CollegeBoard

Are AP® Students More Likely to Graduate from College on Time?

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VALIDITY

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Executive Summary

The current study examined the role of AP® Exam participation and performance on four-year college graduation in four years. Because students who take AP Exams can earn college credit while still in high school, it was expected that AP students would have higher four-year graduation rates. Moreover, it was expected that AP students who earned higher exam scores would also have a higher likelihood of graduating within four years compared to AP students who do not perform well on the exam because academic performance across a variety of measures has been positively linked to graduation. Two national samples were used to test these research questions, and the results confirmed a positive relationship between both AP Exam participation and performance with graduation within four years. This relationship was evident even after controlling for relevant institutional- and/or student-level factors. The academic and financial benefits of the AP Program are discussed.

Introduction

Different types of educational programs and models serve to facilitate and ease the academic transition from high school to college. One such model exposes students to rigorous, college-level course material while in high school, affording them the opportunity to gain both high school and college credit. Perhaps the most well-known example of this model is the Advanced Placement Program®; however, other similar programs exist, including the International Baccalaureate and dual enrollment programs. Since 1955, the AP Program has provided high school students the opportunity to explore college-level course work. At the end of the school year, each course has an associated exam to test the student's knowledge of the subject matter. This exam is criterion referenced and scored on a scale of 1 to 5. Many higher education institutions in the United States grant college credit or course exemption based upon successful AP Exam performance. Many institutions define successful performance as a score of 3 or above, as recommended by the American Council on Education. However, each institution has the discretion to determine its own placement- and credit-granting policies to fit its specific needs. Policies for specific colleges are available at https://apscore.collegeboard.org/creditandplacement/search-credit-policies.

Currently, more than 30 AP courses are offered, covering diverse disciplines, from history to the sciences to foreign languages. The value of the AP Program has been described by Jim Miller, a previous president of the National Association of College Admission Counseling, in the following way, "More schools are beginning to understand a minimum curriculum does not prepare students for success in college," and that AP "… gives students extra credit and shortens time they need to be in college, but its greatest value is the rigor, which helps students be more successful in college" (Adams, 2012, p. 31).

Research has examined whether Exam participation and performance in the AP Program is positively related to a multitude of measures of college success. Specifically, research has examined the relationship between AP and college outcomes such as college enrollment (Chajewski, Mattern, & Shaw, 2011), grades earned in subsequent college courses (Dodd, Fitzpatrick, De Ayala, & Jennings, 2002; Morgan & Crone, 1993; Morgan & Ramist, 1998), first-year grade point average (FYGPA) (Geiser & Santelices, 2004; Hargrove, Godin, & Dodd, 2008; Mattern, Shaw, & Xiong, 2009; Shaw, Marini, & Mattern, 2013; Willingham & Morris, 1986), retention (Mattern et al., 2009), cumulative GPA (Hargrove et al., 2008; Morgan & Ramist, 1998; Morgan & Maneckshana, 2000; Willingham & Morris, 1986), choice of college major (Mattern, Shaw, & Ewing, 2011; Morgan & Klaric, 2007; Morgan & Maneckshana, 2000; Tai, Liu, Almarode, & Fan, 2010), and graduation (Dougherty, Mellor, Jian, 2006; Hargrove et al., 2008).

The results of these studies generally find positive support for the AP Program, even after controlling for previous academic performance and demographic variables. In addition to the varied outcome measures of college success examined, the way that researchers operationally define an AP student or classify students into groups has varied across studies. Historically, researchers have focused on one or more of the following groups compared with students who did not take an AP course and/or exam: (1) students who took an AP Exam and performed well on it (3 or above), (2) students who took an AP Exam and received any score, and (3) students who took an AP course but not the exam. More recently, however, there has been a trend to examine college outcomes by each AP score scale point (1–5) (e.g., Shaw et al., 2013) and even to focus on students who perform poorly on the exam to determine if there are educational benefits at this lower level of performance (Wyatt, Mattern, & Proestler, in press).

AP and the Higher Education Pipeline

Research on the college benefits of AP has not only found that AP students and, particularly, successful AP students are more likely to perform well in college than their non-AP peers; it has also shown that AP students are more likely to simply enroll in a four-year college and university (Chajewski et al., 2011). Based on a national sample of more than 1.5 million students, the odds of enrolling in a four-year institution increased by 171% for students who took one AP Exam compared with students who took no AP Exams. The increase in odds was even higher for students who took more than one AP Exam.

Once in college, research has found that AP students outperform their non-AP peers. Dodd et al. (2002) found that those students who scored well on an AP Exam and earned credit go on to earn equal or higher grades in the subsequent course compared with students who did not earn credit and non-AP students. More recently, Patterson and Ewing (2013) found that after matching AP and non-AP students on important covariates including demographic and academic characteristics, the AP students performed as well as or better than the non-AP students in terms of subsequent college course grades.

In addition to performance in a related or subsequent course, research has also shown that, in general, AP students perform better in the first year of college. A number of studies have confirmed a positive relationship between AP Exam score and FYGPA (Geiser & Santelices, 2004; Hargrove et al., 2008; Mattern et al., 2009; Shaw et al., 2013; Willingham & Morris, 1986). Shaw et al. (2013) found that even after controlling for students' prior academic credentials (SAT® scores and high school grade point average [HSGPA]), a positive relationship between AP performance and FYGPA remained. Among average and below-average students (HSGPA ≤ 3.76; SAT CR+M_W total score ≤ 1800), those with an average AP score of 1 were expected to earn an FYGPA of approximately 2.80 compared with 3.45 for those with an average AP score of 5.

Research has also shown that students who perform well in AP are more likely to return for their second year of college, even after controlling for prior academic performance (Mattern et al., 2009). With information about more than 70,000 students, Mattern et al. (2009) looked at second-year retention rates by AP Exam performance for the four highest volume AP Exams: AP Biology, AP Calculus AB, AP English Language and Composition, and AP U.S. History. AP students, regardless of their score, were more likely to return for their second year than students who did not take the AP Exam, even after controlling for SAT scores and HSGPA. For example, for the AP English Language results, students who earned a score of 3 or higher had 54% higher odds of returning for their second year than students who did not take an AP Exam. Similar results were found for the other exams. What is unclear from the previous research is whether AP performance has a direct effect on retention or an indirect effect through its relationship with FYGPA, which tends to be one of the strongest predictors of retention (Allen, 1999).

The results above indicate that AP students tend to have early academic success in college, but the current study is interested in whether AP students are likely to continue to perform well, persist through college, and ultimately graduate in a timely manner. A handful of studies have examined the relationship between AP performance and more distal outcomes, such as college major, cumulative GPA, and graduation. Morgan and Maneckshana (2000) found that students who took an AP Exam were likely to complete their college degree in the same area as the exam or a closely related discipline. A study by Mattern et al. (2011) corroborated these findings, with AP students more likely to be majoring in a related field than students who did not take an AP Exam in a related content area. Moreover, the study found that students who

did not take any AP Exams were more likely to have an undeclared major by the third year of college compared with AP students, which could severely lengthen the time it takes one to graduate (Tinto, 1999). In addition to having a higher likelihood of persisting in a related major, AP students tend to earn higher grades throughout their college career (Hargrove et al., 2008; Morgan & Ramist, 1998; Morgan & Maneckshana, 2000; Willingham & Morris, 1986).

