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The Relationship between Advanced Placement and College Graduation

2005 AP Study Series, Report 1 – February 2006

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The Relationship between Advanced Placement and College Graduation

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Abstract

This study explores the relationship between college graduation rates and student participation and success in Advanced Placement (AP) courses and exams. We reviewed three approaches to examining this relationship: 1) comparing the college graduation rates of AP and non-AP students; 2) comparing the college graduation rate of AP and non-AP students after controlling for students' demographics and prior achievement and the demographics of their high schools; and 3) examining the relationship between percent of students from a given high school graduating from college, and the school's percent of students in Advanced Placement. We conclude that the percent of a school's students who take and pass AP exams is the best AP-related indicator of whether the school is preparing increasing percentages of its students to graduate from college. The importance of AP exam results indicates the need for schools and districts to pay close attention not only to the quality of teaching in Advanced Placement courses but also to improving the academic preparation of students prior to their enrollment in those courses.

Introduction

Education policymakers are interested in recruiting more low-income and minority students into college. For example, Texas has set a goal of attracting 500,000 additional minority students into Texas public higher education institutions by the year 2015 (Texas Higher Education Coordinating Board, 2005). Yet labor market data tell us that these students are best served if they are also able to graduate from college. Students' academic readiness for college when they leave high school has long been recognized as an important predictor of college completion rates (Adelman, 1999).

One approach to strengthening high school students' college readiness has been to increase their participation in Advanced Placement courses and exams, as students who take and pass AP exams have demonstrated the ability to do college-level work prior to leaving high school. Traditionally Advanced Placement courses were confined to a small minority of highly prepared students, and some high schools excluded all but their top students from taking those courses.[2] More recently participation in Advanced Placement courses has expanded as selective colleges take students' AP course-taking into account in their admissions decisions and as incentive programs have been introduced to encourage a broader student population to take AP courses and exams.

Over the last ten years AP incentive programs have been funded in districts serving large concentrations of low-income and minority students. One such program, funded by the O'Donnell Foundation in Dallas, Texas, has been accompanied by substantial percentage increases in low-

[1] The authors would like to acknowledge the invaluable research assistance of Janey Chaplin in the preparation of this paper.

[2] This practice is documented in Jay Mathews' book *Class Struggle: What's Wrong (and Right) about America's Best Public High Schools,* Times Books, 1998.

income students' AP course participation and exam success.[3] This raises the following question of interest to educators and policymakers:

> By increasing the participation of low-income and minority students in Advanced Placement, are schools and districts improving those students' likelihood of graduating from college?

Answering this question in a way that would isolate the "AP impact" on college graduation rates would require random assignment of students to AP and non-AP classes, an approach that is not feasible in education. However, three questions we *can* answer are:

1. Do students in Advanced Placement graduate from college at higher rates than non-AP students?

2. Do students in Advanced Placement graduate from college at higher rates than non-AP students, controlling for the students' observed characteristics and the characteristics of their schools?

3. Do high schools with a higher percentage of students in Advanced Placement have higher college graduation rates of their students who attend college, controlling for the measured characteristics of those schools?

The answers to these questions should be interpreted based on their ability to address competing explanations of the relationship between Advanced Placement and college graduation rates. These alternative explanations include:

- Self-selection within the school: Better prepared and more highly motivated students are more likely to choose to take AP courses and exams. Much of those students' later success in college may be due not to the AP classes themselves, but to the personal characteristics that led them to participate in the classes in the first place – better academic preparation, stronger motivation, better family advantages, and so on. These selection effects will affect any comparison of AP and non-AP students. Missing is a comparison of the college graduation rates of two *otherwise similar* groups of students, one of which enrolled in AP and pre-AP classes and the other of which did not.

- Self-selection between schools, and other between-school differences in student populations: AP students are likely to be enrolled in schools with more advantaged and academically-focused student bodies, as the largest Advanced Placement programs are likely to be found in such schools. These schools would have produced more college graduates than other schools even if their AP programs had not been present. Strong AP programs may also attract more academically focused students to attend the school and participate in the program.

[3] Dallas is a district with a 76% low-income and 93% minority student population. Between 1995 and 2003 the percentage of low-income students in AP incentive non-magnet schools taking and passing AP exams increased more than sixfold from 0.4% to 2.9%; in AP incentive magnet schools the percentage increased more than tenfold from 0.6% to 6.8%. These are population AP exam passing rates, not exam-taker passing rates, as defined below. Source: NCEA analysis.

- Differences in school programs and strategies not directly related to AP: High schools with strong AP programs may be more effectively organized in other ways, and thus produce more college graduates as a result of these other school attributes. Whereas the previous explanation focused on the *students* the school attracts, this explanation focuses on the capacity and practices of the *school*.[4]

The first question – whether students in Advanced Placement have higher college graduation rates than their counterparts not in AP – does not address alternative explanations for why those students graduate at higher rates. Instead, the answer describes the size of the difference between AP and non-AP students that needs to be explained.

In answering the second question, we were able to control for some but not all of the preexisting student and school characteristics that might cause AP students to graduate from college at higher rates. In particular, information was available on students' demographic characteristics, prior test scores and completion of advanced courses other than AP, and on the demographics and average prior test scores in the high schools those students attended. Controlling for these variables gives us a limited ability to model a comparison of "otherwise similar" students. However, this approach cannot control for unobserved differences between students, such as greater motivation.

The third question bypasses entirely the problem of self-selection within the school. If better students self-select into AP classes, that should affect all comparisons between AP and non-AP students. However, if those classes merely select the best students without affect their college graduation chances, then moving more students into those classes should simply sort the students, but should not affect the school's overall college graduation rate. Thus, the college graduation rate of the school as a whole should not be affected by selection effects within the school.[5]

We were able to partly address differences in populations between schools in our answers to both the second and third questions. We included as control variables each high school's percentage of economically disadvantaged students,[6] the school's ethnic composition, and the average prior test scores of students before they entered the school. We eliminated magnet schools from the analysis in order to reduce the impact of self-selection of students between schools. However, in doing so, we could not completely eliminate the possibility that non-magnet schools with larger AP programs attract better students. That scenario would generate a relationship between AP and college graduation rates due to self-selection of students into schools that emphasize AP.[7]

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[4] A fourth explanation might be college practices not directly related to AP, for example, if AP students end up in colleges with better strategies for helping students graduate.

[5] By analogy, putting the taller students on the school basketball team affects comparisons of average height between basketball players and students who are not basketball players, but does not affect the overall average height of students in the school.

[6] To improve the accuracy of the low-income counts when many high school students do not participate in the free and reduced price lunch program, we used individual students' participation in the program in middle school wherever that information was available.

[7] We do not think this type of self-selection had a large impact on our results, based on the following information: We would expect advantaged parents to be more likely than low-income parents to choose their residence based on the perceived academic quality of the school. If these between-school self-selection effects dominated our results, then we would expect to see a stronger relationship between schoolwide AP exam passing rates and college graduation rates for advantaged students. However, the data showed the

Answering the second and third questions does not address alternative explanations related to school and district practices. Those practices, not just the AP and pre-AP classes themselves, may help to explain higher college graduation rates of students from those schools. The study of those practices is an important topic for further research.[8] A major reason for promoting success in Advanced Placement as a goal is the idea that that will encourage schools to develop a wide range of practices that promote academic success.

To summarize, our answer to the first question defines the magnitude of the differences in college graduation rates that must be explained; our answer to the second partially eliminates self-selection within the school and between-school population differences as competing explanations; our answer to the third completely eliminates self-selection within the school and addresses between-school population differences as well as does our answer to the second question. Based on its ability to do the best job of addressing alternative explanations, we believe that the third question comes closest to answering the original question about the benefits of expanding AP programs.

Data and Methodology

Student Cohort Identification

To answer the three questions, we followed a statewide cohort of 67,412 1994 Texas 8th graders who graduated from high school in 1998 and enrolled in a Texas public college or university within twelve months after high school graduation. By the spring of 2003, the most recent year for which data were available at the time of this analysis, these students had had five years to graduate from college.[9] The analysis focused on the odds that a student would graduate from a Texas public college or university with a Bachelor's degree in five years, given that he or she enrolled in any Texas public college, including two-year institutions, within twelve months after high school graduation.[10]

Students were followed from 8th grade in order to control for students' academic preparation prior to entering high school. Texas data were used because of the ability to track students longitudinally over an extended number of years, and to match K-12 and higher education data using a common student identifier. We disaggregated students by ethnicity into African-American, Hispanic, White, and "Other" (Asian and Native American), and separately by income into low- and non-low-income student groups, to look at the relationship of AP to college graduation separately for each group.

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opposite: the relationship between schoolwide AP exam passing rates and college graduation rates was stronger for disadvantaged students.

