AP Capstone™ Participation, High School Learning, and College Outcomes: Early Evidence

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Executive Summary

The AP Capstone Diploma™ program was launched in 2014 to offer high school students an opportunity to learn interdisciplinary critical thinking and collaboration skills and complete college-level academic research by means of two Advanced Placement® (AP®) courses: AP Seminar and AP Research. Students earning AP Exam scores of 3 or higher in AP Seminar and AP Research, collectively known as the AP Capstone™ courses, and in four additional AP subjects, receive the AP Capstone Diploma. It should be noted at the onset that AP Seminar and AP Research Certificate™, awarded for a 3 or higher in the Capstone courses but not in four additional AP courses, is not within the scope of this current study. This study deals solely with outcomes of students who participated in AP Seminar, AP Research, or earned the AP Capstone Diploma.

AP Seminar and AP Research are different from traditional AP courses in that students determine which content to explore and are assessed on their ability to apply critical thinking, research, and collaboration skills. In these early years of the AP Capstone program, students and teachers have reached out to report that skills learned in AP Capstone courses help students succeed in other AP courses as well as help prepare them for college. This feedback from students and teachers was a catalyst for this study, which is an opportunity for us to understand specific relationships between AP Capstone participation and student secondary and postsecondary educational outcomes.

The findings summarized in this report indicate that after taking into account student background and prior achievement, students who take AP Seminar, or both AP Capstone courses, have higher scores on concurrent and future AP Exams in the English, history, politics, and—in some cases, social sciences and sciences—subject areas. The effect sizes are greatest for students scoring a 3 or higher on the AP Seminar or AP Research cumulative AP Exam. For the most part, AP Seminar and AP Research participation does not have a statistically significant relationship with concurrent or future performance in math and computer science AP Exams.

We also find that students taking an AP Seminar Exam or students earning an AP Capstone Diploma have significantly higher first-year college grades, first-to-second year college retention, and probability of participating in academic research, internships, and honors programs in the first year of college than similar students who did not take any AP Exams in high school. Additionally, taking AP Seminar or earning the AP Capstone Diploma provides a larger boost than comparable content-specific AP exposure with respect to internship, honors program, and research participation. This finding indicates that the specific skills taught in the AP Capstone program help students engage in college learning opportunities that lead to positive college and career outcomes down the line.

The AP Capstone Diploma program is a relatively new offering from College Board at the time of this publication. These early findings may help implementing schools determine how best to position AP Seminar and AP Research in course schedules to maximize student outcomes.

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Background

There is an extensive literature base around the relationship between AP participation, AP performance, and student outcomes. Studies tracking the performance of AP students in college find AP students are more likely to persist to the second year of college (Mattern, Shaw, & Xiong, 2009), earn higher course grades (Kaliski & Godfrey, 2014; Mattern, Shaw, & Xiong, 2009; Patterson, Packman, & Kobrin, 2011; Wyatt, Patterson, & Di Giacomo, 2015) and ultimately earn college degrees (Mattern, Marini, & Shaw, 2013) than similar students who do not take AP Exams in high school. Research aiming to understand the casual effect of AP credit policies on student outcomes finds that earning credit-granting AP scores increases the probability of on-time degree attainment in four years or less (Smith, Hurwitz, & Avery, 2017). In addition to a positive relationship with college grades, persistence, and graduation, there is evidence that taking AP Exams in high school helps students use their college years more productively. For instance, research shows AP students take more advanced lab science and math courses and are more likely to double major, compared to similar students who did not take AP Exams (Ewing, Jagesic, Wyatt, 2018; Evans, 2018).

In an effort to continuously advance and improve offerings of the AP Program, College Board launched the AP Capstone Diploma program in 2014. AP Capstone offers high school students an opportunity to learn and develop college-level academic research skills through two interdisciplinary courses: AP Seminar and AP Research. AP Seminar and AP Research are different from traditional AP courses in that they focus on developing cross-curricular skills rather than acquiring subject-specific content knowledge. AP Seminar and AP Research students determine which content to explore and are assessed on their ability to apply critical thinking, research, and collaboration skills. AP assessments in both courses are project-based and differentiated from traditional AP subject exams. Because AP Seminar and AP Research are substantially different from other AP courses, schools must apply and be approved to offer the AP Capstone Diploma program.

Features of AP Seminar and AP Research

AP Seminar aims to equip students with the skills to analyze and evaluate information with accuracy and precision so they can develop the ability to craft and communicate compelling evidence-based arguments. Using an inquiry framework, students practice reading and analyzing articles, research studies, and foundational literary and philosophical texts; listening to and viewing speeches, broadcasts, and personal accounts; and experiencing artistic works and performances. Throughout their AP Seminar course, students learn to synthesize information from multiple sources and develop their own perspectives based on those sources while also learning to share those perspectives in research-based written essays and oral and visual presentations. An important component of the AP Seminar experience is that students work on assignments both individually and as part of a team. The teamwork component further develops students' ability to evaluate other viewpoints and communicate with a varied audience.

AP Research is a follow-up course to AP Seminar that allows students to continue honing skills acquired through AP Seminar in greater depth. For the duration of their AP Research experience, students design, plan, and conduct a yearlong research-based investigation addressing a research question on a topic of their choosing. In doing so, students deepen the skills acquired in AP Seminar by understanding research methodology, employing ethical research practices, and accessing, analyzing, and synthesizing information as they address a research question.

AP Seminar and AP Research are project-based courses with project-based assessments. The assessment structure for AP Seminar involves two through-course performance tasks and one end-of-course exam. The first performance task includes a team presentation and an individual research report and represents 20% of the AP Seminar Exam score. The second performance task includes an individual written argument, multimedia presentation, or oral defense, and determines 35% of the AP Seminar Exam score. The final assessment piece is a two-hour exam in which students must demonstrate how well they understand the reasoning and analysis that goes into an argument, as well as the ability to synthesize information to develop an evidence-based argument themselves. The AP Research Exam consists of an academic paper of 4,000 to 5,000 words, which counts for 75% of the exam score and a presentation with an oral defense, which counts for 25% of the score.

AP Seminar is a prerequisite to AP Research. Both courses are required for students to have successfully completed the AP Capstone program. Students who earn scores of 3 or higher in both AP Seminar and AP Research and on four additional AP Exams of their choosing receive the AP Capstone Diploma. Students who earn scores of 3 or higher in AP Seminar and AP Research, but not on four additional AP Exams, receive the AP Seminar and Research Certificate. AP Capstone lets students choose to participate to varying extents. Some students only complete the AP Seminar course, while others complete both AP Seminar and AP Research, as well as additional AP Exams, to earn the AP Capstone Diploma. Because students engage in the AP Capstone program at different levels, we have structured our research to understand the outcomes for students who elect to participate in just the AP Seminar course as well as students who complete the entire program. The Data section of this report provides a thorough description of comparison groups used.

Research Questions

High School Outcomes

Qualitative accounts from AP Seminar and AP Research students and teachers suggest that the skills taught in these two courses positively impact student performance in other content-specific AP courses. To see if this observation from high school AP Seminar and AP Research students and teachers is supported by student AP Exam performance, we asked these research questions.

Taking into account student background, grade, prior achievement, prior AP experience, and high school attended, do students who complete AP Seminar or both AP Seminar and AP Research Exams earn higher AP Exam scores on:

(1) AP Exams completed in the same year as AP Seminar or AP Research, compared to AP students who do not take AP Seminar or both AP Capstone courses?

(2) AP Exams completed in the year after AP Seminar or AP Research, compared to AP students who do not take AP Seminar or both AP Capstone courses?

College Outcomes

To understand the relationship between AP Seminar participation, earning the AP Capstone Diploma, and college outcomes, we examined two types of outcomes. We focused on traditional college outcomes such as first-year grades and retention to the second year. We also focused on college outcomes that provide an insight into the richness of the student's college experience, such as whether or not the student participated in internships, academic research, or honors programs in the first year of college.

Because AP Seminar is a prerequisite to AP Research, the college outcomes analyses focus on AP Seminar students (the entry point to AP Capstone) and AP Capstone Diploma recipients (the finishing point of AP Capstone) to understand how partial and complete experiences in the AP Capstone Diploma relate to college outcomes. We compared AP Seminar participants and AP Capstone Diploma earners not only to similar groups of non-AP students but also to similar groups of AP students with comparable levels of AP exposure in content-specific AP Exams. We did this in an effort to understand if there is a unique added benefit that students acquire when they participate in AP Seminar or complete the AP Capstone Diploma program as opposed to other content-specific AP courses. These are the research questions we asked.

Taking into account student background, prior achievement, and postsecondary institution attended, do students who take AP Seminar or complete the requirements for the AP Capstone Diploma:

(1) Earn higher first-year grades, have higher retention to the second year, and a higher probability of participating in internships, academic research, and honors programs than students who do not take any AP Exams?

(2) Earn higher first-year grades, have higher retention to the second year, and a higher probability of participating in internships, academic research, and honors programs than students who have a comparable level of content-specific AP exposure but have never taken AP Seminar or AP Research?

Data

High School Outcomes

Data for the high school outcome analyses come from the College Board database of students who have participated in at least one of the College Board assessments—AP, SAT®, and/or PSAT/NMSQT®. We limited the sample to students attending high schools where AP Seminar or AP Research were offered (academic years 2014-15, 2015-16, and 2016-17 for AP Seminar; 2015-16 and 2016-17 for AP Research) to make sure that all the students in our sample had the opportunity to participate in the courses.[1] In that way, we can adequately compare students who did participate in AP Seminar or both AP Capstone courses and students who did not. The sample descriptive characteristics of students for the high school outcome analyses are provided in Table 1.