In terms of the ultimate indication of college success — graduation, Adelman (1999) found that the best predictor of bachelor's degree attainment was the rigor of the courses a student completed in high school. Given that the hallmark of AP courses is their high level of rigor, these results would suggest that students taking AP have a higher likelihood of obtaining a bachelor's degree, and research suggests that this is the case. For reference, national four-year college graduation rates within four years tend to hover around 36% to 38% (Snyder & Dillow, 2012). Morgan and Maneckshana (2000) found that four-year graduation rates tended to exceed 50% for AP Exam students for each of the exams; however, the study was purely descriptive in nature, with no control group to compare graduation rates against in order to determine whether AP students were graduating at a higher rate than their non-AP peers. Focusing on the 1998–2001 cohorts of students who graduated from high school in Texas and went on to enroll in a public higher education institution in Texas, Hargrove et al. (2008) found that students who took either AP English Language and Composition, AP English Literature and Composition, AP Calculus AB, or AP U.S. History, had significantly higher four-year graduation rates compared to their non-AP peers. The four-year graduation rates hovered around 40% for students who took both the AP course and exam compared to around 30% for non-AP students in the study. Dougherty et al. (2006) examined five-year graduation rates for AP students compared to non-AP students and found that even after controlling for similar student and school characteristics, there was a positive relationship between AP Exam performance and graduating from college in five years.

Alternatively, Duffy (2010) examined five-year graduation rates for AP versus non-AP students in terms of course participation. He found that once other high school curriculum exposure variables (e.g., honors courses and amount of time the subject matter was covered) were taken into account, there was no added benefit of taking an AP course and successfully graduating in five years. Similar to other research, it appears that student performance on the AP Exam is more highly related to future success than simply taking an AP course or exam (Bowen, Chingos, & McPherson, 2009; Geiser & Santelices, 2004; Mattern et al., 2009).

In a similar vein, Horn and Kojaku (2001) examined college persistence by examining students in their third year of college to see if they were still on track for graduation or if they had graduated already. In this study, Horn and Kojaku looked at the type of high school curriculum a student took — core curriculum or less, mid-level, or rigorous (which could include AP course work) — and the effect of the curriculum type on persistence and other college success measures. While this study showed evidence that a rigorous high school curriculum prepares students better for college than a less rigorous curriculum, it does not isolate the effect of AP. However, this study suggested using different variables to control for the various factors that can influence the relationship between high school course work and college outcomes, including high school academic curriculum; college entrance exam scores; demographic variables such as gender, race/ethnicity, parental income, and education; and college-related variables such as type of secondary institution, full- or part-time attendance, FYGPA, and work status.

Understanding factors associated with timely graduation (i.e., graduating in four years) is an important topic to study because the majority of U.S. students fail to achieve this benchmark. Fewer than 4 out of 10 students graduate from college within four years (Snyder & Dillow,

2012). Students who take longer to graduate delay their entrance into the workforce, thereby delaying their potential earnings. Moreover, the cost of college is on the rise; the past 35 years have seen a 1,200% increase in college tuition and fees (Jamrisko & Kolet, 2012). The longer a student takes to graduate, the more potential there is for the student to incur insurmountable debt. The combination of a weak economy and extended time to degree attainment exacerbates the financial burden on the average college student.

Building on the existing literature, the present study examined the role of AP Exam participation and performance in graduating in a timely manner. The study employed two datasets in order to examine the AP–graduation relationship from both a student-level and an institutional-level perspective. One sample tracked students longitudinally within their first institution and the second sample tracked students longitudinally across institutions they have attended. The two datasets allow us to examine whether AP students are more likely to graduate within four years and, more specifically, whether they are more likely than their non-AP peers to graduate within four years from the first institution in which they enroll. Where applicable, relevant student- and institutional-level variables were included as control variables. Though a handful of studies have examined the relationship between AP and college graduation, each has had a slightly different focus than the current study, limiting the generalizability of the results. For example, Dougherty et al. (2006) and Duffy (2010) examined five-year graduation rates, but we are now exceedingly interested in predicting which students will graduate on time, that is, within the traditional four years, given the economic costs associated with prolonged enrollment. Morgan and Maneckshana (2000) examined four-year graduation rates but did not include a control group or control variables in order to isolate the AP effect. Likewise, Hargrove et al. (2008) examined four-year graduation rates but their analyses were limited to a handful of AP Exams and were based on Texas students attending public colleges and universities in Texas. None of the reported studies controlled for institutional factors, although research has consistently found that even after controlling for the academic ability of the student body, differences in graduation rates remain by institutional factors such as control (public versus private) and selectivity (Bowen et al., 2009).

Method
Sample

Sample 1. Two national samples were used in this study. The first dataset was based on four years of data collected on a sample of first-time, first-year students who entered college in the fall of 2007 (for more details about the research effort and the sample, respectively, see Kobrin, Patterson, Shaw, Mattern, & Barbuti, 2008; Patterson, Mattern, & Kobrin, 2009). These data allow for the examination of persistence and graduation within an institution. This sample contained 165,558 students from 78 different colleges and universities. To be included in the analysis, students needed to have a valid score on the PSAT/NMSQT® (missing for 38,080) and valid demographic information for gender (missing for none), ethnicity (missing for 27,741), and parental education level (missing for 36,829), as well as valid institution admittance rate data (missing for 162), which were used as control variables in the study. With these stipulations, the resulting sample included 112,108 students from 77 four-year colleges and universities across the U.S.

Sample 2. The second dataset was obtained from the National Student Clearinghouse (NSC). NSC tracks student enrollment and degree attainment for more than 3,100 two- and four-year colleges and universities in the United States, equivalent to 93% of the U.S. college-going population. NSC enrollment data were matched to the College Board's 2008

cohort database of 2,664,769 students, which contains AP, SAT, and PSAT/NMSQT scores, self-reported HSGPA, and demographic information. These data allow for the examination of persistence and graduation across institutions. Because the current study focused on bachelor degree attainment, only students who first enrolled in a four-year institution post high school were included in the analyses, reducing the sample to 1,297,950 students. Additionally, students needed to have a valid score on the PSAT/NMSQT (missing for 230,599) and valid data on demographic information of gender (missing for 495), ethnicity (missing for 63,267), and parental education level (missing for 471,297) in order to control for relevant factors, resulting in a final sample size of 678,305.

Measures

AP Exam participation. AP Exam scores were obtained from official College Board records and were used to classify students as either AP Exam takers or non–AP Exam takers. Specifically, students who took one or more AP Exam were coded as 1, whereas non–AP Exam takers were coded as 0. For Sample 1 and Sample 2, 67% and 57% of students took at least one AP Exam, respectively. Note that some students could have taken an AP course but not the exam; they are classified as non-AP students in the current study.

AP performance. For the subsample of students who took at least one AP Exam, AP performance was operationalized as the student's average score across all AP Exams completed, which has been shown to be the best predictor of college success among numerous operationalizations of AP performance (Shaw et al., 2013). Specifically, for students who only took one exam, the score on that exam was their average AP score. For students who took two or more AP Exams, the average score was computed.

PSAT/NMSQT scores. Official PSAT/NMSQT scores were obtained from the College Board. Each student's most recent total score was used in the analyses. The PSAT/NMSQT comprises three sections: Critical Reading, Math, and Writing, and the score scale range for each section is 20 to 80, with the total score being the sum of the three section scores.

Gender. Self-reported gender was obtained from student responses to the PSAT/NMSQT Questionnaire.

Underrepresented minority status. Students indicated their race/ethnicity on the PSAT/NMSQT Questionnaire. The categories comprise (1) Native American or Alaska Native; (2) Asian, Asian American, or Pacific Islander; (3) Black or African American; (4) Mexican or Mexican American; (5) Puerto Rican; (6) Other Hispanic, Latino, or Latin American; (7) White; and (8) Other. Based on the responses, a dichotomous variable was created to indicate underrepresented minority status. A value of 0 indicated that the student was not a member of an underrepresented minority group and included Asian and white students. A value of 1 indicated that the student was a member of an underrepresented minority group and included American Indian, African American, and Hispanic students. Students who did not indicate their ethnicity or self-identified as "Other" were excluded.