[8] NCEA has developed a conceptual framework, the Best Practice Framework, based on the study of school practices in over 300 elementary, middle, and high schools. This framework can be used to provide structure to such a research agenda.

[9] Appendix A contains a more complete description of this cohort.

[10] Many students enroll in two-year institutions and later transfer to four-year degree-granting programs. Analyzing the odds that a student will enroll in college requires the use of data from the National Student Clearinghouse to track college enrollment across the U.S. This is especially important in the case of Advanced Placement programs, as students passing AP exams were less likely to enroll in a Texas public college or university than were students failing AP exams, probably because the exam passers were more likely to enroll in private and/or out-of-state universities.

In the schoolwide analysis for Question Three, we limited ourselves to schools with at least 500 students overall and at least 15 students in the student group in question (e.g., African-American students). This reduced the size of our overall student cohort to 54,556 students.

Focus on Academic AP Courses and Exams

For each student, we recorded whether she or he took at least one academic AP course, took at least one academic AP exam, and what the student's highest score was on an academic AP exam. In this paper, "academic" AP courses and exams refer to those in English, mathematics, science, and social studies, on the premise that these areas were most likely to predict a student's college readiness.[11]

Based on this information, we divided students into four groups:

- Passed AP Exam: Students who took and passed at least one academic Advanced Placement exam with a score of 3 or above.

- Took, Did not Pass AP Exam: Students who took one or more academic AP exams, but did not pass any of them.

- Took AP Course, Not AP Exam: Students who took one or more academic AP courses, but did not take any academic AP exams.

- Took No AP Course or Exam: Students who took no academic AP courses or exams.

A student who took an AP exam without taking the corresponding AP course would be placed in the first or second group, depending on the student's score on the exam.

Use of Population AP Exam Passing Rates

For schoolwide analysis we used the *population* AP exam passing rate -- the percent of students in the cohort group in the school who pass at least one AP exam – as the definition of "AP exam passing rate." This rate should be distinguished from the AP *exam taker* passing rate, or the percent of AP exam takers who pass at least one exam. In the first statistic, the denominator is an entire student population, whereas in the second, the denominator is exam takers only. Schools can increase the exam taker passing rate by restricting the number of exam participants to a few top students. On the other hand, schools with broader student participation in AP courses and exams are likely to have higher population passing rates.

Results

Question One: Do students in Advanced Placement graduate from college at higher rates than non-AP students?

A number of prior research analyses have established a predictive relationship at the individual student level between Advanced Placement and college readiness and success measures.[12] The willingness of a student to enroll in an Advanced Placement course and take an AP exam

[11] Passing rates are higher in foreign languages because many native Spanish speakers can acquire easy college credit by taking and passing the Spanish Advanced Placement exam.
[12] Buck, Kostin and Morgan "Examining the Relationship of Content to Gender-Based Performance Differences in Advanced Placement Exams' College Board, 2002;

conveys information about that student that predicts that the student is more likely to graduate from college. The student's success on AP exams conveys additional information (Table 1a).

Table 1a
Five-Year College Graduation Rates
In Texas Public Colleges and Universities

Student Group *(# Enrolled)*		**Passed AP Exam**	**Took, Did not Pass AP Exam**	**Took AP Course, Not AP Exam**	**Took No AP Course or Exam**
African American	% Graduating	53%	37%	30%	10%
(5831)	*# Enrolled*	*92*	*277*	*595*	*4867*
Hispanic	% Graduating	54%	29%	23%	8%
(15176)	*# Enrolled*	*459*	*1198*	*1704*	*11815*
White	% Graduating	65%	47%	41%	21%
(44048)	*# Enrolled*	*4413*	*3037*	*6214*	*30384*
Low Income	% Graduating	46%	27%	21%	7%
(17294)	*# Enrolled*	*492*	*1159*	*1870*	*13773*
Non Low-Income	% Graduating	66%	47%	41%	21%
(50118)	*# Enrolled*	*5057*	*3603*	*7114*	*34344*
Total	% Graduating	64%	42%	37%	17%
(67412)	*# Enrolled*	*5549*	*4762*	*8984*	*48117*

Appendix A contains a more detailed description of this student cohort. The four types of AP status are described in the methodology section above. The counts in this table show the denominator for each percentage: e.g., 92 African-American students in the cohort passed at least one academic AP exam and then enrolled in a Texas public college or university; of these, 53% (49 students) graduated from a Texas public college or university in the following five years.

Table 1b shows the differences indicated by Table 1a between the college graduation rates of the three student groups participating in AP – students passing exams, taking but not passing exams, and taking at least one course but no exam – and the students who took no AP course or exam. For example, this table shows that low-income students in the cohort who took and passed at least one academic Advanced Placement exam had a 39 percentage point higher college

Division of Accountability Research, TEA: 'Advanced Placement and International Baccalaureate Examination Results in Texas 2002-03', August 2004.

graduation rate (46% vs. 7%) than low-income students who did not take any AP course or exam.[13]

Table 1b
Differences in College Graduation Rates
Compared with Students Not Participating in Advanced Placement

Student Group	Passed AP Exam	Took, Did not Pass AP Exam	Took AP Course, No AP Exam
African-American	43%	26%	20%
Hispanic	45%	21%	15%
White	43%	26%	20%
Low-Income	39%	20%	14%
Non-Low-Income	45%	26%	20%

These differences are based on the percentages shown in Table 1a. Apparent discrepancies are due to rounding of numbers, e.g., the college graduation rate for Hispanic AP exam passers was 45.4% higher (53.8% vs. 8.4%) than the graduation rate for Hispanic students who took no AP course or exam. This difference rounds to 45 not 46.

Because of self-selection, the statistics shown in Table 1b may not accurately predict what will happen to college graduation rates as additional students in a school enroll in Advanced Placement classes. The new students enrolling in the class are likely to be representative neither of the current students taking AP classes nor of the current students not in AP classes. Thus, the graduation rate they would have had had they stayed out of AP is not well predicted by that of the general population not in AP, and the rate they will likely have upon switching to AP may not be well predicted by that of the current students in AP.[14] If the newly enrolling students come from near the top of the group they switch from (current non-AP students) and are in the bottom half of the group they switch to (current AP students), then the predicted increase in their college graduation rate will be less than the differences shown in Table 1b.

[13] Students who transfer from Texas public colleges and universities to private or out-of-state colleges are lost from the data. If these students graduate at higher rates, the overall graduation rates shown here are an underestimate. One would expect that the underestimate would be more pronounced for academically better prepared students.

[14] Monitoring how the college graduation rate of AP students changes as the group participating in AP becomes less selective over time provides a rough way to estimate the graduation rates of the "changing" students. This modeling will become possible in future years as additional cohorts of students are followed through college.

Question Two: Do students in Advanced Placement graduate from college at higher rates than non-AP students, controlling for the students' observed characteristics and the characteristics of their schools?

An alternative approach is to model the differences in college graduation rates of a hypothetical group of students who have the same measured student and school characteristics, but differ in whether they enrolled in an AP course, took an AP exam, and passed an AP exam. This is done using a hierarchical linear modeling (HLM) regression approach.[15] This model answers the question, "Do AP students do better than non-AP students with similar measured student and school characteristics?"

Table 2 shows the differences in predicted college graduation rates that emerged from this model. For example, the 39 percentage point advantage of low-income AP exam passers shown in Table 1b drops to 26 percentage points when differences in prior student academic achievement, school poverty rates, and other variables are taken into account.

Table 2
Increase in Probability of College Graduation
Compared with Students Not Participating in Advanced Placement

Student Group	Passed AP Exam	Took, Did not Pass AP Exam	Took AP Course, No AP Exam
African-American	28%	22%	16%
Hispanic	28%	12%	10%
White	33%	22%	20%
Low-Income	26%	17%	12%
Non-Low-Income	34%	23%	19%

Control variables in the model include the student's 8th grade mathematics test score and economically disadvantaged (free and reduced price lunch) status , and the average test scores and percent economically disadvantaged students in the student's school. College graduation probabilities were calculated at the average of each variable for the student group in question, e.g., African-American students.

Question Three: Do high schools with a higher percentage of students in Advanced Placement have higher college graduation rates of their students who attend college, controlling for the measured characteristics of those schools?