The descriptive statistics indicate that students who have taken AP Seminar or both AP Capstone courses are more likely to be female, Asian or white, have parents who have earned a college degree, and have on average higher academic preparation as measured by PSAT/NMSQT scores and high school grades. While each high school outcome analysis drew students from this sample, due to different outcomes requiring students to have completed different AP Exams, the student sample in each analysis was a subset of the larger data set described in Table 1. For the analyses focusing on the relationship between AP Seminar/AP Research participation and concurrent and future AP Exam performance, the students in both the AP Seminar/AP Research group and the No AP Seminar/No AP Research group are students who have participated in the AP Exams that are of interest (see Table 3). As such, both groups of students are AP students.

A majority of the AP Program's research is designed to compare outcomes of students who have taken AP Exams in high school and outcomes of students who have not. The research presented here is different in that it focuses on comparing outcomes for AP students who have taken skills-based AP Exams (AP Seminar and AP Research) to students who have taken content-based AP Exams (e.g., AP English Language and Composition). We hope that this line of research may help schools that are implementing AP Capstone determine how best to position AP Seminar and AP Research in course schedules to maximize student performance.

[1] It is important to note that we do not know the AP course enrollment policies at the schools included in the sample. As such, we cannot identify specific students who did and who did not have access to the courses.

Table 1: Student Sample Descriptive Characteristics, by Grade of AP Seminar/AP Research Participation for High School Samples

	AP Seminar	AP Seminar 10th Grade	AP Seminar 11th Grade	Students Who Did Not Take AP Seminar
Male	39.70%	38.60%	40.30%	44.90%
First-generation	22.60%	21.90%	22.70%	27.90%
Minority	29.30%	30.30%	28.00%	32.00%
PSAT/NMSQT Scores	1172	1172	1177	1110
	(172)	(170)	(173)	(181)
High School GPA	3.72	3.76	3.70	3.52
	(0.48)	(0.47)	(0.49)	(0.54)
Avg. Number of AP Exams in HS	5.19	3.93	6.25	3.59
	(3.44)	(2.77)	(3.45)	(2.96)
Student N	34,101	13,993	16,935	683,390
Number of High Schools			669	
	AP Research	AP Research 11th Grade	AP Research 12th Grade	Students Who Did Not Take AP Research
Male	38.90%	38.20%	39.40%	44.90%
First-generation	19.90%	20.60%	19.60%	29.20%
Minority	28.70%	35.80%	24.90%	35.00%
PSAT/NMSQT Scores	1213	1203	1219	1104
	(161)	(164)	(159)	(182)
High School GPA	3.79	3.78	3.80	3.49
	(0.43)	(0.45)	(0.42)	(0.55)
Avg. Number of AP Exams in HS	8.31	7.12	9.19	3.62
	(3.35)	(2.87)	(3.26)	(2.98)
Student N	8,144	2,666	5,104	388,944
Number of High Schools			327	

Note: Standard deviations are in parentheses for PSAT/NMSQT, HSGPA, and average number of prior AP Exams.

College Outcomes

Data for the college outcomes analyses come from the 2017 cohort of students who participated in at least one of the College Board assessments—AP, SAT, or PSAT/NMSQT—during high school were merged with three additional data sources depending on the outcome of interest. For retention to the second year, College Board data were merged with National Student Clearinghouse (NSC) data to obtain student college enrollment records. NSC tracks student enrollment and degree attainment for over 3,100 two-year and four-year colleges and universities in the United States, equivalent to over 95% of the U.S. college-going population. For first-year college grades, 2017 cohort data

were merged with the College Board national database of college student transcripts collected from colleges and universities throughout the United States to conduct validity research and evaluate the relationship between test scores and student outcomes. For the college richness outcomes (internship, research, and honors program participation), 2017 cohort data were merged with College Board student survey data collected from a sample of college-going students who took the SAT during high school in 2016 or 2017 and students who took AP Seminar or both AP Capstone courses in 2014, 2015, 2016, and/or 2017. The sample descriptive characteristics for each of these data sources are provided in Table 2.

Table 2. Student Sample Descriptive Characteristics, by AP Seminar Participation for College Samples

	College Board & AP Seminar	NSC Data No AP
Male	38.80%	46.30%
First-generation	23.60%	36.50%
Minority	35.00%	39.90%
Low-socioeconomic Status	22.50%	25.70%
SAT Scores	1260 (157)	1030 (152)
High School GPA	3.76 (0.45)	3.29 (0.58)
Student N	4,696	293,193
Number of Postsecondary Institutions	1,735	
	College Board & AP Seminar	Validity Transcript Data No AP
Male	39.40%	45.50%
First-generation	21.40%	30.80%
Minority	28.10%	30.50%
Low-socioeconomic Status	18.60%	19.90%
SAT Scores	1300 (134)	1080 (145)
High School GPA	3.84 (0.35)	3.43 (0.53)
Student N	1,393	48,234
Number of Postsecondary Institutions	132	
	College Board & AP Seminar	Student Survey Data No AP
Male	34.40%	32.10%
First-generation	20.70%	32.70%
Minority	30.40%	32.80%
Low-socioeconomic Status	21.50%	23.60%
SAT Scores	1300 (146)	1080 (185)
High School GPA	3.86 (0.39)	3.43 (0.61)
Student N	550	2,717
Number of Postsecondary Institutions	89	

Analyses focusing on AP Capstone Diploma recipients use a subset of AP Seminar students who have scores of 3 or higher on AP Seminar, AP Research, and four additional AP Exams. Descriptive statistics in Table 2 indicate that students who take AP Seminar in high school are less likely to be male, minority, first-generation, and low-income than students who did not take any AP Exams. AP Seminar students also, on average, have higher academic achievement as measured by SAT scores and high school grades.

Measures

Control Variables Used in All Analyses

High School GPA (HSGPA). Students are asked to report their HSGPA on the PSAT/NMSQT and SAT questionnaires. The range of values available is 0.00 to 4.33.

Gender. Students were asked to report their gender when registering for the AP, PSAT/NMSQT, or SAT exams. We use the most recently reported response. Students are asked to select between "Male" and "Female." The reference category is male students.

Race/Ethnicity. Students were asked to report their race/ethnicity when registering for the AP, PSAT/NMSQT, or SAT exams. We use the most recently reported response. The final variable was dichotomized into "non-minority," which includes white and Asian students, and "minority," which includes American Indian or Alaska Native; Black or African American; Mexican or Mexican American; Puerto Rican; Other Hispanic, Latino or Latin American; Native American; Pacific Islander; and Other. The reference category is nonminority students.

First-generation Status. Students were asked to select their mother's highest level of education and their father's highest level of education separately when registering for the AP, PSAT/NMSQT, or SAT exams. We use the most recently reported response. Students select from the following options: grade school, some high school, high school diploma, business school, some college, associate degree, bachelor's degree, some graduate education, or graduate degree. The mother and father education variables were combined to make one highest level of parental education variable. First-generation students were defined as students whose parents' combined highest education completed was a high school diploma. Students whose parents' combined highest education was associate degree, bachelor's degree, or graduate degree were coded as not first-generation students. The reference category is students who are not first-generation.

AP Seminar/AP Research Participation. Students who participated in AP Seminar are those who had an AP Seminar Exam assessment score on record.[2] Students who had an AP Research Exam assessment score on record were marked as AP Research participants. We were unable to identify students who may have participated in either AP Seminar or AP Research courses without completing all required assignments to earn an AP Exam assessment score.

[2] See the Features of AP Seminar and AP Research section above for a list of assignments and tests that constitute the AP Seminar and AP Research Exam score. Students must complete all assignments to get a final AP Exam score.

AP Capstone Diploma Earning. College Board AP Exam score records were used to identify students who earned the AP Capstone Diploma. Students had to have scored a 3 or higher on AP Seminar, AP Research, and a minimum of four other AP Exams to be designated as AP Capstone Diploma earners.

Control Variables Used in High School Analyses Only

PSAT/NMSQT Performance. PSAT/NMSQT scores were obtained from official College Board records. If a student took the old version of the PSAT/NMSQT that was last administered in October 2014, scores were concorded to the new PSAT/NMSQT for analysis. Only the student's most recent PSAT/NMSQT score was used for analysis.

Number of AP Exams Completed Prior to Outcome of Interest. AP Exam participation was obtained from College Board records. We counted the number of AP Exam scores the student had on record, only including the AP Exams that were completed prior to or at the same time as the outcome of interest. In that way, we can ensure that the relationships we observe are not a result of AP learning in courses outside of AP Seminar or AP Research. The number of AP Exams a student completed is also an indirect control for student motivation because more motivated students likely complete more AP Exams in high school. Note that we did not control for the performance on AP Exams. We only counted the total number of AP Exams completed.

AP Seminar/AP Research Exam Performance. AP Exam performance was obtained from College Board records. Performance in AP Seminar and AP Research is not measured by one end-of-year exam. Instead, the various performance tasks students complete are objectively scored and contribute to an overall assessment score that reflects the criterion developed by the AP Program for all AP Exams. A score of 1 represents "No recommendation for college credit"; 2 represents "Possibly qualified for college credit"; 3 represents "Qualified for college credit"; 4 represents "Well-qualified for college credit"; and 5 represents "Extremely well-qualified for college credit." Many postsecondary institutions award college credit to students who score a 3 or higher on an AP Exam. Thus, for the purposes of the analyses in this study, AP Seminar or AP Research Exam success was operationalized as a score of 3 or higher.

Control Variables Used in College Analyses Only

SAT Performance. SAT scores were obtained from official College Board records. If a student took the old version of the SAT that was last administered in 2015, scores were concorded to the new SAT for analysis. Only the student's most recent SAT score was used for analysis.

Low-Socioeconomic Status.[3]. The low-socioeconomic status indicator is determined based on the mean reported income for the census block in which the student lives.

