Weighting for Recognition: Accounting for Advanced Placement and Honors Courses When Calculating High School Grade Point Average

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Honors and advanced placement (AP) courses are commonly viewed as more demanding than standard high school offerings. Schools employ a range of methods to account for such differences when calculating grade point average and the associated rank in class for graduating students. In turn, these statistics have a sizeable impact on college admission and access to financial aid. The authors establish the relationship between the grade earned and type of high school science course taken for 7,613 students by modeling their later performance in an introductory college course. The sample is drawn from more than 100 introductory science courses at 55 randomly chosen college and universities. Accounting for variations in college grading systems, strong evidence is found in favor of the practice of adding bonus points to students' high school course grades in the sciences, namely, on a 4-point scale, 1 point for AP courses and .5 for honors courses.

Keywords: *science; advanced placement; grade point average; grade weighting; college grades*

Introduction

High school grades and standardized test scores have risen in importance for students and their parents. After socioeconomic status (SES), one's access to higher education, especially highly selective colleges, is impacted by these measures of performance (Vickers, 2000). High school grades are typically aggregated into a single measure, grade point average (GPA), by school administrators and then used to determine rank in class (RIC) of graduating seniors (Hawkins & Clinedinst, 2006). Advanced courses typically complicate the calculation of GPA. There is little in the way of scholarly research that informs policy makers on the validity of the many different systems advocated for weighting GPA.

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Honors and advanced placement (AP) courses represent common avenues by which students are exposed to advanced work while in high school. The AP program has expanded in the past five decades to involve 1,200,000 students taking 2,100,000 AP exams in more than 32 different subjects (Camara, Dorans, Morgan, & Myford, 2000; College Entrance Examination Board [CEEB], 2005a; Hershey, 1990; Rothschild, 1999). Advanced placement was originally conceived of as a program for elite private school students to take college-level courses while still in high school so that exceptional students could start in college with credit for introductory courses, potentially earning their degree in a shorter time (Phillips Academy, 1952). When the program was conceived, no mention was made of the impact on admission to college or how taking advanced courses should impact GPA or honors in high school.

Advanced courses have become a part of political mandates, with several states (e.g., Florida, Louisiana, and Utah) offering incentives to high schools to teach AP courses, whereas others (e.g., South Carolina) require all high schools to participate (Hershey, 1990; Willingham & Morris, 1986). Federal subsidies of AP programs for low-income students were initiated by U.S. Department of Education's Higher Education Act of 1998 and are continuing to increase yearly.

When students select advanced coursework in high school, they (and their parents) expect that such courses will better prepare them for college (Adelman, 1999; Schneider, 2003). Conventional wisdom suggests that such courses should result in greater learning and their attendant benefits: higher standardized test scores, greater probability of being accepted into the college of their choice, better performance in college (Klopfenstein, 2004; National Research Council, 2002; Thompson & Joshua-Shearer, 2002), and more access to merit-based financial aid (Herr, 1991b; Hout, 2005). If a student earns high scores on enough AP exams, he or she may be

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awarded "advanced standing" and enter a college with course credits or even as a sophomore, saving a year's tuition (Dillon, 1986; MacVicar, 1988; Pushkin, 1995). However, enrolling in an AP or honors-level course can result in students earning a lower grade than they would in a standard-level course because more will be expected and higher performing students will be classmates (Attewell, 2001). Lower grades can adversely impact their GPA and lower their RIC. Many high school administrators and teachers are concerned that such a disincentive can adversely impact enrollment in honors and AP courses (Capasso, 1995). High school GPA (HSGPA) and RIC are also commonly used to decide high school graduation honors and can affect "automatic" acceptances at many state universities (e.g., Texas, Maine), eligibility for financial aid credits, and admissions at selective colleges and universities. Even a small disparity in GPA between candidates can mean the difference between acceptance and rejection by a college (Vickers, 2000).

In view of these issues, the majority of high schools in the nation modify or "weight" their calculation of HSGPA (Hawkins & Clinedinst, 2006). However, no standard scheme exists (Cognard, 1996; Dillon, 1986; Jones, 1975; National Research Council, 2002). The majority of high schools average together grades for every course taken (CEEB, 1998), whereas some limit inclusion to courses only in academic subjects (i.e., math, science, English, history, foreign language), excluding ancillary courses (e.g., typing, physical education). Although when tested by Goldman and Sexton (1974), there was no improvement in prediction of college grades when using this more restricted set of courses. The scale used is commonly based on 4 points (A = 4, B = 3, C = 2, D = 1, F = 0), although pluses and minuses awarded may expand the scale upward (e.g., A+ = 4.33). Honors or advanced placement courses are often accounted for by grading on a higher scale (A = 5, B = 4, C = 3, D = 2, F = 1), or more simply, "bonus" points are added to the grade appearing on the transcript (from .5 to a full point). Thus, the seemingly simple process of averaging student high school grades together has many variants. In addition, anomalies exist, which different schemes attempt to remedy; it is possible to attain higher grades by taking remedial courses, fewer courses, or repeating a course for a higher grade (Downs, 2000; Vickers, 2000).

The intention of this study was to investigate the validity of weighting of high school grade point average based on evidence of later performance in college. Rather than accepting those procedures that are prevalent, we sought evidence-based validation with which high school administrators could possibly establish, modify, or defend their policies. For example, Alder (1984) reported that in 1982 the University of California system decided that as an inducement for applicants to take the most demanding high school courses, 1 point should be added to a student's high school grade for each honors or AP course taken (e.g., earning an A in biology would normally result in a score of 4; an A in an honors or AP biology course would be worth a 5). The fact that several states now require such uniform calculations for entry to state colleges and universities did not strike us as evidence that such calculations are warranted.

