

## **AC 2007-793: ADVANCED PLACEMENT CREDIT: A DOUBLE-EDGED SWORD IN ENGINEERING EDUCATION**

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# Advanced Placement Credit: A Double-Edged Sword

## Abstract

Recent reports in the *Chronicle of Higher Education* and elsewhere have raised questions about what Advanced Placement (AP) courses and credits signify about the academic qualifications of students who have taken AP classes and of those who have scored high enough on the AP exam to qualify for college credit. Some research has questioned whether students who receive AP credit for introductory courses actually have appropriate knowledge to move into more advanced courses as first-year students. But in an engineering curriculum packed with required classes, AP credit gives students a good opportunity to free up space in their schedules, enabling them to take lighter loads or to pursue other academic interests and broaden their educational experiences. Such curricular flexibility could make engineering a more appealing course of study for groups not traditionally attracted to the field in large numbers, particularly women. Yet, because some students lack access to AP programs in their high schools, the practice of awarding AP credit could further exacerbate the achievement gap between certain identifiable groups of students, such as between under-represented minority students and others, and could affect the persistence of those students who come to college without having experienced a more challenging high school curriculum.

This paper examines the experience with AP credit among engineering students at the University of Notre Dame. The paper presents data gathered on the performance of students in Calculus III, the third mathematics class in the engineering sequence, comparing students who received AP credit for Calculus I and II with students who actually took Calculus I and II at the University. It also presents data that indicate a clear performance difference in first-year classes between students with significant AP credit versus students with little or no AP credit, and includes demographic breakdowns that indicate that certain subgroups of students, even strong students admitted to a highly selective university like Notre Dame, remain disadvantaged as they enter college because of a lack of access to AP courses in their high schools. The paper concludes with some observations about what AP credit can indicate about individual students and groups of students, and with some suggestions for the role of AP credit in engineering education.

## Introduction

“AP can change your life. Through college-level AP courses, you enter a universe of knowledge that might otherwise remain unexplored in high school; through AP Exams, you have the opportunity to earn credit or advanced standing at most of the nation’s colleges and universities.”<sup>1</sup> So begins the pitch on the College Board’s web site, extolling the benefits of Advanced Placement (AP) courses, exams and credit. Yet several recent studies reported in the *Chronicle of Higher Education* and elsewhere have questioned this very premise, asking what AP courses actually reveal about a student’s preparation for college-level work.

Studies conducted under the auspices of the College Board have attempted to answer the question of whether AP exams “are a reliable equivalent to first-year college examinations.”<sup>2</sup>

These studies have concluded that colleges and universities “should feel comfortable in awarding college credit to students who score well on the tests.”<sup>2</sup> Other studies have asked different questions and have come to less favorable conclusions about AP courses and credits. Researchers at Texas Christian University (TCU) and Mississippi State University (MSU), for example, examined whether students who took AP courses in high school earned higher grades in the first year of college than students who did not take such courses. In this study, researchers concluded that the mere existence of AP courses on a student’s transcript did not predict either success in the first year of college or persistence after the first year.<sup>2</sup> Another forthcoming study by Harvard University and University of Virginia researchers questioned whether students who took AP science courses in high school “[did] as well in college science courses as AP advocates said they should,”<sup>3</sup> and concluded that “[d]oing well in an Advanced Placement science course in high school does not guarantee that a student will do equally well in an introductory college-level course in the same subject.”<sup>4</sup>

The differences in the conclusions of these studies lies in the questions asked. The College Board study examined the link between performance on the AP exam and competency at certain levels of a college curriculum.<sup>2</sup> The TCU/MSU study looked only at the correlation between an AP course on a student’s high school transcript and the student’s performance in college, apparently without regard for how the student did in the course and whether the student actually took the AP exam and scored well enough to earn college credit.<sup>2</sup> The Harvard/Virginia study did not examine whether students who scored well enough on an AP exam to earn college credit had sufficient competency to move forward in the science curriculum. Rather, it examined the academic performance of students “who retook the same course in college that a good AP test score would have allowed them to skip.”<sup>3</sup> Neither of these latter two studies attempted to answer the same question asked by the College Board. Yet, these and other similar studies may have inspired the College Board’s new quest to audit AP course syllabi nationwide, to ensure that the courses meet the College Board’s standards.<sup>5</sup>