Table 3 shows the increase in college graduation rates associated with differences in schools' percentages of students in the three AP categories. This analysis is done using ordinary least

[15] This analysis is described in more detail in Appendix B.

squares (OLS) regression at the school level.[16] The table implies, for example, that a school with 100 additional students passing AP exams from the school's cohort of low-income students would expect to gain 32 additional college graduates from that same cohort. [17]

Table 3a
School-Level Regression Coefficients for College Completion
(Five-Year Graduation Rates)

Student Group	Percent Taking and Passing AP Exams	Percent Taking but not Passing AP Exams	Percent Taking AP Course but No Exam
African-American	0.21	0.18 **	0.10
Hispanic	0.27 ***	0.01	0.00
White	0.19 ***	0.03	0.04
Low-Income	0.32 ***	0.05	0.06 *
Non-Low-Income	0.23 ***	0.00	0.05 *

***p<.01,**p<.05,*p<.10

Control variables in the model include the school's percentage of low-income students, the district dropout rate, the school's percentage of students in the same ethnic group (for the ethnic group regressions), the average 8th grade mathematics score of the students in the group in question, and the percent of the group in question taking at least four mathematics and four science courses. Schools are included that had at least 500 students and at least 15 students in the group enrolling in a Texas public college or university.

Table 3 shows a statistically significant relationship between AP exam passing and college graduation for all groups except African-Americans, despite the narrow range of AP exam pass rates across schools – few schools had more than 10% of low-income and minority students taking and passing AP exams. The lack of statistical significance of the result for African-American students is likely to have been affected by the fact that only 61 African-American students in the cohort passed at least one AP exam.[18]

Enrolling more students in AP courses who do not also take and pass AP exams has a weaker and often not statistically significant relationship to college graduation rates. Schools enrolling large numbers of students in AP classes who do not pass the exams may have relatively weaker AP programs, or they may be enrolling many students in AP classes without a strategy to prepare students ahead of time to succeed in those classes.

[16] This analysis is described in more detail in Appendix C.
[17] Recall that the cohort consists of low-income students who later enroll in Texas public colleges and universities.
[18] This group consists of those students from the group of 92 African-American AP exam passers who were enrolled in high schools with at least 500 students overall and at least 15 African-American students.

Table 3b reproduces the regression results in Table 3a in a format similar to that of Tables 1b and 2.

Table 3b
Differences in College Graduation Rates
Associated with Differences in AP Participation and Exam Success

Student Group	Passed AP Exam	Took, Did not Pass AP Exam	Took AP Course, No AP Exam
African-American	21%	18%	10%
Hispanic	27%	1%	0%
White	19%	3%	4%
Low-Income	32%	5%	6%
Non-Low-Income	23%	0%	5%

This table should be interpreted as follows: A school where 10 percent more of its population of low-income students take and pass AP exams (vs. not participating in AP at all) should expect a college graduation rate 3.2 percentage points higher (32% of 10 percent) for that same population. The low-income population in question is the cohort of low-income students who enrolled in a Texas public college or university within twelve months of high school graduation.

Comparing the Answers to the Three Questions

Educators and policymakers would like to answer the question, “Are schools and districts improving their students’ future college graduation success by enrolling more of those students in Advanced Placement courses?” As discussed earlier, Tables 1-3 do not directly answer this question. Because the approach based on Question 3 minimizes self-selection bias within the school, we believe that this approach comes closest to answering the questions policymakers have about the impact on college graduation rates of including more students in AP. However, Question 3 addresses the relationship between college graduation rates and everything high

schools do that is associated with higher AP participation or exam success, so it is not an assessment of the impact of AP courses by themselves.[19]

Figure 1
Increase in College Graduation Rates
Compared with Students Taking No Academic AP Course or Exam
Low-Income Students

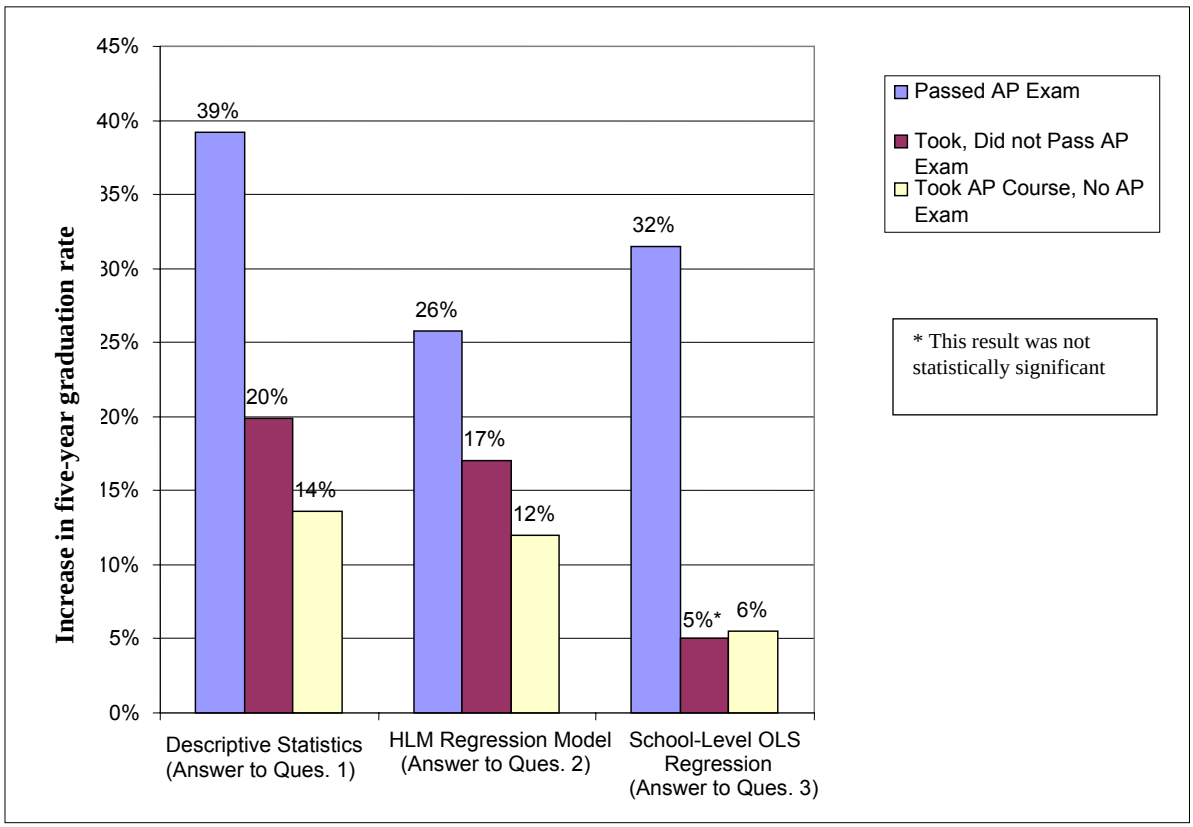

Figure 1 compares the answers to Questions 1-3 for low-income students.[20] For example, the chart shows that low-income students who took but failed one or more academic AP exams had a 20 percentage point higher college graduation rate than did students who did not take any AP course or exams. This AP advantage declined to 17 percentage points when students with similar measured characteristics were compared. But schools only appeared to gain five additional

[19] For example, if schools with higher AP exam passing rates also have stronger pre-AP programs or better extracurricular activities that boost college graduation rates, the model will associate these effects with the higher AP exam passing rates. This implies that it would be valuable to study the overall practices of these schools to see how they compare with those of schools with lower AP exam passing rates.
[20] See Appendix D for charts on the additional student subgroups.

college graduates for each 100 additional low-income students taking and failing AP exams, and this result was not statistically different from zero. [21]

Implications

We believe that the results in this paper have the following implications:

1. **The percent of a school's students who take and pass AP exams is the best AP-related indicator of whether the school is preparing increasing percentages of its students to graduate from college.**

The benefit to college graduation rates that schools obtain from enrolling more students in AP courses appears to be tied mainly to the resulting increase in the percent of the school's overall population who are able to take *and pass* AP exams, as the answer to Question 3 suggests. Most of the better results under Questions 1 and 2 for AP course-takers who do not pass exams could easily be driven by within-school self-selection effects. We have *not* shown that there is no advantage to taking AP courses for students who struggle with the material. However, having many such students may be a sign that a school is not preparing its students well. Based on the answer to Question 3, we would pose the commonsense hypothesis that preparing students to actually learn the material in an AP course is a good indicator that a school is preparing students well for college.

This hypothesis is consistent with the conclusions of Geiser and Santelices (2004), who found that the combined number of AP and Honors courses on a student's transcript did not predict college success – measured by the student's first-year college grade point average and the odds the student would stay in college for at least two years – but that success on SAT II and AP exams did.[22]

Prior research has indicated that student course completion transcripts may be poor indicators of students' college readiness, especially for low-income and minority students.[23] For example, an analysis by the Texas Higher Education Coordinating Board found that the majority of low-income and minority students who graduated from Texas public high schools in under the Recommended (college preparatory) High School Program needed remediation when they entered college.[24] This illustrates the important role that curriculum-based end-of-course exams, such as AP exams,

[21] These results are based on cross-sectional comparisons across schools from a single student cohort. Estimates of the change in graduation rates associated with changes in AP participation and success in the same schools over time will be possible when data from multiple student cohorts are available.