[3] The variable low-socioeconomic status was only used in college outcome analyses because it was not available at the time high school analyses were conducted.

Students who live in a census block where the mean household income is equal to or less than $45,000 are considered low-socioeconomic status.

Outcome Variables

AP Exam Performance (high school outcome). AP Exam performance was obtained from College Board records. To examine performance on future and concurrent AP Exams of the subject group in question, we grouped individual AP Exams. Table 3 outlines the groups of AP Exams used to measure AP subject performance. A student had to have taken at least one of the exams in the group to be included in the analysis. If the student completed more than one exam in a subject group in the same academic year, we averaged the performance in all AP Exams in that subject group and used the average as the outcome. We looked at concurrent AP Exam performance (AP Exams taken in same year as AP Seminar or AP Research) and future AP Exam performance (AP Exams taken in the academic year after AP Seminar or AP Research) separately to allow us to understand whether or not the timing at which the AP Seminar or AP Research course was taken made a difference in student results.

Table 3: AP Exam Groupings for AP Exam Performance Outcome

AP English Exams	English Language and Composition, English Literature and Composition
AP History Exams	European History, United States History, World History, Art History
AP Politics Exams	Comparative Government and Politics, United States Government and Politics
AP Math Exams	Calculus AB, Calculus BC, Statistics
AP Computer Science Exams	Computer Science Principles, Computer Science A
AP Science Exams	Chemistry, Biology, Environmental Science, Physics 1, Physics 2, Physics B, Physics C: Electricity and Magnetism, Physics C: Mechanics
AP Social Science Exams	Macroeconomics, Microeconomics, Psychology, Human Geography

First-year grades (college outcome). Student's first-year grades were obtained from transcripts provided by colleges and universities participating in the College Board national validity study. The range is 0.00 to 4.33.

Retention to the second year (college outcome). Student retention information was obtained from NSC records. A student was considered retained to the second year if there was a record of enrollment in the same postsecondary institution in the fall of 2017 and fall of 2018.

Internship, academic research, and honors college participation (college outcome). College internship, academic research, and honors program information was obtained from a student survey administered by College Board. In the College Board Student Survey and the College Board AP Capstone Survey, students are asked: Do you currently participate or

have you participated in any of the following since you began college? The activities listed are internship, academic research, study abroad, and honors program. Students can select the answers: Yes, No, Not offered at my college/university. Students who select "Yes" for an option are marked as having participated. Students who select "No" are marked as not having participated, and students choosing "Not offered at my college/university" are excluded from analysis.

Analyses

To understand the relationship between AP Seminar or AP Research participation and concurrent and future AP Exam scores, we used a hierarchical linear modeling approach. To confirm that this analysis required such an approach, we computed an unconditional model with a random intercept only and calculated the generalized interclass correlation coefficient (ICC) as recommended by Snijders and Bosker (1999).[4] The resulting test statistic was significant ($p<.0001$) for all data sets, which indicates that the null hypothesis of homogeneity of AP Exam and SAT score performance across high schools can be rejected and that a hierarchical model will provide more accurate results. In our hierarchical models, we grand-mean centered all continuous variables at the student level as recommended by Raudenbush and Bryk (2002, p. 35).

At the student level, we controlled for student first-generation status, minority status, gender, PSAT/NMSQT scores, HSGPA, and number of AP Exams taken in the same year and years prior to AP Exams considered in outcome. Our main variable of interest was AP Seminar or AP Research participation and performance. Students who had any missing control variables were removed from the analysis.

To understand the relationship between participating in AP Seminar, earning an AP Capstone Diploma, and college outcomes, we used a hierarchical linear modeling approach when the data were clustered by higher education institution (first-year grades, retention to the second year) and a logistic regression approach when the data was not clustered (internships, academic research, and honors program participation). The data on internship, academic research, and honors program participation was not clustered because it was collected via an online survey that was sent to students who agreed to be contacted by College Board and was thus not collected on an institution-wide scale like the retention and first-year transcript data. In our hierarchical models, we grand-mean centered all continuous variables at the student level.

For all college outcome analyses we controlled for student first-generation and minority status, gender, SAT scores, HSGPA, and low-income status. Our primary variables of interest were participating in AP Seminar and earning the AP Capstone Diploma. Students who had any missing control variables were removed from the analysis.

[4] Multiple linear regressions were run for all analyses using HLM models. Regression results indicated larger effects of AP Seminar and AP Research participation on concurrent and future AP Exam scores than HLM results. HLM takes into account the variation in AP Exam scores within schools, which reduces the influence of high school quality on estimates.

It is important to highlight that the methodological approaches used in this study—hierarchical linear modeling and linear or logistic regression—are designed to indicate the extent to which variables, such as AP Exam scores and AP Seminar participation, have a correlational relationship. These methods do not allow for causal claims. For example, hierarchical linear regression results do not allow for the claim that AP Seminar participation is the cause for AP Seminar students' higher scores in AP English Language Exams that are completed in the same academic year.

Causal claims cannot be made because regression-based methods do not consider unobserved selection bias. It is possible that students who decide to take AP Seminar are exceptional in some way that is not captured by the extensive control variables used in our hierarchical linear models or linear regression models. Although we cannot eliminate issues of unobserved selection bias altogether using the observational data at our disposal, we conducted a few sensitivity analyses to understand to what extent our results remain robust when we take a different methodological approach. In our second approach described in Appendix 1, we used a matching methodology to compare outcomes of AP Seminar students matched to similar students who attended the same schools in a prior cohort. The comparison group could not self-select into AP Seminar or AP Research because the courses were not offered at the time of their high school enrollment. Results from our matching analyses summarized in Appendix Tables A1, A2, and A3 indicate that the direction of the statistically significant results presented hold even when a different methodology is applied to the research question.

Analysis 1 Results: Relationship Between AP Seminar/AP Research Participation and Concurrent and Future AP Exam Performance

Results for AP Seminar

Figure 1 and Table 4 present the results for the relationship between AP Seminar participation and performance on AP Exams taken in the same year as AP Seminar. Figure 2 and Table 5 present the results for the relationship between AP Seminar participation and performance on AP Exams taken in the academic year following AP Seminar. Column 1 in both tables shows the average AP Exam score in each subject area for AP students who did not take an AP Seminar Exam. We include both the mean AP Exam score of those students as well as the sample size for all the groups included in analysis. The second column in both tables shows the extent to which the average AP Exam score in that subject area is higher or lower for AP students who participated in AP Seminar versus similar AP students who did not participate. The third and final column shows the extent to which the average AP Exam score in that subject area is higher or lower for students who participated in AP Seminar and earned a 3 or higher on the AP Seminar Exam versus similar AP students who did not take an AP Seminar Exam.

Results in Figure 1 show the strongest relationships among AP Seminar participation and students who take English, history, politics, and social science AP Exams. AP Seminar

students score 0.08 to 0.20 points higher on AP Exams in those subject areas than similar AP students who did not take AP Seminar. In other words, their AP Exam score on concurrent AP Exams in those subjects is about 3%–7% higher, with increases being statistically significant.

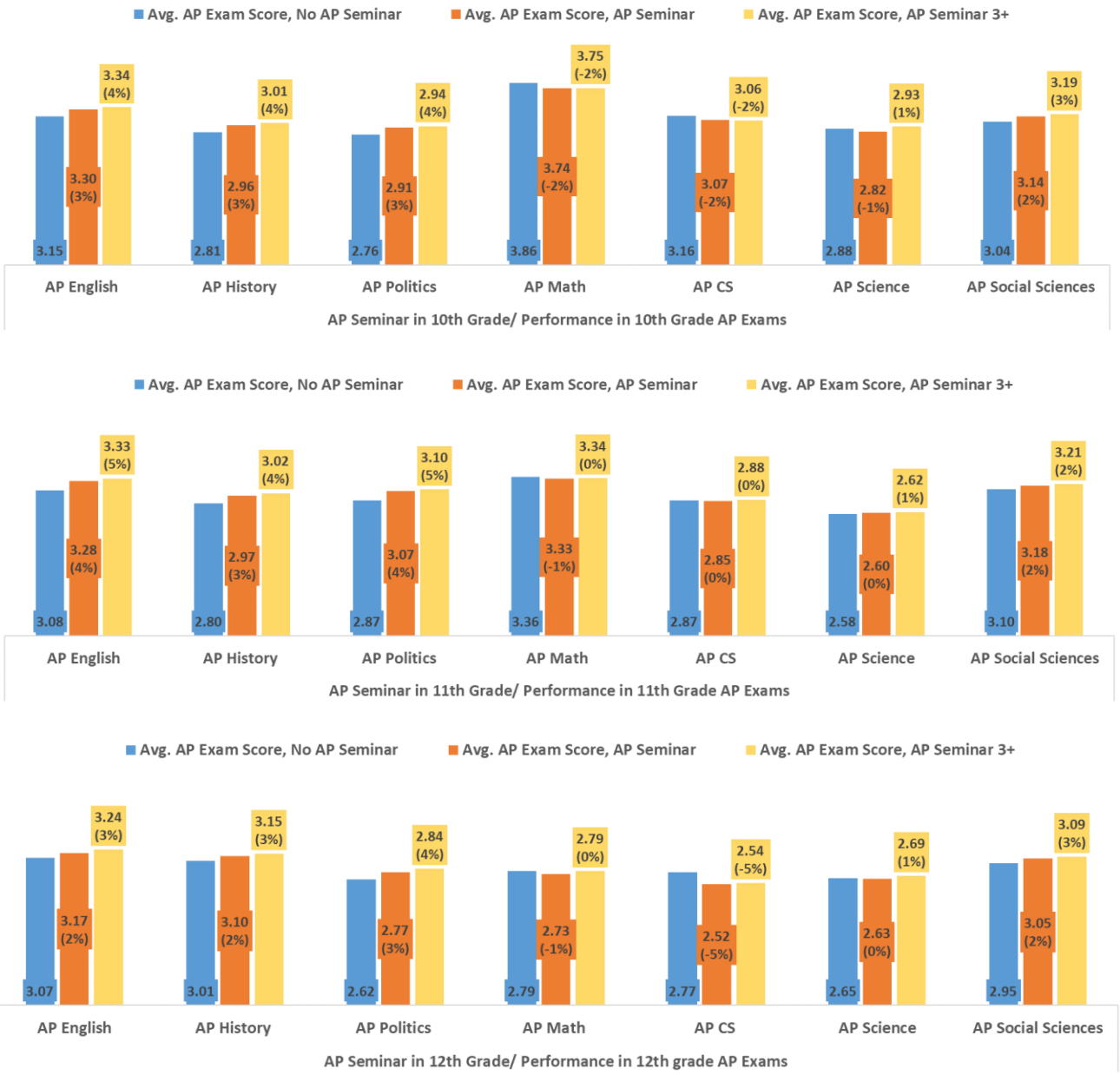
When focusing in on the performance of AP Seminar students on AP Exams taken the year after AP Seminar (see Table 5 or Figure 2), the results remain similarly positive for English, history, and politics. AP Seminar students score 0.08 to 0.19 points higher on AP Exams in those subject areas than similar AP students who did not take AP Seminar, which again translates to a score that is 3% higher, with increases being statistically significant.