First-generation status. Students indicated the highest education level (i.e., no high school diploma, high school diploma, associate degree, bachelor's degree, or graduate degree) achieved for both their mother and father on the PSAT/NMSQT Questionnaire. This information was dichotomized into two categories: students reporting neither parent having earned a bachelor's degree (or higher) and students reporting at least one parent having earned a bachelor's degree to indicate whether or not a student was a first-generation college-going student.

Institutional characteristics. For Sample 1, institutional characteristics of control (public versus private) and selectivity were included in analyses in order to model the differences in graduation rates for different types of institutions. Selectivity was determined by an institution's admittance rate based on data provided by the institutions to the College Board for its Annual Survey of Colleges. Admittance rate was calculated by dividing the number of students who were admitted to the institution by the number of students who applied to the institution. Potential values for selectivity ranged from 1% (admits 1% of applicants, or very selective) to 100% (open enrollment, or not selective). The mean selectivity in the sample was 60% (*SD* = 14%, min = 18%, max = 94%). The majority of institutions in the sample were public (74%). Institutional control was also obtained from the Annual Survey of Colleges responses.

Graduation. For Sample 1, graduation data were provided by participating institutions. Students who graduated from the first institution in which they enrolled in four years or fewer were coded as 1, whereas students who left their original institution or who had not graduated by the end of the fourth year were coded as 0. Thus, the sample is based on students who graduated in four years or fewer compared with those students who did not graduate by their fourth year, which includes those who remained for a fifth year and those who dropped out in their first, second, third, or fourth year. For this sample, 52% had graduated within four years, which is higher than the national average of 37% (Snyder & Dillow, 2012).

For Sample 2, NSC provided enrollment and graduation data through the spring and summer terms of 2012, allowing for the examination of four-year graduation rates for the 2008 entering cohort. All students who began at a four-year institution and earned a bachelor's degree within four years from any institution were coded as having graduated. For Sample 2, the four-year graduation rate was 46%, which is still higher than the national average (Snyder & Dillow, 2012).

Analyses

Graduation from the same institution. To examine whether AP Exam participation or performance or both are related to college graduation in four years from one's initial institution, two sets of analyses were completed to examine both AP variables individually for Sample 1. For the AP Exam participation analyses, a dichotomous variable that simply identifies whether or not a student took one or more AP Exams was the predictor of interest. For the AP performance analyses, the average AP score for AP Exam takers was the predictor of interest. For both analyses, the outcome remained the same — graduating from one's initial institution in four years or fewer versus those who do not graduate within four years. Because this is a dichotomous outcome (1 = graduated; 0 = did not graduate), a logistic regression model was employed. However, because of the hierarchical structure of the data, with students nested within colleges, hierarchical generalized linear modeling (HGLM) rather than logistic regression was employed to model institutional-level variables of control and selectivity. In addition, student-level controls of PSAT/NMSQT score, gender, race/ethnicity, and parental education were included in the model. The HGLM approach models the logarithm of the odds of having graduated within four years or fewer, also known as the logit; this is expressed as the following:

Level 1: (*Student Level*)

Prob(*Graduate in 4 years or less$_{ij}$* = 1 | β_j) = Φ_{ij}

ln [Φ_{ij}/(1- Φ_{ij})] = η_{ij}

η_{ij} = β_{0j} + β_{1j} (PSAT/NMSQT total score$_{ij}$)+ β_{2j} (*Female$_{ij}$*)+ β_{3j} (*Underrepresented Minority$_{ij}$*) + β_{4j} (*First Generation Status$_{ij}$*)+ r_{ij}

Level 2: (*College/University Level*)

β_{0j} = γ_{00} + γ_{01} (*Control: Private*)$_j$ + γ_{02} (*Selectivity$_j$*) + u_{0j}
β_{1j} = γ_{10}
β_{2j} = γ_{20}
β_{3j} = γ_{30}
β_{4j} = γ_{40}

Before adding to the model, the continuous variables, PSAT/NMSQT total score, selectivity, and AP average score were grand-mean centered.

Graduation from any four-year institution. To examine whether AP Exam participation and/or performance is related to college graduation in four years from any four-year institution, two sets of analyses were completed to examine both AP variables individually for Sample 2. As was the case with Sample 1, a dichotomous variable that simply identifies whether or not a student took one or more AP Exams was the predictor of interest for the AP Exam participation analyses. For the AP performance analyses, the average AP score for AP Exam takers was the predictor of interest. For both analyses, the outcome remained the same — graduating from any four-year college within four years versus those who do not graduate within four years. Because this is a dichotomous outcome (1 = graduated; 0 = did not graduate), a logistic regression model was employed. Because these analyses take the student perspective (i.e., Are AP students more likely to graduate in four years, irrespective of the institution in which they first enroll or whether they transfer?), we did not model any institutional-level effects. However, we know AP students do differ from non-AP students on important educationally relevant variables; therefore, the student-level variables included in the analyses for Sample 1 were included in the analyses for Sample 2.

Results

Descriptive Statistics for Sample 1

Table 1 provides four-year graduation rates overall and by student and institutional characteristics for Sample 1. For this group, 52% graduated in four years or fewer, which is higher than the national average of about 37% (Snyder & Dillow, 2012). Comparing AP Exam takers to non-AP students, we find initial support for a positive relationship, with non-AP students having a four-year graduation rate of 38% compared with 58% for AP students. Of the 75,059 students (67%) who took at least one AP Exam, the average AP score was 2.85 (*SD* = 1.05) and the average total PSAT/NMSQT score was 171 (*SD* = 24); the average PSAT/NMSQT score for non-AP students was 148 (*SD* = 22). Among AP Exam takers, a positive relationship between AP *performance* and four-graduation rates also emerged, with a low of 37% for students with an average AP score of 1 to a high of 71% for students with an average AP score of 5. Consistent with previous research, differences in graduation rates by student characteristics were found, with lower rates for males, underrepresented minority

students, first-generation college-going students, and students with lower PSAT/NMSQT scores. Similarly, differences in graduation rates by institutional characteristics emerged, with both private and more selective institutions having higher graduation rates. The preliminary results support the inclusion of student and institutional factors in the model as control variables to isolate the AP effect on subsequent college graduation.

Table 1.

Four-Year Graduation Rates, Overall and by Student and Institutional Characteristics for Sample 1

Variable		*N*	% Graduated
Overall		**112,108**	**0.52**
Average AP Score	No AP	37,049	0.38
	1	7,749	0.37
	2	19,169	0.50
	3	24,824	0.61
	4	18,335	0.69
	5	4,982	0.71
Gender	Female	60,864	0.57
	Male	51,244	0.45
Underrepresented Minority Status	Yes	17,386	0.38
	No	94,722	0.54
First-Generation College-Going Status	Yes	32,975	0.39
	No	79,133	0.57
Control	Private	29,674	0.69
	Public	82,434	0.45
Selectivity (Admittance Rate)	< 50%	12,900	0.78
	50%–75%	77,901	0.51
	> 75%	21,307	0.39
PSAT/NMSQT Total Score	60–89	78	0.12
	90–119	4,090	0.23
	120–149	29,636	0.37
	150–179	47,782	0.54
	180–209	26,247	0.65
	210–240	4,275	0.73

HGLM Results

To further explore the relationship between the role of AP and graduating in four years or fewer from one's initial institution, HGLM was employed. A series of models was estimated to evaluate the impact of adding various predictors to the model on overall model fit, as indexed by the Akaike information criterion (AIC). (Refer to the Appendix for the equations and parameters estimated for each model examined.) First, we examined the relationship between AP Exam participation and college graduation. A null model (i.e., Model 1), which included no random effects, was estimated. Without any other information, the model predicted that a student has about a 52% chance of graduating in four years or fewer

($\hat{\gamma}_{00}$ = 0.06, p <.001; see Table 2), which corresponds to the sample mean. In order to demonstrate the need for a multilevel model and because the standard intraclass correlation coefficient (ICC) is not appropriate with discrete dependent variables such as graduation, the generalized ICC (Commenges & Jacqmin, 1994), which tests heterogeneity of proportions, was calculated. The resulting test statistic was significant (p <.001), thereby rejecting the null hypothesis of homogeneity of graduation rates across institutions and supporting the use of hierarchical modeling.

