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**MA Department of Elementary and Secondary Education**

Evaluation of the Statewide STEM Advanced Placement Program

AP Exam Taking and Passing Rates

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

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**Report Information**

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**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 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. Year 1, Year 2, and Year 3 interim and final evaluation reports, as well as demographic reports overviewing AP exam taking and passing and AP course availability, taking, and passing, were submitted previously.

This report provides a summary of analyses comparing AP exam participation and passing rates at participating schools to those of similar non-participating schools. Future analyses will compare the AP course availability, participation, and passing rates at participating schools to those of similar non-participating schools.

# 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 exam 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 (exam taking and passing) on AP exams in participating schools?

This research question is 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

Future analyses will employ quasi-experimental design and analysis techniques to compare the AP course availability, participation, and passing rates of participating schools to those of similar non-participating schools.

# Data and Data Analysis

This analysis is based on AP exam data provided by ESE from SY07 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 IIIthrough 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 comparative interrupted time series (CITS) model were not available. In total, 55 schools were included in the treatment group, and 252 schools were considered for inclusion in the comparison group. The actual number of schools included in models varied based on the subject and subgroup of interest.

Data summarized in this report include quantitative results of a quasi-experimental design comparing the AP exam taking and passing rates 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 exam the year participation began; and the annual change in the percentage of students taking and passing at least one ELA, math, or science AP exam. Summaries of significant results are found in the text below. Full model results for all analyses are provided in Appendix B and Appendix C. A summary of key results for all models is provided in Appendix D.

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

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 exam taking/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 pre-intervention AP exam taking/passing rates from the four school years prior to intervention, gender, race/ethnicity, low income status, ELL status, special education status, and average school MCAS CPI (by subject, as appropriate for each analysis). 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.[[1]](#footnote-1) Of the 88 models assessed, 26 were balanced after weighting, and 53 were considered partially balanced.

The impacts of the Advancing STEM AP program were assessed for both AP exam taking rates and for AP exam passing rates. Rates were calculated as the number of students taking/passing an AP exam divided by the total number of enrolled high school students in a school. Models assessed the effects of the Advancing STEM AP program on four groupings: AP exam taking/passing rates for any ELA, math, or science AP exam; taking/passing rates for any ELA exam; taking/passing rates for any math AP exam; and taking/passing rates for any science AP exam. For each of these groupings, assessment of impacts on AP exam 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 outcomes measured yielded eight CITS 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 CITS models.)

The time intervals for assessing impacts were based on the number of years between a given administration of the AP exam and when a school began its Advancing STEM AP program. 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 model. Cohort III schools began their Advancing STEM AP program in SY11, Cohort IV in SY12, Cohort V in SY13, and Cohort IV in SY14.

To assess each CITS panel’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 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.” For models that did not achieve full or partial balance, findings are not reported, due to the lack of an adequately matched comparison group. Additionally, two models did not converge, likely due to small sample size, and therefore produced no results.

Even if individual covariates met the criteria just described for full balance or partial balance, the CITS analysis may determine that the four baseline years of AP exam taking/passing data, when considered together, differed in terms of their initial level or their four-year baseline trend (corresponding to the β4 and β5 coefficients; 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 and AP exam taking/passing rates, 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.

Moreover, the table in the findings section below that summarizes significant program impacts indicates which models were only partially balanced and/or had significant differences in their initial AP exam taking/passing rates or four-year AP exam taking/passing trend.

# Findings

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

|  |
| --- |
| **Summary of Key Findings** |
| * Advancing STEM AP programs had a positive effect on ELA, math, and science AP exam taking and passing rates one year after participation began. * On average, the percentage of students taking one or more ELA, math, or science AP exams increased by 6.6 percentage points more at participating schools than at similar non-participating schools the year participation began. * All racial/ethnic groups examined[[2]](#footnote-2) saw an increase in the percentage of students taking any AP exam one year after participation began. The percentage point increase varied by subgroup from 4.4 percentage points to 7.3 percentage points. Notably, increases in the percentage of African American/Black and Hispanic/Latino students taking one or more AP exams one year after participation began were smaller than increases seen for White and Asian students. * Participating schools saw an average increase of 2.0 percentage points in students passing an ELA, math, or science AP exam one year after participation began. Passing rates continued to increase over time, with passing rates increasing at an average of 0.3 percentage points annually for participating schools. * Significant impacts to percent taking an exam the year programming began were observed for most subgroups, but significant impacts for passing rates were not seen consistently across subgroups. |

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

Statistically significant program impacts were identified for 30 of these 44 models, as summarized in the tables below. The tables indicate significance in relation to two aspects of AP exam taking rates. The “AP Exam Taking Rate Change after One Year” column indicates significant AP exam taking rate differences between Advancing STEM AP and comparison schools one year after the Advancing STEM AP schools began their teacher training. The “Annual Change in Percent Taking Rate” column indicates significant differences between Advancing STEM AP and comparison schools in the annual rate of change in their AP exam taking rate during the three years after teacher training began. The changes are presented as the percentage of students taking an AP exam, with a positive number indicating an increase in taking rates.

| **Impacts of Advancing STEM AP on AP Exam Taking,**  **Summary of Significant Findings for ELA, Math, or Science Exam** | | |
| --- | --- | --- |
| Model Description  (Subgroup) | Percentage Point Change in Taking the Year of Participation1 | Annual Rate of Change in Percentage Taking1 |
| All° | 6.6 | n.s. |
| Male° | 5.6 | n.s. |
| White° | 6.3 | n.s. |
| African American/Black° | 4.4 | n.s. |
| Asian° | 7.3 | n.s. |
| Hispanic/Latino | 4.6 | n.s. |
| Non-English Language Learner | 6.2 | n.s. |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results are presented.  1Change in percentage points of students taking an AP exam at a school. A positive number indicates an increase in the percentage taking.  °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced. | | |

**ELA, Math, or Science Exam Taking**. The table above shows that, on average, the percentage of all students taking an ELA, math, or science AP exam increased by 6.6 percentage points the year participation began. The percentage of male students taking an AP exam in any ELA, math, or science subject increased by 5.6 percentage points the year participation began. In general, the percentage of students taking any ELA, math, or science exams increased from 4.4 percentage points to 7.3 percentage points across all racial/ethnic groups examined. Notably, effect sizes for the year participation began were smaller for African American/Black and Hispanic/Latino students (4.4 percentage points and 4.6 percentage points, respectively) than for White and Asian students (6.3 percentage points and 7.3 percentage points, respectively). The percent of non-ELL students taking any ELA, math, or science AP exam also had a one-time increase of 6.2 percentage points the year after participation began. No significant difference in the annual rate of change in percentage of students taking an AP exam was detected.

