RESEARCH REPORT 2009-4

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The Relationship Between AP® Exam Performance and College Outcomes

By Krista D. Mattern, Emily J. Shaw, and Xinhui Xiong

College Board Research Report No. 2009-4

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The College Board, New York, 2009

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Printed in the United States of America.

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Abstract

This study focused on the relationship between students' Advanced Placement Program® (AP®) performance in AP English Language, Biology, Calculus, and U.S. History, and their subsequent college success. For each AP Exam studied, students were divided into three groups according to their AP Exam performance (no AP Exam taken, score of 1 or 2, and a score of 3 or higher). Subsequent college success was measured by students' first-year college grade point average (FYGPA), retention to the second year, and institutional selectivity. Results indicated that, even after controlling for students' SAT® scores and high school grade point average (HSGPA) as measures of prior academic performance, students with an AP score of 3 or higher outperformed the other two groups. Additionally, students with an AP score of 1 or 2 tended to outperform students with no AP scores except in terms of FYGPA. The implications are discussed.

The Relationship Between AP® Performance and College Outcomes

The Advanced Placement Program, administered by the College Board since 1955, offers rigorous, college-level courses and assessments at high schools across the United States and the world. The AP Program currently has course descriptions for more than 30 courses, including Studio Art, Biology, and Calculus, and offers students a unique opportunity to take more advanced courses during high school. Furthermore, each course has an end-of-year exam. AP Exams are criterion-referenced and scored from 1 through 5, with a 5 representing a score of "extremely well-qualified." The AP Program is viewed as a "cooperative educational endeavor" among high schools, colleges, and universities. Students who perform well on the exam (i.e., receive a score of 3 or higher) may receive college credit or course exemption, depending on the AP policies of the college or university they attend. Consequently, there has been a great deal of research devoted to examining AP performance and subsequent college outcomes (Ewing, 2006).

Research on AP Performance and College Success

Given the purpose of the AP Program, it is not surprising that the majority of AP validity research has focused on the relationship between AP Exam performance and course placement (e.g., Burnham & Hewitt, 1971; Dodd, Fitzpatrick, De Ayala, & Jennings, 2002; Morgan & Crone, 1993; Morgan & Ramist, 1998). The results have generally found support for the AP Program in that students who perform well on an AP Exam (i.e., earn a score of 3, 4, or 5) and receive course credit for the exam tend to outperform nonexempt students in subsequent courses, even after controlling for academic preparedness (e.g., standardized test scores, high school GPA).

Additional AP research has examined more general outcomes. For example, a study by Willingham and Morris (1986) found that students who took an AP Exam, regardless of performance, were more likely to earn a B average during their first year of college as compared to students who did not take any AP Exams. This was true even after controlling for academic ability. Furthermore, a study by Dougherty, Mellor, and Jian (2006) found that students who performed well (i.e., earned a score of 3 or higher) on at least one AP Exam in English, mathematics, science, or social studies were more likely to graduate from college in five years as compared to students who took no AP Exams, who received a score of 1 or 2, or who took an AP course but not the corresponding exam. Additionally, students who scored a 1 or 2 graduated at a higher rate than the "No AP" group. Again, this was true even after controlling for academic ability and other student or school characteristics.

Analyzing University of California data, Geiser and Santelices (2004) examined both the impact of the number of AP or honor courses students took in high school as well as performance on AP Exams while controlling for numerous student characteristics, such as their unweighted HSGPA, SAT scores, SAT Subject Test scores, and parental education. They found that the number of AP or honors courses taken was unrelated to college performance as measured by second-year GPA; however, exam performance remained a significant predictor. They concluded that mere participation in rigorous high school courses is not a valid indicator of a student's likelihood of college success, but performance on the AP Exam is a valid indicator of success.

Recently, Hargrove, Godin, and Dodd (2008) examined numerous college outcomes for AP and non-AP Texas high school students who went on to attend public colleges and universities in Texas. After matching these

students in terms of SAT scores and free or reduced-price lunch (FRLP) participation, they found that students who took an AP course and exam outperformed students who took only the course or who did not participate in the AP Program in terms of higher first- and fourth-year college GPAs, and had higher four-year graduation rates. Additionally, comparing students who took an AP Exam, higher AP scores were generally associated with higher college grades.

The purpose of the current study is to build on the extant body of research highlighting the efficacy of the AP Program. Specifically, this study will examine the relationship between AP Exam performance in English Language, Biology, Calculus AB, and U.S. History and subsequent college success, as indexed by first-year college grade point average, retention to the second year of college, and the selectivity level of the institution attended, after controlling for SAT performance and HSGPA. These four AP Exams were selected because they represent the highest-volume AP Exams. Furthermore and more importantly, their content covers several important subject areas emphasized in K-12 education, namely English, science, math, and social studies. Finally, by analyzing data from nearly 100,000 students across 99 institutions (refer to the appendix for the characteristics of the institutions), this study represents the largest sample in AP validity research to date, thereby increasing the generalizability of the results as well as minimizing sampling error.

Method

Sample

The data analyzed in the current study are from the SAT Validity Study database (see Kobrin, Patterson, Shaw, Mattern, & Barbuti, 2008, for more information). The original sample consisted of individual-level data on 196,364 students from 110 colleges and universities from across the United States. Course-level performance data, FYGPA, and retention data were matched back to College Board databases to include SAT scores, SAT Questionnaire responses, AP Exam scores, and institutional characteristics of the colleges and universities. Students in the sample who did not have an FYGPA, retention information, scores on the revised SAT, or a valid HSGPA from the SAT Questionnaire were excluded from the analyses. Additionally, 11 institutions were removed from the sample for the following reasons: (1) four institutions did not provide any retention data; (2) six institutions used a course grading scale that exceeded 4.00; and (3) one institution did not have complete information about its institutional selectivity as reported on the Annual Survey of Colleges; therefore, the analyses are based on 99 institutions. The exact number of students per AP Exam analysis is provided below.