Legislators and bureaucrats have long supported policies that have little to support them. Perhaps the oddest example is an attempt to pass into law a rational value for the irrational number pi. A bill to legislate the value as 3.2 was filed in 1897 in the Indiana House of Representatives (Beckman, 1971). Educators prefer the kind of evidence provided by rigorous studies to make decisions that best serve their constituents.

Background

The College Entrance Examination Board (which administers the AP program; CEEB) has the arguably conservative position that the value of AP courses for students can only be certified when they take the AP exam, maintaining that colleges will grant credit for AP exam scores above a certain level. The CEEB holds no official position on the weighting of high school grade point averages on the basis of enrollment in AP courses. The CEEB does not support the use of AP enrollment in college admissions decisions, and it is not proactive in making available the results of AP exams by admissions officers. One simple reason is timing. In our study, we find that 66% of students take their AP science courses in their senior year. Hence, the majority of AP exams are taken in May well after college admissions decisions are made. Moreover, it is estimated that 30% to 40% of students in AP courses nationally do not take the associated AP exam (National Research Council, 2002). Left without guidance, not content to let credit for college courses be the sole benefit of taking an AP course, and worried that advanced courses might "hurt" students' HSGPA, high schools and colleges respond to pressures from parents, students, and teachers in adopting their own schemes to deal with the issue of accounting for the value of taking AP or honors courses.

Without the standardization of an AP exam score, what can high schools do to reward students who choose these advanced courses? High schools have few options to measure the intrinsic merit of these courses. AP or honors enrollment and the grades students earn could mean a great deal or nothing at all. Many high schools recognize that the knowledge and experience of a teacher determines the quality of AP or honors courses (Dillon, 1986). Although the curriculum may be rigorous in AP and honors courses, high schools also vary in their selectivity policies for determining which students may qualify to enroll. Some accept all students into these advanced courses; others require certain prerequisite classes or exam performance (Nyberg, 1993). Hence, enrollment in such courses without considering the grade received or the AP exam performance may not reflect student achievement. Indeed, the correlation between grade in AP courses and AP exam scores is only .336 for the 964 students in our study. There are many students who earn an A in their AP course and perform quite poorly on their AP exam (Hershey, 1990). William Lichten (2000) of Yale University found evidence for a drop in standards as the AP program has expanded nationally.

Students who enroll in AP courses are arguably the most academically gifted in high school and later do well in college. Educators should keep in mind that there is a difference between enrollment in AP courses as an indicator of college preparation versus the degree to which these courses contribute to college preparation. As an example, the National Merit Scholar program selects 8,200 high school seniors each year for recognition from a field of 1.3 million entrants. No one would argue that these students are not among the best high school scholars, but being selected by the program does nothing to improve their academic preparation per se. So too with AP; the impact of taking an AP course on these highly motivated and intelligent students cannot be assessed by simply comparing students who take AP with those who do not. Careful selection of controls is essential in measuring impact. However, many studies simply compare AP participants and nonparticipants, including studies touted by the CEEB, which is responsible for the quality of the program. This concern was best summarized by Dougherty, Mellor, and Jian (2006):

> Much of those [AP] 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. (p. 3)

Another issue for educators stems from the frequency in which AP courses are offered in different high schools. Some argue that the difference in offerings among schools perpetuates a "two-tiered educational system" (Dupuis, 1999, p. 1) whereby students of higher socioeconomic status have more access to advanced courses and earn much higher HSGPAs as a result (Burdinan, 2000). As an example, the average HSGPA of applicants to the University of California at Los Angeles was 4.19 in 1998, indicating that those high schools that do not offer students the opportunity to earn As in advanced courses may be at a disadvantage in competing at selective colleges (Dupuis, 1999).

Prior Research

Ideally, an experiment whereby students can be randomly assigned to regular, AP, honors, or no course at all in a subject could resolve questions about the impact of AP and honors courses. However, such a draconian research design is neigh impossible in education. Students must be free to choose their courses. Yet, there are many studies that attempt to control for background factors through statistical means or by subject matching. Such studies have come to differing conclusions, either finding that AP and honors courses make a big difference later on or that they make no difference at all.

On the side of calculating a weighted HSGPA to account for AP and honors courses, studies have found the following:

- College GPA is higher for AP students (Burton & Ramist, 2001; Chamberlain, Pugh, & Shellhammer, 1978; Morgan & Ramist, 1998).
- For math and science majors, the weighted HSGPA is a better predictor of first-year college GPA than a nonweighted HSGPA (Bridgeman, McCamley-Jenkins, & Ervin, 2000; Dillon, 1986).

- Accounting for the difficulty of a student's academic program in high school increases the variance explained for college freshman GPA (Bassiri & Schultz, 2003; Lang, 1997).
- AP students are more likely to continue with the subject in college and take higher level courses (Chamberlain et al., 1978; Ruch, 1968) even when matched by sex and SAT score (Cahow et al., 1979).
- Those who teach advanced high school courses find more intellectual stimulation and enjoy greater collegiality with peers who teach AP courses (Herr, 1991a).
- Honors and AP courses more closely match the type and pace of courses students will face in college, bestowing an advantage on students (and their parents) who generally have little idea of the standards, course requirements, and placement tests they would face in college (Venezia & Kirst, 2005).
- Standardized exam scores tend to underpredict female student performance in college. Adding in HSGPA ameliorates this bias in college admissions decisions (Bridgeman & Lewis, 1996; Bridgeman & Wendler, 1991; Gallager & Kaufman, 2005; Wainer & Steinberg, 1992).
- The preference for weighted HSGPAs among directors of admissions at 4-year colleges has grown from 52% in 1971 to 68% in 1989 (Seyfert, 1981; Talley, 1989). The majority of their colleges had official policies to show no preference between candidates with a weighted HSGPA and a nonweighted HSGPA. Yet in a blind rating of candidates, 76% gave preference to those with a weighted HSGPA (Talley, 1989).