Had we combined the three AP groups in Table 3 into a single "percent of students who are AP participants" variable, we would have found, as did Clifford Adelman (1999), a relationship between advanced course participation and college graduation.

[22] Geiser and Santelices used individual-level data for University of California System students and controlled for high school grade point average and parents' education.

[23] This problem is discussed at greater length in Dougherty, Mellor, and Jian (2006).

[24] Email communication from James Dilling, Texas Higher Education Coordinating Board, March 3rd, 2005, cited in Dougherty, Mellor, and Jian (2006).

can play in verifying whether credits on the student's transcript indicate that the student actually learned the material indicated by the course title.[25]

2. The importance of AP exam results indicates the need for schools and districts to pay close attention not only to the quality of teaching in Advanced Placement courses but also to improving the academic preparation of students prior to their enrollment in those courses.

We found in a separate NCEA analysis that although the percentage of low-income and minority students taking Advanced Placement courses and exams has risen encouragingly, the percent of those students passing AP exams is still disappointingly low. For example, the population AP exam passing rate for low-income students in the 2002 high school graduating cohort was around 2%, compared with 13% for more advantaged students. Only around one low-income student in eight who took one or more academic Advanced Placement courses passed any of the corresponding exams. We also found only one non-magnet school with significant concentrations of low-income students in which 25% or more of those students were able to take and pass at least one academic AP exam.

We believe that these results are consistent with the other indicators showing a major college preparation gap for low-income students. To improve their college readiness outcomes for those students, school districts need to approach "Advanced Placement" not as a special set of courses for their already well-prepared students, but as a comprehensive program to prepare large numbers of students, starting in the early grades and including disadvantaged students, to be able to do college-level work before they leave high school.

[25] The need to look at exam results has implications for the many "State Scholars" programs that rely on course completion as their measure of students' mastery of a college preparatory curriculum. Most states with these programs do not have end-of-course exams to determine whether students learned the course content.

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Appendix A
Cohort Definitions and Descriptive Statistics

We began with a group of 273,993 8th grade students in Texas public schools in 1994. Of these, 125,047 were enrolled in Texas public schools between 1994 and 1998, graduated in 1998, and were enrolled at the same school for their junior and senior years. The last requirement is important because students are matched to schools in the statistical analysis whose results are shown in Tables 2, 3a, and 3b in the main section of the paper. The difference between 273,993 and 125,047 students represents dropouts, transfers, and students still in Texas public schools who did not graduate by 1998. Transfers in were not included as they were missing 8th grade test scores.

Of those 125,047 continuously enrolled 1998 high school graduates, 67,412 entered a Texas public college or university in the 1998-99 school year. It is this latter group of students, whom we will describe as the 1998 Texas college-going cohort, who became the denominator for our college graduation analysis in Tables 1a, 1b, and 2.[26] For the analysis with school-level data in Tables 3a and 3b, we included students in high schools with at least 500 students overall and at least 15 students belonging to the 1998 Texas college-going cohort. This requirement was imposed because the analysis was done with school-level statistics. Table A1 shows the relationship of the number of students used in the analysis to the size of the original 8th grade cohort. Table A2 provides the same information for each student subgroup.

Table A1
Cohorts Used in Longitudinal College Graduation Analysis

	Number of Students
1. 8th graders in 1994	273,993
2. High school graduates in 1998	152,962
3. Continuously enrolled 1998 graduates	125,047
4. 1998 graduates in Texas public higher education the following school year	67,412
5. 1998 graduates in Texas public higher education, from schools with at least 500 students and at least 15 students in the subgroup in question (low-income or non-low-income students). The sum across all ethnic categories would differ slightly because of the requirement of 15 students in each ethnic subgroup.	54,556

[26] This cohort differs from the cohort of *all* 78,079 1998 Texas high school graduates entering Texas public colleges and universities by fall 1998 used in Tom Luce, *Do What Works* (2004). The "all graduates" cohort includes transfers into Texas public schools between grades 8 and 12 and students who changed high schools in grades 11 and 12. Transfers in would generally not have an 8th grade test score in the Texas data.

Table A2
Cohorts Used in Longitudinal College Graduation Analysis
Analysis by Student Group

	Low-Income	Non-Low-Income	African-American	Hispanic	White
1. 8th graders in 1994	129,307	144,686	35,512	86,342	125,533
2. High school graduates in 1998	57,905	95,057	19,230	44,045	85,266
3. Continuously enrolled 1998 graduates	42,985	82,062	13,572	32,516	75,367
4. 1998 graduates in Texas public higher education the following school year[a]	17,294	50,118	5,831	15,176	44,048
5. 1998 graduates in Texas public higher education, from schools with at least 500 students and at least 15 students in the group[b]	12,691	41,865	3,683	12,012	35,370
percent of continuously enrolled graduates enrolling in Texas public higher education: (4)/(3)	40.2%	61.1%	43.0%	46.7%	58.4%

(a) Used in Tables 1a, 1b, and 2. Adding up the low- and non-low-income students yields the total cohort size. The three ethnic groups do not add to the total because Asian and Native American students are omitted.

(b) Used in Tables 3a and 3b. Minimum school and group sizes were used so that the percentage of students with a given AP outcome would be a more statistically reliable number.

Comparing the Four Student AP Groups: Poverty and 8th Grade Achievement

Table A3 shows the value of controlling for student characteristics when comparing students based on their Advanced Placement status. For example, students taking and passing AP exams were less likely to be economically disadvantaged and had higher prior 8th grade test scores. Students who took and failed AP exams had a similar profile to those taking the courses but not the exams.

Table A3
Percent Economically Disadvantaged
and Average 8th Grade Test Scores by Advanced Placement Status

Student Group *(# Enrolled)*		**Entire Group**	**Passed AP Exam**	**Took, Did Not Pass AP Exam**	**Took AP Course, Not AP Exam**	**Took No AP Course or Exam**
African American	% Low-Income	50%	22%	44%	42%	52%
	Average 8th Grade Test Score	64.4	80.8	75.1	73.2	62.4
	# students	5831	92	277	595	4867
Hispanic	% Low-Income	63%	43%	61%	57%	65%
	Average 8th Grade Test Score	69.2	84.4	78.2	76.8	66.6
	# students	15176	459	1198	1704	11815
Anglo	% Low-Income	9%	4%	8%	8%	10%
	Average 8th Grade Test Score	76.8	85.6	81.6	81.4	74.1
	# students	44048	4413	3037	6214	30384
Low-Income	Average 8th Grade Test Score	67.8	83.9	78.3	76.3	65.2
	# students	17294	492	1159	1870	13773
Non-Low-Income	Average 8th Grade Test Score	76.2	85.6	81.0	80.8	73.3
	# students	50118	5057	3603	7114	34344

Comparing the Four Student AP Groups: Enrollment Rates In Texas Public Higher Education Institutions

Interestingly enough, 1998 high school graduates who passed AP exams were *less* likely to enroll in Texas public colleges and universities than were AP exam failers (Table A4). Most likely the successful AP students were more likely to attend private or out-of-state colleges and universities and thus not appear in our Texas public higher education enrollment dataset.[27] Note that these enrollment rates include students enrolling in two-year community and technical colleges as well as four-year institutions.

Table A4
College Enrollment Rates for 1998 High School Graduates

Student Group *(# Enrolled)*		**Entire Group**	**Passed AP Exam**	**Took, Did Not Pass AP Exam**	**Took AP Course, Not AP Exam**	**Took No AP Course or Exam**
African American	% Enrolling		46%	57%	54%	41%
	# students	13572	202	484	1104	11782
Hispanic	% Enrolling		59%	70%	69%	43%
	# students	32516	773	1719	2471	27553
Anglo	% Enrolling		61%	70%	69%	56%
	# students	75367	7251	4364	9054	54698
Low-Income	% Enrolling		59%	67%	63%	37%
	# students	42985	839	1733	2979	37434
Non-Low-Income	% Enrolling		61%	70%	69%	59%
	# students	82062	8343	5184	10298	58237
Total	% Enrolling		60%	69%	68%	50%
	# students	125047	9182	6917	13277	95671

This cohort corresponds to the students in Row 3 of Table A1. The three ethnic groups do not add up to the total because of the omission of Asian and Native American students.

[27] In further work we expect to use data from the National Student Clearinghouse (NSC) to track these enrollment patterns. The NSC database covers public and private higher education institutions across the United States.

