



**Research Report**

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A Comparison  
of College  
Performances  
of AP<sup>®</sup> and  
Non-AP Student  
Groups in  
10 Subject Areas

**Leslie Keng and Barbara G. Dodd**



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# Abstract

This study sought to compare the performance of students in the College Board Advanced Placement Program® (AP®) compared to non-AP students on a number of college outcome measures. Ten individual AP Exams were examined in this study of students in four entering classes (1998–2001) at the University of Texas at Austin. The four main groups of students compared included AP students who earned college credit with their AP Exam grade (AP Credit), AP students who did not earn college credit with their AP Exam grade (AP No Credit), non-AP students who were concurrently enrolled in a college-level course while they were still in high school (Concurrent), and a group of non-AP students that were matched on high school academic achievement to the AP Credit students (Non-AP). The college outcome measures included first-year credit hours and GPA, subject or subject area credit hours and GPA, overall college credit hours and GPA, and sequent course grade. Results showed that for each of the 10 individual AP Exam subjects, AP Credit students consistently outperformed non-AP students of similar academic ability in all college outcome measures. Concurrent students generally earned more college credit hours in the related subject area than the other groups of students. However, the Concurrent group's average GPAs in those related subject courses were no higher than those of the other groups. The study's results support previous research that showed that AP students performed as well if not better than non-AP students on most college outcome measures. These findings imply that the results found in these previous studies still apply, even with the rapid expansion of the AP Program.

## Introduction

The College Board Advanced Placement Program (AP) offers college-level classes to high school students while they are still enrolled in high school. The courses and exams are developed by Development Committees composed of an equal number of college professors and high school AP teachers with expertise in the subject matter. There are currently 37 different exams. All AP Exams except Studio Art consist of a multiple-choice section and a free-response section. Scores on the two sections are combined to create a composite score, which in turn is transformed to a 1-to-5 scale for reporting purposes. The American Council on Education recommends that students who earn an AP Exam grade of 3 or higher be considered qualified for placement beyond the entry-level college course, or eligible for college credit by exam in the AP subject matter. However, individual colleges and universities set their own AP

credit and exemption policies. As a consequence, the policies vary from institution to institution. In general, students who achieve a grade of 3 or higher on an AP Exam typically place out of one or more introductory courses in the AP subject. Students who earn an AP Exam grade of 2 may also qualify for placement out of entry-level college courses or credit by exam for some subject areas depending on the college or university policy.

Previous research has shown that students who place out of the introductory course on the basis of the AP Exam grade perform as well if not better in the sequent course than students who take the prerequisite course (Casserly, 1986; Dodd, Fitzpatrick, De Ayala, and Jennings, 2002; Koch, Fitzpatrick, Triscari, Mahoney, and Cope, 1988; Morgan and Crone, 1993; Morgan and Ramist, 1998). In addition, Dodd et al. (2002), Koch et al. (1988), Morgan and Maneckshana (2000), and Willingham and Morris (1986) found that students who take AP Exams typically earn more hours in the AP subject area than non-AP students, that is, students who do not take the exam. Morgan and Maneckshana (2000) also observed that students who took AP Exams tended to major or minor in the AP subject area or a closely related area. Dodd et al. (2002) found that students who earn credit by exam via the AP Exam also earn higher grade point averages (GPAs) in additional courses in the subject area than other student groups.

Several studies have evaluated the effect of student participation in the AP Program using cumulative grade point average (GPA) at different points in time during the college years as an outcome measure. Geiser and Santelices (2004) used second-year GPA as one criterion measure to evaluate the predictive validity of the number of AP courses, AP Exam grades, and other variables. The goal of their research was to determine the utility of AP course participation data in the admissions process. They found that the average AP Exam grade was predictive of second-year GPA, while the number of AP courses taken was not predictive of second-year GPA. Camara and Michaelides (2005), however, questioned whether or not the collinearity among the predictors might account for the results.

In a follow-up study to Morgan and Ramist (1998), Morgan and Maneckshana (2000) also used GPAs collected five years after the student entered one of 21 colleges to evaluate the effectiveness of the AP Program. Students who earned high AP Exam grades had higher GPAs than students who earned lower grades on the AP Exam. They also looked at four- and five-year graduation rates and found that most of the AP students who took exams graduated in four years. Dougherty, Mellor, and Jian (2005) also found that students who took AP courses and earned grades of 3 or higher on the AP Exam graduated in five years at a higher rate than AP students who earned grades of less than 3 on the

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AP Exam, AP students who did not take the exam, and students who did not take AP courses or exams. All AP groups also graduated at a higher rate than the non-AP students.

According to the College Board's AP Central® Web site, the number of schools participating in the AP Program increased 12 percent from 1995 to 2004. In 1995, 493,263 students took 767,881 AP Exams. In 2005, more than 1.2 million students took 2.1 million AP Exams. Over the past 10 years, the number of students taking AP Exams has grown 8 percent to 11 percent annually, and the number of exams has increased 9 percent to 12 percent each year. Due to this rapid growth, some researchers have questioned whether or not the results found in previous studies still apply to the expanded AP Program (Hurwitz and Hurwitz, 2003; Klopfenstein, 2004; Lichten, 2000).

Clearly, new research is warranted to determine if the results found in earlier studies still hold true after this period of growth. Also, previous research needs to be refined to determine whether there are differences in college outcomes among three different types of AP students: (1) students who take AP Exams and score high enough to receive college credit and place out of an entry-level college course; (2) students who take AP Exams but do not score high enough to receive college credit; and (3) students who take AP Exams and score high enough to earn course credit, but then elect to take the entry-level course. These AP groups should also be compared to other non-AP groups of students, such as those who concurrently enrolled in college classes while still in high school.

Accordingly, the present study extends previous research by comparing college-level performance of AP students with matched non-AP students and concurrently enrolled students in a larger number of AP subject areas. For four entering classes at the University of Texas at Austin, the 10 most frequently taken AP subject area exams are investigated. In addition to the number of credit hours and GPA earned in each subject area, the study analyzes college outcome measures such as the number of credit hours and GPA earned during the first year, and overall college credit hours and GPA earned. Specifically, the research question addressed by this study is: Are there differences in college outcome measures among AP students who do not earn credit by exam, AP students who earn credit by exam, non-AP students, and students who concurrently enroll in university courses while still in high school?

## Method

### Data Source

The AP Exams that were taken most frequently by the students at the university were selected to ensure that sufficient data were available for the study. University records and College Board records identified the same most frequently taken AP Exam subject areas. The subject areas identified were in the following 10 AP Exam subjects: Biology, Calculus AB, Calculus BC, Chemistry, Macroeconomics, English Language and Composition, English Literature and Composition, United States Government and Politics, United States History, and Spanish Language. The number of courses students may place out of and the minimum AP Exam grade needed to place out of the courses vary for each subject and across academic years.

The data were obtained from the university's student records database for the 1998–2001 entering classes. Using four entering classes provided the means to determine whether the results are replicable across years. The entering freshman class sizes were 5,910, 6,345, 6,467, and 6,219 for the 1998, 1999, 2000, and 2001 academic years, respectively. Variables obtained from the university's database include grades on all AP Exams, grades and dates of all college courses, overall college GPAs, high school ranks, and admission test scores (SAT® and ACT). Transfer credits, date of first semester in college, and high school graduation date were also obtained in order to identify the students who were concurrently enrolled in a college class in each subject while still in high school. From these data, first-year credit hours and GPAs were computed, along with the number of credit hours and college GPAs in subjects related to each individual AP Exam. Where possible, grades in the sequent course in those subjects where the department specified the next course were also analyzed.

### Participants and Samples

The distribution of AP Exam grades in each of the four entering classes was compared to the distribution of AP Exam grades in the U.S. national sample for the corresponding year. Data for the national sample were obtained from the College Board's AP Central Web site. Across all 10 AP Exams, the AP Exam grade distributions did not differ dramatically between the university sample and the national sample in each of the four entering classes. The mean AP Exam grade was also similar for the two groups.



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The research question was addressed by identifying and comparing four groups of students in each of 10 AP Exam subjects for each of the four entering classes (1998–2001). The four groups of students were:

- *AP Credit group.* This group consisted of students who earned credit by exam based on their AP Exam grade.
- *AP No Credit group.* This group included students who took the AP Exam but did not earn credit by exam via their AP Exam grade. They also needed to have credit hours for at least one college course in the related subject.
- *Concurrent group.* This group consisted of students who did not take the AP Exam and, while still in high school, concurrently enrolled in one of the corresponding college courses for which the AP students can receive credit with the AP Exam.
- *Non-AP group.* This group included students who did not take the AP Exam and did not concurrently enroll in any of the corresponding college courses while still in high school. They also needed to have credit hours for at least one college course in the related subject.

An additional group investigated was AP students who scored above the minimum grade on the AP Exam but elected not to accept the credit by exam and took the introductory subject courses at the university. This group is denoted as the *AP Did Not Claim CBE group*. With the exception of the AP Calculus AB Exam, all AP Did Not Claim CBE groups were substantially smaller ( $N$ 's = 10 to 35) than the four main comparison groups. These group sizes were deemed too small to warrant inclusion as a separate comparison group. As a result, the AP Did Not Claim CBE group was only included in the analyses for the AP Calculus AB Exam.

Note that the comparison groups described above were formed independently for each AP Exam. Thus, for example, a student could have taken the AP Calculus AB Exam and attained credit by exam based on that exam grade. However, he or she also could have elected not to take the AP United States History Exam. This student would, therefore, be classified into the AP Credit group for the AP Calculus AB Exam, but be in the Non-AP group for AP United States History.

## Data Analysis Procedure

The analyses for this study compared, for each AP Exam and within each entering class, the included groups on up to seven dependent measures. Because the sample

size for the Non-AP group was generally much larger than the other groups, it was matched to the AP Credit group in terms of SAT total scores (or ACT scores, if SAT scores were unavailable) and high school ranks. The dependent measures included overall college credit hours taken and GPA, first-year credit hours taken and first-year GPA, college credit hours taken in the subject and subject GPA, and grades in any sequent courses. Of the 10 AP Exam subjects analyzed, only four had a specific sequent course in the subject area. They were AP Biology (BIO 303) in 1998 and 1999,<sup>1</sup> AP Calculus AB (M 408D), AP Calculus BC (M 408D), and AP English Language and Composition (E 316K). Note that any college credit hours and grades earned from receiving AP credit by exam or through concurrent enrollment were included in the computation of the various credit hour and GPA-dependent measures.

To accomplish the matching of the Non-AP group to the AP Credit group, we divided the range of high school ranks into five percentile rank categories. The range of SAT total score was divided into 100-point increments from 400 to 1,600. If only ACT scores were available, the scores were converted to SAT scores using a concordance table (Schneider and Dorans, 1999). Every student in the AP Credit group was assigned to one of the strata based on the classification of high school rank by test score categories. The Non-AP group was then randomly sampled to select an equal number, as in each of the strata in the AP Credit group. In several instances, an insufficient number of non-AP students were available to be selected for some of the strata. Thus, the matched Non-AP groups had smaller sample sizes than the intact AP Credit groups in those cases. Note that matching was only performed on the Non-AP group to the AP Credit group. The AP No Credit and Concurrent groups were not matched to any group and hence stayed intact in the reported analyses.<sup>2</sup> Reductions in sample sizes for these groups in the analyses were the result of listwise deletion due to missing data.

For each AP Exam subject and within each entering class, the analyses performed included, first, a one-way multivariate analysis of variance (MANOVA) to detect overall differences in the multivariate means of the dependent variables across the comparison groups. If the MANOVA yielded a statistically significant result, then univariate analysis of variances (ANOVAs) were run on each dependent variable to identify differences in specific dependent variables. For the dependent variables that resulted in statistically significant ANOVAs, pairwise post-hoc comparisons using the Tukey–Kramer adjustments

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<sup>1</sup> Beginning in the 2000–01 academic year, entering freshmen could receive credit by exam for the entire introductory Biology course sequence at the university. As a result, there was no specified Biology sequent course. The minimum AP Biology Exam grade to receive credit by exam, however, was raised to 4 (from 3) starting in 2000–01.