This paper asks and answers a similarly limited question: Do students who qualify for AP credit in Calculus I and II and who take advantage of that credit to place into Calculus III as first-semester, first-year students perform as well as students who actually take Calculus I and II courses and enter Calculus III as first-semester, sophomore-year students in an engineering curriculum? This paper also addresses how students with a significant number of AP credits on their transcripts perform compared to their peers with fewer or no AP credits, and looks at some demographic differences between these groups.

## **Overview of Student Preparation**

The University of Notre Dame is a highly selective doctoral research university that admits students on the basis of a number of factors, including standardized test scores, high school class rank/performance, extracurricular activities and demonstrated leadership potential. Students admitted to the University must demonstrate, among other things, high intellectual potential through their high school academic records. University admissions officers evaluate a student’s academic record against the course offerings of that student’s high school and require that students take the most challenging curriculum that their high schools offer. Generally, this means that a student who has access to AP courses in high school but does not take them

receives a less favorable review in the admissions process than a student with similar standardized test scores and class rank who pursues a similar high school curriculum, but at a school that does not offer AP courses. Thus, it can be inferred that a student who comes to Notre Dame without AP credit either did not score well enough on the tests to earn the credit (and thus has not mastered the required material) or attended a high school that did not offer the AP curriculum.

Although admissions standards at Notre Dame creep higher and higher each year, the classes studied in this paper performed comparably on standardized tests, as shown in Table 1.

**Table 1**  
**Entrance Credentials, Classes 2008 - 2010**

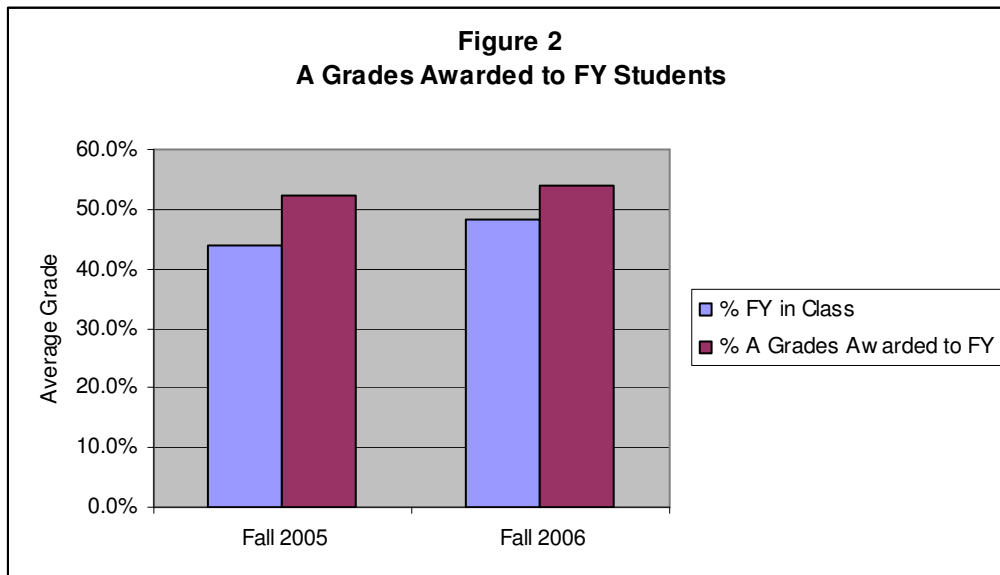
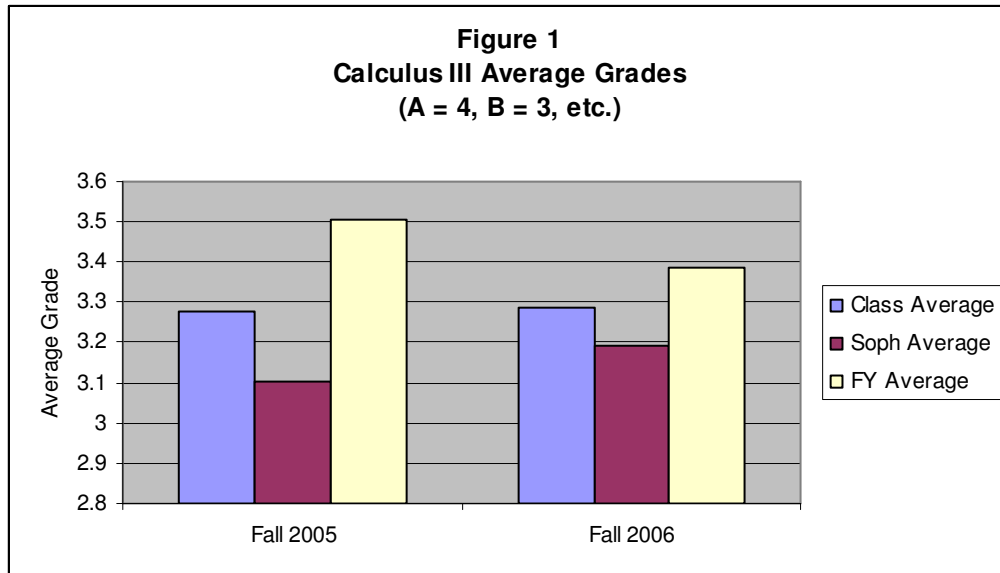
	<b>2008</b>	<b>2009</b>	<b>2010</b>
<b>Mean SAT (Math + Verbal)</b>	1393	1397	1417
<b>Mean Number of AP Credits</b>	12	13	14