For each of the four AP Exams, students were classified into three groups according to their AP performance. Specifically, students who did not take any AP Exams were classified into one group, students who took an AP Exam and received a score of 1 or 2 were classified into another group, and students who received a score of 3 or higher were classified into the last group. Therefore, students who did not take an AP Exam for English Language, Biology, Calculus AB, or U.S. History but took another AP Exam were excluded from the current study. It should be noted that students were classified into the "no AP Exam" group may have taken an AP course but did not take the end-of-course exam. Additionally, students without SAT scores were excluded from the analysis. This resulted in a final sample size of 85,971 students for AP English Language, 71,377 students for AP Biology, 83, 951 students for AP Calculus AB, and 93,775 students for AP U.S. History. Table 1 provides the distribution of these three performance groups by the four AP Exams.

Measures

AP Scores

Official AP scores for English Language, Biology, Calculus AB, and U.S. History were obtained from College Board records. AP scores are criterion referenced and range from 1 to 5. A score of 1 represents "no recommendation"; 2 represents "possibly qualified"; 3 represents "qualified"; 4 represents "well-qualified"; and 5 represents "extremely well-qualified."

Table 1

Percentages of the Three AP Performance Groups by AP Exam

AP Group	*English Language*	*Biology*	*Calculus AB*	*U.S. History*
Took no AP Exams	65.1	78.4	66.7	59.7
Took AP Exam and scored a 1 or 2	11.5	6.6	11.6	15.8
Took AP Exam and scored a 3, 4, or 5	23.4	15.0	21.7	24.5
Sample Size (N)	85,971	71,377	83,951	93,775

SAT® Scores

Official SAT scores were obtained from College Board records. The SAT has three sections: critical reading, mathematics, and writing. The score scale for each section is 200 to 800. The composite SAT score is the sum of the scores of the three sections, and ranges from 600 to 2400. The SAT composite was used as the covariate in each of the analyses to control for prior achievement.

SAT Questionnaire

Gender, race/ethnicity, best language spoken, and HSGPA were self-reported by students on the SAT Questionnaire, completed at the time of SAT registration. Race/ethnicity was collapsed into seven categories: "American Indian or Alaska Native"; "Asian, Asian American, or Pacific Islander"; "Black or African American"; "Hispanic"; "White"; "Other"; and "No Response." "Best language spoken" was classified into four categories: "English Only," "English and Another Language," "Another Language," and "No Response."

First-Year College GPA

FYGPA was supplied by participating institutions and ranged from 0.00 to 4.00.

Retention to the Second Year

Participating institutions indicated whether students who entered in the fall of 2006 returned for the second year of college in fall 2007. Students who did return for the second year received a value of 1, whereas students who did not return received a value of 0.

Institutional Selectivity

Institutional selectivity is the percentage of applicants that were admitted to the institution. The higher the percentage of students admitted by an institution, the less selective it is considered to be. These percentages were computed from institution responses to the College Board's Annual Survey of Colleges.

Analyses and Results

AP English Language

Descriptive Statistics

The demographic characteristics of the three AP English Language groups are provided in Table 2. Female students outnumbered male students within each group: 53.6 percent versus 46.4 percent for the No AP group, 62.2 percent versus 37.8 percent for the AP English Language (1, 2) group, and 58.8 percent versus 41.2 percent for the AP English Language (3, 4, 5) group. As for race/ethnicity, white students made up the majority within each group but to a much smaller degree for the AP English Language (1, 2) group (55.7 percent). Additionally, minority students, namely Hispanic and African American students, made up a significantly larger proportion of the AP English Language (1, 2) group as compared to the AP English Language (3, 4, 5) group. Students who stated that English was their best language represented the majority of each group; however, similar to the race/ethnicity results, students reporting that their

Table 2

Sample Size (%) of AP English Language Performance Groups by Demographic Characteristics

Variable		*No AP*	*AP Eng. (1, 2)*	*AP Eng. (3, 4, 5)*
Gender	Male	25,944 (46.4)	3,738 (37.8)	8,291 (41.2)
	Female	30,010 (53.6)	6,159 (62.2)	11,829 (58.8)
Race/ Ethnicity	American Indian	346 (0.6)	55 (0.6)	92 (0.5)
	Asian/Asian American	3,499 (6.3)	1,151 (11.6)	2,355 (11.7)
	Black/African American	4,754 (8.5)	936 (9.5)	611 (3.0)
	Hispanic	3,539 (6.3)	1,629 (16.5)	1,263 (6.3)
	White	40,073 (71.6)	5,510 (55.7)	14,068 (69.9)
	Other	1,571 (2.8)	281 (2.8)	606 (3.0)
	No Response	2,172 (3.9)	353 (3.4)	1,125 (5.6)
Best Language	English Only	52,407 (93.7)	8,888 (89.8)	19,133 (95.1)
	English and Another Language	2,220 (4.0)	826 (8.3)	755 (3.9)
	Another Language	671 (1.2)	88 (1.0)	39 (0.2)
	No Response	656 (1.2)	84 (0.8)	173 (0.9)

best language was not English represented a larger proportion of the AP English Language (1, 2) group as compared to the AP English Language (3, 4, 5) group.

Table 3 provides the descriptive statistics of SAT, HSGPA, FYGPA, retention rate to the second year, and institutional selectivity rate for each AP English Language group. The results indicate that the No AP group had the lowest mean SAT score (1538) and HSGPA (3.38), whereas the AP English Language (3, 4, 5) group had the highest mean SAT score (1929) and HSGPA (3.88). Furthermore, the No AP group had the lowest mean FYGPA (2.74), lowest second-year retention rate (83 percent), and attended the least selective institutions (on average, 68 percent of applicants were admitted). The AP English Language (3, 4, 5) group had the highest mean FYGPA (3.30), highest second-year retention rate (93 percent), and attended the most selective institutions among the three groups (on average, 57 percent of applicants were accepted).