<sup>2</sup> Additional analyses that, for each AP Exam, directly compared the Concurrent group to a matched AP Credit group were also performed on the same set of dependent measures. In general, the direction of these results matched the findings of the unmatched group comparisons that are represented in this paper. The results of these additional analyses are available by request from the authors.

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(Kramer, 1956) were performed on the least-square means (LS-means) to determine which groups differed significantly on the dependent variable. LS-means were used because the sample sizes across the comparison groups were unbalanced. This was the case even after matching the Non-AP group to the AP Credit group because the AP No Credit and Concurrent groups generally had much smaller group sizes. LS-means are predicted population margins; they are estimates of marginal means over a balanced population and are considered better comparisons than raw means in unbalanced designs. Note that only six of the seven dependent measures—the three GPA and three credit hours measures—were included in the MANOVAs. Sequent course grades were not included because a substantially smaller subset of students within each AP Exam usually had such grades. In order to not reduce the sample size for the MANOVA, a separate univariate ANOVA was performed for sequent course grades across the groups. The significance level used in all MANOVAs, ANOVAs, and post-hoc comparisons was  $\alpha = 0.05$ .

Finally, the effect size measure, partial  $\eta^2$  (Stevens, 1999; Olejnik and Algina, 2003) was computed for the group effect for each credit hour- and GPA-dependent measure across the 10 AP Exams and four entering classes. It quantifies the magnitude of the difference between the groups for each dependent measure beyond the tests of statistical significance described above.

# Results

## MANOVA

Table 1 summarizes the one-way MANOVA results. The table shows that all 40 MANOVAs yielded statistically significant differences in the multivariate means of the comparison groups at  $\alpha = 0.05$ .

Because the MANOVAs for all AP Exam subjects in all four entering classes were statistically significant, they

were each followed up with post-hoc analyses, which included univariate ANOVAs and multiple pairwise Tukey–Kramer comparisons of the LS-means for the three credit hour and three GPA outcome measures. In addition, separate univariate ANOVAs were run on sequent course grades for the four AP Exam subjects that had sequent courses at the university. The sample sizes and LS-means used in the analyses are given in Tables 2–11 for the 10 individual AP Exams, and the following sections summarize these results.

**Table 1**

MANOVA Results					
<i>Subject</i>	<i>Year</i>	<i>Wilks' Lambda</i>	<i>F</i>	<i>DF for F</i>	<i>Pr &gt; F</i>
AP Biology	1998	0.803	8.73	(18, 1949)	<0.001
	1999	0.784	10.91	(18, 2181)	<0.001
	2000	0.789	13.33	(12, 1274)	<0.001
	2001	0.786	10.30	(18, 2085)	<0.001
AP Calculus AB	1998	0.880	11.39	(18, 4421)	<0.001
	1999	0.873	14.21	(18, 5199)	<0.001
	2000	0.907	11.14	(18, 5734)	<0.001
	2001	0.882	16.71	(18, 6644)	<0.001
AP Calculus BC	1998	0.801	10.26	(18, 2263)	<0.001
	1999	0.826	8.96	(18, 2300)	<0.001
	2000	0.810	12.69	(18, 2959)	<0.001
	2001	0.789	15.80	(18, 3256)	<0.001
AP Chemistry	1998	0.800	5.72	(18, 1253)	<0.001
	1999	0.764	7.73	(18, 1392)	<0.001
	2000	0.768	8.53	(18, 1573)	<0.001
	2001	0.754	9.95	(18, 1703)	<0.001
AP Macroeconomics	1998	0.896	3.70	(18, 1683)	<0.001
	1999	0.848	5.05	(18, 1517)	<0.001
	2000	0.844	6.94	(18, 2020)	<0.001
	2001	0.861	4.71	(18, 1553)	<0.001
AP English Language and Composition	1998	0.880	19.47	(18, 7569)	<0.001
	1999	0.895	19.99	(18, 8986)	<0.001
	2000	0.871	26.32	(18, 9487)	<0.001
	2001	0.871	25.43	(18, 9111)	<0.001
AP English Literature and Composition	1998	0.856	22.49	(18, 7182)	<0.001
	1999	0.857	24.97	(18, 8045)	<0.001
	2000	0.849	27.11	(18, 8211)	<0.001
	2001	0.857	24.21	(18, 7745)	<0.001
AP Government and Politics: United States	1998	0.828	9.94	(18, 2586)	<0.001
	1999	0.799	13.59	(18, 2968)	<0.001
	2000	0.809	14.97	(18, 3462)	<0.001
	2001	0.779	16.69	(18, 3259)	<0.001
AP History: United States	1998	0.762	17.30	(18, 3086)	<0.001
	1999	0.787	16.24	(18, 3307)	<0.001
	2000	0.814	16.44	(18, 3915)	<0.001
	2001	0.808	17.18	(18, 3955)	<0.001
AP Spanish	1998	0.720	17.19	(18, 2509)	<0.001
	1999	0.690	21.15	(18, 2719)	<0.001
	2000	0.696	23.24	(18, 3067)	<0.001
	2001	0.718	21.41	(18, 3103)	<0.001

## AP Biology

Table 2 presents the analysis results for the AP Biology groups. Note that the Concurrent groups in 2000 and 2001 were deemed too small for inclusion in the analysis.

The table shows that the AP Credit group significantly outperformed the AP No Credit group in overall college credit hours and GPA, first-year GPA, subject (biology) credit hours, and GPA for all four entering classes, and first-year credit hours in three of the four classes. In addition, compared to the Non-AP group, the AP Credit group had significantly higher LS-means for overall college credit hours and subject credit hours and GPA in all four entering classes, and for first-year credit hours in two of the entering classes. For the two entering classes with large enough Concurrent groups (1998 and 1999), the AP Credit group had significantly higher biology GPA than the Concurrent group in both years. The Concurrent group, on the other hand, earned

significantly more biology credit hours than the Non-AP and AP No Credit groups in both years.

The Non-AP group also outperformed the AP No Credit group on several outcome measures, especially the three GPA-dependent measures. The Non-AP students had significantly higher LS-means for first-year and subject GPAs in all four entering classes and for overall GPA in two of the four classes. They also earned significantly more college credit hours overall in two of the four years. The AP No Credit group, however, earned significantly more biology credit hours than the Non-AP group in two of the four years.

Overall, three primary trends were observed in the AP Biology analysis. They included: the AP Credit students performing consistently better than the other three groups, particularly in their biology GPAs; the Concurrent students earning the most biology credit hours; and the Non-AP students achieving better GPAs in

**Table 2**

Descriptive Statistics and Pairwise Comparison Results for AP Biology

Dependent Measure	Group	1998		1999		2000		2001	
		N	Mean/Rate	N	Mean/Rate	N	Mean/Rate	N	Mean/Rate
Overall College Credit Hours	AP Credit	359	159.12 <sup>ab</sup>	394	158.24 <sup>ab</sup>	231	161.21 <sup>ab</sup>	284	135.46 <sup>ab</sup>
	AP No Credit	108	134.09 <sup>ad</sup>	122	135.72 <sup>ad</sup>	268	133.07 <sup>ad</sup>	287	115.11 <sup>a</sup>
	Non-AP	359	146.75 <sup>bd</sup>	393	143.66 <sup>b</sup>	231	144.86 <sup>bd</sup>	284	122.75 <sup>b</sup>
	Concurrent	58	155.88	70	159.74 <sup>e</sup>				
Overall College GPA	AP Credit	359	3.20 <sup>a</sup>	394	3.32 <sup>a</sup>	231	3.38 <sup>a</sup>	284	3.23 <sup>a</sup>
	AP No Credit	108	2.92 <sup>a</sup>	122	2.90 <sup>ad</sup>	268	3.03 <sup>a</sup>	287	2.97 <sup>ad</sup>
	Non-AP	359	3.14	393	3.18 <sup>d</sup>	231	3.18	284	3.22 <sup>d</sup>
	Concurrent	58	2.88	70	3.21				
First-Year Credit Hours	AP Credit	359	40.32 <sup>abc</sup>	394	39.67 <sup>ab</sup>	231	38.72 <sup>a</sup>	284	37.76
	AP No Credit	108	34.23 <sup>a</sup>	122	35.78 <sup>a</sup>	268	35.05 <sup>a</sup>	287	36.97
	Non-AP	359	36.78 <sup>b</sup>	393	35.25 <sup>b</sup>	231	37.23	284	35.84
	Concurrent	58	29.75 <sup>c</sup>	70	35.37				
First-Year GPA	AP Credit	358	3.30 <sup>a</sup>	394	3.41 <sup>a</sup>	230	3.56 <sup>ab</sup>	284	3.40 <sup>a</sup>
	AP No Credit	108	2.96 <sup>ad</sup>	120	2.95 <sup>ad</sup>	267	3.08 <sup>ad</sup>	287	3.02 <sup>ad</sup>
	Non-AP	359	3.31 <sup>d</sup>	393	3.27 <sup>d</sup>	231	3.35 <sup>bd</sup>	284	3.37 <sup>d</sup>
	Concurrent	58	3.02	70	3.08				
Subject Credit Hours	AP Credit	359	18.21 <sup>ab</sup>	394	20.92 <sup>ab</sup>	231	24.68 <sup>ab</sup>	284	20.67 <sup>ab</sup>
	AP No Credit	108	12.74 <sup>ad</sup>	122	14.04 <sup>ad</sup>	268	16.37 <sup>ad</sup>	287	13.74 <sup>ad</sup>
	Non-AP	359	10.04 <sup>bf</sup>	393	10.64 <sup>bf</sup>	231	12.44 <sup>bd</sup>	284	9.58 <sup>bd</sup>
	Concurrent	58	21.88 <sup>ef</sup>	70	26.22 <sup>ef</sup>				
Subject GPA	AP Credit	231	3.24 <sup>abc</sup>	253	3.33 <sup>abc</sup>	169	3.54 <sup>ab</sup>	209	3.37 <sup>ab</sup>
	AP No Credit	104	2.73 <sup>ad</sup>	121	2.66 <sup>ad</sup>	258	2.77 <sup>ad</sup>	275	2.78 <sup>ad</sup>
	Non-AP	348	3.03 <sup>bd</sup>	380	2.98 <sup>bd</sup>	220	3.14 <sup>bd</sup>	260	3.14 <sup>bd</sup>
	Concurrent	16	2.51 <sup>c</sup>	27	2.86 <sup>c</sup>				
Sequent Course (BIO303) Grade	AP Credit	97	2.99	81	2.70				
	AP No Credit	36	2.72 <sup>d</sup>	20	2.55				
	Non-AP	88	3.24 <sup>d</sup>	68	2.91				
	Concurrent	6	2.50	4	2.00				

Note: Means with matching superscript letters within each year and dependent measure are significantly different at the  $\alpha = 0.05$  level.

<sup>a</sup> The pairwise comparison between the AP Credit and AP No Credit groups on the dependent measure is statistically significant.

<sup>b</sup> The pairwise comparison between the AP Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>c</sup> The pairwise comparison between the AP Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>d</sup> The pairwise comparison between the AP No Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>e</sup> The pairwise comparison between the AP No Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>f</sup> The pairwise comparison between the Non-AP and Concurrent groups on the dependent measure is statistically significant.

their first year, in biology courses, and overall compared to the AP No Credit group.

## AP Calculus AB

Table 3 gives the comparison results for AP Calculus AB. In all four entering classes, there were no students in the Concurrent group; thus, it was excluded from the analysis. AP Calculus AB, however, was the only AP Exam that had a sufficient number of students in the AP Did Not Claim CBE group. Consequently, AP Calculus AB also had four comparison groups.