Appendix B
Hierarchical Linear Modeling Analysis

As discussed in the paper and shown in Appendix A, students who take Advanced Placement courses, take AP exams, and pass AP exams are likely to be less disadvantaged and better academically prepared than their peers who do not participate in AP. Thus, it is valuable to control for students' economic disadvantaged status and prior academic achievement when examining the relationship between AP and college graduation rates. Using hierarchical linear modeling (HLM) enabled us to control for the income and prior academic preparation of the student's peers in the same school as well.

In particular, taking Hispanic students as an example, we estimated the following set of HLM equations predicting *P*, the probability that a Hispanic student who enters a Texas public college or university will graduate with a Bachelor's degree within five years:

Student-level equation:

$$\ln [P/(1-P)] = B_0 + B_1 (\textit{low-income status}) + B_2 (\textit{8th grade math score}) + B_3 (\textit{took AP course, no exam}) + B_4 (\textit{took but failed AP exam}) + B_5 (\textit{took and passed AP exam}) + r_{ij}$$

School-level equations predicting the coefficients in the Hispanic student-level equation:

$$B_0 = \gamma_{00} + \gamma_{01} (\textit{school percent low-income}) + \gamma_{02} (\textit{average 8th grade math score}) + \gamma_{03} (\textit{percent taking AP course}) + \gamma_{04} (\textit{school percent Hispanic})$$

$$B_1 = \gamma_{10}$$

$$B_2 = \gamma_{20}$$

$$B_3 = \gamma_{30} + \gamma_{31} (\textit{school percent low-income}) + \gamma_{32} (\textit{average 8th grade math score}) + \gamma_{33} (\textit{percent taking AP course}) + \gamma_{34} (\textit{school percent Hispanic})$$

$$B_4 = \gamma_{40} + \gamma_{41} (\textit{school percent low-income}) + \gamma_{42} (\textit{average 8th grade math score}) + \gamma_{43} (\textit{percent taking AP course}) + \gamma_{44} (\textit{school percent Hispanic})$$

$$B_5 = \gamma_{50} + \gamma_{51} (\textit{school percent low-income}) + \gamma_{52} (\textit{average 8th grade math score}) + \gamma_{53} (\textit{percent taking AP course}) + \gamma_{54} (\textit{school percent Hispanic})$$

The three dummy variables in the student-level equation, *took AP course, no exam; took but failed AP exam;* and *took and passed AP exam* are mutually exclusive and divide students up into the four AP status groups used in the paper. Because many high school students do not sign up for the free and reduced price lunch program, we counted as low-income any student who was in the program as far back as 8th grade.

This HLM analysis partly controls for the self-selection bias inherent in the fact that more academically prepared students are likely to enroll in AP courses and take AP exams. However,

even when prior test scores are taken into account, more motivated students with the same test score are the ones more likely to participate in AP.[28]

In research conducted by NCEA on 8th grade algebra participation, controlling for 6th grade math scores, we included a school-level variable on the percentage of students taking algebra in the 8th grade on the premise it would capture selectivity at the school level. We hypothesized that the higher the percentage of students taking algebra in the 8th grade, the less selective the group, giving the variable a negative coefficient.[29]

In our AP analysis, we again included a variable to capture additional selectivity and found that the coefficient for the percentage of students taking AP courses at the school was negative and significant for all four groups, and the coefficients were not statistically significantly different for the four groups in most cases. [30]

The probabilities from the HLM models are shown in Table B1. The probabilities shown in the right-hand column of Table B1, in turn, are tabulated in Table 2 of the paper.

The results of the HLM analysis for different student groups are shown in Tables B2-B6. In most cases the schoolwide variables were related to the student intercepts but not to the AP slopes, indicating that the relationship of these variables to student graduation was similar across all four AP groups, and that the AP to graduation relationship at the student level was not much affected by the school-level variables.

To summarize the relationship between AP participation and college graduation implied by these models, we examined the relationship between AP and college graduation when the other variables in the model are set equal to their population means. This make is possible to compare the probabilities that students will graduate from college by using the intercepts for each group. For example, if B_0 is the intercept for the non-AP group, and $B_0 + B_j$ is the intercept for the students in AP group *J*, who took and passed at least one AP exam, then the log odds of college graduation for each group is as follows:

For students taking neither AP courses nor exams:

$$\ln [P/(1-P)] = B_0 \qquad \Rightarrow \qquad P = \frac{e^{Bo}}{1+e^{Bo}}$$

[28] We used 8th grade state test scores rather than 11th grade SAT or ACT scores as the prior achievement variable, because we were concerned about the small size and high selectivity of the group of students taking SAT or ACT exams in the 11th grade.

[29] The coefficient on this variable was indeed negative and significant, and larger in magnitude the smaller the group taking algebra (e.g., fewer students take algebra in 7th than in 8th grade). Additional evidence for the importance of self-selection bias was the fact that students who took algebra in the 8th grade did better on the algebra end-of-course exam (controlling for their 6th grade scores and other variables) than students who took algebra in 9th grade; yet when the data were aggregated, the percent of students taking algebra in 8th grade was independent of the overall algebra exam passing rate. This is exactly what one would expect if the performance differences between 8th and 9th grade students are driven by self-selection effects, and it mirrors our AP results that better outcomes for students taking and failing AP exams show up prominently at the individual level but very little when the data are aggregated.

[30] The exception was for non-low-income and white students, for which the coefficient of this variable was negative for the other groups and close to zero for the AP exam passing group.

For students in AP group J (where J is 3 for students taking AP courses only, 4 for students taking but failing AP exams, and 5 for the AP exam passing group):

$$\ln [P/(1-P)] = B_0 + B_J \quad \Rightarrow \quad P = \frac{e^{Bo+Bj}}{1+e^{Bo+Bj}}$$

Table B1
Comparing the Probabilities of College Graduation for AP and Non-AP Groups

	B	p/(1-p)	p	Δ p
African-American Students				
no AP	-2.38	0.09	0.08	
took AP course only	-1.10	0.33	0.25	0.16
took, failed AP exam	-0.81	0.44	0.31	0.22
passed AP exam	-0.55	0.57	0.36	0.28
Hispanic Students				
no AP	-2.68	0.07	0.06	
AP course only	-1.61	0.20	0.17	0.10
fail exam	-1.51	0.22	0.18	0.12
pass exam	-0.64	0.53	0.34	0.28
White Students				
no AP	-1.50	0.22	0.18	
AP course only	-0.46	0.63	0.39	0.20
fail exam	-0.40	0.67	0.40	0.22
pass exam	0.03	1.04	0.51	0.33
Low-Income Students				
no AP	-2.63	0.07	0.07	
AP course only	-1.47	0.23	0.19	0.12
fail exam	-1.17	0.31	0.24	0.17
pass exam	-0.73	0.48	0.32	0.26
Non-Low-Income Students				
no AP	-1.50	0.22	0.18	
AP course only	-0.55	0.58	0.37	0.19
fail exam	-0.34	0.71	0.42	0.23
pass exam	0.10	1.11	0.53	0.34

Intercept coefficients (shown here) are calculated at the grand mean of the other variables.
p/(1-p) is equal to e^B.
If p/(1-p) = x, then p = x/(1+x)
Δp is the difference compared with the "no AP" students. Apparent discrepancies in this difference are due to rounding error. For example, for the African-American "took AP course only" variable, Δp = .164 = .249 - .085.

Table B2
Hierarchical Linear Model for African-American Students

	coefficient	std error	p-value	significance
student-level variables				
intercept	-2.378	0.073	0.000	***
low-income status	-0.645	0.087	0.000	***
took AP course, no exam	1.274	0.177	0.000	***
took and failed AP exam	1.567	0.207	0.000	***
took and passed AP exam	1.823	0.376	0.000	***
8th grade math score	0.036	0.004	0.000	***
school-level variables				
predicting the student intercept				
8th grade math score	0.001	0.008	0.891	
% taking AP course	-0.018	0.006	0.003	**
% low-income	-0.011	0.004	0.012	*
% African-American	0.004	0.003	0.286	
student slope predictors:				
AP course, no exam				
8th grade math score	-0.031	0.015	0.039	*
% taking AP course	0.007	0.010	0.477	
% low-income	-0.005	0.008	0.555	
% African-American	-0.004	0.005	0.397	
took and failed AP exam				
8th grade math score	-0.018	0.028	0.518	
% taking AP course	-0.001	0.009	0.941	
% low-income	-0.004	0.007	0.628	
% African-American	0.002	0.005	0.724	
passed AP exam				
8th grade math score	-0.100	0.043	0.021	*
% taking AP course	0.018	0.018	0.307	
% low-income	-0.022	0.018	0.219	
% African-American	0.019	0.017	0.258	

The outcome variable is the log odds ratio, ln p/(1-p), that a student will receive a bachelor's degree in five years, given that the student enrolled in a Texas public college or university within one year after high school graduation.
* = p < .05, ** = p < .01, *** = p < .001.