| **Impacts of Advancing STEM AP on AP Exam Taking,**  **Summary of Significant Findings for ELA Exam** | | | |
| --- | --- | --- | --- |
| Model Description  (Subgroup) | Percentage Point Change in Taking the Year of Participation1 | | Annual Rate of Change in Percentage Taking1 |
| All° | 3.7 | n.s. | |
| Male° | 3.1 | n.s. | |
| Female° | 5.3 | n.s. | |
| White° | 4.9 | n.s. | |
| African American/Black | 3.9 | n.s. | |
| Asian | 8.5 | n.s. | |
| Hispanic/Latino | 3.8 | n.s. | |
| Non-English Language Learner | 4.0 | n.s. | |
| Student without Disabilities° | 4.5 | n.s. | |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results are presented.  1Change in percentage points of students taking an AP exam at a school. A positive number indicates an increase in the percentage taking.  °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced. | | | |

**ELA Exam Taking**. When broken down by subject, Advancing STEM AP programs had a positive effect on ELA AP exam taking rates the year participation began. This effect was larger than that seen for math or science exam taking rates. As seen in the table above, participating schools saw an increase from 3.1 to 5.3 percentage points in ELA taking rates for male, female, White, African American/Black, Hispanic/Latino, non-ELL, and non-SWD students. The largest effect was found for Asian students (8.5 percentage points). No significant difference in the annual rate of change in percentage of students taking an ELA AP exam was detected.

| **Impacts of Advancing STEM AP on AP Exam Taking,**  **Summary of Significant Findings for Math Exam** | | | |
| --- | --- | --- | --- |
| Model Description  (Subgroup) | Percentage Point Change in Taking the Year of Participation1 | | Annual Rate of Change in Percentage Taking1 |
| All° | 2.7 | n.s. | |
| Male° | 2.3 | n.s. | |
| Female° | 2.2 | 0.9 | |
| African American/Black° | 2.2 | n.s. | |
| Hispanic/Latino | 1.0 | n.s. | |
| Non-English Language Learner° | 2.3 | 1.1 | |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results are presented.  1Change in percentage points of students taking an AP exam at a school. A positive number indicates an increase in the percentage taking.  °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced. | | | |

**Math Exam Taking**. As seen in the table above, the percentage of students taking a math AP exam increased 2.7 percentage points at participating schools when compared to similar non-participating schools the year participation began. However, no significant difference in the annual rate of change in percentage of students taking a math AP exam was detected.. On average, there was a 2 percentage points increase in taking math AP exams for males, females, African American/Black students, and non-ELL students. Impacts on the percent taking an AP math exam were markedly smaller for Hispanic/Latino students (1 percent). Significant annual changes in the rate of students taking a math AP exam were found for females and non-ELL students (0.9 percentage points and 1.1 percentage points, respectively). Among all ELA, math, and science models, these are the only two significant findings indicating a change in the percentage of students taking an AP exam.

| **Impacts of Advancing STEM AP on AP Exam Taking,**  **Summary of Significant Findings for Science Exam** | | |
| --- | --- | --- |
| Model Description  (Subgroup) | Percentage Point Change in Taking the Year of Participation1 | Annual Rate of Change in Percentage Taking1 |
| All° | 1.9 | n.s. |
| Male | 1.2 | n.s. |
| White | 1.6 | n.s. |
| African American/Black | 1.6 | n.s. |
| Asian | 4.2 | n.s. |
| Hispanic/Latino | 1.2 | n.s. |
| Non-English Language Learner° | 1.5 | n.s. |
| Student without Disabilities° | 1.9 | n.s. |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results are presented.  1Change in percentage points of students taking an AP exam at a school. A positive number indicates an increase in the percentage taking.  °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced. | | |

**Science Exam Taking**. Overall, the table above shows that there was a 2 percentage point increase in the percentage of students taking a science AP exam the year participation began. No significant difference in the annual rate of change in percentage of students taking a science AP exam taking was detected. Looking across subgroups, significant findings for the change in percent taking a science AP exam the year of participation were found for male, White, African American/Black, Asian, Hispanic/Latino, non-ELL, and non-SWD students. No significant difference in the annual rate of change in percentage of students taking a science AP exam was detected.

**Impacts on AP exam passing rates.** For each of the four Advancing STEM AP academic disciplines, impacts on AP exam passing rates were assessed in relation to all students and student subgroups. In total, 44 CITS models were analyzed, with 11 for each of the four academic disciplines.

Statistically significant program impacts were identified for 23 of these 44 models, as summarized in the tables below. The tables indicate significance in relation to two aspects of AP exam passing rates. The “AP Exam Passing Rate Change after One Year” column indicates significant AP exam passing rate differences between Advancing STEM AP and comparison schools one year after the Advancing STEM AP schools began their teacher training. The “Annual Change in Percent Passing Rate” column indicates significant differences between Advancing STEM AP and comparison schools in the annual rate of change in their AP exam passing rate during the three years after teacher training began. The changes are presented as the percentage of students passing an AP exam, with a positive number indicating an increase in passing.

| **Impacts of Advancing STEM AP on AP Exam Passing,**  **Summary of Significant Findings for ELA, Math, or Science Exam** | | |
| --- | --- | --- |
| Model Description  (Subgroup) | Percentage Point Change in Passing the Year of Participation1 | Annual Rate of Change in Percentage Passing1 |
| All° | 2.0 | 0.3 |
| Male° | 2.1 | n.s. |
| Female° | 2.1 | 0.6 |
| White | 2.4 | n.s. |
| Hispanic/Latino | 1.7 | n.s. |
| Non-English Language Learner° | 2.0 | 0.4 |
| Student without Disabilities° | 2.4 | n.s. |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results are presented.  1Change in percentage points of students passing an AP exam at a school. A positive number indicates an increase in the percentage passing.  °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced. | | |

**ELA, Math, or Science Exam Passing**. The table above shows that, on average, the percentage of students passing any ELA, math, or science AP exam increased by 2 percentage points the year participation began. Passing rates continued to increase over time, with passing rates increasing 0.3 percentage points annually for participating schools. Two groups, females and non-ELL students, saw small, persistent change in the passing rate annually, while other subgroups only saw impacts the year participation began. On average, most subgroups saw an increase in percent passing the year of participation by about 2 percentage points.