Thus, it is reasonable to compare the academic performance of members of different classes within the same administration of a course.

### **AP Credit and Calculus III**

Calculus III is the third course in the mathematics sequence required of all engineering majors and some science majors at Notre Dame. Students who follow the usual course sequence take Calculus III in the fall semester of the sophomore year. However, first-year students who have earned a score of at least 4 on the AP Calculus BC exam may elect to receive credit for the first two courses (Calculus I and II) and then take Calculus III in the fall semester of their first year.

In the Fall 2005 semester, a total of 297 students took Calculus III, comprising 129 first-year students, 165 sophomores, and 3 juniors or seniors. In the Fall 2006 semester, a total of 315 students took Calculus III, comprising 148 first-year students, 159 sophomores, and 8 juniors or seniors. Because the juniors and seniors in these classes are in the course because they are somehow behind in their mathematics requirements, this discussion compares only the performance of the first-semester, first-year students with AP credit versus the performance of the first-semester sophomore students who have taken Calculus I and II in the normal course sequence at Notre Dame. The analysis discovered that first-year students, when compared with sophomores in the same administration of Calculus III, earn higher average final grades and a higher proportion of A grades, as shown in Figures 1 and 2.



Additionally, in the 2005 administration, 72.1% of first-year students earned grades of B+ or better, compared with 47.3% of sophomores; in the 2006 administration, 62.2% of first-year students achieved that performance, compared with 48.2% of sophomores.

Thus, for the two administrations of Calculus III studied, first-year students who satisfied their Calculus I and II requirements through AP credit actually outperformed sophomore students who satisfied their Calculus I and II requirements through actual college-level course work. It appears, then, that the claims of the College Board have some merit. In this sample, the AP experience has properly prepared students for the demands of advanced work.

## AP Credit and Overall Academic Performance

This difference in performance in one class leads to the question of whether AP credits correlate to academic performance in any way. In other studies we have done at Notre Dame, we have found very little correlation between academic performance and SAT scores, most likely because our students are clustered near the top of the SAT scoring scale and do not present a broad enough range of scores to allow for such a correlation to emerge.<sup>6</sup> But we have identified some noticeable differences in performance based on the number of AP credits a student has earned, where there is more variation within a class.

Figure 3 presents the first-semester grade-point averages for the Classes of 2004 through 2009 (entering in the fall semesters of 2000 through 2005). Students with 10 or more AP credits for college course performed noticeably better in their first semester at Notre Dame than students with fewer than 10 AP credits. While each class as a whole had an average first-semester GPA around 3.2, students with fewer than 10 AP credits had an average first-semester GPA around 3.0 (around a B), while students with 10 or more AP credits had an average first-semester GPA over 3.3 (B+).