Table 2.

AP® Exam Participation and Four-Year Graduation: HGLM Parameter Estimates and Information Criteria

Fixed Parameter Estimates	Model 1		Model 2		Model 3		Model 4		Model 5	
	Est.	p	Est.	p	Est.	p	Est.	p	Est.	p
Intercept	0.06	<0.001	0.07	0.621	-0.12	0.317	-0.59	<0.001	-0.81	<0.001
Female					0.63	<0.001	0.63	<0.001	0.62	<0.001
Underrep. Minority					-0.35	<0.001	-0.35	<0.001	-0.38	<0.001
First Generation					-0.30	<0.001	-0.30	<0.001	-0.30	<0.001
PSAT/NMSQT[a]					0.01	<0.001	0.01	<0.001	0.01	<0.001
Inst. Control							0.91	<0.001	0.91	<0.001
Inst. Selectivity[a]							-2.76	<0.001	-2.58	<0.001
AP Exam Participation									0.36	<0.001
Random Parameter Estimates										
Intercept			1.33		1.01		0.42		0.42	
Information Criteria										
AIC (# of parameters)			147524.24	1	143341.14	6	143278.26	8	142845.02	9
Δ AIC					-4183.10		-62.88		-433.24	

Note. [a]Variable was grand-mean centered. AIC=Akaike information criterion. For institutional control, private=1 and public=0. Institutional selectivity is based on the admittance rate. ΔAIC=AIC of current model - AIC of previous model.

Motivated by this result, a random intercept effect for institutions was added to the model (Model 2) and served as a baseline to which more complex models were compared. Next, Model 3, which included dichotomous indicators for female, underrepresented minority status, and first-generation status level as well as the student's most recent PSAT/NMSQT score, was estimated. This model decreased the AIC value by 4,183.10, indicating that this model fit better than the empty model. Next, the institutional-level predictors of control and percent admitted were added to the model (Model 4). The addition of these level-2 variables decreased the AIC by 62.88. Last, a variable representing AP Exam participation was added into the model (Model 5). This addition also resulted in a better fitting model, reducing the AIC by 433.24. Refer to Table 2 for more information.

Focusing on Model 5, the parameter estimate for AP Exam participation was positive, indicating that students who took at least one AP Exam had a higher likelihood of graduating in four years compared with students who take no AP Exams ($\hat{\gamma}_{50}$ = 0.36; p <.001). The parameter estimates for underrepresented minority status and first-generation status were negative, indicating lower graduation rates for these students. Likewise, the parameter estimates for institutional selectivity (admittance rate) were negative, indicating lower graduation rates at institutions with

high admittance rates (less selective). Alternatively, the parameter estimates for gender, PSAT/NMSQT, and institutional control were positive, indicating higher graduation rates for females, students with higher PSAT/NMSQT scores, and those attending private institutions.

Based on the parameter estimates from Model 5, expected graduation rates by AP Exam participation and student and institutional characteristics were computed and graphically displayed in Figures 1 and 2. Figure 1 clearly illustrates the positive relationship between AP Exam participation and college graduation in four years, even within specific subgroups of students. For example, first-generation college-going, underrepresented minority females with average PSAT/NMSQT scores attending an average-selectivity public institution have an expected graduation rate of 38% if they participated in the AP Program compared with a 30% rate if they did not participate. In Figure 2, a similar pattern emerges by institutional characteristics. For example, white or Asian, non–first-generation college-going males with average PSAT/NMSQT scores attending a public institution that admits 50% of applicants have an expected graduation rate of 38% if they did not participate in the AP Program compared to 46% if they did.

Figure 1.

Four-year graduation rates by AP Exam participation and student characteristics: Sample 1.

Based on parameter estimates for Model 5 (Table 2), expected four-year graduation rate by AP Exam participation and student characteristics were computed. These values are associated with a student with an average PSAT/NMSQT score attending a public institution of average selectivity.

Figure 2.

Four-year graduation rates by AP Exam participation and institutional characteristics: Sample 1.
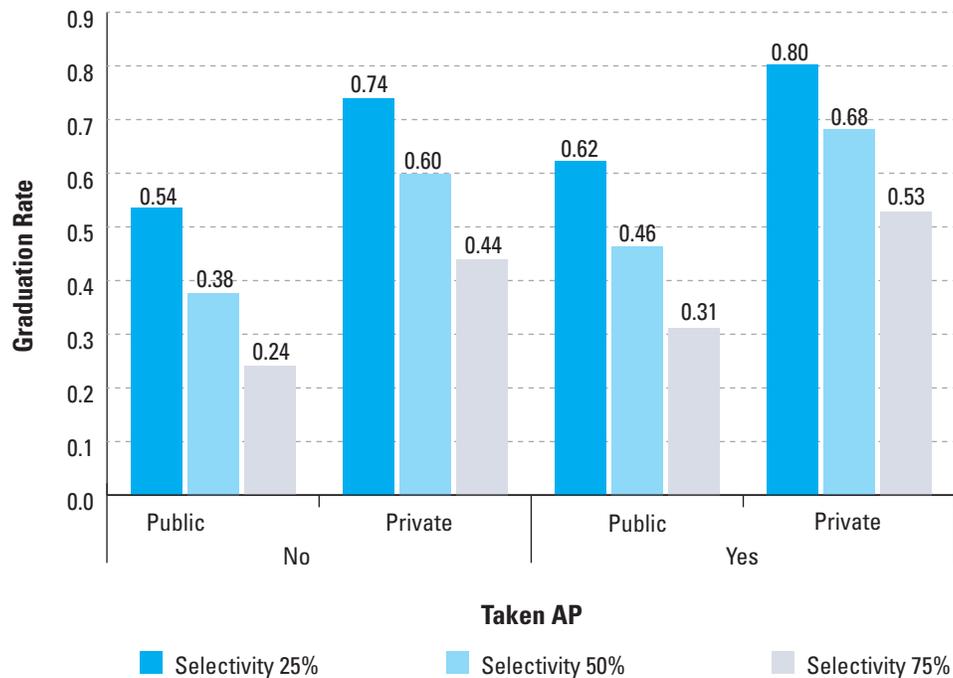
Based on parameter estimates for Model 5 (Table 2), expected four-year graduation rate by AP Exam participation and institutional characteristics were computed. These values are associated with a white or Asian, non-first-generation status male with an average PSAT/NMSQT score.

As was done for the AP Exam participation analyses, the same model-building process was used to examine the relationship between AP performance and college graduation. At each successive stage of model building, the change in AIC value was evaluated to determine the appropriateness of adding additional variables. As was the case with the AP Exam participation results, the best-fitting model was the full model (Model 10), which included student- and institutional- level variables along with the AP Exam performance variable. Table 3 summarizes the results of the different models, including the parameter estimates and corresponding AIC values.

Table 3.