Predictive Validity

The predictive validity of AP group membership for the three college outcomes was examined. For the two continuous outcomes, FYGPA and institutional selectivity of college attended, data were analyzed using ANCOVAs with the AP English Language performance group, which has three categories: No AP, AP English (1, 2) and AP English (3, 4, 5) as the independent variable (predictor), and SAT composite score and HSGPA entered as covariates to control for academic ability. Additionally, retention to the second year was predicted from the AP English Language group, controlling for SAT composite and HSGPA, with logistic regression. Contrasts were computed for all possible group comparisons.

Table 4 provides the results of the group contrasts for FYGPA, institutional selectivity, and retention to the second year without controlling for SAT composite score or HSGPA. All group differences are statistically significant. Specifically, students who took AP English Language and scored a 3, 4, or 5 performed significantly better on all three academic outcomes as compared to

Table 3

Descriptive Statistics of Study Variables by AP English Language Performance Groups

Variable	*No AP*		*AP Eng. (1, 2)*		*AP Eng. (3, 4, 5)*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SAT	1538	211	1619	182	1929	182
HSGPA	3.38	0.52	3.72	0.43	3.88	0.38
FYGPA	2.74	0.75	2.88	0.70	3.30	0.57
Retention	0.83	0.38	0.88	0.33	0.93	0.25
Institutional Selectivity	0.68	0.13	0.67	0.14	0.57	0.19

Note: Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

Table 4

Paired Contrasts for AP English Language Performance Groups

Variable	*Contrast*	*Point Estimate*	*Sig.*	*Effect Size*
FYGPA	No AP vs. AP Eng. (1, 2)	-0.139	0.000	-0.187
	AP Eng. (1, 2) vs. AP Eng. (3, 4, 5)	-0.423	0.000	-0.571
	No AP vs. AP Eng. (3, 4, 5)	-0.562	0.000	-0.758
Institutional Selectivity	No AP vs. AP Eng. (1, 2)	0.010	0.000	0.064
	AP Eng. (1, 2) vs. AP Eng. (3, 4, 5)	0.097	0.000	0.625
	No AP vs. AP Eng. (3, 4, 5)	0.107	0.000	0.690
Retention	No AP vs. AP Eng. (1, 2)	0.647	0.000	-0.241
	AP Eng. (1, 2) vs. AP Eng. (3, 4, 5)	0.530	0.000	-0.351
	No AP vs. AP Eng. (3, 4, 5)	0.343	0.000	-0.592

Note: Point estimates for retention are measured in odds ratio units, which are the ratios of the odds of lower-ranked groups to those of higher-ranked groups. Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

students who scored a 1 or 2 and to students who didn't take any AP Exams. For example, students who scored a 3, 4, or 5 had a FYGPA that was 0.562 higher, on average and attended an institution that accepted 10.7 percent less of their applicants (more selective). Finally, their odds of returning for their second year was 2.92 (1/0.343) times greater than the odds for the No AP group.* Moreover, students who took AP English Language and scored a 1 or 2 performed significantly better on all three academic outcomes as compared to students who did not take any AP Exams. In the last column of Table 4, the effect size measure, standardized difference *d* (Cohen, 1988) is provided for each contrast. As a general rule of thumb, Cohen (1988) defined the magnitude of an effect as "small, $d = 0.2$," "medium, $d = 0.5$," and "large, $d = 0.8$."

Since students are not randomly assigned to AP classes, the student's academic ability should be taken into account in order to disentangle the effects of AP performance on future academic outcomes from prior academic achievement (i.e., SAT scores, HSGPA). Table 5 provides the results of the group contrasts for FYGPA, institutional selectivity, and retention to the second year, controlling for SAT composite score and HSGPA. The differences in academic outcomes across groups are smaller when controlling for SAT scores; however, the pattern of results is the same, with a few exceptions. For example, the AP English Language (3, 4, 5) group earned higher FYGPAs than the other two groups. Specifically, the mean FYGPA of the AP English Language (1, 2) group was 0.149 lower than that of the AP English Language (3, 4, 5) group, and the mean FYGPA of the No AP group was 0.097 lower than that of the AP English Language (3, 4, 5) group. However, the FYGPA for the No AP group was higher than for AP English Language (1, 2) group, although the difference was quite small (point estimate = 0.051).

The mean institutional selectivity of the No AP group was 0.5 percent lower than that of the AP English Language (1, 2) group. For the AP English Language (1, 2) group, the mean institutional selectivity was 4.7 percent higher (accepted 4.7 percent more of applicants — less selective) than that of the AP English Language (3, 4, 5) group. Finally, the mean institutional selectivity of the No AP group was 4.2 percent higher (accepted 4.2 percent more of applicants — less selective) than that of the AP English Language (3, 4, 5) group. In general, AP English Language students who performed well on the exam (earning a score of 3, 4, or 5) attended more selective institutions as compared to students who performed poorly or who didn't take the AP English Language Exam.

The difference in second-year retention rates was significant for each pair of groups. From the odds ratio estimates (ratio of odds of the lower-ranked group to that of the higher-ranked group), students in the No AP group had the lowest probability of returning to the school for a second year, whereas students in the AP English Language (3, 4, 5) group had the highest chance of returning. As compared to the No AP group, the odds of returning for a second year for students who scored a 3, 4, or 5 was 1.54 (1/0.650) times greater. Furthermore, the odds of returning for a second year for students who scored a 1 or 2 was 1.19 (1/0.843) times greater than the odds for the No AP group. Refer to Table 5 for the effect size of each comparison for an indication of the magnitude of the differences between groups.