Several studies have found little or no evidence that weighting HSGPA for advanced high school courses predicted better college performance or persistence:

- No difference was found between matched pairs of AP and non-AP students on college grade in their introductory course or overall freshman GPA (Ruch, 1968).
- The combined number of AP and honors courses taken in high school was not a significant predictor for freshman college GPA or significant in predicting persistence in college (Geiser & Santelices, 2004). For a response to this article, see Camara and Michaelides (2005).
- A study of 28,000 high school graduates in Texas measuring persistence to a second year of college study and first-year college GPA (Klopfenstein & Thomas, 2005) found that AP courses provide little or no additional postsecondary benefit in college GPA or persistence when controlling for the balance of a student's high school curriculum.

Although honors and AP courses often are treated the same in weighted calculations, Herr (1992) studied the difference between these two types of courses by surveying 847 teachers in New York State. He found that honors courses were characterized by greater curricular freedom in choosing texts, topics, and teaching methods. They were less stressful to teach, allowed more time to be spent in the laboratory, and were viewed by their teachers as better at developing students' "thinking skills." AP courses were seen as more satisfying for teachers and covered a greater breadth of topics in greater depth and at a faster pace. Honors and AP courses served different needs. Typically an honors course is taken by students as a prerequisite for AP (Herr, 1993). Among our participants, an earlier high school course in the same science subject was taken by 94% of those who enrolled in AP biology, 92% of those in AP chemistry, and 47% of those in AP physics.

Colleges and universities rely on student transcripts in their admissions process. Half recast GPAs based on their own standards. Ignoring a high school's calculation, the rest use the reported HSGPA unchanged (Hawkins & Clinedinst, 2006). Although college admission offices have flexibility in how they can recalculate HSGPA, this opportunity does not exist for a student's RIC. Rank sums up where a student stands with regard to his or her graduating class, usually converted to a percentile. For RIC, high schools use their own GPA calculation in their determination. Colleges cannot recalculate this rank, so they must accept reported RIC as is or not use it in the admission decision. Rutledge (1991) and Lockhart (1990) reported the cost to applying students when college admissions officers give emphasis on RIC based on an unweighted HSGPA. In a review of college and university admissions policies, HSGPA (or RIC) was the most important factor in college admissions. AP course enrollment ranked above SAT II scores in importance (Breeland, Maxey, Gernand, Cumming, & Trapani, 2002).

While the debate rages, no prior research has attempted to measure the impact of AP or honors courses with the intent of setting a defensible number of "bonus" points for each course type. This is our goal. If large differences in college performance exist based on taking advanced courses, then weighted HSGPAs make sense. If the differences are small, unweighted HSGPAs will do.

Methods

We have chosen to study the relationship between high school grades in science and the level of the high school course (regular, honors, advanced placement) in an attempt to find validation for the award of "bonus" points when calculating a weighted HSGPA. To do this, we used data from 7,613 college students enrolled in introductory science courses in 55 randomly chosen colleges and universities. Several statistical models were built in our attempt to account for the variation in college science grades of these students. High school course type and high school course grade are significant predictors of college science grade. A comparison between these two variables allowed a calculation of the value of "bonus points" for honors and AP courses to be used when figuring HSGPA. Three regression models accounting for increasing degrees of variation in the backgrounds of students buttress the robustness of the findings. Important issues in this analysis are the selection of outcome variables, construction of the survey instrument, sample selection, and the rigorous approach to analysis.

Outcome Variable

The issue for the authors was how to equate high school course rigor and grade through association with one of many possible common metrics. Suggested candidates for this parametric relationship are:

- standardized test scores (e.g., ACT, SAT I, or SAT II),
- performance in college coursework, or
- persistence to the next year of college or to graduation.

Our decision was to carry out this analysis using as a common metric the grade that students earn in their introductory college science course. How well students perform in their college course is the most logical measure of how much a student has learned in his or her high school course in the subject. Presumably, the knowledge gained in a student's high school course endures through their college course, with the best prepared earning the highest grades. In our analysis, both the level of high school science course and the grade earned in high school were employed to calculate the appropriate adjustment to the high school grade. We could carry out this analysis because there are many students who repeat rather than "place out" of the introductory science course even if they have taken an AP course in the subject in high school and performed well on the AP exam (Willingham & Morris, 1986). These students did not take advantage of the opportunity for advanced placement promoted by the CEEB. Why? Students in our study volunteered these reasons:

- I was required by my university. . . . I could not skip major classes.
- I was told that many graduate schools didn't like to see students placing out of classes that were a core part of their major.
- My college certainly allowed people to test out of the first introductory course, but . . . they encouraged people to take the course regardless.
- Though I had done well on the AP exam [an AP exam score of 3] . . . I wanted to make sure I had basic concepts down well.
- [My] university did not accept a score of 4 to receive credit for the course.
- I did not score high enough on the AP test [a score of 5 needed] to take the [university placement] test.
- I missed a passing score [on the university placement exam] by one question [student earned a 5 on his AP exam].
- Although I got a 5 on the AP exam, my university did not give me credit for the introductory course unless I had laboratory documents, which I did not have.

Because all but the grade awarded in the college course was self-reported, questions arise as to reliability and validity. With regard to reliability, we consulted research on the accuracy of self-report in designing our study (Bradburn, Rips, & Shevell, 1987; Groves, 1989; Niemi & Smith, 2003). In addition, the review of Kuncel, Credé, and Thomas (2005) of self-report measures counted college students among those whose self-reports were reasonably accurate. The courses that students took in high school make up a proportionally large part of their relatively short life, and the grades they earned were fairly recent and fresh as most students had applied to college the previous year. Given that the surveys were administered by college science instructors while students were present in their college science courses, it would be doubtful if the students did not reflect on the courses they took in high school and the grades that they earned. To gauge reliability, we conducted a separate study in which 113 college chemistry students took the survey twice, 2 weeks apart. Our analysis found that for groups of 100, only a .07% chance of reversal existed (Thorndike, 1997). As to validity, the outcome used in this analysis, final college science course grades, is well understood by students as an indicator of their performance that will be entered into a permanent record. The method in which these grades are earned is also well articulated to the students in widely distributed course syllabi. Therefore, given the weight and clarity of final course grades as measures of achievement, we believe that it is a viable and clearly relevant though not flawless measure of student performance.