| **Impacts of Advancing STEM AP on AP Exam Passing,**  **Summary of Significant Findings for ELA Exam** | | |
| --- | --- | --- |
| Model Description  (Subgroup) | Percentage Point Change in Passing the Year of Participation1 | Annual Rate of Change in Percentage Passing1 |
| All° | 1.6 | n.s. |
| Male° | 1.5 | n.s. |
| Female° | 1.9 | n.s. |
| White° | 2.1 | n.s. |
| Hispanic/Latino | 1.3 | n.s. |
| Non-English Language Learner° | 1.6 | n.s. |
| Student without Disabilities° | 1.8 | n.s. |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results are presented.  1Change in percentage points of students passing an AP exam at a school. A positive number indicates an increase in the percentage passing.  °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced. | | |

**ELA AP Exam Passing**. When broken down by subject, Advancing STEM AP programs had a positive effect on ELA AP exam passing rates the year participation began. This effect was larger than that seen for math or science exam passing rates. Overall, as seen in the table above, participating schools saw an impact of 1 to 2 percentage points on ELA passing rates for male, female, White, Hispanic/Latino, non-ELL, and non-SWD students the year programming began. No significant difference in the annual rate of change in percentage of students passing an ELA AP exam was detected.

| **Impacts of Advancing STEM AP on AP Exam Passing,**  **Summary of Significant Findings for Math Exam** | | |
| --- | --- | --- |
| Model Description  (Subgroup) | Percentage Point Change in Passing the Year of Participation1 | Annual Rate of Change in Percentage Passing1 |
| All° | n.s. | 0.3 |
| Male° | 0.5 | n.s. |
| White | 0.7 | n.s. |
| Hispanic/Latino | 1.7 | n.s. |
| Non-English Language Learner° | n.s. | 0.3 |
| Student without Disabilities° | 0.6 | 0.3 |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results are presented.  1Change in percentage points of students passing an AP exam at a school. A positive number indicates an increase in the percentage passing.  °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced. | | |

**Math Exam Passing**. As seen in the table above, for the all-student model, there was no significant impact on math passing rates the year intervention began, but there was an impact on the annual change in percent passing. The largest effect was seen for the Hispanic/Latino subgroup, with an increase of 1.7 percentage points in the math AP exam passing rate the year participation began. No significant difference in the annual rate of change in percentage of students passing a Math AP exam was detected.

| **Impacts of Advancing STEM AP on AP Exam Passing,**  **Summary of Significant Findings for Science Exam** | | |
| --- | --- | --- |
| Model Description  (Subgroup) | Percentage Point Change in Passing the Year of Participation1 | Annual Rate of Change in Percentage Passing1 |
| All° | 0.5 | 0.2 |
| Male | 0.7 | n.s. |
| Female° | 0.4 | 0.4 |
| Non-English Language Learner° | 0.5 | 0.2 |
| Student without Disabilities° | 0.6 | 0.2 |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results are presented.  1Change in percentage points of students passing an AP exam at a school. A positive number indicates an increase in the percentage passing.  °After propensity score weighting, Advancing STEM AP and comparison schools were only partially balanced. | | |

**Science Exam Passing**. As seen in the table above, Advancing STEM AP participants saw an increase of about half a percent in the percentage of students passing a science AP exam the year participation began. Annually, the percentage of students passing science AP exams increased by about 0.2 percentage points. Significant findings for the change in percent passing the year of participation were found for male, female, non-ELL, and non-SWD students. Significant differences in the annual rate of change in the percentage of students passing a science AP exam were also seen for females, non-ELL, and non-SWD students. While effect sizes were notably smaller for science models than for ELA models, science models indicate a small annual increase in the percent passing—something that is not evident in ELA models.

**Summary**

A primary goal of the Advancing STEM AP program is to increase participation and performance in ELA, mathematics, and science AP exams, particularly for students from underrepresented groups. In line with this goal, UMDI`s evaluation of the program found that its observed impacts on AP exam taking and passing rates for all students were consistently positive. Results varied by subject and subgroup.

Results were reported for all academic subjects (ELA, math, and science) combined, as well as for individual subjects. In the first year of intervention, results indicate that the Advancing STEM AP program increased the percentage of all students taking any ELA, math, or science AP exam by 6.6 percentage points and increased the percentage of all studentspassing any ELA, math, or science AP exam by 2.0 percentage points. When looking across subjects, results also show that the program significantly increased the percentage of all students taking an AP exam in the first year of intervention, though increases in the percentage of students taking an ELA AP exam were markedly higher than increases in math or science AP exam taking rates. Likewise, ELA AP exam passing rates for all students increased in the first year of intervention but there was no difference in the annual rate of change in the percentage of students passing an exam. Math AP exam passing rates saw no impact in the year of intervention, but did see a significant increase in the annual rate of change in the percentage of students passing an exam. Science AP exam passing rates saw both an increase in the percentage of students passing an AP exam in the first year of intervention and an increase in the annual rate of change in the passing rate.

While consistent positive impacts were detected for some subgroups, impacts were not detected for others. Inconsistent impacts were detected for some subgroups across exam taking and passing models or subject-specific models. In general, across subjects, exam taking rates increased by 4 to 7 percentage points among subgroups during the first year of intervention, while ELA, math, or science AP exam passing rates increased by 0.5 to 2.0 percentage points during that time. Additionally, all racial/ethnic subgroups, as well as male students, saw significant impacts on the percentage of students taking any ELA, math, or science AP exam in the first year of intervention. ELL students and SWD, however, consistently saw no impact on the percentage of students taking a subject-specific exam in the year the program began or on the rate of change in the percentage of students taking an AP exam. Results also indicate that impacts on percentage passing a subject-specific exam in the year that programming began were only evident among female, male, White, and Hispanic/Latino subgroups. Though Asian and African American/Black students did not see an impact on the percentage of students passing an AP exam in the first year of intervention, they did see significant impacts on the percentage of students taking an AP exam during this time.

While the gain in percentage of Hispanic/Latino students taking an AP math exam was smaller than for many other subgroups, models show that students from this subgroup were making large strides in the percentage passing a math AP exam in the year that participation began when compared to other racial/ethnic groups. These findings are noteworthy given that findings from UMDI’s previous demographic report indicate that few Hispanic/Latino students are participating in or passing AP exams when compared to other racial/ethnic groups.

Overall, findings indicate that the Advancing STEM AP program had positive impacts on AP exam taking and passing rates in the year that programming began. Impacts on the annual rate of change in the percentage of students taking or passing an AP exam were seen infrequently across all subjects and subgroups, which indicates a potential need for additional support to sustain progress toward the goal of increasing the proportion of students taking and passing AP exams. By the same token, while some progress was made towards the goal of increasing the AP exam taking rate among students from underrepresented racial/ethnic groups, more support may be needed to further improve AP exam passing rates for these students.