The table shows that the AP Credit group substantially outperformed the AP No Credit group. The LS-means

for every outcome measure in all entering classes were significantly higher for the AP Credit group in all but two instances: first-year credit hours in 1999 and 2000. The AP Credit group also performed significantly better than the matched Non-AP group in most comparisons. The AP Credit group had higher LS-means for overall college credit hours and first-year GPA in all four entering classes; for overall college GPA, first-year credit hours, subject (mathematics) credit hours, and GPA in three of the four classes; and for sequent course (M 408D) grades in two of the four classes. Thus, the AP Credit students were generally superior in college performance than those in the AP No Credit and Non-AP groups.

**Table 3**

Descriptive Statistics and Pairwise Comparison Results for AP Calculus AB

Dependent Measure	Group	1998		1999		2000		2001	
		N	Mean/Rate	N	Mean/Rate	N	Mean/Rate	N	Mean/Rate
Overall College Credit Hours	AP Credit	620	148.07 <sup>ab</sup>	726	144.87 <sup>ab</sup>	776	140.08 <sup>ab</sup>	891	121.70 <sup>abc</sup>
	AP No Credit	288	134.91 <sup>ae</sup>	361	132.04 <sup>a</sup>	437	126.88 <sup>ade</sup>	536	103.76 <sup>ade</sup>
	Non-AP	620	138.00 <sup>b</sup>	726	134.63 <sup>b</sup>	775	133.54 <sup>bcd</sup>	891	113.62 <sup>bcd</sup>
	AP Did Not Claim CBE	110	145.68 <sup>e</sup>	140	137.05	155	136.90 <sup>e</sup>	183	113.13 <sup>ce</sup>
Overall College GPA	AP Credit	620	3.18 <sup>ab</sup>	726	3.21 <sup>abc</sup>	776	3.24 <sup>ab</sup>	891	3.08 <sup>a</sup>
	AP No Credit	288	2.88 <sup>a</sup>	361	2.88 <sup>ad</sup>	437	2.88 <sup>ade</sup>	536	2.86 <sup>ad</sup>
	Non-AP	620	3.03 <sup>b</sup>	726	3.05 <sup>bcd</sup>	776	3.10 <sup>bcd</sup>	891	3.00 <sup>d</sup>
	AP Did Not Claim CBE	110	3.01	140	2.96 <sup>c</sup>	155	3.16 <sup>e</sup>	183	2.97
First-Year Credit Hours	AP Credit	620	38.09 <sup>ab</sup>	726	36.39 <sup>b</sup>	776	36.32	891	36.57 <sup>ab</sup>
	AP No Credit	288	34.59 <sup>a</sup>	361	34.94	437	35.20	536	34.77 <sup>a</sup>
	Non-AP	620	36.15 <sup>b</sup>	726	34.78 <sup>bf</sup>	776	35.38	891	34.60 <sup>b</sup>
	AP Did Not Claim CBE	110	36.37	140	37.28 <sup>f</sup>	155	36.44	183	35.96
First-Year GPA	AP Credit	620	3.33 <sup>ab</sup>	725	3.35 <sup>abc</sup>	775	3.35 <sup>ab</sup>	886	3.36 <sup>abc</sup>
	AP No Credit	288	2.92 <sup>ade</sup>	361	2.95 <sup>ad</sup>	437	3.02 <sup>ade</sup>	535	2.97 <sup>ade</sup>
	Non-AP	618	3.14 <sup>bcd</sup>	724	3.15 <sup>bcd</sup>	773	3.20 <sup>bcd</sup>	889	3.20 <sup>bcd</sup>
	AP Did Not Claim CBE	110	3.24 <sup>e</sup>	140	3.11 <sup>c</sup>	155	3.26 <sup>e</sup>	183	3.18 <sup>ce</sup>
Subject Credit Hours	AP Credit	620	15.09 <sup>ab</sup>	726	14.21 <sup>abc</sup>	776	13.85 <sup>ab</sup>	891	13.07 <sup>abc</sup>
	AP No Credit	288	11.98 <sup>ae</sup>	361	12.61 <sup>ae</sup>	437	12.13 <sup>ae</sup>	536	11.17 <sup>ae</sup>
	Non-AP	620	12.27 <sup>bf</sup>	726	11.98 <sup>bf</sup>	776	12.35 <sup>bf</sup>	891	11.84 <sup>bf</sup>
	AP Did Not Claim CBE	110	16.25 <sup>ef</sup>	140	16.38 <sup>cef</sup>	155	15.55 <sup>ef</sup>	183	15.11 <sup>cef</sup>
Subject GPA	AP Credit	604	3.41 <sup>abc</sup>	702	3.49 <sup>abc</sup>	752	3.49 <sup>abc</sup>	858	3.46 <sup>abc</sup>
	AP No Credit	277	2.82 <sup>ade</sup>	344	2.79 <sup>ad</sup>	419	2.91 <sup>ade</sup>	511	2.76 <sup>ade</sup>
	Non-AP	583	3.08 <sup>bcd</sup>	664	3.04 <sup>bcd</sup>	714	3.16 <sup>bcd</sup>	813	3.13 <sup>bcd</sup>
	AP Did Not Claim CBE	110	3.13 <sup>ce</sup>	140	3.00 <sup>c</sup>	155	3.26 <sup>ce</sup>	183	3.09 <sup>ce</sup>
Sequent Course (M 408D) Grade	AP Credit	380	3.04 <sup>a</sup>	410	3.26 <sup>abc</sup>	430	3.19 <sup>ab</sup>	489	3.05 <sup>a</sup>
	AP No Credit	98	2.54 <sup>ade</sup>	144	2.45 <sup>ade</sup>	165	2.56 <sup>ade</sup>	196	2.45 <sup>ade</sup>
	Non-AP	225	2.89 <sup>d</sup>	250	2.93 <sup>bcd</sup>	269	2.88 <sup>bcd</sup>	297	3.03 <sup>d</sup>
	AP Did Not Claim CBE	88	3.02 <sup>e</sup>	117	2.84 <sup>ce</sup>	127	3.08 <sup>e</sup>	144	2.96 <sup>e</sup>

Note: Means with matching superscript letters within each year and dependent measure are significantly different at the  $\alpha = 0.05$  level.

<sup>a</sup> The pairwise comparison between the AP Credit and AP No Credit groups on the dependent measure is statistically significant.

<sup>b</sup> The pairwise comparison between the AP Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>c</sup> The pairwise comparison between the AP Credit and AP Did Not Claim CBE groups on the dependent measure is statistically significant.

<sup>d</sup> The pairwise comparison between the AP No Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>e</sup> The pairwise comparison between the AP No Credit and AP Did Not Claim CBE groups on the dependent measure is statistically significant.

<sup>f</sup> The pairwise comparison between the Non-AP and AP Did Not Claim CBE groups on the dependent measure is statistically significant.

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The Non-AP group performed better than the AP No Credit group on the three GPA measures and sequent course grade. It had significantly higher LS-means for first-year GPA, math GPA, and sequent course grade in four entering classes and for overall GPA in three of the classes. It also earned significantly more overall college credit hours in two of the four years.

Because AP Calculus AB was the only AP Exam with sufficient sample sizes to include the AP Did Not Claim CBE group, a closer look at its results was taken.

First, compared to the AP Did Not Claim CBE group, the AP Credit group had a significantly higher math GPA in all four comparison years and higher first-year GPA in two of the years. Students in the AP Did Not Claim CBE group, however, earned significantly more math credit hours than the AP Credit students in the two of the four entering classes. This implies that although these two groups of AP students both attained high enough exam grades in AP Calculus AB to earn credit by exam for the introductory calculus course (M 408C), those who chose not to claim the credit did not perform as well in their math courses. They did, on the other hand, earn more math credit hours.

Second, compared to the AP No Credit group, the AP Did Not Claim CBE group had significantly more math credit hours and higher sequent course grades in all four comparison years, more overall college credit hours and higher math GPA in three of the four years, and higher first-year GPA in two of the years. Thus, AP Did Not Claim CBE students tended to be more proficient in college performance, especially in math, than AP No Credit students.

Finally, students in the AP Did Not Claim CBE group also had significantly more math credit hours than the Non-AP group in all four entering classes. Therefore, it seems that AP Did Not Claim CBE students consistently earn the most math credit hours in college compared to all other groups studied.



## AP Calculus BC

Table 4 presents the comparison results of the AP Calculus BC groups. Like those who took the AP Calculus AB Exam, students who received grades of 3 or higher on the AP Calculus BC Exam are eligible for credit by exam in the introductory differential and integral calculus class (M 408C). Unlike AP Calculus AB students, these AP Calculus BC students can also choose to receive credit by exam in two separate introductory differential and integral calculus courses (M 308K and M 308L). Students in the business school programs often choose this latter route. However, compared to the general university student population, only a small proportion of students

choose to do this. This is why the overall sample sizes of the AP Calculus BC groups were smaller than those of the AP Calculus AB groups. On the other hand, many students did concurrently enroll in M 308K and M 308L while they were still in high school. Thus, there were large enough sample sizes in all four years to include the Concurrent group in the AP Calculus BC analysis.

Two general patterns emerged from the comparison of the AP Calculus BC groups. The first was again the consistently better performance of the AP Credit group. The comparisons of the AP Credit group with the AP No Credit group are similar to what was observed in AP Biology and AP Calculus AB: The AP Credit group significantly outperformed the AP No Credit group in all

**Table 4**

Descriptive Statistics and Pairwise Comparison Results for AP Calculus BC

Dependent Measure	Group	1998		1999		2000		2001	
		N	Mean/Rate	N	Mean/Rate	N	Mean/Rate	N	Mean/Rate
Overall College Credit Hours	AP Credit	335	157. <sup>ab</sup>	339	154.58 <sup>ab</sup>	447	150.13 <sup>ab</sup>	486	132. <sup>ab</sup>
	AP No Credit	106	143.69 <sup>a</sup>	108	143.92 <sup>a</sup>	136	140.08 <sup>a</sup>	146	117. <sup>ae</sup>
	Non-AP	335	139.41 <sup>b</sup>	339	139.41 <sup>b</sup>	447	135.65 <sup>bf</sup>	486	118.00 <sup>bf</sup>
	Concurrent	72	149. <sup>7</sup>	84	145.16 <sup>7</sup>	87	153.44 <sup>f</sup>	96	136.81 <sup>ef</sup>
Overall College GPA	AP Credit	335	3.32 <sup>ab</sup>	339	3.34 <sup>abc</sup>	447	3.32 <sup>abc</sup>	486	3.14
	AP No Credit	106	3.01 <sup>a</sup>	108	2.95 <sup>a</sup>	136	3.06 <sup>a</sup>	146	3.09
	Non-AP	335	3.03 <sup>b</sup>	339	3.13 <sup>b</sup>	447	3.05 <sup>b</sup>	486	3.07
	Concurrent	72	3.05	84	2.97 <sup>c</sup>	87	3.00 <sup>c</sup>	96	3.06
First-Year Credit Hours	AP Credit	335	39.88 <sup>bc</sup>	339	40.34 <sup>abc</sup>	447	38.95 <sup>bc</sup>	486	37.17 <sup>c</sup>
	AP No Credit	106	39.86 <sup>a</sup>	108	35.47 <sup>a</sup>	136	37.13 <sup>a</sup>	146	37.59 <sup>a</sup>
	Non-AP	335	36.97 <sup>bf</sup>	339	35.06 <sup>b</sup>	447	35.43 <sup>b</sup>	486	35.61
	Concurrent	72	31.21 <sup>cef</sup>	84	34.97 <sup>c</sup>	87	32.31 <sup>ce</sup>	96	33.30 <sup>ce</sup>
First-Year GPA	AP Credit	335	3.47 <sup>abc</sup>	339	3.50 <sup>abc</sup>	447	3.49 <sup>abc</sup>	485	3.47 <sup>abc</sup>
	AP No Credit	106	3.08 <sup>ad</sup>	108	3.19 <sup>a</sup>	136	3.23 <sup>a</sup>	146	3.21 <sup>a</sup>
	Non-AP	335	3.28 <sup>bcd</sup>	339	3.30 <sup>b</sup>	447	3.22 <sup>b</sup>	482	3.33 <sup>bf</sup>
	Concurrent	72	3.12 <sup>c</sup>	84	3.07 <sup>c</sup>	86	3.08 <sup>c</sup>	96	3.03 <sup>cf</sup>
Subject Credit Hours	AP Credit	335	17.79 <sup>ab</sup>	339	17.88 <sup>ab</sup>	447	17.99 <sup>bc</sup>	486	16.64 <sup>abc</sup>
	AP No Credit	106	14.94 <sup>ae</sup>	108	14.48 <sup>ae</sup>	136	16.55 <sup>de</sup>	146	12.75 <sup>ae</sup>
	Non-AP	335	13.03 <sup>bf</sup>	339	12.74 <sup>bf</sup>	447	12.11 <sup>bdf</sup>	486	11.58 <sup>bf</sup>
	Concurrent	72	19.88 <sup>ef</sup>	84	18.97 <sup>ef</sup>	87	21.66 <sup>cef</sup>	96	19.64 <sup>cef</sup>
Subject GPA	AP Credit	332	3.57 <sup>abc</sup>	337	3.62 <sup>abc</sup>	445	3.59 <sup>abc</sup>	485	3.60 <sup>abc</sup>
	AP No Credit	105	3.04 <sup>a</sup>	103	3.18 <sup>a</sup>	129	3.22 <sup>a</sup>	145	3.24 <sup>ae</sup>
	Non-AP	316	3.20 <sup>b</sup>	324	3.31 <sup>bf</sup>	420	3.21 <sup>b</sup>	466	3.26 <sup>bf</sup>
	Concurrent	56	3.09 <sup>c</sup>	58	2.94 <sup>cf</sup>	61	3.01 <sup>c</sup>	69	2.94 <sup>cef</sup>
Sequent Course (M 408D) Grade	AP Credit	203	3.37 <sup>ab</sup>	200	3.52 <sup>abc</sup>	286	3.44 <sup>ab</sup>	294	3.41 <sup>ab</sup>
	AP No Credit	62	2.71 <sup>a</sup>	66	2.89 <sup>a</sup>	80	2.85 <sup>a</sup>	84	2.81 <sup>ad</sup>
	Non-AP	145	2.96 <sup>b</sup>	137	3.09 <sup>b</sup>	170	3.13 <sup>b</sup>	177	3.16 <sup>bd</sup>
	Concurrent	21	2.81	24	2.83 <sup>c</sup>	19	3.05	27	2.93