Table 5

Paired Contrasts for AP English Language Performance Groups with SAT and HSGPA as Covariates

Variable	*Contrast*	*Point Estimate*	*Sig.*	*Effect Size*
FYGPA	No AP vs. AP Eng. (1, 2)	0.051	0.000	0.069
	AP Eng. (1, 2) vs. AP Eng. (3, 4, 5)	-0.149	0.000	-0.201
	No AP vs. AP Eng. (3, 4, 5)	-0.097	0.000	-0.131
Institutional Selectivity	No AP vs. AP Eng. (1, 2)	-0.005	0.003	-0.032
	AP Eng. (1, 2) vs. AP Eng. (3, 4, 5)	0.047	0.000	0.303
	No AP vs. AP Eng. (3, 4, 5)	0.042	0.000	0.271
Retention	No AP vs. AP Eng. (1, 2)	0.843	0.000	-0.094
	AP Eng. (1, 2) vs. AP Eng. (3, 4, 5)	0.771	0.000	-0.144
	No AP vs. AP Eng. (3, 4, 5)	0.650	0.000	-0.238

Note: Point estimates for retention are measured in odds-ratio units, which are the ratios of the odds of lower-ranked groups to those of higher-ranked groups. Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

* The formula for odds ratio is p(1-q)/q(1-p). For ease of interpretation, the point estimate for the retention analyses can be considered in the following way: If the two groups in the contrast had the same odds of returning for the second year, then the point estimate would have a value of 1. The farther the value is from one, the larger the discrepancy in the two groups' odds. Values of less than one indicate that the lower-performing AP group was less likely to return for their second year. A value of 1 indicates no association, whereas values larger than 3 or less than 0.33 are considered strong associations (Haddock, Rindskopf, & Shadish, 1998).

AP Biology

Descriptive Statistics

Table 6 provides the distribution of students based on gender, ethnicity, and best language for the AP Biology performance groups. Similar to the AP English Language results, females outnumbered males in all groups. Furthermore, a larger percentage of Asian American students and students who stated that their best language was English and Another Language made up the AP Biology (1, 2) group and AP Biology (3, 4, 5) group, as compared to the No AP group. Finally, African American and Hispanic students made up a smaller percentage of students in the AP Biology (3, 4, 5) group as compared to the other two groups.

Mean performance on the academic indicators by AP Biology performance groups was computed and presented in Table 7. Similar to AP English Language, students who took no AP Exams performed the lowest on the SAT (1538) and HSGPA (3.38), had the lowest FYGPA (2.74), had the lowest retention rate (0.83), and attended the least selective institutions (admitting 68 percent) as compared to the other two groups. Students who scored a 3, 4, or 5 on the AP Biology Exam had the highest mean performance on all four academic indicators. For example, the AP Biology (3, 4, 5) group had a mean SAT score of 1936, which is 400 points higher than the No AP group.

Predictive Validity

As with the AP English Language analyses, ANCOVAs and logistic regression models were run to examine the predictive validity of AP Biology group membership on FYGPA, retention, and institutional selectivity. SAT performance and HSGPA were used as controls for students' academic achievement in order to examine

Table 6

Sample Size (%) of AP Biology Performance Groups by Demographic Characteristics

Variable		*No AP*	*AP Bio (1, 2)*	*AP Bio (3, 4, 5)*
Gender	Male	25,944 (46.4)	1,643 (35.0)	4,808 (44.8)
	Female	30,010 (53.6)	3,055 (65.0)	5,917 (55.2)
Race/ Ethnicity	American Indian	346 (0.6)	22 (0.5)	32 (0.3)
	Asian/Asian American	3,499 (6.3)	759 (16.2)	2,021 (18.8)
	Black/African American	4,754 (8.5)	426 (9.1)	293 (2.7)
	Hispanic	3,539 (6.3)	490 (10.4)	419 (3.9)
	White	40,073 (71.6)	2,669 (56.8)	6,999 (65.3)
	Other	1,571 (2.8)	149 (3.2)	372 (3.5)
	No Response	2,172 (3.9)	183 (3.9)	589 (5.5)
Best Language	English Only	52,407 (93.7)	4,182 (89.0)	9,888 (92.2)
	English & Another Language	2,220 (4.0)	393 (8.4)	646 (6.0)
	Another Language	671 (1.2)	71 (1.5)	89 (0.8)
	No Response	656 (1.2)	52 (1.1)	102 (1.0)

Note: Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

Table 7

Descriptive Statistics of Study Variables by AP Biology Performance Groups

Variable	*No AP*		*AP Bio (1, 2)*		*AP Bio (3, 4, 5)*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SAT	1538	211	1668	196	1936	193
HSGPA	3.38	0.52	3.71	0.42	3.89	0.36
FYGPA	2.74	0.74	2.95	0.63	3.33	0.54
Retention	0.83	0.38	0.90	0.30	0.95	0.22
Institutional Selectivity	0.68	0.13	0.63	0.15	0.54	0.19

Note: Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

the effect of AP performance irrespective of academic ability. Contrasts were computed for all possible group comparisons. Table 8 provides the results of group comparisons without controlling for academic ability. Congruent with the AP English Language analyses, all contrasts were significant ($p < 0.001$). Additionally, an effect size was computed for each comparison and is displayed in the last column of Table 8.

Similarly, even after controlling for SAT and HSGPA, all group comparisons remained significant except for the difference in FYGPA between the No AP group and AP Biology (1, 2), though the differences were smaller. For example, the mean FYGPA for AP Biology (3, 4, 5) was 0.593 higher than the No AP group. When controlling for SAT and HSGPA, the difference was reduced to 0.140. A similar pattern emerges for retention and institutional selectivity. Unlike the AP English Language results, the mean institutional selectivity of the No AP group was significantly (admitted 2.8 percent more of their applicants) higher (less selective) than that of the AP English Language (1, 2) group. Finally, the odds of students in the AP Biology (3, 4, 5) group returning for their second year was 2.14 (1/0.467) times greater than that of students in the No AP group. Additionally, the odds of students in the AP Biology (1, 2) group returning for their second year was 1.44 (1/0.695) times greater than the No AP group. In sum, students who took AP Biology but performed poorly (1, 2) did not earn significantly higher FYGPAs, but did attend more selective institutions and were more likely to return for their second year as compared to students who took no AP Exams; however, the magnitude of the effects are small. Refer to Table 9 for group comparison results after controlling for SAT performance and HSGPA.