Table B3
Hierarchical Linear Model for Hispanic Students

	coefficient	std error	p-value	significance
student-level variables				
intercept	-2.676	0.059	0.000	***
low-income status	-0.405	0.052	0.000	***
took AP course, no exam	1.070	0.126	0.000	***
took and failed AP exam	1.162	0.122	0.000	***
took and passed AP exam	2.033	0.172	0.000	***
8th grade math score	0.045	0.004	0.000	***
school-level variables				
predicting the student intercept				
8th grade math score	0.020	0.008	0.020	*
% taking AP course	-0.009	0.004	0.017	*
% low-income	-0.011	0.004	0.002	**
% Hispanic	0.009	0.003	0.001	***
student slope predictors:				
AP course, no exam				
8th grade math score	0.006	0.015	0.681	
% taking AP course	-0.005	0.006	0.386	
% low-income	0.005	0.005	0.381	
% Hispanic	-0.003	0.004	0.509	
took and failed AP exam				
8th grade math score	-0.005	0.014	0.727	
% taking AP course	0.007	0.005	0.151	
% low-income	-0.011	0.007	0.090	
% Hispanic	0.008	0.005	0.126	
passed AP exam				
8th grade math score	-0.059	0.020	0.003	**
% taking AP course	0.004	0.007	0.617	
% low-income	-0.003	0.011	0.784	
% Hispanic	0.000	0.008	0.964	

The outcome variable is the log odds ratio, ln p/(1-p), that a student will receive a bachelor's degree in five years, given that the student enrolled in a Texas public college or university within one year after high school graduation.
* = p < .05, ** = p < .01, *** = p < .001.

Table B4
Hierarchical Linear Model for White Students

	coefficient	std error	p-value	significance
student-level variables				
intercept	-1.502	0.036	0.000	***
low-income status	-0.965	0.050	0.000	***
took AP course, no exam	1.038	0.064	0.000	***
took and failed AP exam	1.104	0.069	0.000	***
took and passed AP exam	1.537	0.075	0.000	***
8th grade math score	0.037	0.002	0.000	***
school-level variables				
predicting the student intercept				
8th grade math score	0.010	0.015	0.478	
% taking AP course	-0.013	0.001	0.000	***
% low-income	-0.009	0.003	0.001	***
% White	-0.003	0.002	0.134	
student slope predictors:				
AP course, no exam				
8th grade math score	0.025	0.015	0.090	
% taking AP course	0.003	0.003	0.261	
% low-income	0.014	0.003	0.000	***
% White	0.005	0.003	0.069	
took and failed AP exam				
8th grade math score	-0.012	0.010	0.235	
% taking AP course	0.011	0.002	0.000	***
% low-income	-0.004	0.004	0.399	
% White	-0.005	0.003	0.183	
passed AP exam				
8th grade math score	-0.011	0.013	0.411	
% taking AP course	0.013	0.002	0.000	***
% low-income	0.000	0.005	0.948	
% White	-0.001	0.003	0.668	

The outcome variable is the log odds ratio, ln p/(1-p), that a student will receive a bachelor's degree in five years, given that the student enrolled in a Texas public college or university within one year after high school graduation.
* = p < .05, ** = p < .01, *** = p < .001.

Table B5
Hierarchical Linear Model for Low-Income Students

	coefficient	std error	p-value	significance
student-level variables				
intercept	-2.633	0.043	0.000	***
took AP course, no exam	1.163	0.098	0.000	***
took and failed AP exam	1.468	0.105	0.000	***
took and passed AP exam	1.901	0.126	0.000	***
8th grade math score	0.033	0.003	0.000	***
school-level variables				
predicting the student intercept				
8th grade math score	0.009	0.007	0.215	
% taking AP course	-0.013	0.004	0.001	***
% low-income	-0.003	0.002	0.057	
student slope predictors:				
AP course, no exam				
8th grade math score	0.015	0.014	0.278	
% taking AP course	-0.008	0.007	0.244	
% low-income	0.005	0.003	0.092	
took and failed AP exam				
8th grade math score	0.000	0.014	0.978	
% taking AP course	0.003	0.006	0.682	
% low-income	-0.004	0.003	0.219	
passed AP exam				
8th grade math score	-0.015	0.020	0.461	
% taking AP course	0.012	0.008	0.154	
% low-income	0.005	0.004	0.206	

The outcome variable is the log odds ratio, ln p/(1-p), that a student will receive a bachelor's degree in five years, given that the student enrolled in a Texas public college or university within one year after high school graduation.
* = p < .05, ** = p < .01, *** = p < .001.

Table B6
Hierarchical Linear Model for Non-Low-Income Students

	coefficient	std error	p-value	significance
student-level variables				
intercept	-1.504	0.037	0.000	***
took AP course, no exam	0.959	0.058	0.000	***
took and failed AP exam	1.161	0.051	0.000	***
took and passed AP exam	1.608	0.062	0.000	***
8th grade math score	0.037	0.002	0.000	***
school-level variables				
predicting the student intercept				
8th grade math score	0.016	0.017	0.350	
% taking AP course	-0.013	0.001	0.000	***
% low-income	-0.009	0.001	0.000	***
student slope predictors:				
AP course, no exam				
8th grade math score	0.011	0.012	0.376	
% taking AP course	0.005	0.002	0.041	*
% low-income	0.006	0.002	0.006	**
took and failed AP exam				
8th grade math score	-0.014	0.009	0.120	
% taking AP course	0.010	0.002	0.000	***
% low-income	0.002	0.002	0.465	
passed AP exam				
8th grade math score	-0.014	0.012	0.238	
% taking AP course	0.013	0.002	0.000	***
% low-income	0.002	0.002	0.387	

The outcome variable is the log odds ratio, ln p/(1-p), that a student will receive a bachelor's degree in five years, given that the student enrolled in a Texas public college or university within one year after high school graduation.
* = p < .05, ** = p < .01, *** = p < .001.

Appendix C
Ordinary Least Squares Analysis With School-Level Data

Question 3 in the paper asked:

Do high schools with a higher percentage of students in Advanced Placement have higher college graduation rates of their students who attend college, controlling for the measured characteristics of those schools?

To address this question, we followed the graduates of each high school who enrolled in a Texas public college or university within twelve months after high school graduation. For high schools with at least 500 students overall and at least 15 students in the student group in question (e.g., African American students) enrolling in a Texas public college, we calculated the five-year graduation rate for that group of college-enrolling students. That college graduation rate tied back to the high school was the dependent variable in an ordinary least squares (OLS) regression analysis in which the independent variables were the school's percent of low-income students; the district longitudinal dropout rate (to allow for attrition rates); the school's percent of students in the ethnic group in question (for the ethnic group regressions); the average prior 8th grade mathematics test scores of the student group in question, and the percent of students in the group taking advanced non-AP mathematics and science courses (mostly Algebra 2, Precalculus, and advanced courses in biology, chemistry, and physics), AP courses, and AP exams.

Thus, the regression equation for Group i (where i = African-American, Hispanic, White, Low-Income, or Non-Low-Income) in School J is:

$$grad_{iJ} = B_0 + B_1(lowinc)_J + B_2\,(district\_dropout\_rate) + B_3\,(group\_pct)_J + B_4\,(avg\_8^{th}\_math\_score)_J + B_5\,(adv\_courses)_{iJ} + B_6\,(AP\_course)_{iJ} + B_7\,(fail\_AP\_exam)_{iJ} + B_8\,(pass\_AP\_exam)_{iJ} + u_{iJ}$$

where

lowinc =	the schoolwide percent of low-income students
district_dropout_rate =	the percent of the original cohort that dropped out of the district before high school graduation
group_pct =	the percentage of each student subgroup in the school
avg_8th_math_score =	the average 8th grade math score of the subgroup
adv_courses =	percentage of the subgroup taking advanced math and science courses other than academic AP courses
AP_course =	percentage of the subgroup who took at least one academic AP course but no academic AP exams
Fail_AP_exam =	percentage of the subgroup who took one or more academic AP exams, but did not pass any of them
Pass_AP_exam =	percentage of the subgroup who took and passed at least one academic AP exam with a score of 3 or above

Table C1 presents the coefficients from the five student subgroup regression models. As shown in the table, AP exam passing has a statistically significant relationship to college graduation for all groups except African-Americans. We believe that the result for African-American students is most likely an artifact of the fact that only 61 African-American students in the cohort passed at least one AP exam. Thus in our school-level data there was little variation across schools in the percent of African-American students passing exams, the number being zero in most cases. An independent variable that varies little across observations is unlikely to show much predictive power.