Note: Means with matching superscript letters within each year and dependent measure are significantly different at the  $\alpha = 0.05$  level.

<sup>a</sup> The pairwise comparison between the AP Credit and AP No Credit groups on the dependent measure is statistically significant.

<sup>b</sup> The pairwise comparison between the AP Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>c</sup> The pairwise comparison between the AP Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>d</sup> The pairwise comparison between the AP No Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>e</sup> The pairwise comparison between the AP No Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>f</sup> The pairwise comparison between the Non-AP and Concurrent groups on the dependent measure is statistically significant.

but a handful of comparisons. In addition, compared to the Non-AP group, the AP Credit group had significantly higher LS-means on all but two pairwise comparisons: overall GPA and first-year credit hours in 2001. Compared to the Concurrent group, AP Credit students also had significantly higher math GPA, first-year GPA, and first-year credit hours in all four entering classes, and higher overall college GPA in two of the four years.

The second pattern was that the Concurrent group consistently earned the most math credit hours. Concurrent students had significantly higher LS-means for math credit hours than those in the AP No Credit and Non-AP groups in all four entering classes and those in the AP Credit group in two of the four years.

## AP Chemistry

Table 5 presents comparison results for the AP Chemistry groups. Students are required to attain a grade of at least 4 on the AP Chemistry Exam to receive credit by exam for two introductory chemistry courses (CH 301 and 302). This credit by exam requirement is one point higher than that of most other AP Exams, which typically have a minimum AP Exam grade of 3. This likely explains the smaller AP Credit group sizes across all entering classes for AP Chemistry.

The trends observed in the AP Chemistry groups are similar to those for the AP Calculus BC groups. First, students in the AP Credit group had consistently higher performance for all outcome measures and entering classes. The AP Credit group significantly outperformed the AP No Credit and Non-AP groups in all but a handful of comparisons. It also had significantly higher LS-means

**Table 5**

Descriptive Statistics and Pairwise Comparison Results for AP Chemistry

Dependent Measure	Group	1998		1999		2000		2001	
		N	Mean/Rate	N	Mean/Rate	N	Mean/Rate	N	Mean/Rate
Overall College Credit Hours	AP Credit	141	163.15 <sup>ab</sup>	143	169.21 <sup>ab</sup>	166	164.87 <sup>ab</sup>	187	144.76 <sup>ab</sup>
	AP No Credit	182	144.16 <sup>a</sup>	226	142.36 <sup>a</sup>	259	134.56 <sup>a</sup>	280	116.36 <sup>ae</sup>
	Non-AP	141	143.23 <sup>b</sup>	143	147.90 <sup>b</sup>	165	141.14 <sup>b</sup>	187	122.96 <sup>bf</sup>
	Concurrent	64	156.93	66	159.53	75	150.18	69	143.93 <sup>cf</sup>
Overall College GPA	AP Credit	141	3.40 <sup>ab</sup>	143	3.40 <sup>a</sup>	166	3.41 <sup>a</sup>	187	3.23 <sup>a</sup>
	AP No Credit	182	3.00 <sup>a</sup>	226	3.00 <sup>a</sup>	259	3.07 <sup>a</sup>	280	2.91 <sup>a</sup>
	Non-AP	141	3.02 <sup>b</sup>	143	3.21	165	3.19	187	3.15
	Concurrent	64	3.15	66	3.23	75	3.08	69	3.10
First-Year Credit Hours	AP Credit	141	39.36	143	42.16 <sup>ab</sup>	166	39.67 <sup>abc</sup>	187	39.54
	AP No Credit	182	37.32	226	35.63 <sup>a</sup>	259	36.77 <sup>a</sup>	280	36.84
	Non-AP	141	37.23	143	36.71 <sup>b</sup>	165	35.73 <sup>b</sup>	187	36.79
	Concurrent	64	34.79	66	36.83	75	34.64 <sup>c</sup>	69	35.26
First-Year GPA	AP Credit	140	3.57 <sup>ab</sup>	143	3.60 <sup>abc</sup>	166	3.57 <sup>abc</sup>	186	3.54 <sup>ac</sup>
	AP No Credit	182	3.11 <sup>a</sup>	226	3.16 <sup>a</sup>	259	3.21 <sup>a</sup>	280	3.24 <sup>a</sup>
	Non-AP	141	3.20 <sup>b</sup>	143	3.32 <sup>b</sup>	165	3.24 <sup>b</sup>	187	3.39 <sup>f</sup>
	Concurrent	64	3.21	66	3.20 <sup>c</sup>	74	3.04 <sup>c</sup>	69	2.95 <sup>cf</sup>
Subject Credit Hours	AP Credit	141	20.32 <sup>ab</sup>	143	21.29 <sup>ab</sup>	166	21.21 <sup>ab</sup>	187	20.08 <sup>abc</sup>
	AP No Credit	182	14.70 <sup>ade</sup>	226	14.19 <sup>ae</sup>	259	14.08 <sup>ae</sup>	280	13.73 <sup>ae</sup>
	Non-AP	141	10.29 <sup>bdf</sup>	143	11.33 <sup>bf</sup>	165	11.17 <sup>bf</sup>	187	10.67 <sup>bf</sup>
	Concurrent	64	25.82 <sup>ef</sup>	66	27.97 <sup>ef</sup>	75	25.12 <sup>ef</sup>	69	28.41 <sup>cef</sup>
Subject GPA	AP Credit	108	3.59 <sup>abc</sup>	113	3.69 <sup>abc</sup>	117	3.62 <sup>abc</sup>	129	3.64 <sup>abc</sup>
	AP No Credit	179	2.97 <sup>a</sup>	219	3.01 <sup>a</sup>	254	3.04 <sup>ae</sup>	271	3.12 <sup>a</sup>
	Non-AP	138	3.08 <sup>b</sup>	139	3.19 <sup>b</sup>	161	3.01 <sup>b</sup>	184	3.21 <sup>bf</sup>
	Concurrent	28	2.77 <sup>c</sup>	30	2.84 <sup>c</sup>	33	2.61 <sup>ce</sup>	27	2.75 <sup>cf</sup>

Note: Means with matching superscript letters within each year and dependent measure are significantly different at the  $\alpha = 0.05$  level.

<sup>a</sup> The pairwise comparison between the AP Credit and AP No Credit groups on the dependent measure is statistically significant.

<sup>b</sup> The pairwise comparison between the AP Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>c</sup> The pairwise comparison between the AP Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>d</sup> The pairwise comparison between the AP No Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>e</sup> The pairwise comparison between the AP No Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>f</sup> The pairwise comparison between the Non-AP and Concurrent groups on the dependent measure is statistically significant.



than the Concurrent group for chemistry GPA in all four entering classes and for first-year GPA in three of the four classes. Second, students in the Concurrent group consistently earned the most chemistry credit hours. They had significantly more chemistry credit hours than the AP No Credit and Non-AP students in all four classes.

## AP Macroeconomics

Table 6 presents the descriptive statistics and pairwise comparison results for the AP Macroeconomics groups. From 1998 to 2000, students were required to attain a grade of at least 4 on the AP Macroeconomics Exam to receive

credit by exam for the introductory macroeconomics course (ECO 304L). This credit-by-exam requirement is one point higher than that of most other AP Exams. This, in part, explains the smaller AP Credit group sizes across all entering classes for AP Macroeconomics. In addition, starting in 2001, students were required to attain a grade of 5 on the AP Macroeconomics Exam to receive credit-by-exam for ECO 304L. This new requirement decreased the size of the AP Credit group even more for 2001 while substantially increasing the size of the AP No Credit group.

Relatively fewer pairwise comparisons of the AP Macroeconomics groups were statistically significant. All the ones that were significant involved the AP Credit