Table 8

Paired Contrasts for AP Biology Performance Groups

Variable	*Contrast*	*Point Estimate*	*Sig.*	*Effect Size*
FYGPA	No AP vs. AP Bio (1, 2)	-0.212	0.000	-0.286
	AP Bio (1, 2) vs. AP Bio (3, 4, 5)	-0.381	0.000	-0.514
	No AP vs. AP Bio (3, 4, 5)	-0.593	0.000	-0.800
Institutional Selectivity	No AP vs. AP Bio (1, 2)	0.048	0.000	0.313
	AP Bio (1, 2) vs. AP Bio (3, 4, 5)	0.090	0.000	0.587
	No AP vs. AP Bio (3, 4, 5)	0.139	0.000	0.906
Retention	No AP vs. AP Bio (1, 2)	0.524	0.000	-0.357
	AP Bio (1, 2) vs. AP Bio (3, 4, 5)	0.488	0.000	-0.396
	No AP vs. AP Bio (3, 4, 5)	0.256	0.000	-0.753

Note: Point estimates for retentions are in odds ratio units, which are the ratios of the odds of the lower-ranked group to those of the higher-ranked group. Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

Table 9

Paired Contrasts for AP Biology Performance Groups with SAT and HSGPA as Covariates

Variable	*Contrast*	*Point Estimate*	*Sig.*	*Effect Size*
FYGPA	No AP vs. AP Bio (1, 2)	0.002	0.854	0.003
	AP Bio (1, 2) vs. AP Bio (3, 4, 5)	-0.142	0.000	-0.191
	No AP vs. AP Bio (3, 4, 5)	-0.140	0.000	-0.189
Institutional Selectivity	No AP vs. AP Bio (1, 2)	0.028	0.000	0.183
	AP Bio (1, 2) vs. AP Bio (3, 4, 5)	0.051	0.000	0.333
	No AP vs. AP Bio (3, 4, 5)	0.079	0.000	0.515
Retention	No AP vs. AP Bio (1, 2)	0.695	0.000	-0.201
	AP Bio (1, 2) vs. AP Bio (3, 4, 5)	0.672	0.000	-0.219
	No AP vs. AP Bio (3, 4, 5)	0.467	0.000	-0.420

Note: Point estimates for retention are measured in odds ratio units. They are the ratios of the odds of lower-ranked groups to those of higher-ranked groups. Institution selectivity is the ratio of the number admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

AP Calculus

Descriptive Statistics

Similar to the other two exams, the demographic characteristics of the three AP performance groups were computed for AP Calculus AB. The results are presented in Table 10. Unlike AP English Language and AP Biology, males outnumbered females in the AP Calculus AB (3, 4, 5) group. Females remained the majority in the other two groups. Asian American students made up a larger proportion of the AP Calculus (1, 2) group (12.9 percent) and AP Calculus (3, 4, 5) group (14.9 percent) as compared to the No AP group (6.3 percent), whereas African American and Hispanic students made up a smaller proportion of the AP Calculus (3, 4, 5) group as compared to the other two AP groups.

In Table 11, the mean performance by academic indicator is provided for the three AP Calculus performance groups. Similar to the previous analyses, students who took no AP Exams scored the lowest on the SAT (1538) and had the lowest HSGPA (3.38), had the lowest FYGPA average (2.74) and second-year retention rates (0.83), and attended the least selective institutions (institutions admitting 68 percent of applicants, on average). Students who scored a 3, 4, or 5 on the AP Calculus Exam had the highest SAT scores (1914), HSGPA (3.90), FYGPA (3.33), and second-year retention rates (0.95), and attended the most selective institutions (institutions admitting 56 percent of applicants, on average).

Predictive Validity

In order to test whether there were significant differences in college academic outcomes by group memberships, ANCOVAs and logistic regression models were run with and without controlling for SAT performance and HSGPA.

Table 10

Sample Size (%) of the AP Calculus Performance Groups by Demographic Characteristics

Variable		*No AP*	*AP Calculus (1, 2)*	*AP Calculus (3, 4, 5)*
Gender	Male	25,944 (46.4)	4,634 (47.4)	9,885 (54.2)
	Female	30,010 (53.6)	5,140 (52.6)	8,338 (45.8)
Race/ Ethnicity	American Indian	346 (0.6)	40 (0.4)	60 (0.3)
	Asian/Asian American	3,499 (6.3)	1,260 (12.9)	2,714 (14.9)
	Black/African American	4,754 (8.5)	675 (6.9)	488 (2.7)
	Hispanic	3,539 (6.3)	1,059 (10.8)	858 (4.7)
	White	40,073 (71.6)	6,093 (62.3)	12,744 (69.9)
	Other	1,571 (2.8)	273 (2.8)	490 (2.7)
	No Response	2,172 (3.9)	374 (3.8)	869 (4.8)
Best Language	English Only	52,407 (93.7)	8,874 (90.8)	16, 929 (92.9)
	English & Another Language	2,220 (4.0)	655 (6.7)	889 (4.9)
	Another Language	671 (1.2)	139 (1.4)	247 (1.4)
	No Response	656 (1.2)	106 (1.1)	158 (0.9)

Table 11

Descriptive Statistics of Study Variables by AP Calculus Performance Groups

Variable	*No AP*		*AP Calculus (1, 2)*		*AP Calculus (3, 4, 5)*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SAT	1538	211	1718	200	1914	191
HSGPA	3.38	0.52	3.81	0.39	3.90	0.36
FYGPA	2.74	0.74	2.97	0.66	3.33	0.54
Retention	0.83	0.38	0.91	0.29	0.95	0.22
Institutional Selectivity	0.68	0.13	0.64	0.16	0.57	0.19

Note: Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

Paired contrasts were run for all possible comparisons, and effect sizes were computed. Table 12 provides the results of the contrasts with no covariates. All comparisons are significant. Similar to the previous exams, students who performed better on AP Calculus (i.e., scored a 3, 4, or 5) had significantly higher FYGPAs and retention rates, and attended more selective institutions than students who scored a 1 or 2 and students who did not take any AP Exams. Additionally, students who scored a 1 or 2 on the AP Calculus Exam had significantly higher FYGPAs and retention rates, and attended more selective institutions than students who did not take any AP Exams.