The Survey Instrument

Our instrument has the advantage of being constructed after two pilot studies, a review of the relevant research literature, and interviews with stakeholders, teachers, and college professors. The items relevant to this survey involved high school enrollment choices made by students and their performance in their high school science courses (see Figure 1). We also collected measures of the variation in their high school, including location, size, and ZIP code (to determine average home value, a measure of SES of the community in which their high school is located). The majority of the questions on the instrument were designed to establish the pedagogical choices made by high school science teachers: laboratory frequency and freedom, classroom activities, homework and other assignments, and the time devoted to particular scientific concepts. These were used to build models that account for students' performance in college science courses based on the instructional strategies of their high school science teachers while controlling for student background and the kinds of courses taken. Published work using these variables include the teaching of chemistry (Tai, Sadler, & Loehr, 2005; Tai, Ward, & Sadler, 2006), block scheduling (Dexter, Tai, & Sadler, 2006), and preparation for success in college science (Tai, Sadler, & Mintzes, 2006). Our earlier study (Sadler & Tai, 2001) found a significant effect on the earned college grade depending on the year in their studies in which they took the course. Graduate students in particular who enrolled in an introductory undergraduate course performed particularly well, so it is important to control for this effect.

Figure 1. Survey Questions Relating to High School Course Taking in Science and Mathematics

8 For each science course you took in each of the science topics listed below, please indicate the level of the course, the year in school you took the course, and the grade you earned in each course. *Please provide information for only one additional science course if this applies to you.*

SCIENCE TOPIC	COURSE LEVEL		YEAR IN SCHOOL	FINAL GRADE
	Regular/General	Honors		
Physical Science	○	○	8 9 10 11 12	A B C D F
Biology	○	○	8 9 10 11 12	A B C D F
Chemistry	○	○	8 9 10 11 12	A B C D F
Physics	○	○	8 9 10 11 12	A B C D F
Other: ____________	○	○	8 9 10 11 12	A B C D F
AP Biology:	AP test score: ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ Not taken		8 9 10 11 12	A B C D F
AP Chemistry:	AP test score: ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ Not taken		8 9 10 11 12	A B C D F
AP Physics:	AP(AB) test score: ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ Not taken AP(BC) test score: ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ Not taken		8 9 10 11 12	A B C D F

The Sample

This study is a part of a larger research effort, Factors Influencing College Science Success (Project FICSS), a grant-funded, national study that includes interviews and surveys of college science students, high school science teachers, and professors in biology, chemistry, and physics (interviews available online at www.ficss.org). The 55 colleges and universities included were selected from all U.S. 4-year schools, stratified to account for the proportional representation of the national variation in undergraduate enrollment. Initially, professors were recruited to administer an eight-page survey to students during the first 3 weeks of their introductory biology, chemistry, or physics course. Set aside for the semester, these surveys were later marked with students' final grades and then sent back to the research team. Once received, the surveys were checked, machine scanned, and the data compiled for analysis. Roughly 25% of survey participants volunteered their e-mail addresses for follow-up communications.

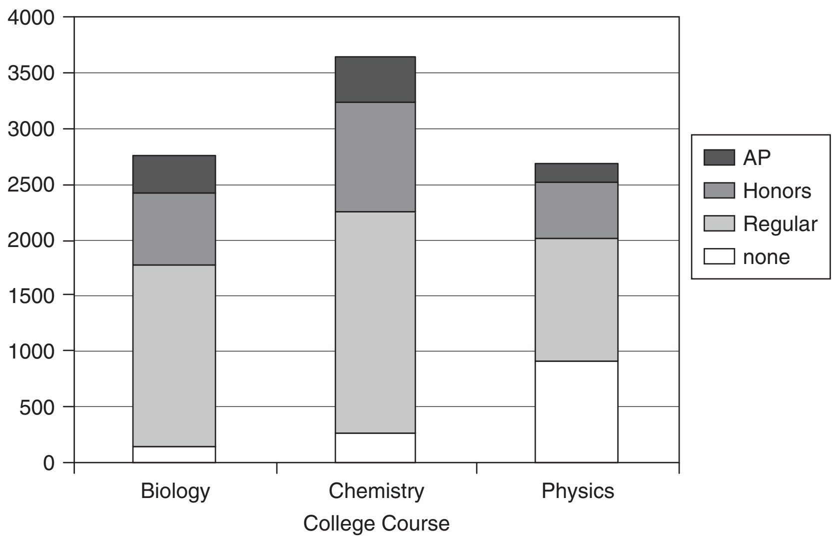
The overall sample consisted only of students in those introductory science courses fulfilling graduation requirements for majors in science or engineering. Of our sample, 40% of students took chemistry, and the rest split equally between physics and biology. In addition, 85% of students had enrolled in a course in the same subject in high school; of those, roughly half took a regular course in high school, a quarter took an honors course, and one tenth were in an AP course (see Table 1).

Figure 2 shows a proportional representation of these four groupings of students' high school course background. Many students who did not take a high school course were foreign students whose science curricula had different formats. These students were not included in the analysis.