**Table 6**

Descriptive Statistics and Pairwise Comparison Results for AP Macroeconomics

Dependent Measure	Group	1998		1999		2000		2001	
		N	Mean/Rate	N	Mean/Rate	N	Mean/Rate	N	Mean/Rate
Overall College Credit Hours	AP Credit	339	145.66	301	149.39 <sup>b</sup>	380	144.11 <sup>a</sup>	126	139.81 <sup>abc</sup>
	AP No Credit	173	138.82	175	142.06	248	134.25 <sup>a</sup>	541	119.90 <sup>a</sup>
	Non-AP	332	139.35	288	138.50 <sup>b</sup>	373	139.97	126	121.18 <sup>b</sup>
	Concurrent	145	141.33	165	144.27	254	134.22	337	120.24 <sup>c</sup>
Overall College GPA	AP Credit	339	3.12	301	3.32 <sup>a</sup>	380	3.25	126	2.99
	AP No Credit	173	2.99	175	3.04 <sup>a</sup>	248	3.08	541	2.88
	Non-AP	332	3.01	288	3.18	373	3.13	126	3.01
	Concurrent	145	2.88	165	2.95	254	3.07	337	2.91
First-Year Credit Hours	AP Credit	339	38.02	301	38.86 <sup>c</sup>	380	38.07 <sup>bc</sup>	126	36.79
	AP No Credit	173	36.77	175	36.32	248	36.43	541	36.73 <sup>a</sup>
	Non-AP	332	35.88	288	35.78	373	34.87 <sup>b</sup>	126	34.90
	Concurrent	145	36.60	165	32.24 <sup>c</sup>	254	34.21 <sup>c</sup>	337	33.32 <sup>e</sup>
First-Year GPA	AP Credit	338	3.43 <sup>abc</sup>	301	3.53 <sup>abc</sup>	380	3.59 <sup>abc</sup>	126	3.72 <sup>abc</sup>
	AP No Credit	173	3.06 <sup>ad</sup>	175	3.15 <sup>a</sup>	248	3.12 <sup>ad</sup>	540	3.25 <sup>a</sup>
	Non-AP	332	3.24 <sup>bd</sup>	288	3.26 <sup>b</sup>	372	3.27 <sup>bd</sup>	126	3.32 <sup>b</sup>
	Concurrent	144	3.09 <sup>c</sup>	165	3.10 <sup>c</sup>	253	3.08 <sup>c</sup>	337	3.16 <sup>c</sup>
Subject Credit Hours	AP Credit	339	10.58 <sup>ab</sup>	301	10.22 <sup>ab</sup>	380	10.89 <sup>ab</sup>	126	10.48 <sup>abc</sup>
	AP No Credit	173	6.90 <sup>a</sup>	175	6.10 <sup>a</sup>	248	7.05 <sup>a</sup>	541	6.99 <sup>a</sup>
	Non-AP	332	6.57 <sup>b</sup>	288	6.04 <sup>b</sup>	373	6.70 <sup>b</sup>	126	5.87 <sup>b</sup>
	Concurrent	145	9.56	165	8.60	254	8.30	337	7.63 <sup>c</sup>
Subject GPA	AP Credit	122	3.29 <sup>a</sup>	98	3.46 <sup>abc</sup>	131	3.42 <sup>abc</sup>	52	3.74 <sup>abc</sup>
	AP No Credit	153	2.79 <sup>a</sup>	151	2.88 <sup>a</sup>	209	2.72 <sup>ad</sup>	320	3.05 <sup>a</sup>
	Non-AP	286	3.04	251	3.09 <sup>b</sup>	316	3.03 <sup>bdf</sup>	99	3.03 <sup>b</sup>
	Concurrent	43	2.90	45	2.80 <sup>c</sup>	67	2.58 <sup>cf</sup>	87	2.80 <sup>c</sup>

Note: Means with matching superscript letters within each year and dependent measure are significantly different at the  $\alpha = 0.05$  level.

<sup>a</sup> The pairwise comparison between the AP Credit and AP No Credit groups on the dependent measure is statistically significant.

<sup>b</sup> The pairwise comparison between the AP Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>c</sup> The pairwise comparison between the AP Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>d</sup> The pairwise comparison between the AP No Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>e</sup> The pairwise comparison between the AP No Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>f</sup> The pairwise comparison between the Non-AP and Concurrent groups on the dependent measure is statistically significant.

group. Specifically, the AP Credit group had significantly higher LS-means than the other three groups in most of the comparisons, with a notable exception being the overall college GPA outcome measure. On the other hand, none of the comparisons between the AP No Credit, Non-AP, and Concurrent groups yielded significant results. Thus, it is clear that for AP Macroeconomics, the college performance of AP Credit students was substantially better than those in the other groups.

## AP English Language and Composition

Table 7 presents the comparison results for AP English Language and Composition. The general trend of the AP Credit group consistently outperforming the other three groups was also evident for this AP Exam. The AP Credit group had significantly higher means in every comparison with the AP No Credit group. It had significantly higher LS-means than the matched Non-AP

**Table 7**

Descriptive Statistics and Pairwise Comparison Results for AP English Language and Composition

Dependent Measure	Group	1998		1999		2000		2001	
		N	Mean/Rate	N	Mean/Rate	N	Mean/Rate	N	Mean/Rate
Overall College Credit Hours	AP Credit	1,361	142.28 <sup>ab</sup>	1,611	139.46 <sup>ab</sup>	1,775	139.16 <sup>abc</sup>	1,907	123.81 <sup>abc</sup>
	AP No Credit	321	136.10 <sup>a</sup>	412	132.88 <sup>a</sup>	467	128.31 <sup>a</sup>	460	104.63 <sup>ae</sup>
	Non-AP	1,257	136.07 <sup>b</sup>	1,415	132.06 <sup>bf</sup>	1,416	126.65 <sup>bf</sup>	1,365	107.59 <sup>bf</sup>
	Concurrent	737	137.39	820	137.30 <sup>f</sup>	1,026	131.79 <sup>cf</sup>	1,047	115.67 <sup>cef</sup>
Overall College GPA	AP Credit	1,361	3.11 <sup>ab</sup>	1,611	3.18 <sup>abc</sup>	1,775	3.18 <sup>abc</sup>	1,907	3.16 <sup>abc</sup>
	AP No Credit	321	2.91 <sup>a</sup>	412	2.89 <sup>ad</sup>	467	2.94 <sup>a</sup>	460	2.79 <sup>ade</sup>
	Non-AP	1,257	3.00 <sup>b</sup>	1,415	3.01 <sup>bd</sup>	1,416	2.99 <sup>b</sup>	1,365	3.01 <sup>bd</sup>
	Concurrent	737	3.01	820	3.02 <sup>c</sup>	1,027	2.98 <sup>c</sup>	1,047	3.02 <sup>ce</sup>
First-Year Credit Hours	AP Credit	1,361	38.12 <sup>abc</sup>	1,611	35.81 <sup>bc</sup>	1,775	36.19 <sup>abc</sup>	1,907	35.69 <sup>abc</sup>
	AP No Credit	321	34.59 <sup>ae</sup>	412	34.43 <sup>e</sup>	467	34.39 <sup>ae</sup>	460	33.79 <sup>a</sup>
	Non-AP	1,257	34.57 <sup>bf</sup>	1,415	33.45 <sup>bf</sup>	1,416	33.69 <sup>bf</sup>	1,365	34.03 <sup>bf</sup>
	Concurrent	737	31.81 <sup>cef</sup>	820	31.90 <sup>cef</sup>	1,027	31.84 <sup>cef</sup>	1,047	32.47 <sup>cf</sup>
First-Year GPA	AP Credit	1,361	3.25 <sup>abc</sup>	1,608	3.24 <sup>abc</sup>	1,773	3.29 <sup>abc</sup>	1,903	3.32 <sup>abc</sup>
	AP No Credit	319	2.90 <sup>ad</sup>	410	2.92 <sup>ad</sup>	466	2.99 <sup>a</sup>	458	2.87 <sup>ade</sup>
	Non-AP	1,252	3.08 <sup>bd</sup>	1,414	3.06 <sup>bd</sup>	1,411	3.09 <sup>b</sup>	1,360	3.10 <sup>bd</sup>
	Concurrent	736	3.00 <sup>c</sup>	819	3.04 <sup>c</sup>	1,021	3.02 <sup>c</sup>	1,045	3.11 <sup>ce</sup>
Subject Credit Hours	AP Credit	1,361	11.06 <sup>ab</sup>	1,611	10.56 <sup>ab</sup>	1,775	10.39 <sup>ab</sup>	1,907	9.51 <sup>abc</sup>
	AP No Credit	321	8.07 <sup>ae</sup>	412	7.81 <sup>ae</sup>	467	7.61 <sup>ae</sup>	460	7.08 <sup>ae</sup>
	Non-AP	1,257	8.66 <sup>bf</sup>	1,415	8.33 <sup>bf</sup>	1,416	7.82 <sup>bf</sup>	1,365	7.64 <sup>bf</sup>
	Concurrent	737	11.55 <sup>ef</sup>	820	11.29 <sup>ef</sup>	1,027	10.80 <sup>ef</sup>	1,047	10.93 <sup>cef</sup>
Subject GPA	AP Credit	924	3.54 <sup>abc</sup>	1,159	3.54 <sup>abc</sup>	1,204	3.56 <sup>abc</sup>	1,246	3.63 <sup>abc</sup>
	AP No Credit	271	3.16 <sup>ad</sup>	339	3.10 <sup>ad</sup>	375	3.15 <sup>ad</sup>	370	3.12 <sup>ad</sup>
	Non-AP	1,098	3.32 <sup>bdf</sup>	1,228	3.34 <sup>bdf</sup>	1,238	3.32 <sup>bdf</sup>	1,141	3.35 <sup>bdf</sup>
	Concurrent	394	3.06 <sup>cf</sup>	463	3.15 <sup>cf</sup>	552	3.05 <sup>cf</sup>	478	3.22 <sup>cf</sup>
Sequent Course (E316K) Grade	AP Credit	241	3.24 <sup>ac</sup>	287	3.15 <sup>a</sup>	280	3.19 <sup>a</sup>	313	3.36 <sup>abc</sup>
	AP No Credit	168	2.92 <sup>a</sup>	206	2.86 <sup>ade</sup>	212	2.95 <sup>a</sup>	210	3.06 <sup>a</sup>
	Non-AP	640	3.08	714	3.10 <sup>d</sup>	763	3.11	602	3.15 <sup>b</sup>
	Concurrent	325	2.99 <sup>c</sup>	388	3.13 <sup>e</sup>	461	3.02	377	3.18 <sup>c</sup>

Note: Means with matching superscript letters within each year and dependent measure are significantly different at the  $\alpha = 0.05$  level.

<sup>a</sup> The pairwise comparison between the AP Credit and AP No Credit groups on the dependent measure is statistically significant.

<sup>b</sup> The pairwise comparison between the AP Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>c</sup> The pairwise comparison between the AP Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>d</sup> The pairwise comparison between the AP No Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>e</sup> The pairwise comparison between the AP No Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>f</sup> The pairwise comparison between the Non-AP and Concurrent groups on the dependent measure is statistically significant.

group for all outcome measures except sequent course (E 316K) grade. The AP Credit group also significantly outperformed the Concurrent group in all outcome measures except subject (English) credit hours in at least two of the four entering classes.

Between the Non-AP and AP No Credit group, comparisons involving the three GPA-dependent measures yielded consistent significant findings across the years. The Non-AP group had significantly higher English GPA in all four entering classes, higher first-year GPA in three of the classes, and higher overall college GPA in two of the four classes. Finally, as seen in several of the other AP Exams, the Concurrent group earned significantly more subject (English) credit hours than the AP No Credit and Non-AP groups in all four entering classes.

## AP English Literature and Composition

Table 8 gives comparison results for the AP English Literature and Composition groups. The trends observed for this AP Exam were similar to what was found for AP English Language and Composition. First, the AP Credit group significantly outperformed the AP No Credit and Non-AP group in every outcome measure across all four entering classes. It also significantly outperformed the Concurrent group in first-year credit hours, first-year GPA, and English GPA for three of the four years. Second, the Non-AP group significantly outperformed the AP No Credit group in the three GPA-dependent measures. It had significantly higher first-year and English GPAs in

**Table 8**

Descriptive Statistics and Pairwise Comparison Results for AP English Literature and Composition