To test whether an AP effect remained after controlling for academic achievement, the same analyses were run with SAT and HSGPA entered as covariates. The results of these analyses are presented in Table 13. After controlling for SAT performance and HSGPA, all paired comparisons were significant; however, the difference between FYGPA between No AP and AP Calculus (1, 2) groups was in the opposite direction with the No AP group having a slightly higher mean FYGPA (0.053 higher). On the other hand, the AP Calculus (3, 4, 5) group had a FYGPA that was 0.143 higher than the No AP group. The AP Calculus (3, 4, 5) group also attended institutions that accepted 4.6 percent fewer applicants than the No AP group. Finally, the odds of students in the AP Calculus (3, 4, 5) group returning for the second year of college was 2.07 (1/0.482) times greater than the odds of students in the No AP group. The AP Calculus (1, 2) group was also more likely

Table 12

Paired Contrasts for AP Calculus Performance Groups

Variable	*Contrast*	*Point Estimate*	*Sig.*	*Effect Size*
FYGPA	No AP vs. AP Calculus (1, 2)	-0.237	0.000	-0.322
	AP Calculus (1, 2) vs. AP Calculus (3, 4, 5)	-0.357	0.000	-0.485
	No AP vs. AP Calculus (3, 4, 5)	-0.594	0.000	-0.807
Institutional Selectivity	No AP vs. AP Calculus (1, 2)	0.039	0.000	0.249
	AP Calculus (1, 2) vs. AP Calculus (3, 4, 5)	0.072	0.000	0.459
	No AP vs. AP Calculus (3, 4, 5)	0.111	0.000	0.708
Retention	No AP vs. AP Calculus (1, 2)	0.467	0.000	-0.421
	AP Calculus (1, 2) vs. AP Calculus (3, 4, 5)	0.566	0.000	-0.315
	No AP vs. AP Calculus (3, 4, 5)	0.264	0.000	-0.736

Note: Point estimates for retention are measured in odds ratio units. They are the ratios of the odds of lower-ranked groups to those of higher-ranked groups. Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

Table 13

Paired Contrasts for AP Calculus Performance Groups with SAT and HSGPA as Covariates

Variable	*Contrast*	*Point Estimate*	*Sig.*	*Effect Size*
FYGPA	No AP vs. AP Calculus (1, 2)	0.053	0.000	0.072
	AP Calculus (1, 2) vs. AP Calculus (3, 4, 5)	-0.196	0.000	-0.266
	No AP vs. AP Calculus (3, 4, 5)	-0.143	0.000	-0.194
Institutional Selectivity	No AP vs. AP Calculus (1, 2)	0.008	0.000	0.051
	AP Calculus (1, 2) vs. AP Calculus (3, 4, 5)	0.039	0.000	0.249
	No AP vs. AP Calculus (3, 4, 5)	0.046	0.000	0.294
Retention	No AP vs. AP Calculus (1, 2)	0.686	0.000	-0.208
	AP Calculus (1, 2) vs. AP Calculus (3, 4, 5)	0.704	0.000	-0.194
	No AP vs. AP Calculus (3, 4, 5)	0.482	0.000	-0.403

Note: Point estimates for retention are measured in odds ratio units. They are the ratios of the odds of lower-ranked groups to those of higher-ranked groups. Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

to return for their second year of college (1.46 times greater) as compared to the No AP group.

AP U.S. History

Descriptive Statistics

The demographic characteristics of the AP U.S. History performance groups are provided in Table 14. Similar to the AP English Language and Biology results, females outnumbered males in all three groups; however, the distribution for the AP U.S. History (3, 4, 5) group approached an even split for gender. A similar pattern to the other tests emerged for race/ethnicity. Namely, the AP U.S. History (1, 2) group and the AP U.S. History (3, 4, 5) group were made up of a larger percentage of Asian American students as compared to the No AP group. A smaller percentage of Hispanic and African American students made up the AP U.S. History (3, 4, 5) group as compared to the other two groups. That is, underrepresented minorities who took the AP Exam tended to earn a score of 1 or 2.

Mean academic performance differences existed among the three AP U.S. History groups. Students who received a 3, 4, or 5 on the exam had the highest SAT scores (1940), HSGPAs (3.88), FYGPAs (3.34), and second-year retention rates (0.94), and attended the most selective institutions (institutions admitting 54 percent of applicants, on average). Students in the No AP group had the lowest SAT scores (1538), HSGPA (3.38),

Table 14

Sample Size (%) of AP U.S. History Performance Groups by Demographic Characteristics

Variable		*No AP*	*AP U.S. History (1, 2)*	*AP U.S. History (3, 4, 5)*
Gender	Male	25,944 (46.4)	6,219 (42.0)	11,344 (49.3)
	Female	30,010 (53.6)	8,598 (58.0)	11,660 (50.7)
Race/ Ethnicity	American Indian/Alaska Native	346 (0.6)	86 (0.6)	76 (0.3)
	Asian/Asian American	3,499 (6.3)	1,577 (10.6)	2,827 (12.3)
	Black/African American	4,754 (8.5)	1,150 (7.8)	678 (2.9)
	Hispanic	3,539 (6.3)	1,769 (11.9)	1,111 (4.8)
	White	40,073 (71.6)	9,244 (62.4)	16,254 (70.7)
	Other	1,571 (2.8)	437 (2.9)	690 (3.0)
	No Response	2,172 (3.9)	554 (3.7)	1,368 (5.9)
Best Language	English Only	52,407 (93.7)	13,518 (91.2)	21,675 (94.2)
	English & Another Language	2,220 (4.0)	1,047 (7.1)	1,016 (4.4)
	Another Language	671 (1.2)	112 (0.8)	90 (0.4)
	No Response	656 (1.2)	140 (0.9)	223 (1.0)

Table 15

Descriptive Statistics of Study Variables by AP U.S. History Performance Groups

Variable	*No AP*		*AP U.S. History (1, 2)*		*AP U.S. History (3, 4, 5)*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
SAT	1538	211	1687	198	1940	188
HSGPA	3.38	0.52	3.71	0.43	3.88	0.37
FYGPA	2.74	0.74	2.94	0.67	3.34	0.53
Retention	0.83	0.38	0.89	0.31	0.94	0.23
Institutional Selectivity	0.68	0.13	0.64	0.14	0.54	0.19

Note: Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

FYGPAs (2.74), and second-year retention rates (0.83), and attended the least selective institutions (institutions admitting 68 percent of applicants on average). Refer to Table 15 for more details.