Table C1
School-Level OLS Model Predicting Five-Year College Graduation Rates

	coefficient	std error	p-value	significance
African American Model				
% low-income	-0.138	0.057	0.018	**
district dropout rate	-0.084	0.140	0.547	
% African American	-0.024	0.038	0.517	
8th grade math score	0.022	0.091	0.812	
% took non-AP advanced courses	0.088	0.050	0.081	*
% took AP course, no exam	0.102	0.061	0.101	
% took and failed AP exam	0.177	0.081	0.031	**
% took and passed AP exam	0.213	0.154	0.169	
Hispanic Model				
% low-income	-0.107	0.039	0.007	***
district dropout rate	-0.055	0.073	0.455	
% Hispanic	0.062	0.029	0.035	**
8th grade math score	0.421	0.095	0.000	***
% took non-AP advanced courses	-0.013	0.029	0.654	
% took AP course, no exam	-0.002	0.043	0.963	
% took and failed AP exam	0.012	0.050	0.814	
% took and passed AP exam	0.267	0.084	0.002	***
White Model				
% low-income	-0.075	0.046	0.101	
district dropout rate	-0.283	0.064	0.000	***
% White	-0.032	0.032	0.318	
8th grade math score	0.369	0.087	0.000	***
% took non-AP advanced courses	0.057	0.034	0.093	*
% took AP course, no exam	0.042	0.035	0.230	
% took and failed AP exam	0.026	0.055	0.640	
% took and passed AP exam	0.186	0.050	0.000	***
Low-Income Model				
district dropout rate	-0.042	0.059	0.484	
% low-income	-0.019	0.016	0.222	
8th grade math score	0.189	0.065	0.004	***
% took non-AP advanced courses	0.012	0.024	0.627	
% took AP course, no exam	0.056	0.032	0.080	*
% took and failed AP exam	0.051	0.045	0.259	
% took and passed AP exam	0.315	0.069	0.000	***
Non-Low-Income Model				
district dropout rate	-0.236	0.057	0.000	***
% non-low-income	0.093	0.021	0.000	***
8th grade math score	0.219	0.069	0.002	***
% took non-AP advanced courses	0.045	0.029	0.117	
% took AP course, no exam	0.051	0.031	0.100	*
% took and failed AP exam	-0.003	0.045	0.942	
% took and passed AP exam	0.229	0.045	0.000	***

Appendix D

Differences in College Graduation Rates Compared with Students Not Participating in Advanced Placement

Figure 1
Increase in College Graduation Rates
Compared with Students Taking No Academic AP Course or Exam
African-American Students

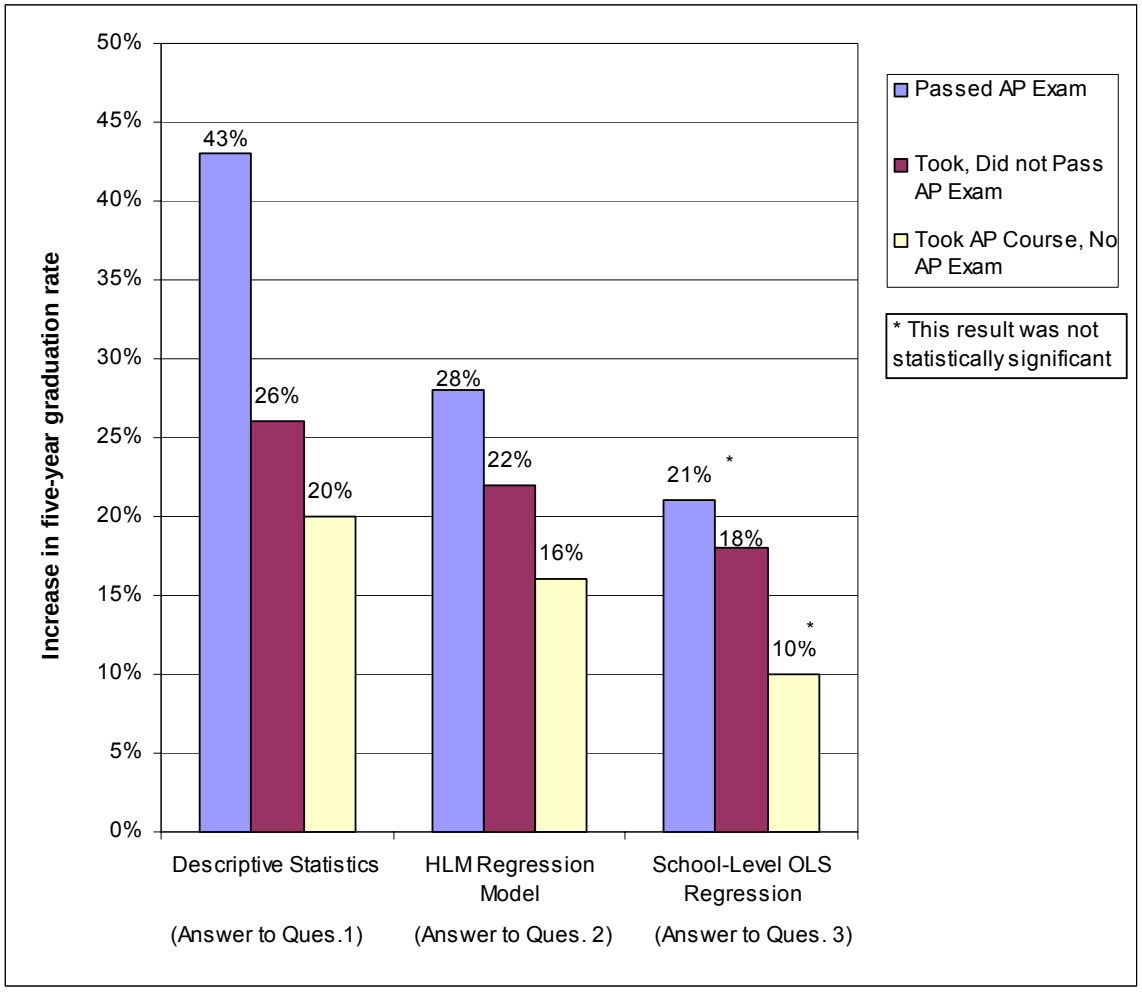

Figure 2
Increase in College Graduation Rates
Compared with Students Taking No Academic AP Course or Exam
Hispanic Income Students

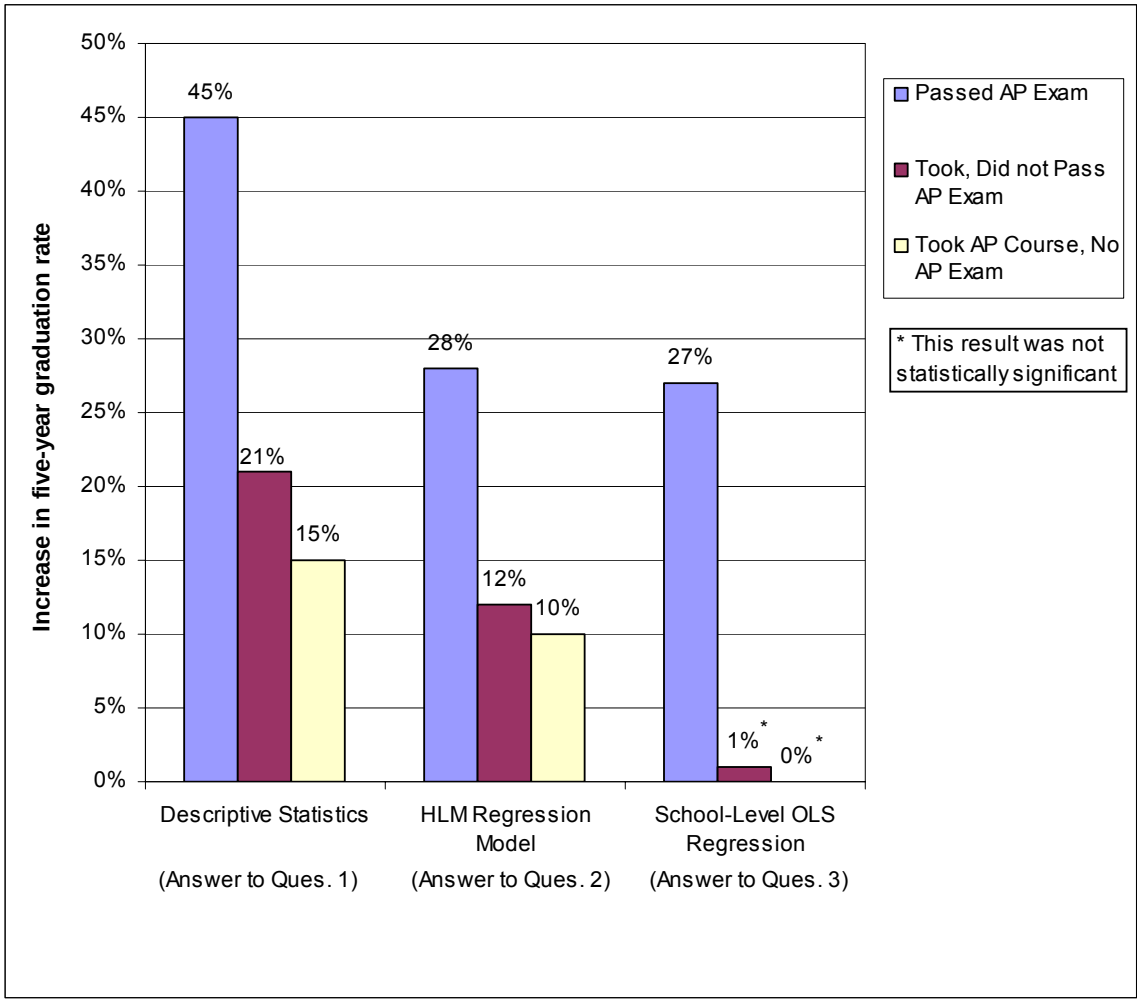

Figure 3
Increase in College Graduation Rates
Compared with Students Taking No Academic AP Course or Exam
White Students