The percent increase or decrease in concurrent and future AP Exam scores for students who participate in AP Seminar in their sophomore, junior, or senior year of high school is similar. This indicates that the relationship between AP Seminar participation and AP Exam performance is not sensitive to the student's decision on when to take AP Seminar in their high school career. Furthermore, the similarity of effects in performance gains between concurrent and future AP Exams in each subject area suggests that the increase in AP Exam score for AP Seminar participants is not primarily driven by AP Seminar helping students who take the course understand their own interests and abilities in a way that helps them self-select into a future AP course that matches their interests and skills. If this were the case, we would expect to see the effect to be larger for AP Exams taken in the year after AP Seminar than AP Exams taken in the same year as AP Seminar. Because we see similar effects in both AP Exams taken in the same year as well as AP Exams taken in future years, it is likely that the skills learned in AP Seminar are positively related to performance in other AP Exams.

While there is a positive relationship between English, history, and politics AP Exam scores and AP Seminar participation, the relationship between math, computer science, and science AP Exam scores and AP Seminar participation is most often near zero and statistically insignificant.

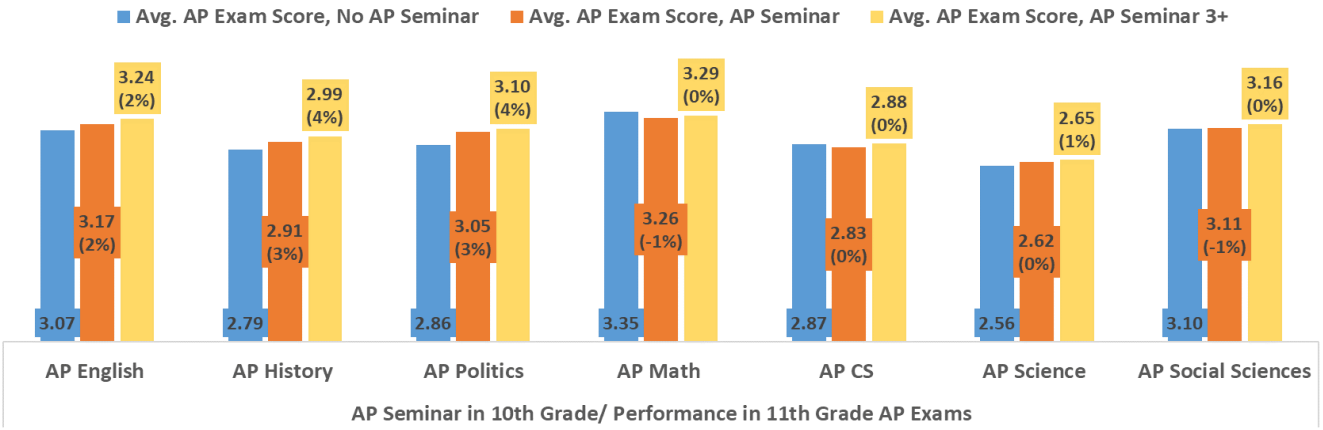
For the 15 results summarizing the relationship between AP Seminar participation and performance on AP Exams in math, computer science, and science shown in Column 2 of Tables 4 and 5, 9 results indicate that there is no statistically significant relationship present. This finding that there is often either no statistically significant or a negative relationship between AP Seminar participation and AP Exam performance in math, computer science , and science is not surprising as the activities students enrolled in AP Seminar engage in—reading and analyzing articles, research studies, and foundational literary and philosophical texts; listening to and viewing speeches, broadcasts, and personal accounts; and experiencing artistic works and performances—are more often used in English, history, politics, and social science courses.

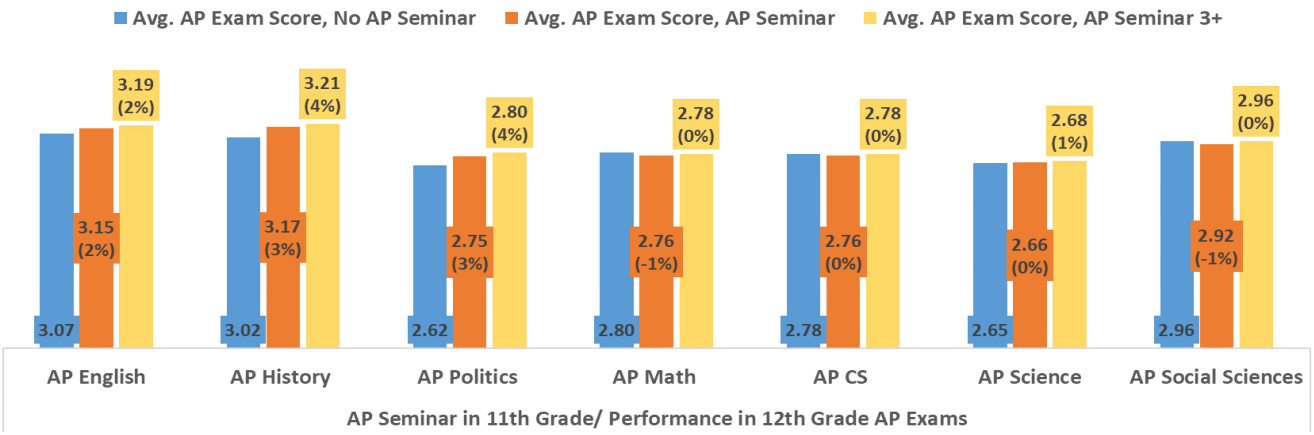
Figure 1: AP Seminar and Performance on Concurrent AP Exams



Note: Percent values in parentheses indicate the percent increase/decrease in AP Exam score for AP Seminar participants.

Figure 2: AP Seminar and Performance on Future AP Exams





Note: Percent values in parentheses indicate the percent increase/decrease in AP Exam score for AP Seminar participants.

It is important to note, however, that the results do indicate that students who take AP Seminar have higher AP science exam scores than AP students who did not take AP Seminar when that AP science exam is taken in the academic year after the AP Seminar course. This suggests that the benefits of AP Seminar participation on AP science exam performance may be variable rather than insignificant across the board.

As would be expected, students who earn a score of 3 or higher on the AP Seminar Exam on average have higher AP Exam scores in both concurrent and subsequent AP Exams. However, even those high scoring AP Seminar students are not more likely to earn higher scores on AP Exams in math, computer science and, to some extent, science, compared to AP students who did not take the AP Seminar Exam.

Table 4: AP Seminar and Performance on Concurrent AP Exams

	Outcome		No AP Seminar	AP Seminar, Overall	AP Seminar, Score 3+
AP Seminar in 10th Grade	AP English Exams in 10th Grade	Mean	3.15	0.15***	0.19***
		N	5,679	405	351
	AP History Exams in 10th Grade	Mean	2.81	0.15***	0.20***
		N	101,723	7,467	6,270
	AP Politics Exams in 10th Grade	Mean	2.76	0.15***	0.18***
		N	8,014	374	343
	AP Math Exams in 10th Grade	Mean	3.86	-0.12***	-0.11**
		N	5,857	515	486
	AP CS Exams in 10th Grade	Mean	3.16	-0.09	-0.10
		N	6,295	273	252
	AP Science Exams in 10th Grade	Mean	2.88	-0.06**	0.05**
		N	22,745	1,862	1,601
	AP Social Sciences Exams in 10th Grade	Mean	3.04	0.10**	0.15***
		N	24,060	1,653	1,329
AP Seminar in 11th Grade	AP English Exams in 11th Grade	Mean	3.08	0.20***	0.25***
		N	125,182	11,057	9,637
	AP History Exams in 11thGrade	Mean	2.80	0.17***	0.22***
		N	107,472	8,161	7,006
	AP Politics Exams in 11th Grade	Mean	2.87	0.20***	0.23***
		N	9,309	879	803
	AP Math Exams in 11th Grade	Mean	3.36	-0.03	-0.02
		N	38,333	3,867	3,597
	AP CS Exams in 11th Grade	Mean	2.87	-0.02	0.01
		N	7,771	462	420
	AP Science Exams in 11th Grade	Mean	2.58	0.02	0.04***
		N	91,822	7,431	6,674
	AP Social Sciences Exams in 11th Grade	Mean	3.10	0.08***	0.11***
		N	55,153	3,172	2,851
AP Seminar in 12th Grade	AP English Exams in 12th Grade	Mean	3.07	0.10***	0.17***
		N	91,594	839	619
	AP History Exams in 12th Grade	Mean	3.01	0.09	0.14
		N	12,739	153	125
	AP Politics Exams in 12th Grade	Mean	2.62	0.15***	0.22***
		N	66,364	579	428
	AP Math Exams in 12th Grade	Mean	2.79	-0.06	0.00
		N	102,809	759	584
	AP CS Exams in 12th Grade	Mean	2.77	-0.25*	-0.23
		N	9,687	65	52
	AP Science Exams in 12th Grade	Mean	2.65	-0.02	0.04
		N	85,831	660	512
	AP Social Sciences Exams in 12th Grade	Mean	2.95	0.10**	0.14***
		N	89,958	617	456