# Appendices

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

For each academic discipline (i.e., ELA, mathematics, and science), a CITS model was developed to assess the impact of the Advancing STEM AP intervention on (a) a school’s AP exam taking/passing rate one year after the program began, and (b) the trend (i.e., the slope) of AP exam taking/passing rate during the period after the program began. This procedure was used for all 88 CITS models. The following equation represents the CITS model:

*Yit = β0 + β1Timet, + β2Interventiont + β3TimetInterventiont* ***+*** *β4Participanti + β5ParticipantiTimet + β6ParticipantiInterventiont + β4ParticipantiTimetInterventiont + 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 Advancing STEM AP 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 Advancing STEM AP program on schools’ AP exam taking/passing rate. β7 represents the impact of the Advancing STEM AP program on the trend (i.e., the slope) of AP exam taking/passing rate 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). When the value for β4 and/or β5 is statistically significant, it indicates that, despite propensity score weighting, significant pre-intervention differences in Advancing STEM AP schools and comparison schools’ AP exam taking/passing rates remained.

**Appendix B: AP Exam Taking, Full Model Results**

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| **Impacts of Advancing STEM AP on AP Exam Taking, Any ELA, Math, or Science Exam** | | | | | | | | |
|  | All° | Male° | White° | Black/Af. Am.° | Asian° | Hispanic/ Latino | ELL° | Non-ELL° |
| Intercept (β0) | 4.92\*\*\*  (0.95) | 2.00\*\* (0.66) | 3.89\*\*\* (0.54) | 0.52 (0.56) | 10.03\*\*\* (1.39) | 0.76+ (0.42) | 0.50 (0.34) | 4.72\*\*\* (0.76) |
| Time (β1) | 1.87\*\* (0.57) | 1.72\* (0.79) | 1.41\*\*\* (0.30) | 0.77\*\*\* (0.20) | 1.11\*\* (0.38) | 0.75\*\*\* (0.20) | -0.06 (0.09) | 1.73\*\*\* (0.50) |
| Intervention Period (β2) | -1.78\*\* (0.63) | -1.65\* (0.67) | -1.58+ (0.93) | -1.21\* (0.53) | 0.43 (1.23) | -1.13\* (0.45) | -0.15 (0.31) | -1.06\* (0.50) |
| Time by Intervention (β3) | -2.02+ (1.16) | -1.91 (1.45) | -0.86+ (0.52) | -0.23 (0.31) | -0.76 (0.96) | -0.41 (0.30) | 0.07 (0.11) | -1.76+ (0.97) |
| Participant (β4) | -1.46 (1.09) | 0.67 (0.79) | -0.13 (0.90) | 0.33 (0.94) | 1.47 (3.15) | 0.07 (0.59) | -0.46 (0.74) | -1.40 (0.92) |
| Participant by Time (β5) | -0.62 (0.6) | -0.79 (0.8) | -0.05 (0.38) | 0.38 (0.39) | -0.39 (0.91) | 0.11 (0.27) | 0.20 (0.30) | -0.40 (0.52) |
| Participation by Intervention (β6) | 6.57\*\*\*  (0.85) | 5.56\*\*\* (0.79) | 6.29\*\*\* (1.14) | 4.35\*\* (1.50) | 7.27\* (3.31) | 4.62\*\*\* (1.04) | 0.00 (0.71) | 6.18\*\*\* (0.76) |
| Participation by Time by Intervention (β7) | 1.88 (1.19) | 1.72 (1.48) | 0.78 (0.65) | 0.36 (0.87) | 0.23 (1.74) | 0.08 (0.76) | 0.18 (0.44) | 1.53 (1.03) |
| + p < 0.1, \*p < .05, \*\**p* < .01, \*\*\**p* < .001  °After propensity score weighting, Pre-AP and comparison schools were only partially balanced.  β6 represents the difference in the level between Advancing STEM AP and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between Advancing STEM AP and non-Advancing STEM AP schools in the slope from the years before the Advancing STEM AP intervention (i.e., SY07–SY10 for Cohort III) to the years after the Advancing STEM AP intervention (i.e., SY12–SY13 for Cohort III). | | | | | | | | |

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| **Impacts of Advancing STEM AP on AP Exam Taking, ELA Exam** | | | | | | | | | |
|  | All° | Male° | Female° | White° | Black/Af. Am. | Asian | Hispanic/ Latino | Non-ELL | Non-SWD° |
| Intercept (β0) | 1.87\*\* (0.54) | 0.34 (0.28) | 2.41\*\*\* (0.37) | 1.97\*\*\* (0.41) | 0.22 (0.34) | 3.95\*\*\* (0.99) | 0.05 (0.26) | 1.85\*\*\* (0.48) | 2.04\*\* (0.65) |
| Time (β1) | 0.80\*\*\* (0.17) | 0.63\*\* (0.21) | 1.15\*\*\* (0.22) | 0.94\*\*\* (0.20) | 0.83\*\* (0.28) | 0.84\*\* (0.29) | 0.76\*\*\* (0.19) | 0.89\*\*\* (0.17) | 0.94\*\*\* (0.21) |
| Intervention Period (β2) | -0.14 (0.47) | -0.29 (0.45) | -0.89 (0.65) | -1.17+ (0.61) | -1.71\* (0.74) | -1.31 (0.93) | -1.31\* (0.60) | -0.19 (0.58) | -0.36 (0.40) |
| Time by Intervention (β3) | -0.34 (0.24) | -0.34 (0.50) | -0.61\* (0.26) | -0.35 (0.27) | -0.23 (0.38) | -0.50 (0.53) | -0.55+ (0.30) | -0.31 (0.26) | -0.39 (0.29) |
| Participant (β4) | -0.54 (0.68) | 0.40 (0.44) | -0.63 (0.68) | -0.13 (0.76) | 0.09 (0.63) | 0.53 (2.14) | -0.10 (0.39) | -0.59 (0.64) | -0.50 (0.80) |
| Participant by Time (β5) | 0.24 (0.24) | 0.02 (0.25) | 0.25 (0.31) | 0.12 (0.31) | 0.25 (0.41) | 0.19 (0.65) | 0.03 (0.24) | 0.22 (0.24) | 0.29 (0.29) |
| Participation by Intervention (β6) | 3.72\*\*\* (0.65) | 3.08\*\*\* (0.55) | 5.30\*\*\* (0.96) | 4.87\*\*\* (0.86) | 3.94\*\* (1.47) | 8.48\*\* (2.56) | 3.78\*\* (1.09) | 4.03\*\*\* (0.75) | 4.51\*\*\* (0.69) |
| Participation by Time by Intervention (β7) | 0.14 (0.38) | 0.21 (0.56) | 0.37 (0.48) | 0.26 (0.48) | -0.25 (0.82) | -1.21 (1.39) | 0.26 (0.64) | 0.01 (0.43) | 0.06 (0.46) |
| + p < 0.1, \*p < .05, \*\**p* < .01, \*\*\**p* < .001  °After propensity score weighting, Pre-AP and comparison schools were only partially balanced.  β6 represents the difference in the level between Advancing STEM AP and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between Advancing STEM AP and non-Advancing STEM AP schools in the slope from the years before the Advancing STEM AP intervention (i.e., SY07–SY10 for Cohort III) to the years after the Advancing STEM AP intervention (i.e., SY12–SY13 for Cohort III). | | | | | | | | | |