AP Exam Performance and Four-Year Graduation: HGLM Parameter Estimates and Information Criteria

Fixed Parameter Estimates	Model 6		Model 7		Model 8		Model 9		Model 10	
	Est.	p	Est.	p	Est.	p	Est.	p	Est.	p
Intercept	0.34	<0.001	0.30	0.015	0.12	0.276	-0.31	0.006	-0.31	0.006
Female					0.61	<0.001	0.61	<0.001	0.63	<0.001
Underrep. Minority					-0.35	<0.001	-0.35	<0.001	-0.33	<0.001
First Generation					-0.28	<0.001	-0.28	<0.001	-0.26	<0.001
PSAT/NMSQT[a]					0.01	<0.001	0.01	<0.001	0.00	<0.001
Inst. Control							0.81	<0.001	0.79	<0.001
Inst. Selectivity[a]							-2.42	<0.001	-2.30	<0.001
AP Average[a]									0.23	<0.001
Random Parameter Estimates										
Intercept			1.06		0.86		0.40		0.40	
Information Criteria										
AIC (# of parameters)			98544.42	1	96195.04	6	96143.36	8	95691.58	9
Δ AIC					-2349.38		-51.68		-451.78	

Note. [a]Variable was grand-mean centered. AIC=Akaike information criterion. For institutional control, private=1 and public=0. Institutional selectivity is based on the admittance rate. ΔAIC=AIC of current model - AIC of previous model.

Of particular interest, the parameter estimate for the AP performance variable was positive, indicating that students who earn higher scores on an AP Exam(s) have a higher likelihood of graduating in four years compared with students who earn lower scores ($\hat{\gamma}_{50}$ = 0.23, p <.001). As was the case in the previous analyses, the parameter estimates for underrepresented minority status and first-generation status were negative, indicating lower graduation rates for these students. Likewise, the parameter estimates for institutional selectivity (admittance rate) were negative, indicating lower graduation rates at institutions with high admittance rates (less selective). Alternatively, the parameter estimates for gender, PSAT/NMSQT, and institutional control were positive, indicating higher graduation rates for females, students with higher PSAT/NMSQT scores, and those attending private institutions. These findings are congruent with previous research.

As was done with the AP Exam participation results, expected graduation rates by AP performance and student and institutional characteristics were computed and plotted in Figures 3 and 4, based on the parameter estimates from Model 10 (Table 3). As shown in Figure 3, even within specific subgroups of students, higher AP scores are associated with higher four-year graduation rates. For example, first-generation, underrepresented minority females with average PSAT/NMSQT scores attending an average-selectivity public institution have an expected graduation rate of 33% if their average AP score was a 1, compared with 55% if their average AP score was 5. In Figure 4, expected four-year graduation rates by AP performance and institutional characteristics are plotted. For example, white or Asian, non–first-generation status males with average PSAT/NMSQT scores attending a public institution that admits 50% of applicants have an expected graduation rate of 39% if their average AP score was 1, compared to 61% for students with an average AP score of 5.

Figure 3.

Four-year graduation rates by AP performance and student characteristics: Sample 1.
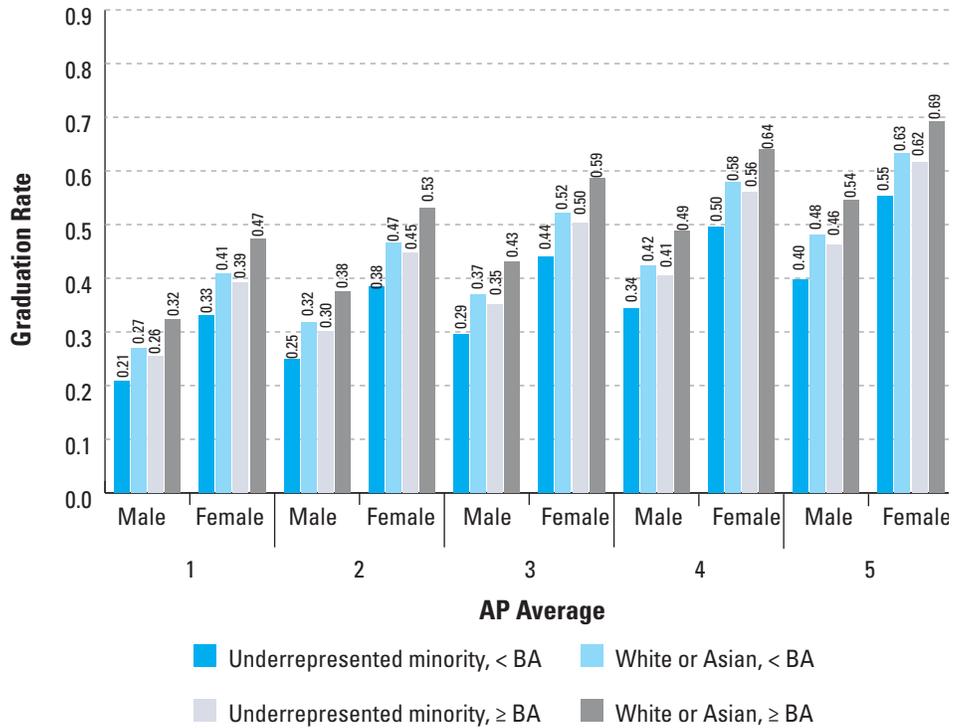
Based on parameter estimates for Model 10 (Table 3), expected four-year graduation rate by AP performance and student characteristics were computed. These values are associated with a student with an average PSAT/NMSQT score attending a public institution of average selectivity.

Figure 4.

Four-year graduation rates by AP performance and institutional characteristics: Sample 1.

Based on parameter estimates for Model 10 (Table 3), expected four-year graduation rate by AP performance and institutional characteristics were computed. These values are associated with a white or Asian, non-first-generation status male with an average PSAT/NMSQT score.
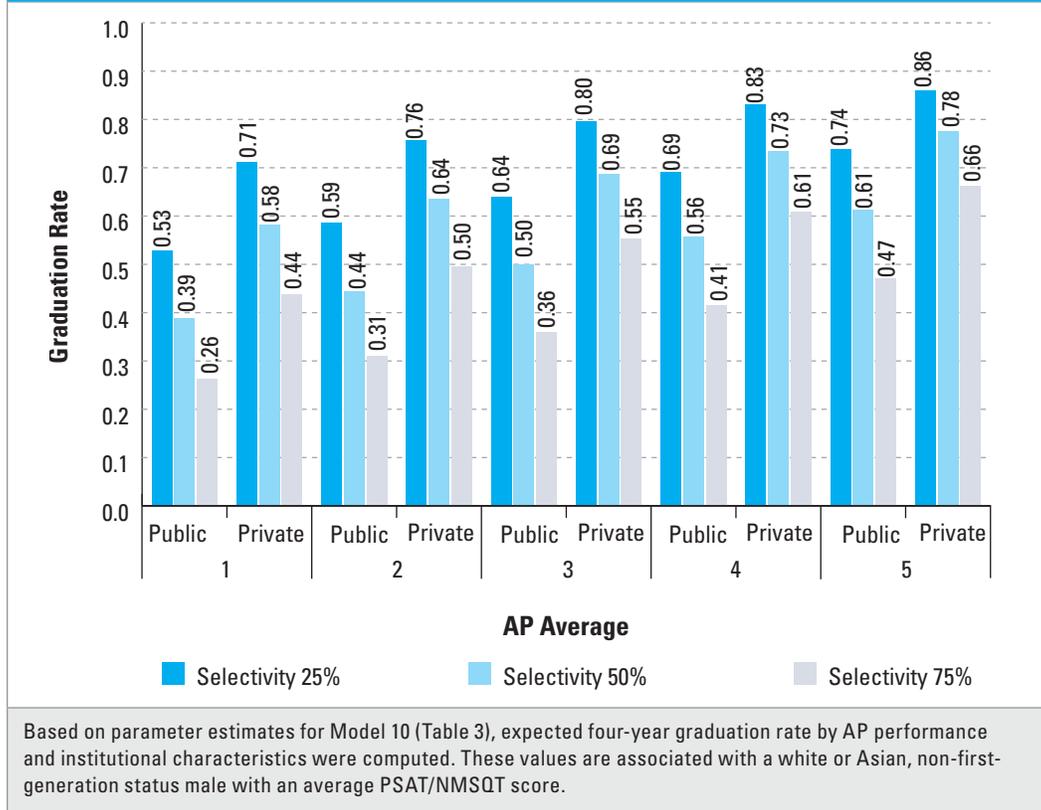
Descriptive Statistics for Sample 2