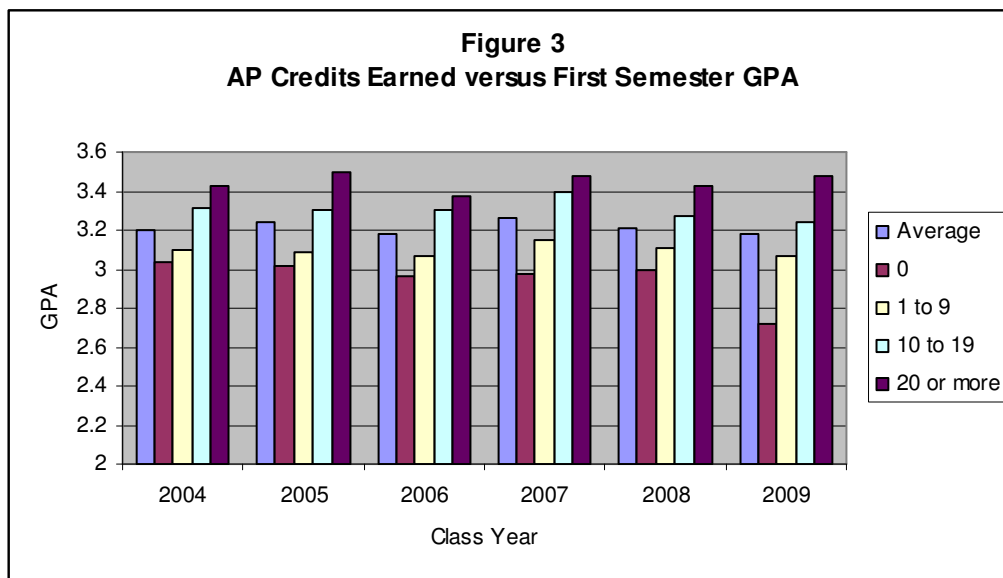
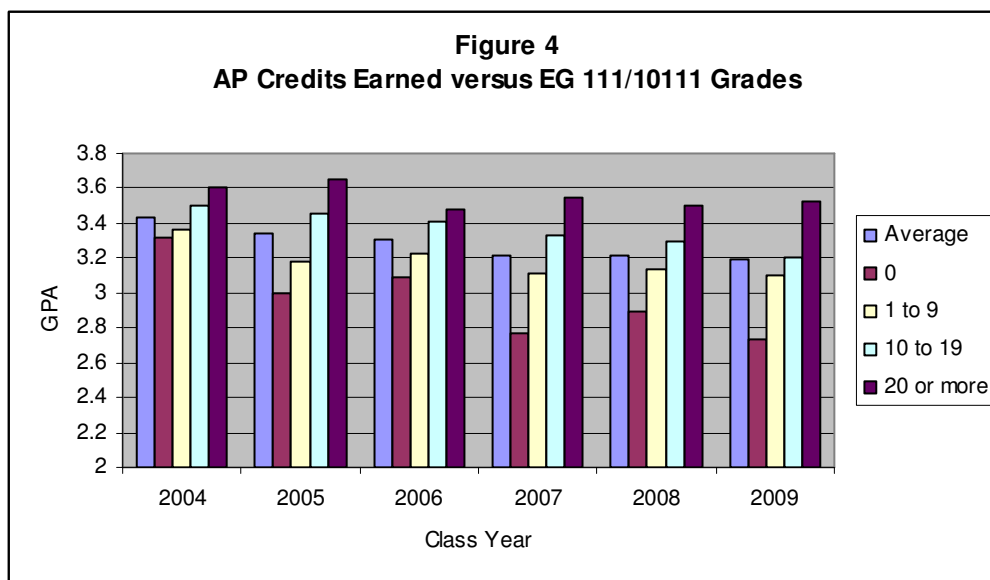


Figure 4 presents similar data on academic performance in the first course in the two-course Introduction to Engineering Systems sequence (EG 111/10111), taken by all first-year students in the fall semester. The course average has deliberately and gradually moved downward, from 3.437 (between A- and B+) in the Fall 2000 semester, to 3.189 (between B+ and B) for the Fall 2005 semester. Students with fewer than 10 AP credits have averaged around a 3.0 (B) in the course, while students with 10 or more AP credits have performed better, earning around a 3.4 or 3.5 (between B+ and A-).