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| **Impacts of Advancing STEM AP on AP Exam Taking, Math Exam** | | | | | | | |
|  | All° | Male° | Female° | Black/Af. Am.° | Asian | Hispanic/ Latino | Non-ELL° |
| Intercept (β0) | -0.22 (1.01) | 0.01 (0.59) | 0.54 (0.33) | 0.08 (0.19) | 4.70\*\*\* (0.81) | 0.11 (0.12) | 0.26 (0.73) |
| Time (β1) | 0.88 (0.56) | 0.49+ (0.25) | 0.49\* (0.20) | 0.30\* (0.14) | 0.27+ (0.15) | 0.23\*\*\* (0.06) | 0.68 (0.42) |
| Intervention Period (β2) | -0.76 (0.87) | -0.40 (0.48) | -0.11 (0.65) | -0.82 (0.57) | 1.25 (0.78) | -0.25 (0.23) | -0.23 (0.74) |
| Time by Intervention (β3) | -1.10 (0.85) | -0.41 (0.40) | -0.50 (0.37) | 0.00 (0.10) | 0.09 (0.39) | -0.19 (0.12) | -0.88 (0.62) |
| Participant (β4) | 1.54 (1.04) | 1.20+ (0.62) | 0.81+ (0.48) | -0.03 (0.38) | 1.36 (1.83) | 0.06 (0.23) | 1.06 (0.78) |
| Participant by Time (β5) | -0.52 (0.57) | -0.18 (0.26) | -0.11 (0.24) | 0.04 (0.21) | -0.31 (0.64) | 0.02 (0.11) | -0.30 (0.43) |
| Participation by Intervention (β6) | 2.68\*\* (0.96) | 2.27\*\*\* (0.57) | 2.18\* (0.85) | 2.21\* (0.89) | 2.22 (2.31) | 1.00\* (0.50) | 2.29\*\* (0.86) |
| Participation by Time by Intervention (β7) | 1.35 (0.87) | 0.55 (0.44) | 0.89+ (0.45) | 0.43 (0.40) | 0.47 (1.26) | 0.48 (0.29) | 1.13+ (0.65) |
| + p < 0.1, \*p < .05, \*\**p* < .01, \*\*\**p* < .001  °After propensity score weighting, Pre-AP and comparison schools were only partially balanced.  β6 represents the difference in the level between Advancing STEM AP and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between Advancing STEM AP and non-Advancing STEM AP schools in the slope from the years before the Advancing STEM AP intervention (i.e., SY07–SY10 for Cohort III) to the years after the Advancing STEM AP intervention (i.e., SY12–SY13 for Cohort III). | | | | | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Impacts of Advancing STEM AP on AP Exam Taking, Science Exam** | | | | | | | | | | |
|  | All° | Male | White | Black/Af. Am. | Asian | Hispanic/ Latino | ELL° | Non-ELL° | SWD° | Non-SWD° |
| Intercept (β0) | 0.23 (0.36) | 0.18 (0.19) | 0.52\* (0.21) | 0.74+ (0.44) | 4.28\*\* (1.42) | 0.93\*\*\* (0.24) | 0.29 (0.3) | 0.39\* (0.18) | 0.03 (0.03) | 0.52+ (0.30) |
| Time (β1) | 0.37\*\*\* (0.10) | 0.32\*\*\* (0.09) | 0.41\*\*\* (0.09) | 0.14\* (0.07) | 0.14 (0.35) | 0.02 (0.06) | -0.06 (0.09) | 0.30\*\*\* (0.07) | 0.00 (0.01) | 0.38\*\*\* (0.09) |
| Intervention Period (β2) | -0.63+ (0.38) | -0.25 (0.17) | -0.38 (0.33) | -0.21 (0.31) | -0.01 (0.61) | 0.14 (0.19) | 0.21 (0.22) | -0.24 (0.20) | -0.02 (0.03) | -0.53+ (0.28) |
| Time by Intervention (β3) | -0.02 (0.17) | -0.11 (0.15) | 0.04 (0.20) | 0.01 (0.14) | 0.92+ (0.49) | 0.25 (0.15) | -0.01 (0.06) | 0.10 (0.13) | 0.04+ (0.02) | 0.06 (0.18) |
| Participant (β4) | 0.86\* (0.43) | 0.72\* (0.28) | 0.59\* (0.30) | 0.06 (0.62) | 2.49 (2.66) | 0.22 (0.41) | -0.10 (0.32) | 0.78\* (0.31) | 0.06 (0.08) | 0.77+ (0.40) |
| Participant by Time (β5) | -0.02 (0.13) | 0.00 (0.11) | 0.02 (0.12) | 0.04 (0.13) | -0.07 (0.71) | 0.05 (0.14) | 0.04 (0.10) | 0.07 (0.11) | -0.01 (0.03) | 0.03 (0.12) |
| Participation by Intervention (β6) | 1.86\*\*\* (0.47) | 1.24\*\*\* (0.29) | 1.64\*\* (0.48) | 1.57\* (0.71) | 4.22+ (2.36) | 1.17\* (0.52) | -0.25 (0.35) | 1.54\*\*\* (0.35) | 0.13 (0.10) | 1.94\*\*\* (0.42) |
| Participation by Time by Intervention (β7) | 0.32 (0.22) | 0.22 (0.22) | 0.27 (0.28) | 0.64 (0.43) | -0.28 (1.22) | -0.39 (0.42) | 0.24 (0.21) | 0.15 (0.23) | -0.01 (0.05) | 0.28 (0.25) |
| + p < 0.1, \*p < .05, \*\**p* < .01, \*\*\**p* < .001  °After propensity score weighting, Pre-AP and comparison schools were only partially balanced.  β6 represents the difference in the level between Advancing STEM AP and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between Advancing STEM AP and non-Advancing STEM AP schools in the slope from the years before the Advancing STEM AP intervention (i.e., SY07–SY10 for Cohort III) to the years after the Advancing STEM AP intervention (i.e., SY12–SY13 for Cohort III). | | | | | | | | | | |