Table 4 provides four-year graduation rates overall and by student characteristics for Sample 2. For this group, 46% graduated in four years or fewer, compared with the national average of about 37% (Snyder & Dillow, 2012). Comparing AP Exam takers to non-AP students, we again find support for a positive relationship, with non-AP students having a four-year graduation rate of 34%, compared with 55% for AP students. Of the 388,978 students (57%) who took at least one AP Exam, the average AP score was 2.75 (SD = 1.10) and the average total PSAT/NMSQT score was 163 (SD = 25); the average PSAT/NMSQT score for non-AP students was 139 (SD = 23). Among AP Exam takers, a positive relationship between AP performance and four-graduation rates also emerged, with a low of 34% for students with an average AP score of 1 to a high of 73% for students with an average AP score of 5. As was the case with Sample 1, differences in graduation rates by student characteristics were found, with lower rates for males, underrepresented minority students, first-generation college-going students, and students with lower PSAT/NMSQT scores.

Table 4.			
Four-Year Graduation Rates, Overall and by Student Characteristics for Sample 2			
Variable		**N**	**% Graduated**
Overall		678,305	0.46
Average AP Score	No AP	289,327	0.34
	1	52,766	0.34
	2	105,551	0.47
	3	118,192	0.59
	4	85,039	0.68
	5	27,430	0.73
Gender	Female	378,796	0.51
	Male	299,509	0.40
Underrepresented Minority Status	Yes	149,001	0.30
	No	529,304	0.51
First Generation Status	Yes	242,158	0.35
	No	436,147	0.52
PSAT/NMSQT Total Score	60–89	3,646	0.11
	90–119	68,331	0.21
	120–149	243,096	0.37
	150–179	250,302	0.53
	180–209	98,327	0.66
	210–240	14,603	0.75

Logistic Regression Results

To further explore the relationship between graduating in four years or fewer from any four-year institution and the role of AP, logistic regressions were run. First, we examined the relationship between AP Exam participation and college graduation. In the first step of the logistic regression analysis, we entered student demographic characteristics of gender, underrepresented minority status, and first-generation college-going status as well as the student's most recent PSAT/NMSQT score, which was grand-mean centered (Model 11). In the second step, the AP Exam participation variable was added into the model (Model 12). As shown in Table 5, the parameter estimate for AP Exam participation was positive, indicating that students who took at least one AP Exam had a higher likelihood of graduating in four years, compared with students who took no AP Exams ($B = 0.45$, $p < .001$). For underrepresented minority students and first-generation college-going students, the parameter estimates were negative, indicating lower graduation rates for these students. Alternatively, the parameter estimates for gender and PSAT/NMSQT were positive, indicating higher graduation rates for females and for students with higher PSAT/NMSQT scores.

Table 5.

AP Exam Participation and Four-Year Graduation: Logistic Regression Parameter Estimates and Information Criteria for Sample 2

Variable	Model 11		Model 12	
	B	*p*	*B*	*p*
Intercept	-0.29	< 0.000	-0.53	< 0.000
Female	0.63	< 0.000	0.61	< 0.000
Underrepresented Minority	-0.48	< 0.000	-0.53	< 0.000
First Generation Status	-0.39	< 0.000	-0.38	< 0.000
PSAT/NMSQT	0.02	< 0.000	0.02	< 0.000
AP Exam Participation			0.45	< 0.000
AIC	851,720.84		845,719.87	
Δ AIC			-6000.96	

Note: *B* = Unstandardized coefficient.

Based on these parameter estimates, expected graduation rates by AP Exam participation and student characteristics were computed and graphically displayed in Figure 5. Figure 5 clearly illustrates the positive relationship between AP Exam participation and college graduation in four years, even within specific subgroups of students. For example, first-generation college-going, underrepresented minority females with average PSAT/NMSQT scores have an expected graduation rate of 41% if they participated in the AP Program, compared with a 30% rate if they did not participate.

Figure 5.

Four-year graduation rates by AP Exam participation and student characteristics: Sample 2.
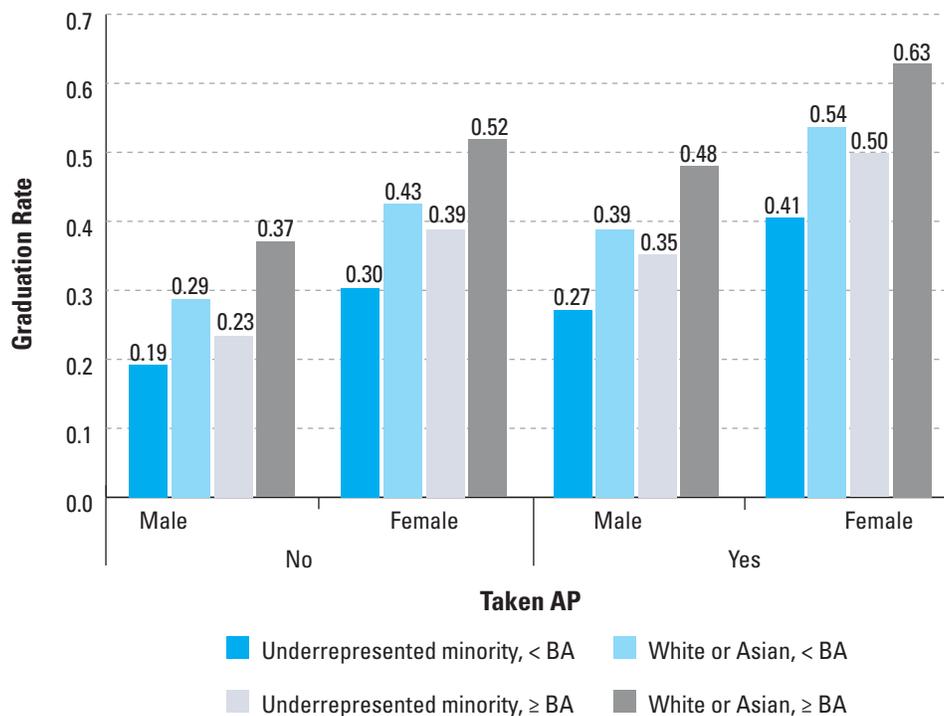
Based on parameter estimates for Model 12 (Table 5), expected four-year graduation rates by AP Exam participation and student characteristics were computed. These values are associated with a student with an average PSAT/NMSQT score.

As was done for the AP Exam participation analyses, a logistic regression was run to examine the relationship between AP performance and college graduation. AP performance was grand-mean centered, and the results are summarized in Table 6. Of particular interest, the parameter estimate for the AP performance variable was positive, indicating that students who earn higher scores on an AP Exam(s) have a higher likelihood of graduating in four years compared with students who earn lower scores ($B = 0.28$, $p < .001$). For underrepresented minority status and first-generation college-going status, the parameter estimates were negative, indicating lower graduation rates for those students. Alternatively, the parameter estimates for gender and PSAT/NMSQT were positive, indicating higher graduation rates for females and students with higher PSAT/NMSQT scores. These findings are congruent with previous research and the results from Sample 1.

Table 6.