The data in Table 2 show that students with no AP credit are over-represented among students with a first-semester GPA less than or equal to 2.5, and under-represented among students with a first-semester GPA greater than or equal to 3.5. Approximately 20 percent of each class arrives at Notre Dame without any AP credit. Yet, 40 to 50 percent of the students with a GPA less than or equal to 2.5 have no AP credit, while only 10 to 15 percent of the students with a GPA greater than or equal to 3.5 have no AP credit.

**Table 2**  
**Academic Performance in the First Semester of Students with No AP Credit**

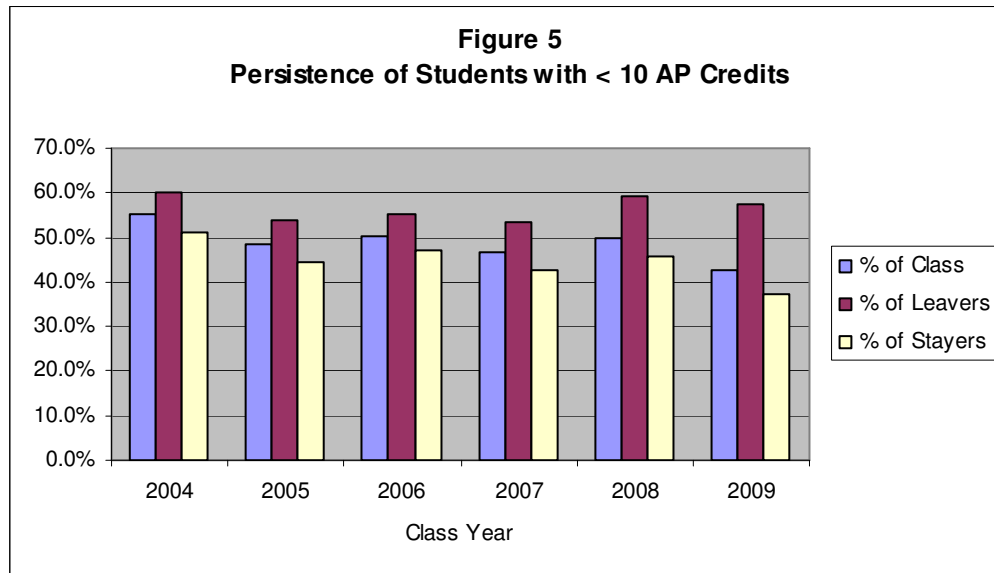
	2004	2005	2006	2007	2008	2009
<b>% in class with no AP credit</b>	21%	18%	18%	19%	25%	15%
<b>% of class with no AP credit and GPA <math>\leq</math> 2.5</b>	34%	40%	41%	50%	54%	47%
<b>% of class with no AP credit and GPA <math>\geq</math> 3.5</b>	15%	11%	8%	11%	18%	6%

Thus, it appears that AP credits may correlate with academic success in the first semester of college in a way that SAT test scores typically do not.<sup>7</sup> Whether the relationship is causal is unclear, but at a minimum, AP credits earned might be a good predictor of academic success.

### AP Credit and Persistence

The TCU/MSU study looked for any correlation between AP credits and persistence in college, and concluded that students who took AP courses were no less likely than their “non-AP peers” to drop out of college before their sophomore year.<sup>2</sup> However, looking at only those students

who began at Notre Dame in the engineering curriculum reveals that, although students with less than 10 AP credit hours do not leave the University, they do comprise a disproportionately high percentage of students who leave engineering for other majors before the start of sophomore year. As Figure 5 shows, for most years, students with fewer than 10 AP credits comprise a greater proportion of leavers and a smaller proportion of stayers when compared with their representation in the class as a whole.