**Appendix C: AP Exam Passing, Full Model Results**

| **Impacts of Advancing STEM AP on AP Exam Passing, Any ELA, Math, or Science Exam** | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | All° | Male° | Female° | White | Black/Af. Am.° | Asian | Hispanic/ Latino | ELL° | Non-ELL° | SWD° | Non-SWD° |
| Intercept (β0) | 0.80\*\*\* (0.22) | 0.45\* (0.22) | 0.76\*\* (0.29) | 1.50\*\*\* (0.32) | -0.24\* (0.11) | 4.59\*\*\* (0.95) | -0.01 (0.16) | 0.06 (0.06) | 0.88\*\*\* (0.23) | 0.00 (0.02) | 0.99\*\*\* (0.26) |
| Time (β1) | 0.46\*\*\* (0.10) | 0.38\*\*\* (0.09) | 0.56\*\*\* (0.11) | 0.65\*\*\* (0.11) | 0.30\*\*\* (0.07) | 0.54\*\* (0.2) | 0.28\*\*\* (0.07) | -0.01 (0.02) | 0.47\*\*\* (0.09) | 0.01 (0.01) | 0.56\*\*\* (0.13) |
| Intervention Period (β2) | 0.03 (0.22) | -0.25 (0.30) | 0.20 (0.37) | -0.20 (0.22) | -0.31 (0.22) | 0.56 (0.51) | -0.13 (0.17) | 0.10 (0.10) | 0.11 (0.29) | 0.00 (0.03) | -0.09 (0.24) |
| Time by Intervention (β3) | -0.28\* (0.14) | -0.06 (0.10) | -0.47\* (0.19) | -0.45\* (0.19) | -0.11 (0.12) | -0.04 (0.34) | -0.20 (0.13) | -0.04 (0.08) | -0.29\* (0.12) | 0.06+ (0.03) | -0.39+ (0.23) |
| Participant (β4) | 0.58 (0.37) | 0.60+ (0.35) | 0.78+ (0.46) | 0.60 (0.52) | 0.03 (0.22) | 1.14 (2.04) | 0.09 (0.30) | 0.10 (0.22) | 0.63+ (0.38) | 0.06 (0.08) | 0.63 (0.43) |
| Participant by Time (β5) | 0.11 (0.13) | 0.07 (0.12) | 0.13 (0.17) | 0.07 (0.19) | 0.09 (0.12) | 0.01 (0.64) | 0.07 (0.14) | -0.01 (0.08) | 0.11 (0.13) | -0.01 (0.03) | 0.12 (0.17) |
| Participation by Intervention (β6) | 2.03\*\*\* (0.40) | 2.06\*\*\* (0.45) | 2.08\*\*\* (0.57) | 2.40\*\*\* (0.52) | 0.82 (0.55) | 0.73 (1.88) | 1.67\*\* (0.56) | 0.06 (0.16) | 1.96\*\*\* (0.44) | 0.02 (0.08) | 2.42\*\*\* (0.47) |
| Participation by Time by Intervention (β7) | 0.33+ (0.20) | 0.02 (0.20) | 0.60\* (0.28) | 0.40 (0.3) | 0.33 (0.29) | 0.39 (0.96) | -0.36 (0.44) | 0.20 (0.2) | 0.36+ (0.19) | 0.04 (0.08) | 0.41 (0.28) |
| + p < 0.1, \*p < .05, \*\**p* < .01, \*\*\**p* < .001  °After propensity score weighting, Pre-AP and comparison schools were only partially balanced.  β6 represents the difference in the level between Advancing STEM AP and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between Advancing STEM AP and non-Advancing STEM AP schools in the slope from the years before the Advancing STEM AP intervention (i.e., SY07–SY10 for Cohort III) to the years after the Advancing STEM AP intervention (i.e., SY12–SY13 for Cohort III). | | | | | | | | | | | |

| **Impacts of Advancing STEM AP on AP Exam Passing, ELA Exam** | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | All° | Male° | Female° | White° | Black/Af. Am. | Asian | Hispanic/ Latino | ELL° | Non-ELL° | SWD° | Non-SWD° |
| Intercept (β0) | 0.52\*\* (0.17) | 0.13 (0.17) | 0.39\* (0.18) | 0.92\*\*\* (0.23) | -0.15 (0.10) | 2.22\*\* (0.76) | 0.14 (0.11) | 0.00 (0.00) | 0.54\*\* (0.16) | -0.01 (0.01) | 0.65\*\* (0.21) |
| Time (β1) | 0.35\*\*\* (0.08) | 0.27\*\* (0.09) | 0.48\*\*\* (0.1) | 0.50\*\*\* (0.11) | 0.23\*\*\* (0.06) | 0.33\* (0.17) | 0.18\*\* (0.05) | 0.00 (0.00) | 0.36\*\*\* (0.08) | 0.00 (0.00) | 0.42\*\*\* (0.10) |
| Intervention Period (β2) | 0.04 (0.18) | -0.15 (0.26) | -0.12 (0.22) | -0.39+ (0.22) | -0.54\* (0.23) | -0.01 (0.37) | -0.15 (0.15) | 0.02 (0.02) | 0.06 (0.21) | 0.00 (0.02) | -0.01 (0.18) |
| Time by Intervention (β3) | -0.21+ (0.12) | -0.06 (0.14) | -0.36\* (0.15) | -0.38\* (0.18) | -0.01 (0.09) | -0.10 (0.25) | -0.14 (0.11) | -0.01 (0.01) | -0.19+ (0.11) | 0.04 (0.03) | -0.27 (0.17) |
| Participant (β4) | 0.11 (0.28) | 0.21 (0.26) | 0.27 (0.35) | 0.21 (0.44) | -0.01 (0.21) | 0.29 (1.59) | 0.04 (0.23) | 0.00 (0.00) | 0.16 (0.28) | 0.10 (0.07) | 0.08 (0.33) |
| Participant by Time (β5) | 0.11 (0.12) | 0.03 (0.12) | 0.14 (0.16) | 0.07 (0.18) | 0.06 (0.11) | 0.15 (0.55) | 0.03 (0.11) | 0.00  (0.00) | 0.12 (0.12) | -0.03 (0.02) | 0.13 (0.15) |
| Participation by Intervention (β6) | 1.55\*\*\* (0.32) | 1.54\*\*\* (0.35) | 1.90\*\*\* (0.45) | 2.10\*\*\* (0.44) | 0.81 (0.49) | 2.04 (1.47) | 1.29\* (0.58) | 0.06 (0.06) | 1.57\*\*\* (0.35) | 0.08 (0.05) | 1.81\*\*\* (0.37) |
| Participation by Time by Intervention (β7) | 0.04 (0.19) | -0.17 (0.21) | 0.24 (0.25) | 0.18 (0.29) | 0.08 (0.28) | -0.28 (0.95) | -0.26 (0.30) | -0.01 (0.04) | 0.01 (0.19) | 0.05 (0.07) | 0.03 (0.25) |
| + p < 0.1, \*p < .05, \*\**p* < .01, \*\*\**p* < .001  °After propensity score weighting, Pre-AP and comparison schools were only partially balanced.  β6 represents the difference in the level between Advancing STEM AP and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between Advancing STEM AP and non-Advancing STEM AP schools in the slope from the years before the Advancing STEM AP intervention (i.e., SY07–SY10 for Cohort III) to the years after the Advancing STEM AP intervention (i.e., SY12–SY13 for Cohort III). | | | | | | | | | | | |