Dependent Measure	Group	1998		1999		2000		2001	
		N	Mean/Rate	N	Mean/Rate	N	Mean/Rate	N	Mean/Rate
Overall College Credit Hours	AP Credit	1,516	142.81 <sup>ab</sup>	1,718	140.67 <sup>ab</sup>	1,875	138.73 <sup>ab</sup>	1,775	125.18 <sup>ab</sup>
	AP No Credit	415	132.72 <sup>a</sup>	450	129.34 <sup>a</sup>	461	125.75 <sup>a</sup>	667	107.77 <sup>a</sup>
	Non-AP	1,381	134.90 <sup>b</sup>	1,455	132.67 <sup>b</sup>	1,548	128.16 <sup>b</sup>	1,423	111.73 <sup>b</sup>
	Concurrent	133	137.32	144	134.29	175	140.22	213	118.56
Overall College GPA	AP Credit	1,516	3.11 <sup>ab</sup>	1,718	3.21 <sup>ab</sup>	1,875	3.20 <sup>ab</sup>	1,775	3.19 <sup>ab</sup>
	AP No Credit	415	2.90 <sup>a</sup>	450	2.91 <sup>a</sup>	461	2.83 <sup>ad</sup>	667	2.88 <sup>ad</sup>
	Non-AP	1,381	2.99 <sup>b</sup>	1,455	2.99 <sup>b</sup>	1,549	3.01 <sup>bd</sup>	1,423	3.02 <sup>bd</sup>
	Concurrent	133	3.20	144	2.91	175	3.06	213	2.98
First-Year Credit Hours	AP Credit	1,516	37.59 <sup>abc</sup>	1,718	36.35 <sup>abc</sup>	1,875	36.30 <sup>abc</sup>	1,775	35.74 <sup>ab</sup>
	AP No Credit	415	33.45 <sup>a</sup>	450	33.47 <sup>a</sup>	461	34.43 <sup>ae</sup>	667	34.16 <sup>a</sup>
	Non-AP	1,381	34.50 <sup>b</sup>	1,455	33.52 <sup>b</sup>	1,549	33.60 <sup>bf</sup>	1,423	33.94 <sup>b</sup>
	Concurrent	133	31.32 <sup>c</sup>	144	31.10 <sup>c</sup>	175	29.27 <sup>cef</sup>	213	33.00
First-Year GPA	AP Credit	1,515	3.25 <sup>ab</sup>	1,716	3.29 <sup>abc</sup>	1,872	3.31 <sup>abc</sup>	1,772	3.34 <sup>abc</sup>
	AP No Credit	414	2.86 <sup>ad</sup>	448	2.90 <sup>ad</sup>	461	2.92 <sup>ad</sup>	664	2.93 <sup>ad</sup>
	Non-AP	1,377	3.06 <sup>bd</sup>	1,453	3.05 <sup>bd</sup>	1,548	3.10 <sup>bd</sup>	1,416	3.15 <sup>bd</sup>
	Concurrent	133	3.15	144	3.00 <sup>c</sup>	171	2.97 <sup>c</sup>	213	3.04 <sup>c</sup>
Subject Credit Hours	AP Credit	1,516	11.08 <sup>abc</sup>	1,718	10.95 <sup>abc</sup>	1,875	10.76 <sup>abc</sup>	1,775	10.36 <sup>abc</sup>
	AP No Credit	415	8.28 <sup>ae</sup>	450	7.77 <sup>ae</sup>	461	7.76 <sup>ae</sup>	667	7.13 <sup>ae</sup>
	Non-AP	1,381	8.64 <sup>bf</sup>	1,455	8.30 <sup>bf</sup>	1,549	8.17 <sup>bf</sup>	1,423	8.01 <sup>bf</sup>
	Concurrent	133	19.68 <sup>cef</sup>	144	15.59 <sup>cef</sup>	175	15.08 <sup>cef</sup>	213	14.46 <sup>cef</sup>
Subject GPA	AP Credit	1,019	3.63 <sup>ab</sup>	1,232	3.63 <sup>abc</sup>	1,215	3.64 <sup>abc</sup>	1,122	3.69 <sup>abc</sup>
	AP No Credit	354	3.10 <sup>ad</sup>	377	3.10 <sup>ad</sup>	388	3.00 <sup>ad</sup>	518	3.12 <sup>ad</sup>
	Non-AP	1,143	3.24 <sup>bd</sup>	1,204	3.24 <sup>bd</sup>	1,274	3.29 <sup>bd</sup>	1,074	3.35 <sup>bd</sup>
	Concurrent	34	3.35	41	3.09 <sup>c</sup>	37	3.12 <sup>c</sup>	39	3.29 <sup>c</sup>

Note: Means with matching superscript letters within each year and dependent measure are significantly different at the  $\alpha = 0.05$  level.

<sup>a</sup> The pairwise comparison between the AP Credit and AP No Credit groups on the dependent measure is statistically significant.

<sup>b</sup> The pairwise comparison between the AP Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>c</sup> The pairwise comparison between the AP Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>d</sup> The pairwise comparison between the AP No Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>e</sup> The pairwise comparison between the AP No Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>f</sup> The pairwise comparison between the Non-AP and Concurrent groups on the dependent measure is statistically significant.

all four entering classes and overall college GPA in two of the four classes. And finally, the Concurrent group earned significantly more English credit hours than the other three groups in all four entering classes.

## AP Government and Politics: United States

Table 9 presents comparison results for the AP Government and Politics: United States groups. Note that to earn credit by exam for the college-level introductory American government course (GOV 310L), students must

also take a placement test administered by the university assessing their knowledge of the state government. Eligibility for credit is based on the grades on both the AP Exam and the placement test.

The consistently higher performance of the AP Credit group was also found for this AP Exam. The AP Credit group had consistent significantly higher LS-means than the other three groups for all but one outcome measure. This one exception was for subject (government) credit hours, for which very few pairwise comparisons yielded statistically significant results.

A unique trend observed for this AP Exam subject was the poor performance of the Concurrent group. The

**Table 9**

Descriptive Statistics and Pairwise Comparison Results for AP Government and Politics: United States									
Dependent Measure	Group	1998		1999		2000		2001	
		N	Mean/Rate	N	Mean/Rate	N	Mean/Rate	N	Mean/Rate
Overall College Credit Hours	AP Credit	387	152.63 <sup>ac</sup>	465	148.91 <sup>abc</sup>	484	150.70 <sup>abc</sup>	445	141.06 <sup>abc</sup>
	AP No Credit	308	137.49 <sup>c</sup>	314	136.34 <sup>c</sup>	459	132.83 <sup>c</sup>	523	114.86 <sup>c</sup>
	Non-AP	386	141.54 <sup>a</sup>	465	141.61 <sup>a</sup>	484	137.08 <sup>a</sup>	445	117.16 <sup>a</sup>
	Concurrent	248	145.32	297	140.13 <sup>b</sup>	366	132.97 <sup>b</sup>	397	115.96 <sup>b</sup>
Overall College GPA	AP Credit	387	3.23 <sup>abc</sup>	465	3.32 <sup>abc</sup>	484	3.31 <sup>abc</sup>	445	3.26 <sup>abc</sup>
	AP No Credit	308	2.87 <sup>c</sup>	314	2.94 <sup>c</sup>	459	3.03 <sup>c</sup>	523	2.91 <sup>c</sup>
	Non-AP	386	3.03 <sup>a</sup>	465	3.10 <sup>a</sup>	484	3.14 <sup>a</sup>	445	2.97 <sup>a</sup>
	Concurrent	248	2.92 <sup>b</sup>	297	2.94 <sup>b</sup>	366	3.02 <sup>b</sup>	397	2.84 <sup>b</sup>
First-Year Credit Hours	AP Credit	387	38.62 <sup>abc</sup>	465	36.93 <sup>abc</sup>	484	38.91 <sup>abc</sup>	445	38.36 <sup>abc</sup>
	AP No Credit	308	35.18 <sup>c</sup>	314	34.83 <sup>cd</sup>	459	34.23 <sup>cd</sup>	523	33.68 <sup>c</sup>
	Non-AP	386	35.36 <sup>a</sup>	465	34.47 <sup>ad</sup>	484	35.31 <sup>ad</sup>	445	33.30 <sup>a</sup>
	Concurrent	248	34.12 <sup>b</sup>	297	31.27 <sup>bcd</sup>	366	31.53 <sup>bcd</sup>	397	32.18 <sup>b</sup>
First-Year GPA	AP Credit	387	3.44 <sup>abc</sup>	465	3.46 <sup>abc</sup>	484	3.52 <sup>abc</sup>	445	3.56 <sup>abc</sup>
	AP No Credit	308	2.99 <sup>ce</sup>	314	3.01 <sup>ce</sup>	459	3.08 <sup>ce</sup>	521	3.05 <sup>ce</sup>
	Non-AP	385	3.17 <sup>ae</sup>	464	3.25 <sup>ade</sup>	484	3.31 <sup>ade</sup>	443	3.19 <sup>ae</sup>
	Concurrent	247	3.06 <sup>b</sup>	296	3.02 <sup>bd</sup>	365	3.06 <sup>bd</sup>	396	3.08 <sup>b</sup>
Subject Credit Hours	AP Credit	387	8.30	465	8.40 <sup>a</sup>	484	8.29	445	9.09
	AP No Credit	308	8.39	314	7.80	459	8.54	523	7.84 <sup>f</sup>
	Non-AP	386	7.15 <sup>d</sup>	465	7.15 <sup>a</sup>	484	7.91	445	7.80 <sup>d</sup>
	Concurrent	248	9.98 <sup>d</sup>	297	8.14	366	9.02	397	10.09 <sup>df</sup>
Subject GPA	AP Credit	309	3.58 <sup>abc</sup>	401	3.60 <sup>abc</sup>	402	3.61 <sup>abc</sup>	356	3.64 <sup>abc</sup>
	AP No Credit	256	2.84 <sup>c</sup>	263	2.74 <sup>ce</sup>	377	2.89 <sup>ce</sup>	417	2.95 <sup>c</sup>
	Non-AP	277	3.00 <sup>a</sup>	301	3.08 <sup>ae</sup>	326	3.19 <sup>ade</sup>	273	3.05 <sup>ad</sup>
	Concurrent	81	2.96 <sup>b</sup>	94	2.94 <sup>b</sup>	128	2.71 <sup>bd</sup>	118	2.80 <sup>bd</sup>

Note: Means with matching superscript letters within each year and dependent measure are significantly different at the  $\alpha = 0.05$  level.

<sup>a</sup> The pairwise comparison between the AP Credit and AP No Credit groups on the dependent measure is statistically significant.

<sup>b</sup> The pairwise comparison between the AP Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>c</sup> The pairwise comparison between the AP Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>d</sup> The pairwise comparison between the AP No Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>e</sup> The pairwise comparison between the AP No Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>f</sup> The pairwise comparison between the Non-AP and Concurrent groups on the dependent measure is statistically significant.

Concurrent group had significantly lower LS-means than the Non-AP group for first-year credit hours, first-year GPA, and government GPA in two of the four years. It even had significantly lower first-year credit hours than the AP No Credit group for two of the four entering classes.

## AP History: United States

Table 10 gives the analysis results for the AP History: United States groups. Again, the AP Credit group significantly outperformed the other three groups in all but one outcome measure across the four entering classes. The one exception was overall college GPA, but even for this case, the AP Credit group had significantly higher LS-means than the AP No Credit and Concurrent groups in two of the entering classes. Also, the Concurrent group tended to earn significantly more history credit hours than those in the AP No Credit and Non-AP groups.

**Table 10**

Descriptive Statistics and Pairwise Comparison Results for AP History: United States