AP Exam Performance and Four-Year Graduation: Logistic Regression Parameter Estimates and Information Criteria for Sample 2

Variable	Model 13		Model 14	
	B	p	B	p
Intercept	-0.29	< 0.000	-0.04	< 0.000
Female	0.63	< 0.000	0.62	< 0.000
Underrepresented Minority	-0.48	< 0.000	-0.45	< 0.000
First Generation Status	-0.39	< 0.000	-0.36	< 0.000
PSAT/NMSQT	0.02	< 0.000	0.01	< 0.000
AP Performance			0.28	< 0.000
AIC	851720.836		493153.503	
Δ AIC			-358567.333	
Note: *B* = Unstandardized coefficient.				

As was done with the AP Exam participation results, expected graduation rates by AP performance and student characteristics were computed and plotted in Figure 6, based on the parameter estimates from Model 14 (Table 6). As shown in Figure 6, even within specific subgroups of students, higher AP scores are associated with higher four-year graduation rates. For example, first-generation college-going, underrepresented minority females with average PSAT/NMSQT scores have an expected graduation rate of 35% if their average AP score was 1 compared with 57% if their average AP score was 5.

Figure 6.

Four-year graduation rates by AP performance and student characteristics: Sample 2.

Based on parameter estimates for Model 14 (Table 6), expected four-year graduation rates by AP performance and student characteristics were computed. These values are associated with a student with an average PSAT/NMSQT score.
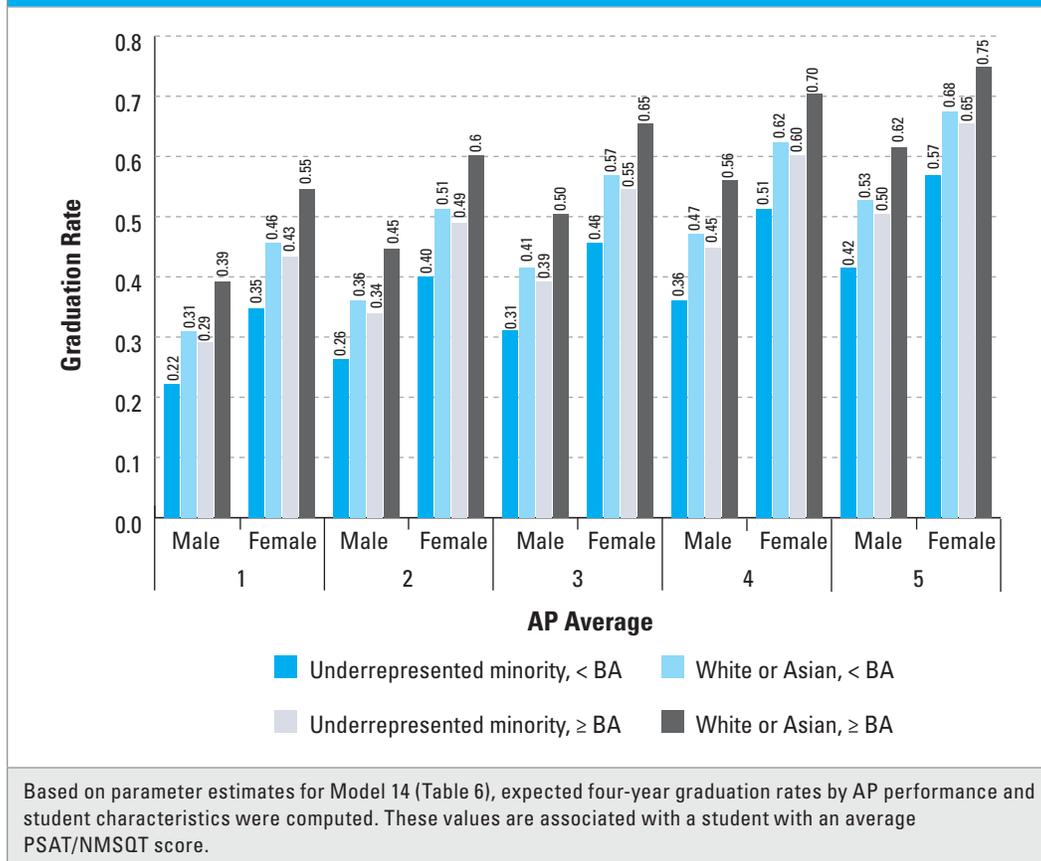
Discussion

This study found a positive relationship between AP Exam participation and performance with four-year graduation rates after controlling for relevant student and institutional characteristics known to be associated with graduation. Successful performance on the AP end-of-course exam, taken while in high school, can allow students to earn college credit and/or placement into higher-level courses once enrolled in college. On the most elementary level, one may assume that there is a positive relationship between AP Exam participation and time to graduation, particularly because these students may be entering college with previously earned credits, which should lessen the credit load needed for a degree and shorten the time to graduation. This study provides the empirical evidence to support the statement that AP Exam participation and performance are both positively related to four-year graduation rates, though the reason for the relationship remains a question for future research. We cannot be sure whether this positive relationship is linked to the notion that an AP student would be more likely to enter college with more college credits and is therefore more likely to graduate in four years or whether the positive relationship could be linked to the notion that AP students have been exposed to college-level work and are therefore more comfortable with managing this work; perhaps it is a combination of the two or another alternate explanation.

The results from this study indicate that participation in the AP Program, through the completion of one or more AP Exams, was related to an increased likelihood that a student

would graduate in four years or fewer, with graduation rates of 58% and 55% for AP Exam takers compared with 38% and 34% for non-AP students for the Samples 1 and 2, respectively. This means that regardless of what score was earned on the AP Exam(s), students who took an AP Exam were more likely to graduate in four years or fewer than students who took no AP Exams. Focusing on performance in an AP Exam(s), the results showed that those students who earned higher scores were more likely to graduate in four years or fewer than those who earned lower scores, with four-year graduation rates of 37% and 34% for students with an average AP score of 1 compared to graduation rates of 71% and 73% for students with an average score of 5 for Samples 1 and 2, respectively. In other words, high-performing AP students are almost twice as likely to graduate within four years compared with low-performing AP students.

The model-based analyses also show that AP Exam participation and performance both uniquely contributed to predicting four-year graduation, above and beyond such variables as students' prior academic performance, gender, underrepresented minority status, and first-generation college-going status, which we know from the literature are associated with graduation rates. For Sample 1, we additionally controlled for institutional characteristics of control and selectivity and still found that AP Exam participation and performance were related to graduation, providing further evidence of the value of the AP Program.

With the ever-rising cost of attending college, this research has important implications for college students, their families, educators, policymakers, and researchers. Reducing the amount of time spent in college so that students graduate on time would reduce the total cost of college. According to the National Center for Education Statistics, the total college cost for an undergraduate student attending a public institution (including tuition, room, and board) rose 42%, after adjusting for inflation, between 2000-01 and 2010-11. To meet the rising costs of college, many students are seeking financial aid, including loans. In fact, total college debt has exceeded total credit card debt (Kantrowitz, 2010) and the Student Loan Debt Clock (available on www.finaid.org/loans/studentloandebtclock.phtml) lists the current outstanding student loan debt as more than $1 trillion.

With these figures in mind, it becomes increasingly urgent to not linger in a college program without sufficient and steady progress. Contrary to the intended model of higher education, the majority of students enrolled in a four-year college or university do not graduate in four years. Specifically, fewer than 4 out of 10 students graduate from a four-year college within four years, roughly half graduate within five years, and nearly 60% graduate within six years (U.S. Department of Education, 2010). Given that the average annual cost of a college education at a four-year institution was $21,657 in 2010-11, extending the time to graduate by even a semester is a huge financial burden (Snyder & Dillow, 2012).