Note: Averages are based on HLM model controlling for student demographics, academic achievement, prior AP exposure, and high school effects. P < 0.1*, 0.05**, 0.01***

Table 5: AP Seminar and Performance on Future AP Exams

	Outcome		No AP Seminar	AP Seminar, Overall	AP Seminar, Score 3+
AP Seminar in 10th Grade	AP English Exams in 11th Grade	Mean	3.07	0.10***	0.17***
		N	125,182	4,023	3,163
	AP History Exams in 11th Grade	Mean	2.79	0.12***	0.20***
		N	107,472	3,185	2,453
	AP Politics Exams in 11th Grade	Mean	2.86	0.19***	0.24***
		N	9,309	355	307
	AP Math Exams in 11th Grade	Mean	3.35	-0.09***	-0.06**
		N	38,333	1,392	1,171
	AP CS Exams in 11th Grade	Mean	2.87	-0.04	0.01
		N	7,771	222	170
	AP Science Exams in 11th Grade	Mean	2.56	0.06***	0.09***
		N	91,822	2,710	2,170
	AP Social Sciences Exams in 11th Grade	Mean	3.10	0.01	0.06*
		N	55,153	1,157	895
AP Seminar in 11th Grade	AP English Exams in 12th Grade	Mean	3.07	0.08***	0.12***
		N	91,594	3,849	3,224
	AP History Exams in 12th Grade	Mean	3.02	0.15***	0.19***
		N	12,739	557	505
	AP Politics Exams in 12th Grade	Mean	2.62	0.13***	0.18***
		N	66,364	2,400	2,050
	AP Math Exams in 12th Grade	Mean	2.80	-0.04**	-0.02
		N	102,809	3,974	3,483
	AP CS Exams in 12th Grade	Mean	2.78	-0.02	0.00
		N	9,687	431	382
	AP Science Exams in 12th Grade	Mean	2.65	0.01	0.03
		N	85,831	3,121	2,728
	AP Social Sciences Exams in 12th Grade	Mean	2.96	-0.04**	0.00
		N	89,958	3,348	2,843

Note: Averages are based on HLM model controlling for student demographics, academic achievement, prior AP exposure, and high school effects. P < 0.1*, 0.05**, 0.01***

Results for AP Research

Figure 3 and Table 6 present the results of our analysis on the relationship between AP Research participation and performance in concurrent AP Exams, and Figure 4 and Table 7 present the results of our analysis on the relationship between AP Research participation and performance on AP Exams taken the following year. The tables and figures have the same layout as those described in the Results for AP Seminar section.

It is important to note that the sample sizes for the AP Research analysis are significantly smaller than those for the AP Seminar analysis. This is because students can, and often do, take AP Seminar without subsequently taking AP Research. AP Research students, however, must take AP Seminar as a prerequisite. Furthermore, AP Research was instituted

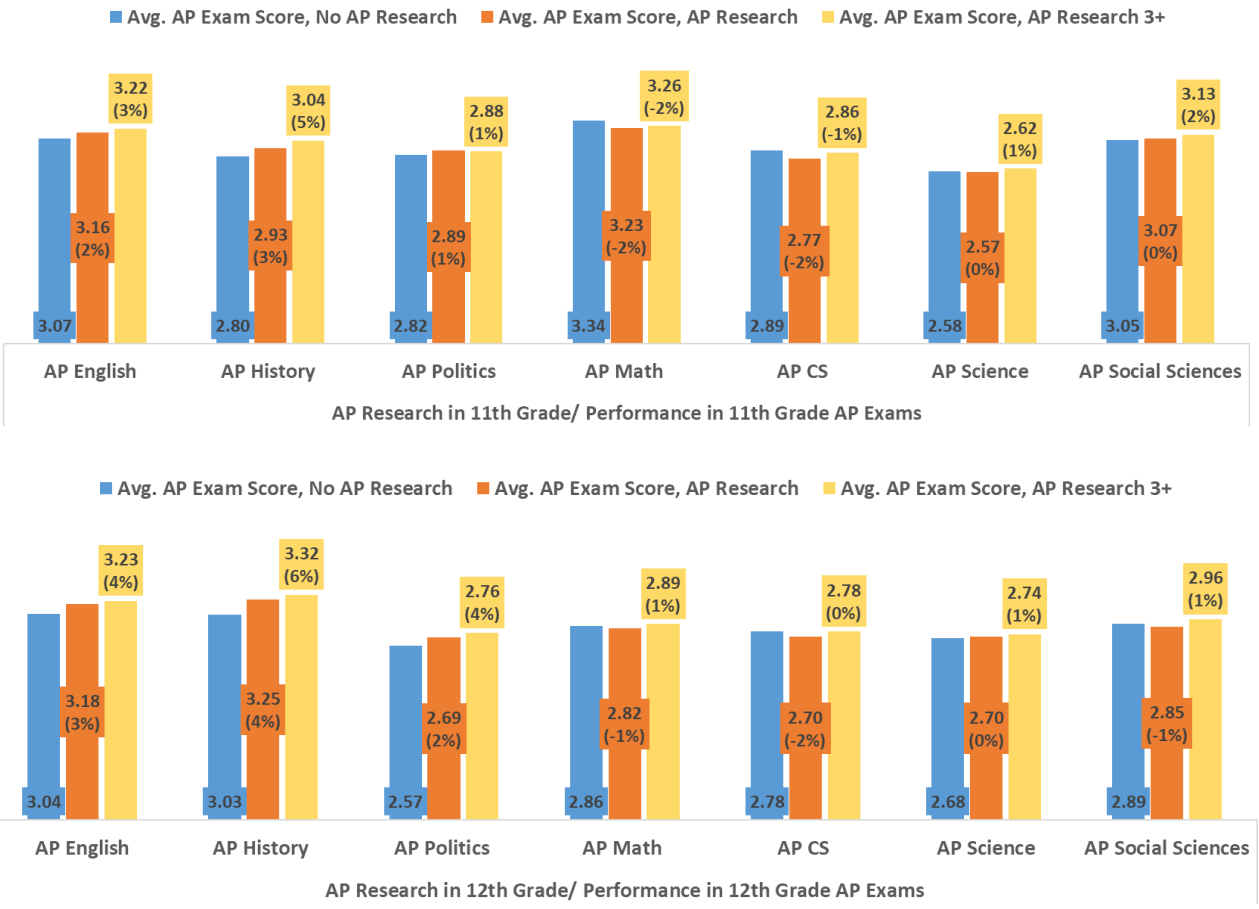
in high schools one year after AP Seminar, which means that some high schools may have offered AP Seminar, but not AP Research, at the time of this analysis.

The AP Research results are like AP Seminar results in that the relationship between AP Research participation and performance on concurrent and future AP Exams differs by subject area. AP Research participation has the most positive relationship with AP Exam scores in the English, history, and politics subject areas. Students who take the AP Research Exam score 0.07 to 0.22 points higher on their English, history, and politics AP Exams taken in the same year as AP Research, compared to AP Students who did not take AP Research (see Figure 3 and Table 6). This translates to a score that is 2%–7% higher, a statistically significant difference in all cases except AP politics exams. Students who score a 3 or higher on the AP Research Exam see even greater increases of up to 0.29 points.

Focusing on performance in AP Exams taken in the year after AP Research participation (see Figure 4 and Table 7), students who take AP Research score 0.03 to 0.40 points higher on their English, history, and politics AP Exams taken in the year following AP Research, compared to similar AP Students who did not take AP Research. In this case, the differences are not statistically significant for English and politics. It is important to note, however, that most students take AP Research as senior. Consequently, the sample sizes for studying the relationships of AP Research students who completed the Research Exam in 11th grade and went on to take further AP Exams in the 12th grade is smaller than what we observe in other analyses.

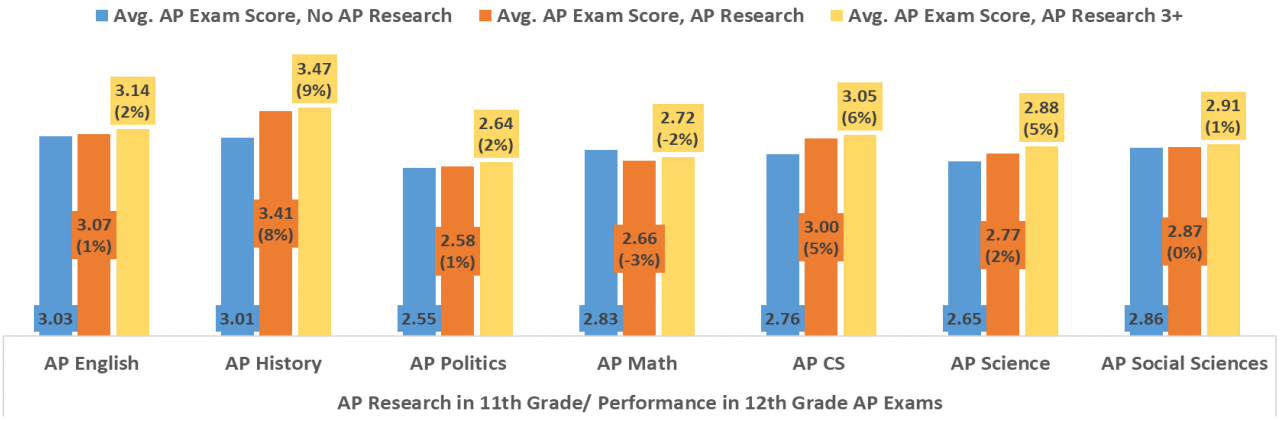
As with AP Seminar, the relationship with participation in AP Research and performance in math, computer science, and science is most often near zero and not statistically significant. For the nine results summarizing the relationship between AP Research participation and performance on AP Exams in math, computer science, and science shown in Column 2 of Tables 6 and 7, six results indicate that there is no statistically significant relationship present. AP Research participants do, however, have on average statistically significant higher AP Exam scores in science exams that are taken in the year following AP Research than similar AP students who did not take AP Research.

