ | 0.16(0.40) | 1.50\*\*\*(0.39) | 1.45\*(0.56) |
| +p<.10, \*p < .05, \*\* p < .01, \*\*\* p < .001. 1Change 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 E: Summary of Key Results for all Models**

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| **Summary Table: Advancing STEM AP Impacts by Subgroup****Difference in Percentage Point Change vs. Control Group** |
| Subgroup | Subject | Course Taking1 | Course Passing1 |
| All students | Any ELA, Math, or Science | 4.7 | 5.1 |
| ELA | 5.0 | 4.8 |
| Math | n.r. | n.r. |
| Science | 1.5 | n.s. |
| Female students | Any ELA, Math, or Science | 7.5 | 7.7 |
| ELA | 6.8 | 6.6 |
| Math | 2.5 | 2.6 |
| Science | 2.1 | 2.8 |
| Male students | Any ELA, Math, or Science | 3.8 | 3.5 |
| ELA | 2.5 | 3.6 |
| Math | 1.4 | 1.3 |
| Science | 1.1 | 1.1 |
| African American/Black students | Any ELA, Math, or Science | 7.0 | 6.9 |
| ELA | 4.5 | n.s. |
| Math | 1.9 | 1.5 |
| Science | 2.2 | 2.2 |
| Asian students | Any ELA, Math, or Science | n.s. | n.s. |
| ELA | 7.3 | 6.2 |
| Math | n.s. | n.s. |
| Science | n.s. | n.s. |
| Hispanic/Latino students | Any ELA, Math, or Science | 4.1 | 0.6 |
| ELA | 3.9 | 0.3 |
| Math | 1.4 | n.s. |
| Science | n.s. | n.s. |
| White Students | Any ELA, Math, or Science | 4.9 | 4.2 |
| ELA | 6.5 | 5.5 |
| Math | n.r. | n.r. |
| Science | n.s. | n.s. |
| ELL | Any ELA, Math, or Science | 4.3 | 1.8 |
| ELA | n.s. | n.s. |
| Math | n.s. | n.s. |
| Science | 1.7 | n.s. |
| Non-ELL | Any ELA, Math, or Science | n.r. | n.r. |
| ELA | 5.4 | 5.1 |
| Math | n.r. | n.r. |
| Science | n.r. | 1.5 |
| SWD | Any ELA, Math, or Science | n.s. | n.s. |
| ELA | n.s. | n.s. |
| Math | n.s. | n.s. |
| Science | n.s. | -0.5 |
| Non-SWD | Any ELA, Math, or Science | 6.3 | 6.5 |
| ELA | 5.7 | 5.5 |
| Math | n.r. | n.r. |
| Science | 1.6 | 1.5 |
| *Note*: “n.s.” means “no significant findings.” Only results significant at the p<.05 level are presented. “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.1Change in percentage points of students taking/passing an AP exam at a school compared to change for control group. A positive number indicates a greater increase in the percentage taking/passing for participating schools |

1. Increaseing participation and performance in English Laguage Arts (ELA) AP courses and AP exams is not a stated goal of the project. However, increaseing participation and performance in ELA AP courses and exams is frequently reflected as a goal of the program in practice. [↑](#footnote-ref-1)
2. In order 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-2)
3. We calculated schools’ AP course passing rates based on the number of students enrolled in the school rather than the number of students enrolled in AP courses at the school because the objective of the analysis (as agreed by ESE, MIE, and UMDI) 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-3)
4. Rubin, D.B. “Using Propensity Scores to Help Design Observational Studies: Application to the Tobacco Litigation.” Health Services & Outcomes Research Methodology. 2001;2:169–188. [↑](#footnote-ref-4)