Table 1. Distribution of Students in College Science Courses by Level of High School Science Course in the Same Subject

High School Science Course Level	Biology	Chemistry	Physics	Total	Percentage
No high school science course	151	268	902	1,321	15
Regular	1,626	1,993	1,114	4,733	52
Honors	650	983	506	2,139	24
Advanced placement	335	393	161	889	10
Total	2,762	3,637	2,683	9,082	100
Column percentage	30	40	30	100	

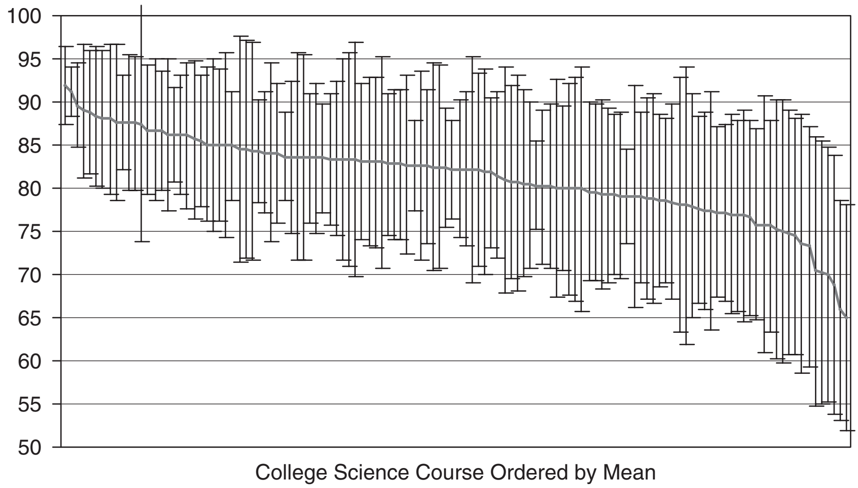
Figure 2. Distribution of Student High School Science Background in the Same Field for Students Taking Introductory College Biology, Chemistry, and Physics Courses



Note: AP = advanced placement.

It is of special note that the students who enrolled in these courses and who had taken an AP course in high school did not tend to be those who had performed poorly in their AP courses. Namely, 45% of these AP students reported that they took the AP exam. Their mean score on the exam was 3.05 (out of 5) compared to a mean score of 2.99 for students who took the exam nationally in these subject areas (CEEB, 2005b).

Figure 3. Mean and Standard Deviation in Student Grade in Introductory College Science Courses in the 123 College Science Courses Surveyed



The college course grading schemes differed across classrooms with a mean score of 81.32 and a mean standard deviation of 10.23 points, where final course grades were assigned values of A+ = 98, A = 95, A– = 92, B+ = 88, etc. (see Figure 3). We chose to assign college grades using this scale for ease of interpretation. Because we have no way to equate the difficulty of courses among institutions, we concerned ourselves with how well students performed within an institution. For this purpose, we entered each institution into our regression models as a separate variable to account for differences across institutions.

Analysis

To make sense of our data, we first examined the raw scores of students in college courses through tabular summaries and then by graphing the data with appropriate error bars. We then constructed three regression models. The first model accounts for variation in college science grade on the basis of HS grade in that subject and the course type (regular, honors, or AP). The second model includes variables that control for the differences at the college level, accounting for the impact of different levels of grading stringency (college ID) and when in a student's college career they took the course (year in college, which includes 1, 2, 3, 4, graduate, and special students status). At the level of the particular high school, our controls include a measure of the wealth of the community (mean home value taken from students' ZIP code), high school type (public, private, or other), and college course (college biology, chemistry, or physics). A third model incorporates student performance in other high school courses (mathematics and English) and the highest level of mathematics taken. Students who did not take a high school course in the corresponding science discipline are not included in the model because they have no high school grade in the related course type.

Descriptive Statistics

Table 2 presents the aggregated raw data of all students who took a high school course in the subject. Only 1% of students enrolled in the college subject earned a grade of D or lower in high school, with the majority earning a grade of A. College science courses (at least in courses that count for majors in science or engineering) can be considered to be populated by students who have done well in the subject while in high school. There are some general patterns that one can see in the college course means if one ignores those students who earned a low grade in high school as the counts are so few and the corresponding standard errors are so large.

For students earning an A, B, or C in high school, those with higher grades within this range do better in college. Also, students who take honors do better than those who enrolled in a regular course. Those enrolled in AP did better still. The pattern can be seen easily in Figure 4. The plotted error bars (±1 standard error of the mean) do not intersect, showing that these differences are all significant at the $p \leq .05$ level. For grades C or better, the relationship between college and high school grade are certainly monotonic and appear almost linear, allowing us to consider high school grade as a linear variable because these lines have nearly the same slope.

Regression Models

Multiple linear regression is employed for this analysis. This technique produces a mathematical model of students' performance in their introductory college science courses. Regression has the benefit of being able to measure the predictive power of variables while holding others constant, isolating the effect of conditions that may vary along with each other. In this case, we wanted to isolate the level of course students take in high school (regular, honors, or AP) from their grades in these courses (A, B, C, D, F) while controlling for high-school-level factors of community wealth, the type of high school, which colleges students are attending, and what year they are in within their college careers. Controlling for these factors freed us to analyze the large data set as a whole rather than having to break the analysis down into smaller groups (e.g., public vs. private schools, or students in their first, second, third, or fourth year of college). We developed three regression models shown in Table 3.