Figure 3: AP Research and Performance on Concurrent AP Exams



Note: Percent values in parentheses indicate the percent increase/decrease in AP Exam score for AP Research participants.

Figure 4: AP Research and Performance on Future AP Exams



Note: Percent values in parentheses indicate the percent increase/decrease in AP Exam score for AP Research participants.

Table 6: AP Research and Performance on Concurrent AP Exams

	Outcome		No AP Research	AP Research, Overall	AP Research, Score 3+
AP Research in 11th Grade	AP English Exams in 11th Grade	Mean	3.07	0.09***	0.15***
		N	48,424	1,949	1,360
	AP History Exams in 11th Grade	Mean	2.80	0.13***	0.24***
		N	40,173	1,616	1,077
	AP Gov./Politics Exams in 11th Grade	Mean	2.82	0.07	0.06
		N	3,929	116	95
	AP Math Exams in 11thGrade	Mean	3.34	-0.11	-0.08
		N	14,736	789	608
	AP CS Exams in 11th Grade	Mean	2.89	-0.12	-0.03
		N	3,527	98	71
	AP Science Exams in 11th Grade	Mean	2.58	-0.01	0.04
		N	35,611	1,436	1,035
	AP Social Science Exams in 11th Grade	Mean	3.05	0.02	0.08
		N	23,453	545	387
AP Research in 12th Grade	AP English Exams in 12th Grade	Mean	3.04	0.14***	0.19***
		N	32,236	2,827	1,996
	AP History Exams in 12th Grade	Mean	3.03	0.22***	0.29***
		N	4,682	397	312
	AP Gov./Politics Exams in 12thGrade	Mean	2.57	0.12***	0.19***
		N	24,370	1,772	1,297
	AP Math Exams in 12th Grade	Mean	2.86	-0.04*	0.03
		N	37,055	2,889	2,172
	AP CS Exams in 12th Grade	Mean	2.78	-0.08	0.00
		N	4,167	314	240
	AP Science Exams in 12th Grade	Mean	2.68	0.02	0.06**
		N	29,851	2,279	1,704
	AP Social Science Exams in 12th Grade	Mean	2.89	-0.04*	0.07**
		N	34,547	2,347	1,705

Note: Averages are based on HLM model controlling for student demographics, academic achievement, prior AP exposure, and high school effects. P < 0.1*, 0.05**, 0.01***

Table 7: AP Research and Performance on Future AP Exams

	Outcome		No AP Research	AP Research, Overall	AP Research, Score 3+
AP Research in 11th Grade	AP English Exams in 12th Grade	Mean	3.03	0.04	0.11**
		N	32,236	354	240
	AP History Exams in 12th Grade	Mean	3.01	0.40***	0.46**
		N	4,682	51	33
	AP Gov./Politics Exams in 12th Grade	Mean	2.55	0.03	0.09
		N	24,370	348	235
	AP Math Exams in 12th Grade	Mean	2.83	-0.17***	-0.11
		N	37,055	350	228
	AP CS Exams in 12th Grade	Mean	2.76	0.24	0.29
		N	4,167	31	20
	AP Science Exams in 12th Grade	Mean	2.65	0.12**	0.23***
		N	29,851	301	206
	AP Social Science Exams in 12th Grade	Mean	2.86	0.01	0.05
		N	34,547	410	264

Note: Averages are based on HLM model controlling for student demographics, academic achievement, prior AP exposure, and high school effects. P < 0.1*, 0.05**, 0.01***

Analysis 2 Results: Relationship Between AP Seminar, AP Capstone Diploma, and College Outcomes

As mentioned in the Research Questions section, the analyses of the relationship between college outcomes and participation in the AP Capstone Diploma Program focus on two groups of students. First, the analyses focus on the college outcomes of students who have only completed the AP Seminar Exam and did not pursue AP Research. These students represent those with minimal exposure to the AP Capstone Diploma program. Second, the analyses focus on AP Capstone Diploma recipients. These are the students who have completed the entire AP Capstone program, earning scores of 3 or higher on AP Seminar, AP Research, and four additional AP Exams.

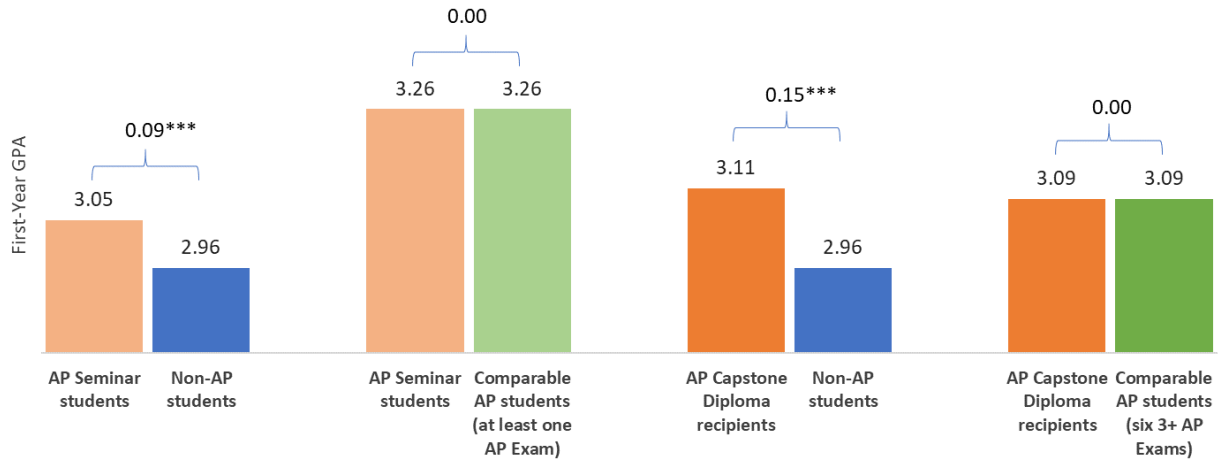
In all analyses, the AP Seminar students and the AP Capstone Diploma earners are compared both to similar students who did not take any AP Exams in high school, as well as to AP students who have never taken AP Seminar or AP Research but have taken a similar number of content-specific AP Exams in high school. As explained earlier, we include the AP comparison to understand if there is a unique added benefit that students acquire when they participate in AP Seminar and the AP Capstone Diploma program as opposed to other content-specific AP courses.

Figure 5 shows that both students who participate in AP Seminar, and students who earn the AP Capstone Diploma, on average, earn higher first-year grades than similar non-AP students (+0.09 and +0.15, respectively). When AP Seminar participants are compared to a group of similar AP students, which in the case of AP Seminar students are students who have taken at least one AP Exam in high school but have not taken either AP Seminar or AP

Research, then the AP Seminar students have the same first-year college grades as comparable students who have taken at least one AP Exam in high school.

The result is similar when AP Capstone Diploma earners are compared to a group of similar AP students, which in this case are students who have earned a 3 or higher on at least six AP Exams in high school but have not taken either AP Seminar or AP Research. When AP Capstone Diploma earners are compared to students who have scored a 3 or higher on at least six AP Exams, they have the same predicted first-year college grades.

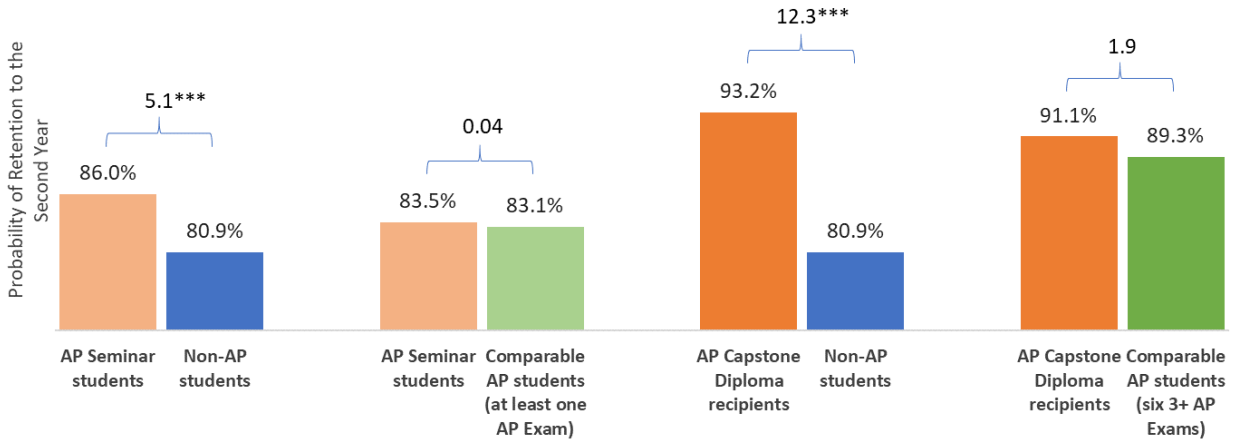
Figure 5. AP Seminar Participation, AP Capstone Diploma Earning, and First-Year College Grades



Note: Averages are based on HLM model controlling for student race, first-generation status, low-income, gender, SAT scores and high school grades. *P<0.10, **P<0.05, ***P<0.01

The relationships between AP Seminar participation, AP Capstone Diploma earning, and first-year college grades are mirrored in the differences observed in probability of retention to the second year shown in Figure 6. When it comes to retention to the second year, AP Seminar participants and AP Capstone Diploma earners are significantly more likely to retain to the second year than similar non-AP students (+5.1 percentage points and +12.3 percentage points, respectively), and as likely to retain to the second year as comparable AP students who did not take AP Seminar or earn an AP Capstone Diploma.