Predictive Validity

In order to test whether there were significant differences in college academic outcomes by group membership, ANCOVAs and logistic regression models were run with and without controlling for SAT performance and HSGPA. Table 16 provides the results of the group membership paired contrasts, without controlling for academic ability. All paired comparisons were significant (refer to the last column for an effect size). Specifically, the AP U.S. History (3, 4, 5) group outperformed the AP U.S. History (1, 2) group and the No AP group on all three academic indicators. For example, students who received a 3, 4, or 5 had FYGPAs that were 0.607 points higher than students in the No AP group. Additionally, the AP U.S. History (1, 2) group outperformed the No AP group on all three academic indicators. Continuing the example above, students who received a 1 or 2 had FYGPAs that were 0.207 points higher than students in the No AP group.

Finally, to examine the effect of AP participation and performance beyond that of academic achievement, the same analyses were conducted controlling for SAT scores and HSGPA. The results are presented in Table 17. All paired comparisons remained significant; however, similar to results for English Language and Calculus AB, the difference in FYGPA for the No AP group and AP U.S. History (1, 2) group reversed, with the No AP group having a higher mean FYGPA, although the effect size is considered quite small (0.019). On the other hand, the AP U.S. History (3, 4, 5) group performed significantly better in college in terms of FYGPA and retention rates, and attended more selective institutions as compared to the AP U.S. History (1, 2) group and the No AP group. Similarly, the AP U.S. History (1, 2) group performed significantly better in college in terms of retention rates

Table 16

Paired Contrasts for AP U.S. History Performance Groups

Variable	*Contrast*	*Point Estimate*	*Sig.*	*Effect Size*
FYGPA	No AP vs. AP U.S. History (1, 2)	-0.207	0.000	-0.283
	AP U.S. History (1, 2) vs. AP U.S. History (3, 4, 5)	-0.400	0.000	-0.547
	No AP vs. AP U.S. History (3, 4, 5)	-0.607	0.000	-0.831
Institutional Selectivity	No AP vs. AP U.S. History (1, 2)	0.037	0.000	0.231
	AP U.S. History (1, 2) vs. AP U.S. History (3, 4, 5)	0.099	0.000	0.617
	No AP vs. AP U.S. History (3, 4, 5)	0.136	0.000	0.848
Retention	No AP vs. AP U.S. History (1, 2)	0.558	0.000	-0.323
	AP U.S. History (1, 2) vs. AP U.S. History (3, 4, 5)	0.516	0.000	-0.365
	No AP vs. AP U.S. History (3, 4, 5)	0.288	0.000	-0.688

Note: Point estimates for retention are measured in odds ratio units. They are the ratios of the odds of lower-ranked groups to those of the higher-ranked groups. Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

Table 17

Paired Contrasts for AP U.S. History Performance Groups with SAT and HSGPA as Covariates

Variable	*Contrast*	*Point Estimate*	*Sig.*	*Effect Size*
FYGPA	No AP vs. AP U.S. History (1, 2)	0.019	0.002	0.026
	AP U.S. History (1, 2) vs. AP U.S. History (3, 4, 5)	-0.173	0.000	-0.237
	No AP vs. AP U.S. History (3, 4, 5)	-0.154	0.000	-0.211
Institutional Selectivity	No AP vs. AP U.S. History (1, 2)	0.010	0.000	0.062
	AP U.S. History (1, 2) vs. AP U.S. History (3, 4, 5)	0.057	0.000	0.355
	No AP vs. AP U.S. History (3, 4, 5)	0.068	0.000	0.424
Retention	No AP vs. AP U.S. History (1, 2)	0.757	0.000	-0.154
	AP U.S. History (1, 2) vs. AP U.S. History (3, 4, 5)	0.701	0.000	-0.196
	No AP vs. AP U.S. History (3, 4, 5)	0.531	0.000	-0.350

Note: Point estimates for retention are measured in odds ratio units. They are the ratios of the odds of lower-ranked groups to those of the higher-ranked groups. Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

and attended more selective institutions as compared to the No AP group.

Discussion

This study demonstrated that higher AP performance on the English Language, Biology, Calculus AB, and U.S. History Exams corresponded to higher FYGPAs, higher second-year retention rates, and attendance at more selective institutions. After controlling for SAT composite score and HSGPA, similar patterns of results remained. One exception was that the AP (1, 2) group did not earn significantly higher FYGPAs than the No AP group across all four exams. The finding that the AP (1, 2) group earned lower first-year college GPAs than the No AP group actually replicates the direction of the means found in previous research (e.g., Keng & Dodd, 2008); although results from this study found significant differences between the two groups, the effect size was quite small. Reasons for why this may be occurring are offered below. While association is not equivalent to causation, the results of this study do provide support for the role of participation in the AP Exam in subsequent college performance and success.

Though it can be argued that students with stronger academic backgrounds are more likely to participate in the AP Program, earn higher AP scores and FYGPAs, have higher second-year retention rates, and attend more selective institutions (as the results of this research suggest), the current study showed that even when prior academic performance was controlled for (i.e., SAT scores and HSGPA), significant group differences still existed for the AP performance group comparisons across four of the highest-volume AP Exams (see Table 18, which summarizes the group comparisons across all four AP Exams). That is, after controlling for the effects of prior academic performance, students earning a 3, 4, or 5 on one of the AP Exams tended to outperform students who received lower AP scores, as well as students who did not take any AP Exams, with regard to FYGPA, retention, and institution selectivity. Moreover, students who took an AP Exam but earned a low score (1 or 2) attended more selective institutions and were more likely to return for their second year of college than the No AP group.