The variables of interest are organized into three groups, which are accounted for successively in the regression models. The first model only includes the variables of primary interest: HS science grade and course type. The second group included college- and high-school-level demographic factors. The third group included the subject level

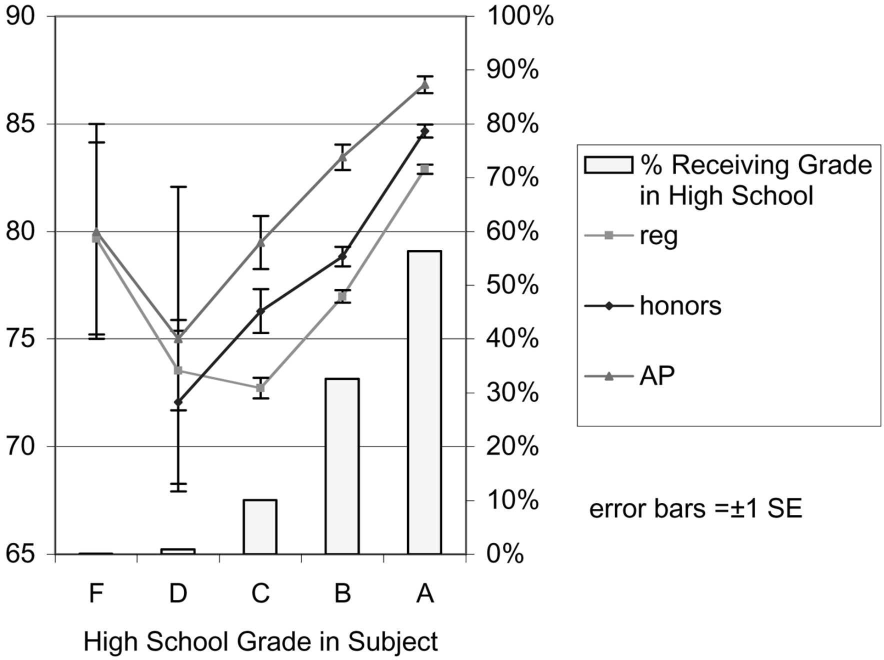
Table 2. Average College Grade for Groupings of Reported High School Grades Earned in Preparatory High School Science Course

	High School Grade Groupings												College Grade	
	Not Reported		F		D		C		B		A			
High School Course Level	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Regular	78.8	0.7	79.7	4.5	73.5	1.9	72.7	0.5	77.0	0.3	82.9	0.2	79.5	0.2
Honors	80.6	1.2	—		72.1	3.8	76.3	1.0	78.8	0.5	84.7	0.3	82.2	0.3
Advanced placement	81.4	1.9	80.0	5.0	75.0	7.1	79.5	1.2	83.5	0.6	86.8	0.4	85.1	0.3
Overall	79.1	0.6	79.9	3.6	73.5	1.6	74.0	0.4	78.2	0.2	83.9	0.2	80.6	0.1

Counts

	Not Reported	F	D	C	B	A	Totals
Regular	273	6	51	538	1,508	2,356	4,733
Honors	93	0	13	136	631	1,266	2,139
Advanced placement	25	2	5	64	260	532	889
Overall	391	8	69	738	2,399	4,154	7,761
Percentage		< 1	1	10	33	56	

Figure 4. Mean Introductory College Science Course Grade by Level of High School Course and Grade Earned in that Course



Note: AP = advanced placement.

difference in relevant high school courses, mathematics and English. We have substituted dummy variables for each categorical variable for the purpose of comparison.

The Model A accounts for 11% of the variance in college grade. Students who earn higher grades in high school science or who take advanced courses (or both) do significantly better in their college science course.

Model B accounts for an additional 8% of the variance in college science grade by including the additional college- and high-school-level variables described earlier. The variables include year in college to account for the fact that graduate and special students who take introductory courses perform much better than undergraduates. The particular college course (i.e., biology, chemistry, or physics) differs in mean grade, as do the individual college courses. At the high school level, we account for the HS type (public, private, or other) and SES through the mean home value generated from U.S. census data associated with students' ZIP codes. Students from private high schools earn higher grades in college science. In Model B, students

Table 3. Regression Models Predicting College Grades in Introductory Science Based on High School Grade, Level of Course, and Control Variables

		Main Effects Models									
		A			B			C			
Variables	*df*	Coefficient	*SE*	Significance	Coefficient	*SE*	Significance	Coefficient	*SE*	Significance	Standardized Coefficient
Constant	1	61.2	0.8	***	62.0	1.0	***	52.0	1.3	***	
High school science grade	1	4.6	0.2	***	4.8	0.2	***	2.5	0.2	***	0.16
High school course type											
Advanced placement	1	2.1	0.2	***	2.3	0.2	***	1.8	0.2	***	0.08
Honors	1	–0.4	0.2		0.1	0.2		–0.4	0.2		–0.01
Regular	1	–2.3	0.2	***	–2.4	0.2	***	–1.4	0.2	***	–0.04
Mean home value in $K	1				Included			Included			
Year in college	5				Included			Included			
College course discipline	2				Included			Included			
High school type	2				Included			Included			
College course ID	122				Included			Included			
Highest high school math class											
Algebra 2 or lower								–4.2	0.3	***	–0.13
Precalculus								–1.8	0.2	***	–0.08
Calculus	1							0.6	0.3	*	0.02
Calculus AB								2.1	0.2	***	0.07
Calculus BC								3.4	0.4	***	0.07
Last high school math grade	1							2.8	0.2	***	0.19
Last high school English grade	1							1.8	0.2	***	0.10
List-wise deleted		516			904			943			
Sample size		7,613			7,225			7,186			
R^2		0.11			0.20			0.28			

*≤ .05. **≤ .01. ***≤ .001.

who earn higher grades in high school science again perform better when they take their college science course. Students who take honors courses earn higher college grades than those who take a regular course. Those who take an AP course in the subject earn even higher grades. One should note that each of the included demographic factors is significant.