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| **Impacts of Advancing STEM AP on AP Exam Passing, Math Exam** | | | | | | | | | | |
|  | All° | Male° | White | Black/Af. Am.° | Asian | Hispanic/ Latino | ELL° | Non-ELL° | SWD° | Non-SWD° |
| Intercept (β0) | -0.17 (0.10) | -0.16 (0.11) | 0.67\*\*\* (0.12) | -0.09\* (0.04) | 1.88\*\*\* (0.51) | -0.01 (0.16) | 0.05 (0.05) | 0.19+ (0.1) | -0.01 (0.01) | 0.10 (0.13) |
| Time (β1) | 0.11\*\*\* (0.03) | 0.12\*\* (0.04) | 0.16\*\*\* (0.04) | 0.09\*\*\* (0.02) | 0.32\*\* (0.12) | 0.28\*\*\* (0.07) | 0.00 (0.01) | 0.12\*\*\* (0.03) | 0.01 (0.01) | 0.14\*\* (0.04) |
| Intervention Period (β2) | 0.27 (0.23) | 0.17 (0.15) | 0.19 (0.13) | -0.08 (0.08) | 0.27 (0.35) | -0.13 (0.17) | -0.04 (0.04) | 0.37 (0.33) | -0.01 (0.02) | 0.26 (0.23) |
| Time by Intervention (β3) | -0.12 (0.09) | -0.01 (0.11) | -0.10 (0.09) | 0.02 (0.06) | 0.07 (0.20) | -0.20 (0.13) | -0.01 (0.03) | -0.15 (0.11) | 0.00 (0.01) | -0.13 (0.1) |
| Participant (β4) | 0.26 (0.17) | 0.31 (0.19) | 0.19 (0.21) | 0.04 (0.10) | 0.73 (1.16) | 0.09 (0.30) | 0.07 (0.21) | 0.29+ (0.16) | 0.01 (0.01) | 0.35+ (0.21) |
| Participant by Time (β5) | 0.01 (0.05) | 0.01 (0.05) | 0.02 (0.07) | 0.02 (0.06) | -0.06 (0.44) | 0.07 (0.14) | -0.01 (0.08) | 0.01 (0.05) | 0.00 (0.01) | 0.01 (0.06) |
| Participation by Intervention (β6) | 0.47 (0.29) | 0.54\* (0.24) | 0.66\* (0.26) | 0.11 (0.26) | 0.10 (1.55) | 1.67\*\* (0.56) | 0.09 (0.13) | 0.37 (0.37) | -0.02 (0.05) | 0.59+ (0.31) |
| Participation by Time by Intervention (β7) | 0.26\* (0.13) | 0.21 (0.17) | 0.16 (0.16) | 0.05 (0.15) | 0.04 (0.84) | -0.36 (0.44) | 0.20 (0.17) | 0.30\* (0.14) | 0.02 (0.03) | 0.30\* (0.15) |
| + p < 0.1, \*p < .05, \*\**p* < .01, \*\*\**p* < .001  °After propensity score weighting, Pre-AP and comparison schools were only partially balanced.  β6 represents the difference in the level between Advancing STEM AP and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between Advancing STEM AP and non-Advancing STEM AP schools in the slope from the years before the Advancing STEM AP intervention (i.e., SY07–SY10 for Cohort III) to the years after the Advancing STEM AP intervention (i.e., SY12–SY13 for Cohort III). | | | | | | | | | | |