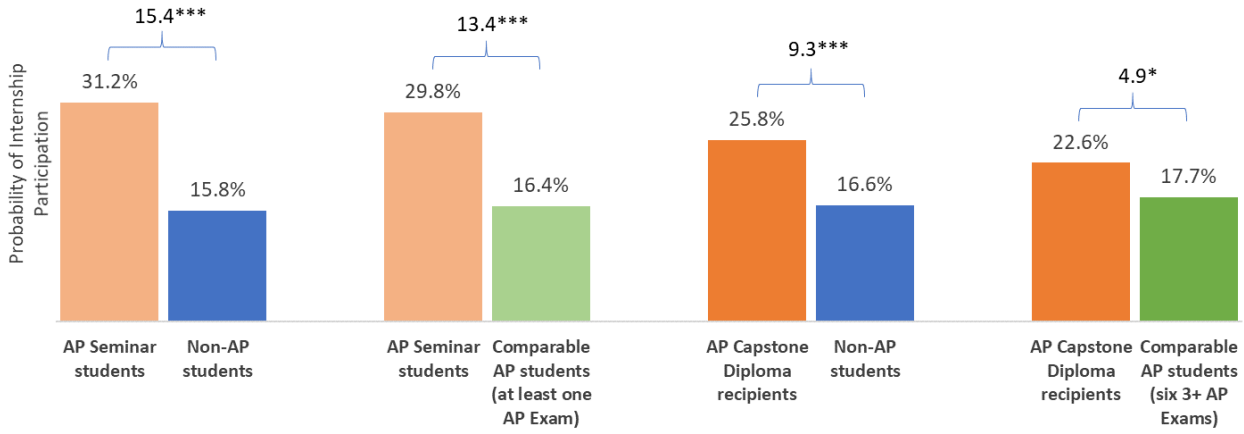
Figure 6. AP Seminar Participation, AP Capstone Diploma Earning, and Retention to the Second Year



Note: Probabilities are calculated for the average student who is white /Asian, female, not first-generation, not low-income, and has average SAT scores and high school grades. Differences in probability of retention are similar when considering first-generation, minority, and low-SES students.*P<0.10, **P<0.05, ***P<0.01

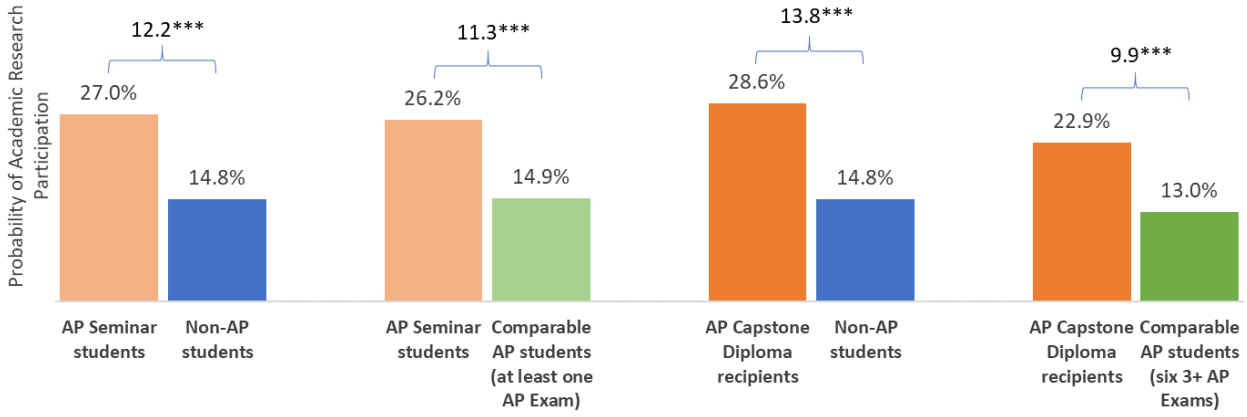
Figure 7 shows that AP Seminar participants and AP Capstone Diploma earners are significantly more likely to participate in internships in the first year of college than similar non-AP students (+15.4 percentage points and +9.3 percentage points, respectively). They are also significantly more likely to participate in internships than comparable AP students who did not take AP Seminar or earn an AP Capstone Diploma (+13.4 percentage points and +4.9 percentage points, respectively).

Figure 7. AP Seminar Participation, AP Capstone Diploma Earning, and Internship Participation



Note: Probabilities are calculated for the average student who is white /Asian, female, not first-generation, not low-income, and has average SAT scores and high school grades. Differences in probability of internship participation are similar when considering first-generation, minority, and low-SES students. *P<0.10, **P<0.05, ***P<0.01

Figure 8. AP Seminar Participation, AP Capstone Diploma Earning, and Academic Research Participation



Note: Probabilities are calculated for the average student who is white /Asian, female, not first-generation, not low-income, and has average SAT scores and high school grades. Differences in probability of academic research participation are similar when considering first-generation, minority, and low-SES students. *P<0.10, **P<0.05, ***P<0.01

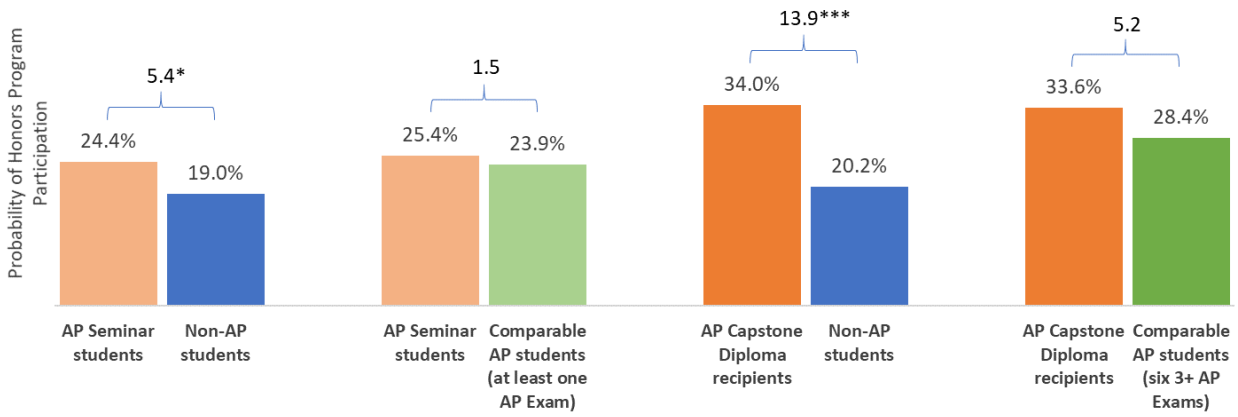
This same relationship is also evident when participation in academic research in the first year of college is considered. Figure 8 shows that AP Seminar participants and AP Capstone Diploma earners are more likely to participate in academic research in the first year of college than similar non-AP students (+12.2 percentage points and +13.8 percentage points, respectively) and also more likely to participate in academic research, compared to similar AP students who did not take AP Seminar or earn an AP Capstone Diploma (+11.3 percentage points and +9.9 percentage points, respectively).

The finding that AP Seminar participants and AP Capstone Diploma earners are more likely to participate in academic research and internships in their first year of college than students who have never taken any AP Exams as well as students who have similar levels of AP exposure suggests that the unique skills that students acquire through their participation in AP Capstone—even if they are only exposed to AP Seminar, the first course—likely helps them feel more comfortable in seeking out engaging work opportunities in college sooner than students who have not had the experience of AP Seminar or both AP Capstone courses. This is encouraging as prior research has shown that students who engage in internships in college, on average, earn higher grades, report greater satisfaction with their college experience, and are more likely to receive a job offer upon graduation when compared to students who do not participate in internships (Routon and Walker, 2015, 2019; Nunley, Pugh, Romero, & Seals, 2016).

Finally, Figure 9 shows that AP Seminar participants and AP Capstone Diploma earners are more likely to participate in honors programs in the first year of college than similar non-AP students (+5.4 percentage points and +13.9 percentage points, respectively) and slightly more likely to participate in honors programs than similar AP students who did not take AP Seminar or earn an AP Capstone Diploma. The differences observed between AP Seminar

participants and comparable AP students and AP Capstone Diploma earners and comparable AP students are not statistically significant.

Figure 9. AP Seminar Participation, AP Capstone Diploma Earning, and Honors Program Participation



Note: Probabilities are calculated for the average student who is white /Asian, female, not first-generation, not low-income, and has average SAT scores and high school grades. Differences in probability of honors program participation are similar when considering first-generation, minority, and low-SES students. *P<0.10, **P<0.05, ***P<0.01

Because AP Seminar and the AP Capstone Diploma program are new offerings at the time of publication, we currently only have one year of college outcome data for students who have had the opportunity to participate in the program. This limitation of data availability likely affects studying honors program participation because many universities have college honors programs that do not start until later in a student's college career. Future work should revisit this analysis with additional years of data as they become available and should also add further college outcomes such as college persistence, major choice, and college completion.