Model C adds in the variables for high school mathematics (last math grade and highest math course taken) and English (last English grade) preparation. These variables account for differences in students' background that impact the grades earned in college. This final model accounts for 27.9% of the variance in college science grades. This model more carefully isolates the impact of high school grade in science and the level of course taken. One should note that high school grade in science and type of high school course have smaller coefficients in Model C than in Models A or B. The math and English variables better account for some of the variance formerly explained by the science variables alone. Among the course-taking variables, last math grade has a larger standardized coefficient (.19) than HS science grade (.16); performance in high school math is a better predictor of college science success than performance in a particular high school science course. Taking AB or BC calculus in high school is nearly equal in predictive power to taking AP science across biology, physics, and chemistry. Doing well in HS English appears to have almost as much to do with college science performance as taking an AP course in science. The many demographic variables that are significant show that accounting for such differences is important to any analysis of college performance. One should keep in mind that 72% of the variance still remains unexplained in Model C. Other factors unavailable at the time of graduation from high school could certainly account for the remaining variance (e.g., level of effort in college, student homesickness, roommate problems, partying behavior, etc.).

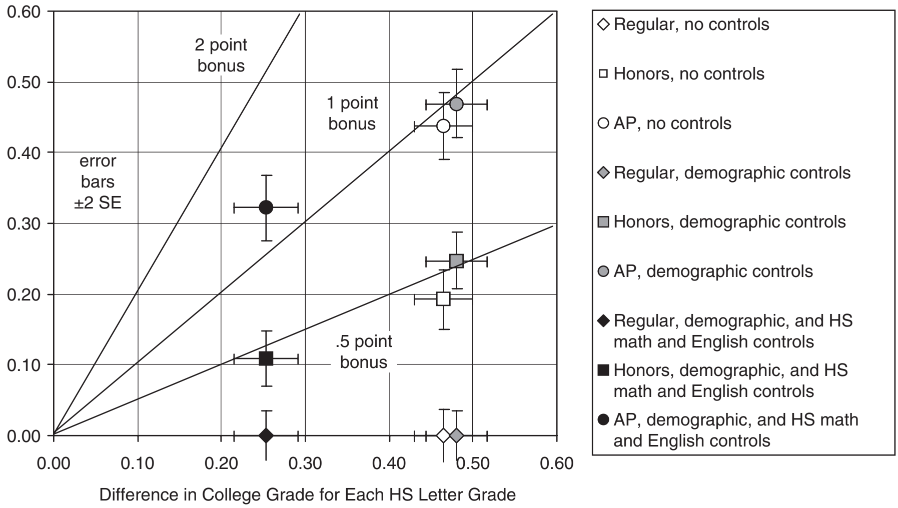
The key calculation in this study was made by first finding the difference in college letter grade associated with a one letter grade difference in high school science. For example, in Model A, students who had enrolled in a high school AP course do better than their college classmates who only took a regular course by .44 of a letter grade. A one letter grade difference in high school science (e.g., from a grade of C to B or from B to a grade of A) translates into .46 of a letter grade increase in college science. When one divides the former number by the latter, a bonus point ratio results. This is a defendable estimate of the "bonus points" to be used in a weighted HSGPA for honors or AP coursework in science. These are shown in Table 4. Note that for all models the bonus point ratios for regular, honors, and AP courses are very similar. The value of two standard errors of the mean for each variable are calculated along with those of the bonus values.

Plotting high school grade earned against the impact of the high school course helps to reveal the equivalence between high school grade earned and level of high school course (see Figure 5). For this graph, the axes are scaled to one letter grade

Table 4. Differences in College Science Performance Associated With One Letter Grade Difference in High School Science Grade and With the Science Course Type

	Main Effects Models					
	A		B		C	
	Difference in College Grade	Bonus Point Ratio	Difference in College Grade	Bonus Point Ratio	Difference in College Grade	Bonus Point Ratio
Difference of one high school letter grade	0.46		0.48		0.25	
High school course type						
Advanced placement	0.44	0.94	0.47	0.98	0.32	1.27
Honors	0.19	0.41	0.25	0.51	0.11	0.43
Regular	0.00	0.00	0.00	0.00	0.00	0.00
2 Strandard errors						
Letter grade	0.03		0.04		0.04	
Advanced placement	0.05	0.12	0.05	0.13	0.05	0.28
Honors	0.04	0.09	0.04	0.09	0.04	0.17
Regular	0.04		0.04		0.04	

Figure 5. Comparison of Calculated Bonus Point Values for Honors and Advanced Placement (AP) Courses



in college science. This graph has the benefit of directly showing the "leverage" of one letter grade difference in high school science on college science. The ratio (AP difference from regular/difference of one letter grade) provides an equivalent impact of AP in units of high school grade.

As an example of one of the graph's data points, we can examine the results from Model A for students taking AP in high school, which is represented by the white circle. The position of the data point along the horizontal axis represents our finding that for each increase in high school letter grade, students average 0.46 of a letter grade higher in their college science course. The position of the data point along the vertical axis represents our finding that students who have had an AP course in the subject average 0.44 of a letter grade higher in their college course than those students who have had only a regular course in the subject in high school. The ratio of the two values is 0.94, placing the data point very near the diagonal line of "1 bonus point." The same holds true for AP courses in Model B (gray circle) and Model C (black circle) with respective ratios of 0.98 with demographic controls and 1.27 points with high school math and English controls added. For honors courses this bonus is 0.41 based on the raw data, 0.51 with demographic controls, and 0.43 with high school math and English controls added. With error bars of ±2 *SE*, one can see that the bonus of 1 point for AP and 0.5 points for honors appears to be quite reasonable for all models.

Discussion

"It is better to take a tougher course and get a low grade than to take an easy course and get a high grade" opined Senior Research Analyst Clifford Adelman (Lee, 1999, p. 6). This view is echoed in other reports as well: "One of the best predictors of success is taking rigorous high school classes. Getting good grades in lower-level classes will not prepare students for college-level work" (Venezia, Kirst, & Antonio, 2003, p. 31; Rose & Betts, 2001). We have attempted to gauge the truth of these statements. Is it really better to earn a D in an AP course than an A in a regular course? Do students get anything out of a high-level course for which they are unprepared and as a result earn a low grade?