Dependent Measure	Group	1998		1999		2000		2001	
		N	Mean/Rate	N	Mean/Rate	N	Mean/Rate	N	Mean/Rate
Overall College Credit Hours	AP Credit	423	153.62 <sup>abc</sup>	405	151.03 <sup>abc</sup>	520	146.42 <sup>abc</sup>	551	135.41 <sup>abc</sup>
	AP No Credit	661	138.74 <sup>a</sup>	805	136.57 <sup>a</sup>	942	132.69 <sup>a</sup>	1,016	113.87 <sup>a</sup>
	Non-AP	422	140.08 <sup>b</sup>	400	141.64 <sup>b</sup>	516	137.91 <sup>b</sup>	548	117.91 <sup>b</sup>
	Concurrent	287	137.11 <sup>c</sup>	309	134.46 <sup>c</sup>	490	135.68 <sup>c</sup>	483	116.41 <sup>c</sup>
Overall College GPA	AP Credit	423	3.16	405	3.24 <sup>ac</sup>	520	3.17 <sup>c</sup>	551	3.14
	AP No Credit	661	2.99	805	3.04 <sup>a</sup>	942	3.03	1,016	3.00
	Non-AP	422	3.00	400	3.14	517	3.09	548	3.06
	Concurrent	287	3.10	309	2.96 <sup>c</sup>	490	2.87 <sup>c</sup>	483	3.04
First-Year Credit Hours	AP Credit	423	40.92 <sup>abc</sup>	405	38.11 <sup>abc</sup>	520	38.33 <sup>abc</sup>	551	36.80 <sup>abc</sup>
	AP No Credit	661	35.50 <sup>a</sup>	805	34.49 <sup>ae</sup>	942	34.45 <sup>a</sup>	1,016	34.68 <sup>a</sup>
	Non-AP	422	35.53 <sup>b</sup>	400	34.73 <sup>bf</sup>	517	35.44 <sup>bf</sup>	548	34.51 <sup>b</sup>
	Concurrent	287	31.82 <sup>c</sup>	309	30.69 <sup>cef</sup>	490	32.46 <sup>cf</sup>	483	32.45 <sup>c</sup>
First-Year GPA	AP Credit	423	3.40 <sup>abc</sup>	405	3.43 <sup>abc</sup>	520	3.37 <sup>ac</sup>	550	3.44 <sup>abc</sup>
	AP No Credit	660	3.04 <sup>a</sup>	804	3.06 <sup>ad</sup>	940	3.14 <sup>ad</sup>	1,015	3.11 <sup>ad</sup>
	Non-AP	420	3.15 <sup>b</sup>	400	3.26 <sup>bdf</sup>	516	3.28 <sup>df</sup>	548	3.23 <sup>bdf</sup>
	Concurrent	286	3.09 <sup>c</sup>	309	3.07 <sup>c</sup>	485	2.98 <sup>cf</sup>	482	3.13 <sup>c</sup>
Subject Credit Hours	AP Credit	423	13.98 <sup>abc</sup>	405	14.23 <sup>abc</sup>	520	13.12 <sup>ab</sup>	551	12.22 <sup>abc</sup>
	AP No Credit	661	7.54 <sup>ae</sup>	805	8.06 <sup>a</sup>	942	7.97 <sup>ae</sup>	1,016	7.19 <sup>ae</sup>
	Non-AP	422	7.58 <sup>bf</sup>	400	8.31 <sup>b</sup>	517	8.08 <sup>bf</sup>	548	6.86 <sup>bf</sup>
	Concurrent	287	10.16 <sup>cef</sup>	309	10.23 <sup>c</sup>	490	13.02 <sup>ef</sup>	483	10.14 <sup>cef</sup>
Subject GPA	AP Credit	257	3.50 <sup>abc</sup>	238	3.52 <sup>abc</sup>	291	3.50 <sup>abc</sup>	310	3.61 <sup>abc</sup>
	AP No Credit	466	2.90 <sup>a</sup>	573	2.88 <sup>a</sup>	621	2.93 <sup>a</sup>	646	3.01 <sup>a</sup>
	Non-AP	321	2.90 <sup>b</sup>	296	2.99 <sup>b</sup>	368	3.03 <sup>b</sup>	367	3.06 <sup>b</sup>
	Concurrent	57	2.96 <sup>c</sup>	71	2.99 <sup>c</sup>	115	2.89 <sup>c</sup>	86	2.94 <sup>c</sup>

Note: Means with matching superscript letters within each year and dependent measure are significantly different at the  $\alpha = 0.05$  level.

<sup>a</sup> The pairwise comparison between the AP Credit and AP No Credit groups on the dependent measure is statistically significant.

<sup>b</sup> The pairwise comparison between the AP Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>c</sup> The pairwise comparison between the AP Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>d</sup> The pairwise comparison between the AP No Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>e</sup> The pairwise comparison between the AP No Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>f</sup> The pairwise comparison between the Non-AP and Concurrent groups on the dependent measure is statistically significant.

## AP Spanish Language

Table 11 presents the analysis results for the AP Spanish Language groups. Students who attain a grade of at least 2 on the AP Spanish Language Exam are eligible to receive credit by exam for at least two of the many introductory Spanish (SPN) courses. This requirement is one point lower than that of most other AP Exams. This explains why the AP No Credit groups were substantially smaller than the AP Credit and Non-AP groups for AP Spanish Language across all four entering classes. The Concurrent groups were also a lot smaller. Consequently, the power to detect statistical differences between the two smaller

groups and the two larger ones was greatly reduced for AP Spanish Language.

Even with this lack of statistical power, the AP Credit group still had significantly higher LS-means than the AP No Credit group for subject (Spanish) credit hours in all four years, for subject GPA in three of the years, and for overall credit hours in two of the years.

In addition, the AP Credit group significantly outperformed the matched Non-AP group in most cases. AP Credit students had significantly higher LS-means for overall credit hours, first-year credit hours, Spanish credit hours, and Spanish GPA across all four entering classes.

**Table 11**

Descriptive Statistics and Pairwise Comparison Results for AP Spanish Language

Dependent Measure	Group	1998		1999		2000		2001	
		N	Mean/Rate	N	Mean/Rate	N	Mean/Rate	N	Mean/Rate
Overall College Credit Hours	AP Credit	457	149.45 <sup>ab</sup>	499	149.30 <sup>b</sup>	544	147.45 <sup>b</sup>	551	132.05 <sup>ab</sup>
	AP No Credit	28	130.81 <sup>a</sup>	28	131.96	31	138.07	42	112.30 <sup>a</sup>
	Non-AP	457	138.58 <sup>b</sup>	486	137.68 <sup>b</sup>	538	134.13 <sup>b</sup>	550	116.85 <sup>b</sup>
	Concurrent	22	129.20	32	133.00	41	144.95	44	119.60
Overall College GPA	AP Credit	457	3.13	499	3.17	545	3.24 <sup>b</sup>	551	3.15
	AP No Credit	28	2.88	28	2.82	31	3.17	42	2.94
	Non-AP	457	3.03	486	3.12	538	2.99 <sup>b</sup>	550	3.08
	Concurrent	22	3.20	32	3.26	41	3.28	44	3.12
First-Year Credit Hours	AP Credit	457	39.19 <sup>b</sup>	499	38.32 <sup>bc</sup>	545	37.66 <sup>b</sup>	551	37.25 <sup>b</sup>
	AP No Credit	28	34.73	28	34.75	31	33.32	42	34.43
	Non-AP	457	34.90 <sup>b</sup>	486	34.86 <sup>b</sup>	538	35.20 <sup>b</sup>	550	35.13 <sup>b</sup>
	Concurrent	22	28.40	32	28.85 <sup>c</sup>	41	32.42	44	33.60
First-Year GPA	AP Credit	457	3.23 <sup>b</sup>	498	3.26	543	3.25	549	3.29 <sup>a</sup>
	AP No Credit	28	3.02	28	2.94	31	3.34	42	3.01 <sup>a</sup>
	Non-AP	456	3.03 <sup>b</sup>	486	3.15	536	3.16	550	3.20
	Concurrent	22	3.11	32	3.24	41	3.14	44	3.37
Subject Credit Hours	AP Credit	457	23.13 <sup>ab</sup>	499	23.73 <sup>ab</sup>	545	23.69 <sup>ab</sup>	551	21.92 <sup>ab</sup>
	AP No Credit	28	17.54 <sup>a</sup>	28	14.33 <sup>ab</sup>	31	15.86 <sup>a</sup>	42	15.15 <sup>a</sup>
	Non-AP	457	16.20 <sup>b</sup>	486	16.71 <sup>bf</sup>	538	15.39 <sup>b</sup>	550	14.55 <sup>bf</sup>
	Concurrent	22	15.00	32	25.69 <sup>ef</sup>	41	20.11	44	20.65 <sup>f</sup>
Subject GPA	AP Credit	457	3.89 <sup>ab</sup>	499	3.91 <sup>abc</sup>	545	3.91 <sup>bc</sup>	551	3.91 <sup>ab</sup>
	AP No Credit	26	3.46 <sup>a</sup>	24	3.60 <sup>a</sup>	28	3.76 <sup>d</sup>	40	3.59 <sup>a</sup>
	Non-AP	409	3.42 <sup>b</sup>	435	3.44 <sup>b</sup>	506	3.45 <sup>bd</sup>	497	3.54 <sup>b</sup>
	Concurrent	5	3.40	13	3.52 <sup>c</sup>	19	3.44 <sup>c</sup>	20	3.79

\* Means with matching superscript letters within each year and dependent measure are significantly different at the  $\alpha = 0.05$  level.

<sup>a</sup> The pairwise comparison between the AP Credit and AP No Credit groups on the dependent measure is statistically significant.

<sup>b</sup> The pairwise comparison between the AP Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>c</sup> The pairwise comparison between the AP Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>d</sup> The pairwise comparison between the AP No Credit and Non-AP groups on the dependent measure is statistically significant.

<sup>e</sup> The pairwise comparison between the AP No Credit and Concurrent groups on the dependent measure is statistically significant.

<sup>f</sup> The pairwise comparison between the Non-AP and Concurrent groups on the dependent measure is statistically significant.

## Effect Sizes

Table 12 summarizes the partial  $\eta^2$  values found across the 10 AP Exams for each of the GPA- and credit hour-dependent measures. Cohen (1977) characterizes an effect size as small if  $\eta^2 = 0.01$ , as medium if  $\eta^2 = 0.06$ , and as large if  $\eta^2 = 0.14$ . Because the difference between  $\eta^2$  and partial  $\eta^2$  is small when sample sizes are as large as in this study (Stevens, 1999), Cohen's criteria are used to classify the effect sizes found.

The table shows that most effect sizes were small to medium (that is, between 0.01 and 0.13). A few large effect sizes were also found. In terms of dependent measures, effect-size measures for subject credit hours and GPA were consistently high, implying a larger difference in the comparison groups in their performance in the related subject area. Looking at the effect size within each individual AP Exam, we notice that the science, mathematics, and social studies exams (AP Biology, Chemistry, Calculus AB and BC, U.S. History, and U.S. Government and Politics) tended to have larger effect sizes, while the English effect sizes were generally smaller.

**Table 12**

Partial  $\eta^2$  for GPA- and Credit Hour-Dependent Measures in All 10 AP Exams

Entering Class	College Outcome Measure	AP Examination									
		Biology	Calculus AB	Calculus BC	Chemistry	Macro-economics	English Language	English Literature	U.S. Gov. & Politics	U.S. History	Spanish Language
1998	Overall College Credit Hours	0.05	0.05	0.05	0.04	0.01	0.01	0.01	0.04	0.04	0.03
	Overall College GPA	0.01	0.01	0.03	0.04	0.01	0.01	0.01	0.03	0.01	0.00
	First-Year Credit Hours	0.04	0.04	0.04	0.01	0.01	0.05	0.03	0.02	0.05	0.03
	First-Year GPA	0.03	0.03	0.05	<b>0.08</b>	0.04	0.03	0.04	<b>0.08</b>	0.05	0.01
	Subject Credit Hours	<b>0.09</b>	<b>0.09</b>	<b>0.08</b>	<b>0.09</b>	0.05	0.03	0.05	0.01	<b>0.13</b>	<b>0.17</b>
	Subject GPA	0.04	0.04	<b>0.09</b>	<b>0.08</b>	0.03	0.05	<b>0.08</b>	<b>0.14</b>	<b>0.09</b>	<b>0.15</b>
1999	Overall College Credit Hours	<b>0.06</b>	0.02	0.04	<b>0.10</b>	0.01	0.01	0.02	0.03	0.03	0.04
	Overall College GPA	0.03	0.02	0.03	0.04	0.02	0.02	0.02	0.04	0.01	0.01
	First-Year Credit Hours	0.03	0.01	0.03	<b>0.06</b>	0.02	0.02	0.03	0.03	0.03	0.03
	First-Year GPA	0.05	0.04	0.04	<b>0.08</b>	0.04	0.03	0.04	<b>0.09</b>	0.05	0.02
	Subject Credit Hours	<b>0.13</b>	0.02	<b>0.10</b>	<b>0.11</b>	<b>0.07</b>	0.04	0.05	0.01	<b>0.11</b>	<b>0.15</b>
	Subject GPA	<b>0.06</b>	<b>0.09</b>	<b>0.07</b>	<b>0.10</b>	0.05	0.05	<b>0.08</b>	<b>0.17</b>	<b>0.09</b>	<b>0.18</b>
2000	Overall College Credit Hours	<b>0.10</b>	0.02	0.04	<b>0.10</b>	0.01	0.03	0.03	<b>0.07</b>	0.03	0.04
	Overall College GPA	0.03	0.03	0.02	0.03	0.01	0.02	0.03	0.02	0.01	0.02
	First-Year Credit Hours	0.02	0.01	0.03	0.03	0.02	0.03	0.02	0.05	0.03	0.02
	First-Year GPA	<b>0.09</b>	0.03	0.04	0.05	<b>0.07</b>	0.03	0.04	<b>0.09</b>	0.03	0.01
	Subject Credit Hours	<b>0.10</b>	0.02	<b>0.10</b>	<b>0.10</b>	0.05	0.05	0.05	0.00	<b>0.11</b>	<b>0.20</b>
	Subject GPA	<b>0.11</b>	<b>0.07</b>	<b>0.06</b>	<b>0.09</b>	<b>0.08</b>	<b>0.06</b>	<b>0.09</b>	<b>0.14</b>	<b>0.07</b>	<b>0.15</b>
2001	Overall College Credit Hours	0.05	0.03	0.04	<b>0.09</b>	0.03	0.05	0.05	<b>0.12</b>	<b>0.06</b>	0.05
	Overall College GPA	0.03	0.01	0.00	0.02	0.00	0.02	0.02	0.03	0.00	0.00
	First-Year Credit Hours	0.01	0.01	0.01	0.01	0.02	0.02	0.01	<b>0.06</b>	0.01	0.01
	First-Year GPA	<b>0.08</b>	0.04	0.03	0.04	<b>0.06</b>	0.05	0.05	<b>0.12</b>	0.04	0.01
	Subject Credit Hours	<b>0.11</b>	0.02	<b>0.10</b>	<b>0.11</b>	0.04	0.04	0.05	0.01	<b>0.11</b>	<b>0.16</b>
	Subject GPA	<b>0.07</b>	<b>0.08</b>	<b>0.06</b>	<b>0.07</b>	<b>0.07</b>	<b>0.06</b>	<b>0.09</b>	<b>0.15</b>	<b>0.09</b>	<b>0.11</b>