The expenditures segmented by institutional control show that the annual cost for a four-year public institution in 2010 was $15,605, compared with $31,957 at a private institution. In other words, if a student attending a private institution takes an additional two years to graduate from college, it will cost nearly an additional $65,000 compared with the total cost had he or she graduated on time (in four years). Furthermore, as the national statistics cited above highlight, graduating from college in six years is not unheard of, and in fact, six years is a commonly employed timeframe for reporting graduation rates.

The less debt that accrues during the college years means the less debt that must be paid back upon graduation, which is increasingly important in a turbulent economy. That being said, educational programs that are positively related to graduating on time or earlier, such as the AP Program, are important to research and promote in order to assist those who would

benefit the most from such programs; that is not to say that anyone should take AP courses without being prepared for such rigorous work, but rather that the AP Program is an important tool that can be used to prepare students for college. For those who are academically ready for the type of curriculum AP offers, AP course work can be an effective preview of the academic demands of college.

As with all research studies, some limitations should be mentioned. First, although we examined a rich database that included information on each AP Exam a student took and the score earned, we did not have information on whether the student received credit from his or her attending institution for that AP performance. Such information would allow for a more direct test of whether students who took an AP Exam and earned college credit graduated faster because they earned college credits before attending; if it was because of another aspect of AP such as self-regulatory skills or cognitive skills that are promoted in AP courses and exams, which translate to better management of college course work; or if it was caused by some other factor(s). The current study did include PSAT/NMSQT scores in the model as a measure of general academic performance, alleviating some of this concern; however, there are other competing hypotheses such as differences in motivation, self-efficacy, or time management skills of AP students compared with non-AP students that could explain the current results. This should be investigated in future research.

Another potential limitation was the outcome examined — graduation within four years. This graduation rate was an important outcome to study because we were investigating whether students who took and performed well on AP Exams were more likely to graduate on time. By dichotomizing the variable, however, we lose meaningful information across students. For example, one student may have graduated in three years and one in four years, but they appear the same by our definition of graduation. Alternatively, by modeling time to graduate as opposed to graduation within four years, we can examine the average time it takes AP students to graduate versus non-AP students. That information would be useful to determine if AP students graduate faster and then to better understand the associated cost saving. When examining time to graduation, a database that includes more distal outcomes would be useful. Specifically, we would want to have at least six years of college data, allowing for the collection of graduation information on students who took five and six years to graduate. The dataset used in the current study had only four years of data available and only 52% of the sample graduated in that time period. The remaining 48% of students would not have had any information if time to graduate had been the variable of interest.

The current study found a positive relationship between both AP Exam participation and performance and graduation within four years. This relationship held, even after controlling for relevant student and institutional factors associated with graduation rates. Given the financial burden associated with extending the time to graduate, this study provides support for the AP Program as an educational opportunity that may aid in timely completion of college. In particular, it may be worthwhile to explore the policy implications of these findings to work toward decreasing the time to college graduation and decrease student debt in a meaningful and large-scale way.

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Appendix

Table A1.		
HGLM Equations for the AP Exam Participation and Performance Models Examined		
Model	**Level-1 Equations**	**Level-2 Equations**
Models 1 & 6	Prob($Graduate\ in\ 4\ years\ or\ less_{ij} = 1\|\ \beta_j$) = Φ_{ij} $\ln\ [\Phi_{ij}/(1-\Phi_{ij})]$ = η_{ij} $\eta_{ij} = \beta_{0j}$	$\beta_{0j} = \gamma_{00}$
Models 2 & 7	Prob($Graduate\ in\ 4\ years\ or\ less_{ij} = 1\|\ \beta_j$) = Φ_{ij} $\ln\ [\Phi_{ij}/(1-\Phi_{ij})]$ = η_{ij} $\eta_{ij} = \beta_{0j}$	$\beta_{0j} = \gamma_{00} + u_{0j}$
Models 3 & 8	Prob($Graduate\ in\ 4\ years\ or\ less_{ij} = 1\|\ \beta_j$) = Φ_{ij} $\ln\ [\Phi_{ij}/(1-\Phi_{ij})]$ = η_{ij} $\eta_{ij} = \beta_{0j} + \beta_{1j}\ (PSAT/NMSQT\ total\ score_{ij}) + \beta_{2j}\ (Female_{ij}) + \beta_{3j}\ (Underrepresented\ Minority_{ij}) + \beta_{4j}\ (First\ Generation\ Status_{ij}) + r_{ij}$	$\beta_{0j} = \gamma_{00} + u_{0j}$ $\beta_{1j} = \gamma_{10}$ $\beta_{2j} = \gamma_{20}$ $\beta_{3j} = \gamma_{30}$ $\beta_{4j} = \gamma_{40}$
Models 4 & 9	Prob($Graduate\ in\ 4\ years\ or\ less_{ij} = 1\|\ \beta_j$) = Φ_{ij} $\ln\ [\Phi_{ij}/(1-\Phi_{ij})]$ = η_{ij} $\eta_{ij} = \beta_{0j} + \beta_{1j}\ (PSAT/NMSQT\ total\ score_{ij}) + \beta_{2j}\ (Female_{ij}) + \beta_{3j}\ (Underrepresented\ Minority_{ij}) + \beta_{4j}\ (First\ Generation\ Status_{ij}) + r_{ij}$	$\beta_{0j} = \gamma_{00} + \gamma_{01}\ (Control: Private)_j + \gamma_{02}\ (Selectivity_j) + u_{0j}$ $\beta_{1j} = \gamma_{10}$ $\beta_{2j} = \gamma_{20}$ $\beta_{3j} = \gamma_{30}$ $\beta_{4j} = \gamma_{40}$
Model 5	Prob($Graduate\ in\ 4\ years\ or\ less_{ij} = 1\|\ \beta_j$) = Φ_{ij} $\ln\ [\Phi_{ij}/(1-\Phi_{ij})]$ = η_{ij} $\eta_{ij} = \beta_{0j} + \beta_{1j}\ (PSAT/NMSQT\ total\ score_{ij}) + \beta_{2j}\ (Female_{ij}) + \beta_{3j}\ (Underrepresented\ Minority_{ij}) + \beta_{4j}\ (First\ Generation\ Status_{ij}) + \beta_{5j}\ (AP\ Participation_{ij}) + r_{ij}$	$\beta_{0j} = \gamma_{00} + \gamma_{01}\ (Control: Private)_j + \gamma_{02}\ (Selectivity_j) + u_{0j}$ $\beta_{1j} = \gamma_{10}$ $\beta_{2j} = \gamma_{20}$ $\beta_{3j} = \gamma_{30}$ $\beta_{4j} = \gamma_{40}$ $\beta_{5j} = \gamma_{50}$
Model 10	Prob($Graduate\ in\ 4\ years\ or\ less_{ij} = 1\|\ \beta_j$) = Φ_{ij} $\ln\ [\Phi_{ij}/(1-\Phi_{ij})]$ = η_{ij} $\eta_{ij} = \beta_{0j} + \beta_{1j}\ (PSAT/NMSQT\ total\ score_{ij}) + \beta_{2j}\ (Female_{ij}) + \beta_{3j}\ (Underrepresented\ Minority_{ij}) + \beta_{4j}\ (First\ Generation\ Status_{ij}) + \beta_{5j}\ (AP\ Average_{ij}) + r_{ij}$	$\beta_{0j} = \gamma_{00} + \gamma_{01}\ (Control: Private)_j + \gamma_{02}\ (Selectivity_j) + u_{0j}$ $\beta_{1j} = \gamma_{10}$ $\beta_{2j} = \gamma_{20}$ $\beta_{3j} = \gamma_{30}$ $\beta_{4j} = \gamma_{40}$ $\beta_{5j} = \gamma_{50}$

Note: Sample sizes differ between the AP Exam participation and performance analyses, resulting in models that are same in equation, but different in parameter estimates.

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