We find that on average, students who take an AP or honors science course in high school perform better in a follow-up college science course. However, our study shows that there is a limit to the apparent value of AP and honors courses over regular science courses. On average, students who end their high school years with a B in an AP course do not do better in the college subject than those who earn an A in the regular course. Those who earn a C in AP science do significantly worse than those who earn an A in a regular science course. This raises a troubling concern. Most students who take an AP course enroll in it only after taking a regular high school course in the subject. For students who earn a whole letter grade less in AP science than in their regular course, there appears to be no apparent benefit when predicting their college science grade. As an example, a student who earns an A in regular chemistry and goes on to earn a B in AP chemistry may perform no better than a student who stops with the A in regular chemistry. For students who start in an honors chemistry course, the difference is half a letter grade.

The fact that Model C is most predictive of college science grades is an important finding. Standardized coefficients for math and English variables in this model are of a larger magnitude than that for science courses. In particular, performance in HS mathematics is more connected than doing well in HS science to performance in college science. AP calculus courses and AP science courses have nearly the same standardized coefficients; they are equally associated with performance in college science. These findings agree with research showing that quantitative skills are essential to good performance in college science (Marsh & Anderson, 1989).

Should this study be interpreted as proving that AP and honors courses are effective at preparing students for college science? No, this is not the view we wish to promote. It is only that among students who take college science, those with honors and AP courses in their backgrounds do significantly better. This may be for many reasons, and the difference in college grade between those with different levels of high school courses is small.

One of the pressures on schools to give bonus points for honors and AP courses is that grade inflation has compressed the scale of HSGPAs at the high end; 18% of seniors had an A average in 1968 versus 47% in 2004 (Cooperative Institutional Research Program, 2005; Kirst & Bracco, 2004). The inclusion of bonus points helps to increase the spread of HSGPAs, aiding colleges in making judgments among competing candidates.

Many high schools offer science courses that are taught by teachers who are underqualified. Nationally, 38% of the life science students (middle school life science and high school biology) and 56% of physical science students (middle school earth science and physical science and high school chemistry and physics) are taught by teachers without a major or minor in that field (Ingersoll, 1999). We did not control for teacher background in this study. Because better prepared teachers generally gravitate toward the AP and honors courses, the apparent advantage of these higher level courses may result, at least in part, from more talented or more highly experienced teachers rather than from the more rigorous standards or faster pace.

We find that SES is a factor. Why? AP courses are much more common in more affluent schools. Students in AP courses in less affluent areas may have to deal with the fact that such course taking is more rare in their school and may conflict with some of the ways in which they relate to their friends, causing social isolation. Students could be under adverse social stress because they study more than peers in regular courses (Ferguson, 2001).

Teachers of AP courses can have difficulty maintaining standards because others may judge their effectiveness by the fraction of students who earn a 3, 4, or 5 on the AP exam (Lurie, 2000). The CEEB recently announced that it will now audit all AP courses to ensure that all courses meet their high standards. Some are AP courses in name only, not offering a fast pace or rigorous standards (Honowar, 2005). No such audit for honors courses exists. Venezia et al. (2003) told of a school system that redesignated each of its courses as honors courses—while making no changes in rigor—when hearing that the University of Georgia gave extra weight to honors courses.

This study involves a policy issue that concerns students, parents, teachers, and administrators. We have constructed our models to account for information available at the end of a student's senior year and not information that would be available to college admissions officers. In some school districts, decisions concerning GPA, RIC, and class honors are made at the school level by teachers and principals. More commonly, district administrators and boards of education must wrestle with these issues particularly because they have a wide impact on individuals and institutions. In some cases, the issue is so charged that students, teachers, parents, and administrators all desire to sway the decision of the school board (Papadonis, 2006). School administrators must balance the desire of most individual students (and their parents) to maximize their appeal to postsecondary institutions against the collective reputation of their own school (Attewell, 2001). Weighted HSGPA allows exceptional students to stand out more prominently to colleges, whereas a policy of nonweighting tends to benefit students who do not take advanced courses when applying to colleges that do not recalculate HSGPA.

High school principals who wish to influence policies concerning HSGPA calculation, RIC, and the award of honors should consider the data presented here at two levels, school and district. At the school level, it is wise to acknowledge that the recognition of students through high HSGPA, RIC, or honors is a scarce resource in an educational system where access to financial aid or admission to prestigious schools is at stake. Colleges are driven to select students who will best succeed in their classrooms. Our study presents evidence that students who take more advanced coursework in high school perform better in their introductory college courses. High school faculty and staff should consider whether they wish to help make the difficult distinction between students through a uniform HSGPA policy or not. If they do not make these judgments, they defer to college admissions officers who will attempt to make distinctions between applicants with whatever tools they have at hand. At the district level, empirical data concerning the impact of high school course taking on college performance are rare as anecdotes from teachers who speak to former students or parents' perceptions offer little in the way of generalizable evidence. Our study can be used to advocate for more advanced level courses in high school but only for the population of students who can perform well in them. We see no evidence that students who enroll and do poorly in honors or AP courses (i.e., below C) benefit when they later enroll in college. This study also argues for students to be well rounded in English and mathematics if they wish to pursue science and engineering careers.

Conclusion

We find that the common practice of adding bonus points for AP and honors courses taken in high school when calculating HSGPA is supported. Those students taking these more advanced courses perform better in their college science courses. There is a large difference between AP and honors in their predicted impact on college grades, with honors courses valued at about half the level of AP courses. Thus, we find no support for these courses to be valued equally. We find strong support for high schools to calculate weighted grade point averages and assign RIC and honors based on these measures.

Performance in college science also appears to have a substantial connection to preparation in high school mathematics and English. We have investigated these relationships for science courses only and have no evidence to support or refute the awarding of bonus points for nonscience AP or honors courses.

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