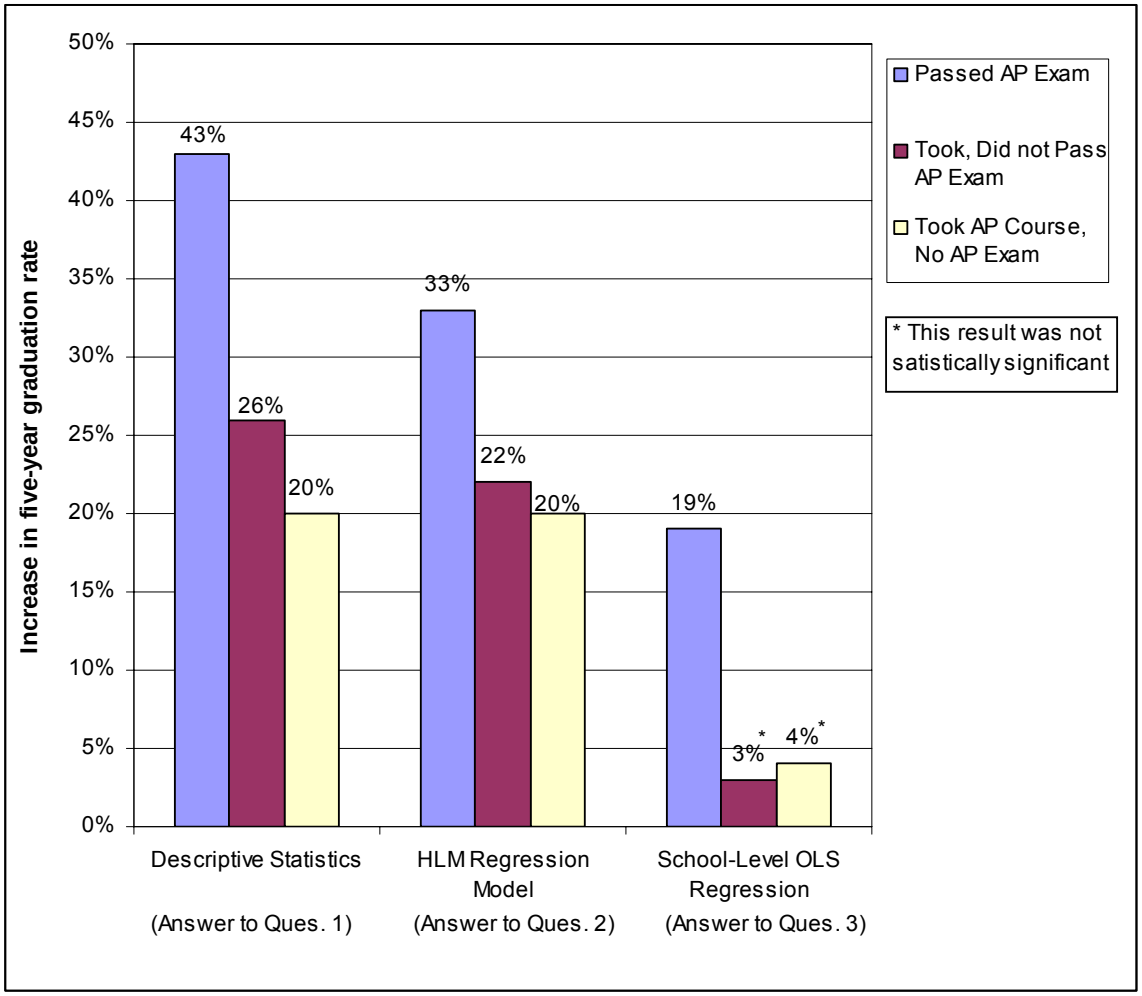

Figure 4
Increase in College Graduation Rates
Compared with Students Taking No Academic AP Course or Exam
Low-Income Students

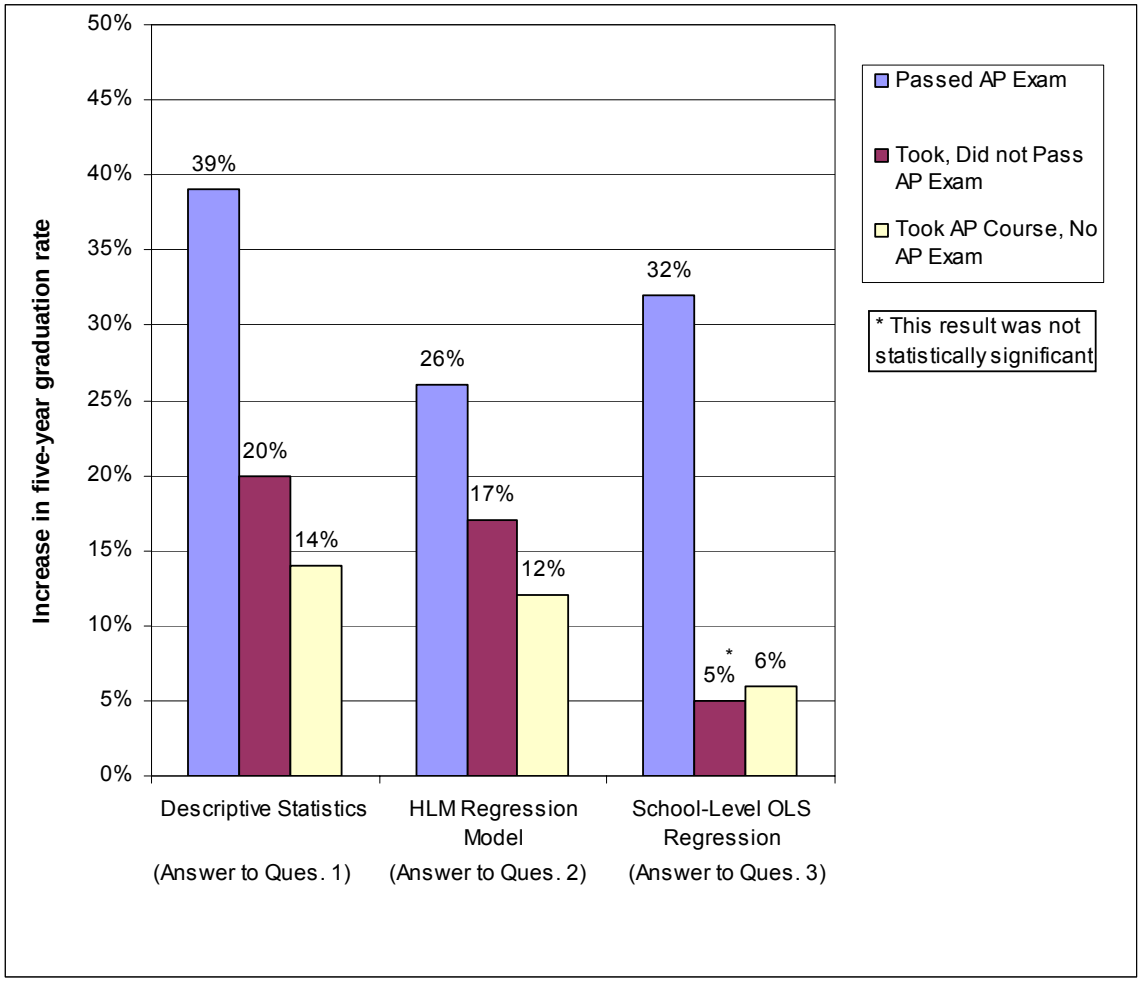

Figure 5
Increase in College Graduation Rates
Compared with Students Taking No Academic AP Course or Exam
Non Low-Income Students