| **Impacts of Advancing STEM AP on AP Exam Passing, Science Exam** | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | All° | Male | Female° | White° | Black/ Af. Am. | Asian | Hispanic/ Latino | ELL° | Non-ELL° | SWD° | Non-SWD° |
| Intercept (β0) | -0.22\*\* (0.07) | -0.16\* (0.07) | 0.00 (0.07) | 0.24\*\* (0.08) | -0.07\* (0.03) | 1.23\* (0.49) | 0.10 (0.08) | 0.01 (0.03) | -0.08 (0.07) | -0.01 (0.02) | -0.02 (0.08) |
| Time (β1) | 0.10\*\*\* (0.02) | 0.13\*\*\* (0.03) | 0.10\*\*\* (0.02) | 0.15\*\*\* (0.03) | 0.07\*\* (0.02) | 0.19 (0.11) | 0.04 (0.02) | 0.01 (0.01) | 0.10\*\*\* (0.02) | 0.01 (0.01) | 0.11\*\*\* (0.02) |
| Intervention Period (β2) | 0.08 (0.07) | -0.01 (0.09) | 0.12+ (0.07) | 0.14 (0.12) | -0.02 (0.07) | 0.72+ (0.42) | 0.27\*\* (0.10) | 0.09 (0.10) | 0.05 (0.06) | -0.03 (0.03) | 0.03 (0.07) |
| Time by Intervention (β3) | 0.03 (0.04) | -0.01 (0.05) | 0.06 (0.05) | 0.05 (0.06) | -0.06 (0.04) | 0.08 (0.19) | -0.05 (0.07) | -0.08 (0.06) | 0.05 (0.04) | 0.02 (0.01) | 0.04 (0.05) |
| Participant (β4) | -0.07 (0.14) | 0.17 (0.15) | 0.11 (0.13) | 0.18 (0.15) | -0.01 (0.07) | 1.29 (1.03) | 0.02 (0.16) | 0.02 (0.06) | 0.20 (0.13) | 0.00 (0.03) | 0.19 (0.15) |
| Participant by Time (β5) | 0.03 (0.04) | 0.01 (0.05) | 0.01 (0.04) | 0.03 (0.06) | 0.02 (0.04) | 0.03 (0.30) | 0.02 (0.06) | 0.00 (0.03) | 0.02 (0.04) | 0.00 (0.01) | 0.02 (0.04) |
| Participation by Intervention (β6) | 0.51\*\* (0.18) | 0.68\*\* (0.21) | 0.36+ (0.21) | 0.45 (0.28) | 0.57 (0.41) | -0.98 (1.52) | 0.44 (0.33) | -0.14 (0.12) | 0.54\*\* (0.18) | 0.04 (0.06) | 0.64\*\* (0.21) |
| Participation by Time by Intervention (β7) | 0.17+ (0.09) | -0.02 (0.12) | 0.37\*\* (0.11) | 0.09 (0.13) | 0.24 (0.23) | 1.06 (0.87) | -0.22 (0.26) | 0.07 (0.07) | 0.17+ (0.09) | -0.03 (0.03) | 0.20+ (0.11) |
| + p < 0.1, \*p < .05, \*\**p* < .01, \*\*\**p* < .001  °After propensity score weighting, Pre-AP and comparison schools were only partially balanced.  β6 represents the difference in the level between Advancing STEM AP and comparison schools during the year immediately following intervention (i.e. SY12 for Cohort III). β7 represents the difference between Advancing STEM AP and non-Advancing STEM AP schools in the slope from the years before the Advancing STEM AP intervention (i.e., SY07–SY10 for Cohort III) to the years after the Advancing STEM AP intervention (i.e., SY12–SY13 for Cohort III). | | | | | | | | | | | |

**Appendix D: Summary of Key Results for all Models**

| **Summary Table: Advancing STEM AP Impacts by Subgroup**  **Percentage Point Change** | | | | | |
| --- | --- | --- | --- | --- | --- |
| Subgroup | Subject | Exam Taking1 | | Exam Passing1 | |
| Change Year 1 | Annual Rate of Change | Change Year 1 | Annual Rate of Change |
| All students | Any ELA, Math, or Science | 6.6 | n.s. | 2.0 | 0.3 |
| ELA | 3.7 | n.s. | 1.5 | n.s. |
| Math | 2.7 | n.s. | n.s. | 0.3 |
| Science | 1.9 | n.s. | 0.5 | 0.2 |
| Male students | Any ELA, Math, or Science | 5.6 | n.s. | 2.1 | n.s. |
| ELA | 3.1 | n.s. | 1.5 | n.s. |
| Math | 2.3 | n.s. | 0.5 | n.s. |
| Science | 1.2 | n.s. | 0.7 | n.s. |
| Female students | Any ELA, Math, or Science | n.s. | n.s. | 2.1 | 0.6 |
| ELA | 5.3 | n.s. | 1.9 | n.s. |
| Math | 2.2 | 0.9 | n.s. | n.s. |
| Science | n.s. | n.s. | 0.4 | 0.4 |
| White students | Any ELA, Math, or Science | 6.3 | n.s. | 2.4 | n.s. |
| ELA | 4.9 | n.s. | 2.1 | n.s. |
| Math | n.r. | n.r. | 0.7 | n.s. |
| Science | 1.6 | n.s. | n.s. | n.s. |
| African American/Black students | Any ELA, Math, or Science | 4.4 | n.s. | n.s. | n.s. |
| ELA | 3.9 | n.s. | n.s. | n.s. |
| Math | 2.2 | n.s. | n.s. | n.s. |
| Science | 1.6 | n.s. | n.s. | n.s. |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Subgroup | Subject | Exam Taking1 | | Exam Passing1 | |
| Change  Year 1 | Annual  Rate of  Change | Change Year 1 | Annual Rate of Change |
| Asian students | Any ELA, Math, or Science | 7.3 | n.s. | n.s. | n.s. |
| ELA | 8.5 | n.s. | n.s. | n.s. |
| Math | n.s. | n.s. | n.s. | n.s. |
| Science | 4.2 | n.s. | n.s. | n.s. |
| Hispanic/Latino students | Any ELA, Math, or Science | 4.6 | n.s. | 1.7 | n.s. |
| ELA | 3.8 | n.s. | 1.3 | n.s. |
| Math | 1.0 | n.s. | 1.7 | n.s. |
| Science | 1.2 | n.s. | n.s. | n.s. |
| ELL | Any ELA, Math, or Science | n.s. | n.s. | n.s. | n.s. |
| ELA | n.r | n.r. | n.s. | n.s. |
| Math | n.r | n.r. | n.s. | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |
| Non-ELL | Any ELA, Math, or Science | 6.2 | n.s. | 2.0 | 0.4 |
| ELA | 4.0 | n.s. | 1.6 | n.s. |
| Math | 2.3 | 1.1 | n.s. | 0.3 |
| Science | 1.5 | n.s. | 0.5 | 0.2 |
| SWD | Any ELA, Math, or Science | n.r. | n.r. | n.s. | n.s. |
| ELA | n.r. | n.r. | n.s. | n.s. |
| Math | n.r. | n.r. | n.s. | n.s. |
| Science | n.s. | n.s. | n.s. | n.s. |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Subgroup | Subject | Exam Taking1 | | Exam Passing1 | |
| Change  Year 1 | Annual  Rate of  Change | Change Year 1 | Annual Rate of Change |
| Non-SWD | Any ELA, Math, or Science | n.s. | n.s. | 2.4 | n.s. |
| ELA | 4.5 | n.s. | 1.8 | n.s. |
| Math | n.r. | n.r. | 0.6 | 0.3 |
| Science | 1.9 | n.s. | 0.6 | 0.2 |
| *Note*: “n.s.” means “no significant findings.” Only statistically significant results 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. A positive number indicates an increase in the percentage taking/passing. | | | | | |

1. Rubin DB. Using propensity scores to help design observational studies: Application to the tobacco litigation. Health Services & Outcomes Research Methodology. 2001;2:169–188. [↑](#footnote-ref-1)
2. Analyses include White, African American/Black, Asian, and Hispanic/Latino students. American Indian/Alaskan native, native Hawaiian/Pacific Islanders, and multi-racial/non-Hispanic students were excluded from analysis due to small sample sizes. [↑](#footnote-ref-2)