Note: Bolded values indicated medium (0.06–0.14) to large (>0.14) effect sizes.



## Discussion

Three primary trends were observed across 10 AP Exams investigated. Table 13 summarizes how the three primary trends were observed across the 10 AP Exams. These trends provided compelling evidence to help address our research question on the difference in college performances of various types of AP and non-AP students.

Trend 1 was that AP students who earned credit by exam (AP Credit group) consistently outperformed other types of students in college, especially in the related subject area. This trend was found in the analyses for all 10 AP Exams investigated. This finding is particularly noteworthy because the non-AP students had been matched by high school rank and SAT (or ACT) score category to the AP Credit students. This matching procedure tended to eliminate from the analysis many of the less proficient non-AP students, that is, the non-AP students who had lower high school ranks and lower SAT/ACT scores. Yet the AP Credit students still consistently outperformed the non-AP students.

Trend 2 was that concurrently enrolled students tended to earn the most college credit hours in the related subject area, especially in comparison to the AP No Credit and Non-AP groups. This trend was observed in 6 of the 10 AP Exams investigated. To interpret the practical implication of this trend, it should also be

noted that the Concurrent group generally performed no differently than the Non-AP and AP No Credit groups in subject GPA. Thus, while the Concurrent students tended to earn more subject credit hours, their average grades in those subject courses were no better than students in the other groups. This means that while Concurrent students could expect to have a substantial gain in the *quantity* of college credit hours earned in the subject area, they did not necessarily have an advantage in the *quality* of their college performance.

Trend 3 was the apparent poor performance of the AP students who did not earn credit by exam (AP No Credit group). It was found in 4 of the 10 AP Exams analyzed. This trend seems to indicate that the AP No Credit group had the poorest college performance. Such a conclusion, however, is somewhat misleading. The fact that the AP No Credit group performed poorer than the AP Credit group should come as no surprise. The AP No Credit group consisted of AP students who did not attain high enough AP Exam grades to earn college credit in the AP subject. Thus, the AP No Credit students are by definition generally less proficient in the subject than those in the AP Credit group. As for the poorer performance of the AP No Credit group compared to the Non-AP group, recall that the non-AP students used in the analysis had been matched by high school and SAT/ACT test rank to students in the AP Credit group. Thus, the Non-AP groups were not representative samples of all

**Table 13**

Summary of Primary Trends Observed Across AP Exams

<i>AP Examination</i>	<i>Trend 1<sup>a</sup></i>	<i>Trend 2<sup>b</sup></i>	<i>Trend 3<sup>c</sup></i>
AP Biology	√	√	√
AP Calculus AB	√		√
AP Calculus BC	√	√	
AP Chemistry	√	√	
AP Macroeconomics	√		
AP English Language and Composition	√	√	√
AP English Literature and Composition	√	√	√
AP Government and Politics: United States	√		
AP History: United States	√	√	
AP Spanish Language	√		

<sup>a</sup> (Trend 1) The AP Credit group significantly outperformed the other groups on most outcome measures.

<sup>b</sup> (Trend 2) The Concurrent group earned significantly more subject credit hours than the AP No Credit and Non-AP groups.

<sup>c</sup> (Trend 3) The Non-AP group significantly outperformed the AP No Credit group in the GPA-dependent measures.



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non-AP students for the respective AP Exams. In fact, as a consequence of matching with the AP Credit group, those in each Non-AP group tended to be the more proficient non-AP students in the respective subject. Students in the AP No Credit group were not matched with those in another comparison group, and by definition tended to be the less proficient AP students in high school academic achievement. Thus, it was not surprising to find that the Non-AP group outperformed the AP No Credit group in 4 of the 10 subject areas. One should, therefore, be careful not to overinterpret the comparison results between the AP No Credit and Non-AP groups. To draw meaningful conclusions, future studies that match non-AP students to the AP No Credit students should be conducted so that more appropriate comparisons can be made.

It should be noted that while this study was conducted on a large sample of college freshmen, all students were from a single college campus. Caution should be exercised in generalizing the study findings to all U.S. college students. Future studies should include students across multiple campuses. Also, while matching was performed to equalize the groups on high school ranks and SAT/ACT scores, additional factors such as motivation, parental education, and socioeconomic status could be used, if the data are available.

Collectively, the study's findings support previous research that showed that AP students performed as well if not better than non-AP students on most college outcome measures. Thus, these results imply that the findings in these previous studies still apply even with the rapid expansion of the AP Program.

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# References

- Camara, W., & Michaelides, M. (2005). *AP<sup>®</sup> use in admissions: A response to Geiser and Santelices*. Retrieved January 12, 2006, from [http://www.collegeboard.com/research/pdf/051425Geiser\\_050406.pdf](http://www.collegeboard.com/research/pdf/051425Geiser_050406.pdf).
- Casserly, P. L. (1986). *Advanced placement revisited* (College Board Report No. 86-6). New York, NY: The College Board.
- Cohen, J. (1977). *Statistical power analysis for the behavioral sciences (revised edition)*. New York, NY: Academic Press.
- College Board. (1997). National Summary Reports. Retrieved June 26, 2006, from [http://www.collegeboard.com/prod\\_downloads/student/testing/ap/sumrpts/1997/national\\_1997.pdf](http://www.collegeboard.com/prod_downloads/student/testing/ap/sumrpts/1997/national_1997.pdf).
- College Board. (2000). National Summary Reports. Retrieved June 26, 2006, from [http://www.collegeboard.com/prod\\_downloads/student/testing/ap/sumrpts/2000/national\\_2000.pdf](http://www.collegeboard.com/prod_downloads/student/testing/ap/sumrpts/2000/national_2000.pdf).
- College Board. (2001). National Summary Reports. Retrieved June 26, 2006, from [http://www.collegeboard.com/prod\\_downloads/student/testing/ap/sumrpts/2001/pdf/national\\_2001.pdf](http://www.collegeboard.com/prod_downloads/student/testing/ap/sumrpts/2001/pdf/national_2001.pdf).
- College Board. (2002). National Summary Reports. Retrieved June 26, 2006, from [http://www.collegeboard.com/prod\\_downloads/student/testing/ap/sumrpts/2002/pdf/national\\_2002.pdf](http://www.collegeboard.com/prod_downloads/student/testing/ap/sumrpts/2002/pdf/national_2002.pdf).
- College Board. (2003). National Summary Reports. Retrieved June 26, 2006, from [http://www.collegeboard.com/prod\\_downloads/student/testing/ap/sumrpts/2003/pdf/national\\_2003.pdf](http://www.collegeboard.com/prod_downloads/student/testing/ap/sumrpts/2003/pdf/national_2003.pdf).
- College Board. (2004). National Summary Reports. Retrieved June 26, 2006, from [http://www.collegeboard.com/prod\\_downloads/student/testing/ap/sumrpts/2004/pdf/national\\_2004.pdf](http://www.collegeboard.com/prod_downloads/student/testing/ap/sumrpts/2004/pdf/national_2004.pdf).
- Dodd, B. G., Fitzpatrick, S. J., De Ayala, R. J., & Jennings, J. A. (2002). *An investigation of the validity of AP grades of 3 and a comparison of AP and non-AP student groups* (College Board Research Report No. 2002-9). New York, NY: The College Board.
- Dougherty, C., Mellor, L., & Jian, S. (2005). *The relationship between advanced placement and college graduation* (2005 AP Series, Report 1). Austin, TX: The National Center for Accountability.
- Geiser, S., & Santelices, V. (2004). *The role of advanced placement and honors courses in college admissions*. Berkeley, CA: Center for Studies in Higher Education, University of California, Berkeley. Retrieved January 12, 2006, from <http://cshe.berkeley.edu/publications/papers/papers/ROP.Geiser.4.04.pdf>.
- Hurwitz, N., & Hurwitz, S. (2003). Is the shine off the A.P. apple? *American School Board Journal*, 190(3).
- Klopfenstein, K. (2004, December 12). The advanced placement expansion of the 1990s: How did traditionally underserved students fare? *Education Policy Analysis Archives*, 12(68). Retrieved January 9, 2006, from <http://epaa.asu.edu/epaa/v12n68/>.
- Koch, W. R., Fitzpatrick, S. J., Triscari, R. S., Mahoney, S. S., & Cope, J. E. (1988). *The Advanced Placement Program<sup>®</sup>: Student attitudes, academic performance, and institutional policies*. Austin, TX: The University of Texas at Austin, Measurement and Evaluation Center.
- Kramer, C. Y. (1956). Extension of multiple range tests to group means with unequal numbers of replications. *Biometrics*, 12, 307-10.
- Lichten, W. (2000, June 24). Whither advanced placement? *Education Policy Analysis Archives*, 8(29). Retrieved January 9, 2006, from <http://epaa.asu.edu/epaa/v8n29.html>.
- Morgan, R., & Crone, C. (1993). *Advanced Placement<sup>®</sup> examinees at the University of California: An examination of the freshman year courses and grades of examinees in biology, calculus, and chemistry* (ETS Statistical Report No. 93-210). Princeton, NJ: Educational Testing Service.
- Morgan, R., & Maneckshana, B. (2000). *AP students in college: An investigation of their course-taking patterns and college majors* (ETS Statistical Report No. 2000-09). Princeton, NJ: Educational Testing Service.
- Morgan, R., & Ramist, L. (1998). *Advanced placement students in college: An investigation of course grades at 21 colleges* (ETS Statistical Report No. 98-13). Princeton, NJ: Educational Testing Service.
- Olejnik, S., & Algina, J. (2003). Generalized eta and omega squared statistics: measures of effect size for some common research designs. *Psychological Methods*, 8(4), 434-47.
- Schneider, D., & Dorans, N. J. (1999). Correspondence between ACT and SAT I scores (College Board Research Report No. 99-1). New York, NY: The College Board.
- Stevens, J. (1999). *Intermediate statistics: A modern approach (2nd edition)*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Willingham, W. W., & Morris, M. (1986). *Four years later: A longitudinal study of advanced placement students in college* (College Board Report No. 86-2; ETS Research Report No. 85-46). New York, NY: The College Board.