One interesting finding from the current study was that after controlling for both SAT performance and HSGPA, AP (1, 2) students did not earn higher FYGPAs than students who did not take any AP Exams. There are at least two explanations for this finding. Similar to the conclusion of Geiser and Santelices (2004), perhaps it's not merely participation in the AP Program but rather high performance that results in better college outcomes; however, the results here did find significant differences for the other two outcomes (retention and institutional selectivity). On the other hand, perhaps students in the No AP group enrolled in less rigorous courses in college. Given that the best predictor of future behavior is past behavior (Fishbein & Ajzen, 1975), it seems likely that students who did not take rigorous courses in high school may also not be likely to take rigorous courses in college. If that is the case, controlling for course difficulty may lead to different conclusions than those of the current study, in that the No AP group's mean FYGPA may be artificially inflated by their less difficult course load.

If an institution is merely interested in admitting students who will earn higher grades, then knowing

Table 18

Summary of All Paired Contrasts for the AP Performance Groups Across Four High-Volume AP Exams with SAT and HSGPA Included as Covariates

Variable	*Contrast*	*AP English Language*	*AP Biology*	*AP Calculus*	*AP U.S. History*
FYGPA	No AP vs. AP (1, 2)	0.051	*0.002*	0.053	0.019
	AP (1, 2) vs. AP (3, 4, 5)	-0.149	-0.142	-0.196	-0.173
	No AP vs. AP (3, 4, 5)	-0.097	-0.140	-0.143	-0.154
Institutional Selectivity	No AP vs. AP (1, 2)	-0.005	0.028	0.008	0.010
	AP (1, 2) vs. AP (3, 4, 5)	0.047	0.051	0.039	0.057
	No AP vs. AP (3, 4, 5)	0.042	0.079	0.046	0.068
Retention	No AP vs. AP (1, 2)	0.843	0.695	0.686	0.757
	AP (1, 2) vs. AP (3, 4, 5)	0.771	0.672	0.704	0.701
	No AP vs. AP (3, 4, 5)	0.650	0.467	0.482	0.531

Note: An italicized value indicates a nonsignificant difference. Point estimates for retention are measured in odds ratio units, which are the ratios of the odds of lower-ranked groups to those of higher-ranked groups. Institution selectivity is the ratio of the number of admitted students divided by the number of applicants. Larger numbers indicate less selective institutions.

whether a student took no AP Exams at all versus whether a student took an AP Exam and scored a 1 or 2, may not provide useful information. However, if AP students do take more rigorous courses in college and if that is something an institution values, then the distinction may prove useful. Future research examining AP performance and college outcomes should consider controlling for course difficulty to determine if it has an impact on the results.

In sum, these results suggest that participation in an AP Exam may better prepare students for the more rigorous academic demands of college-level work. Nevertheless, it is possible that other factors beyond prior academic performance contribute to the group differences. Future research should identify other useful variables to control for when examining the impact of AP performance on academic outcomes. Additionally, this study only examined the effects of four AP Exams. It would be useful to determine whether the same pattern of results hold for other AP Exams, specifically for exams that have less content alignment with general education such as AP Studio Art or AP Latin: Vergil.

A limitation of the current study was that we were only able to examine students by AP Exam performance. Therefore, students classified into the No AP group may have taken an AP course but did not take the end-of-course exam, making it possible that some students in the No AP group were exposed to the more rigorous course material and workload of an AP class that may have more effectively prepared them for college-level work. In 2007, the SAT Questionnaire was revised to ask students to specifically indicate whether they had taken any AP courses — irrespective of whether they had taken an AP Exam. With this additional information, future research should examine whether students who take an AP course but no exam perform significantly better in college than students who have taken no AP courses.

Future Research

Based on the caveats described above, there are several avenues for future research.

First, the analyses should be replicated with other AP Exams to test whether this pattern of group differences generalizes to other, lower-volume AP Exams. Furthermore, additional outcomes should be examined such as college-going rates, cumulative GPA, and graduation. For example, it would be useful to understand whether there are differences in the percentage of students attending college among the three AP performance groups, as well as by AP Exam area. Cumulative GPA should also be assessed as an outcome to determine whether the initial benefit of AP participation and performance carries through to more distal college outcomes. Similarly, graduation is the ultimate goal of college and should be regarded as one of the more important measures of college success. Therefore, future research should also examine the relationship between AP participation and performance and graduation. Previous research has already found promising results in this domain (Dougherty et al., 2006).

Finally, other individual characteristics, such as the quality of the students' high schools, for example, should be examined when analyzing the relationship between AP performance and subsequent college success. Data should also be analyzed by institutional characteristics, such as institutional selectivity and control (i.e., public, private). That is, does the "AP effect" remain once other variables are also considered? Additionally, as mentioned above, future research should take into consideration course difficulty when examining college grades across AP groups.

Conclusion

In sum, the national SAT Validity Study database provided a significant opportunity to examine the effect of AP performance on college outcomes, with the largest AP sample to date. This sample includes students from thousands of high schools, attending nearly 100 different institutions of higher education. This greatly increases the generalizability of the findings of this research. The results of the current study support the efficacy of the AP Program and underscore the utility of participation in the AP Program as a way for students to better prepare themselves for higher education.

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Appendix

Table A1

Percentage of Institutions in Sample by Key Variables (N = 99)

Variable		***Percentage***
Region of U.S.	Midwest	16%
	Mid-Atlantic	24%
	New England	20%
	South	11%
	Southwest	10%
	West	18%
Selectivity	Admits under 50%	20%
	Admits 50 to 75%	56%
	Admits over 75%	24%
Size	Small	19%
	Medium to Large	39%
	Large	23%
	Very large	18%
Control	Public	41%
	Private	59%

Note: Percentages may not sum to 100 due to rounding. With regard to institution size, "small" = 750 to 1,999 undergraduates; "medium to large" = 2,000 to 7,499 undergraduates; "large" = 7,500 to 14,999 undergraduates; and "very large" = 15,000 or more undergraduates.

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