Summary

The results in this report show that AP Seminar and AP Research participation is related to higher scores on concurrent and future AP Exams in the subject areas of English, history, politics and, in some cases, social sciences and science. This is true for all AP Seminar or AP Capstone participants but especially those who score a 3 or higher on the Capstone exams.

AP Seminar or AP Research participation in most cases does not have a statistically significant relationship with concurrent or future AP Exam performance in math and computer science fields. This finding is not surprising in light of the fact that the type of skills students develop in AP Seminar are more directly applicable to subjects such as English, history, and politics, as opposed to math and computer science. The learning that takes place in AP Research is highly individualized and can focus on any subject area from science to humanities. For schools implementing the AP Capstone Diploma program, the

high school outcome evidence presented in this report may help with scheduling AP Seminar and AP Research to optimize future or concurrent learning in other AP courses.

Results on the relationship between taking an AP Seminar Exam or completing the AP Capstone Diploma and college outcomes show that students taking an AP Seminar Exam or students earning an AP Capstone Diploma have significantly higher first-year grades, second-year retention, and probability of participating in academic research, internships, and honors programs than students who did not take any AP Exams in high school. Furthermore, while AP Seminar students and AP Capstone Diploma earners have similar first-year grades and retention as AP students with a comparable number of AP Exams, taking AP Seminar or earning the AP Capstone Diploma provides a larger predicted boost than comparable content-specific AP exposure with respect to internship, honors program, and research participation in the first year of college. This finding suggests that the specific skills taught in the AP Capstone program help students engage in college learning opportunities that lead to positive college and career outcomes down the line.

Overall, the results presented in this report provide early evidence of the effectiveness of AP Seminar and AP Research courses in preparing students for success in other AP coursework, particularly in English, history, and politics, as well as for success in college. Future research should continue to track student outcomes as more high schools adopt AP Capstone and more students participate in the program in order for the generalizability of these findings to be evaluated beyond early-adopter high schools.

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Appendix: Sensitivity Analyses

In order to understand the robustness of the results presented, we replicated three of the analyses shared in this report using a matching based methodology (Godfrey, 2016). In this approach, we matched students who participated in AP Seminar to students who attended the same high school where AP Seminar was offered in the years prior to the advent of AP Seminar. The years we selected are 2010 and 2011 in order to avoid the time period when AP Seminar was piloted in several high schools prior to the official launch of the course.

We matched the AP Seminar students and students who attended the same high school in the years before AP Seminar was offered exactly on gender, parental education status (less than bachelor's degree, bachelor's degree, more than bachelor's degree), underrepresented minority status, high school grades, number of STEM AP Exams completed, and number of non-STEM AP Exams completed. Additionally, we also matched the students on PSAT/NMSQT score (separately for math, reading, and writing sections), allowing for students to be matched if their PSAT/NMSQT score was within one point.

Once we matched students, we compared their performance in selected AP Exams to see how the results change using the matching versus hierarchical linear model methodology. Table 1A, 1B, and 1C show the results for students before the match, after the match, and compares these to the result achieved using the hierarchical linear method (see last row).

Table A1. AP Seminar Participation and AP Exam Performance Using Matching Methodology, Seminar 11th Grade, AP English 11th Grade

	Seminar Pre-match		No Seminar Pre-match			Seminar Post-match		No Seminar Post-match		
Variable	Mean	STD	Mean	STD	Diff	Mean	STD	Mean	STD	Diff
PSAT/NMSQT Reading	30.46	4.32	29.84	4.71	0.62	30.71	4.04	30.74	4.06	-0.02
PSAT/NMSQT Writing	30.35	4.38	29.79	4.63	0.56	30.76	4.02	30.78	4.01	-0.01
PSAT/NMSQT Math	29.56	4.71	29.40	4.73	0.17	29.85	4.39	29.90	4.41	-0.06
Parental ed., more than BA	0.42		0.38		0.04	0.46		0.46		0.00
Parental ed., BA	0.31		0.32		-0.01	0.31		0.31		0.00
Parental ed., less than BA	0.27		0.30		-0.03	0.23		0.23		0.00
Underrepresented Minority	0.27		0.24		0.02	0.18		0.18		0.00
Male	0.37		0.38		-0.01	0.32		0.32		0.00
HS GPA	3.76		3.65		0.11	3.80		3.80		0.00
Number AP STEM	1.17	1.35	0.63	0.93	0.54	0.83	1.02	0.83	1.02	0.00
Number AP non-STEM	3.16	1.42	2.53	1.22	0.62	2.81	1.08	2.81	1.08	0.00
AP English Exam Score	3.38	1.12	3.11	1.11	0.28	3.46	1.10	3.32	1.07	0.14***
N	11057		65024			5931		5931		
Difference found in HLM analysis:										0.20***

P < 0.1*, 0.05**, 0.01***

HLM results in Table 4 show that students who took AP Seminar in the 11th grade scored 0.20 points higher on their 11th-grade AP English Exams, compared to students who did not take AP Seminar. The matching results for that analysis show that AP Seminar students scored 0.14 points higher on their 11th-grade AP English Exams, compared to matched students who attended the high school prior to the year that AP Seminar was offered (See Table A1). Both the 0.20 and the 0.14 are statistically significant at alpha 0.01. This comparison indicates that the HLM results are robust.

HLM results in Table 5 show that students who took AP Seminar in the 11th grade scored 0.15 points higher on their 12th-grade AP History Exams, compared to students who did not take AP Seminar. The matching results for that analysis show that AP Seminar students scored 0.40 points higher on their 12th-grade AP History Exams, n compared to matched students who attended the high school prior to the year that AP Seminar was offered (See Table A2). While the difference of 0.15 is statistically significant, the difference of 0.40 is not. This is likely due to the small sample of students that we were able to match using our matching algorithm (N=42). Nonetheless, the fact that the score difference is higher for AP Seminar students using both the HLM and the matching approach indicates that the overarching finding remains robust.

Table A2. AP Seminar Participation and AP Exam Performance Using Matching Methodology, Seminar 11th Grade, AP History 12th Grade

	Seminar Pre-match		No Seminar Pre-match			Seminar Post-match		No Seminar Post-match		
Variable	Mean	STD	Mean	STD	Diff	Mean	STD	Mean	STD	Diff
PSAT/NMSQT Reading	31.11	4.01	30.09	4.85	1.01	32.12	3.22	32.19	3.47	-0.07
PSAT/NMSQT Writing	30.98	3.90	29.85	4.73	1.13	31.95	3.46	31.88	3.29	0.07
PSAT/NMSQT Math	30.18	4.24	29.13	4.70	1.05	30.98	3.84	30.96	3.96	0.01
Parental ed,, more than BA	0.48		0.41		0.07	0.74		0.74		0.00
Parental ed., BA	0.28		0.30		-0.02	0.17		0.17		0.00
Parental ed., less than BA	0.24		0.29		-0.05	0.10		0.10		0.00
Underrepresented Minority	0.23		0.21		0.02	0.00		0.00		0.00
Male	0.41		0.44		-0.02	0.31		0.31		0.00
HS GPA	3.80		3.60		0.20	3.91		3.91		0.00
Number AP STEM	2.38		1.35		1.03	1.74		1.74		0.00
Number AP non-STEM	6.03		4.38		1.65	5.50		5.50		0.00
AP History Exam Score	3.41	1.18	2.93	1.29	0.48	3.52	1.13	3.12	1.21	0.40
N	557		8346			42		42		
Difference found in HLM analysis:										0.15***

P < 0.1*, 0.05**, 0.01***

Similarly, when we looked at the performance of 11th-grade AP Seminar students on 11th-grade AP Math exams, we find that the difference is small in magnitude and statistically insignificant both using the HLM and matching approach. HLM results showed that AP Seminar students scored 0.03 (see Table 4) points lower on AP Exams, while matching results showed that AP Seminar students scored 0.08 points higher (see Table A3).

Overall, the matching results highlight that the statistically significant HLM and regression results presented in this study remain robust when replicated using a different approach and methodology.

Table A3. AP Seminar Participation and AP Exam Performance Using Matching Methodology, Seminar 11th Grade, AP Math 11th Grade

	Seminar Pre-match		No Seminar Pre-match			Seminar Post-match		No Seminar Post-match		
Variable	Mean	STD	Mean	STD	Diff	Mean	STD	Mean	STD	Diff
PSAT/NMSQT Reading	32.31	3.74	31.54	4.58	0.77	33.39	3.23	33.48	3.32	-0.09
PSAT/NMSQT Writing	32.26	3.91	31.49	4.38	0.78	33.60	3.28	33.66	3.26	-0.07
PSAT/NMSQT Math	33.02	3.89	33.33	3.89	-0.31	34.59	3.22	34.70	3.30	-0.11
Parental ed., more than BA	0.52		0.47		0.05	0.65		0.65		0.00
Parental ed., BA	0.30		0.30		-0.01	0.25		0.25		0.00
Parental ed., less than BA	0.19		0.23		-0.04	0.10		0.10		0.00
Underrepresented Minority	0.17		0.16		0.02	0.05		0.05		0.00
Male	0.49		0.54		-0.05	0.50		0.50		0.00
HS GPA	3.92		3.84		0.08	4.00		4.00		0.00
Number AP STEM	2.50	1.35	1.91	1.01	0.60	2.25	1.07	2.25	1.07	0.00
Number AP non-STEM	3.22	1.69	2.25	1.58	0.97	2.76	1.31	2.76	1.31	0.00
AP Math Exam Score	3.69	1.36	3.52	1.44	0.16	4.06	1.21	3.98	1.26	0.08
N	3867		16832			1378		1378		
Difference found in HLM analysis:										-0.03

P < 0.1*, 0.05**, 0.01***

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