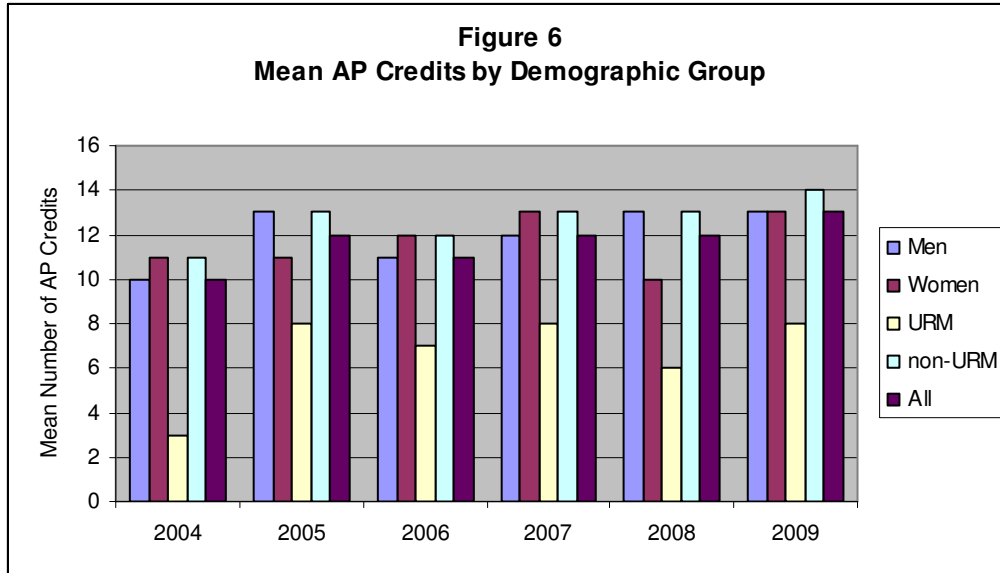


Thus, there appears to be some correlation between AP credit and persistence in engineering. The reasons for this connection should be investigated more fully.

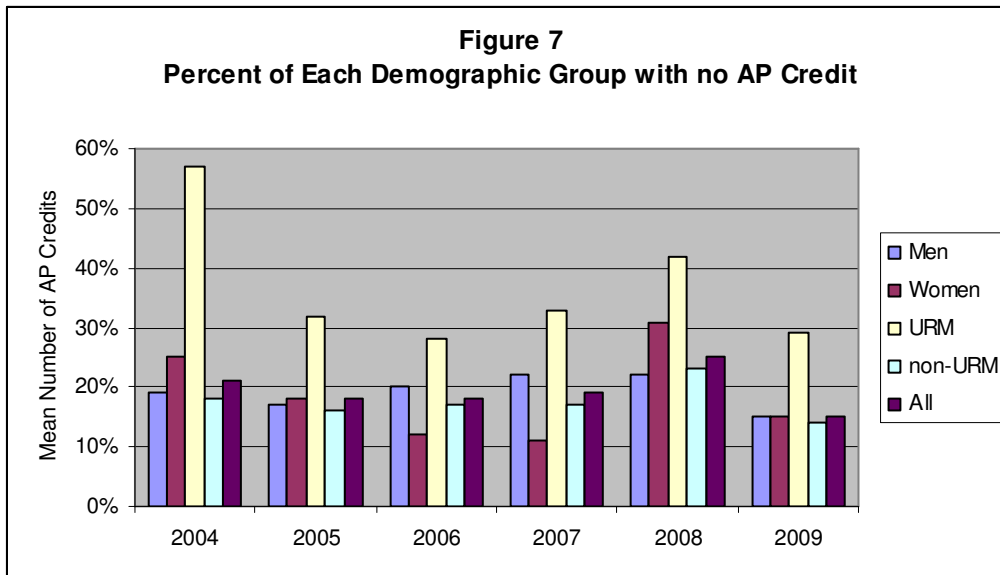
### AP Credit and Demographics

It is also interesting to note that, while women and men come to Notre Dame with substantially similar levels of AP credit, as shown in Figure 6, under-represented minority (URM) students differ significantly from non-URM students in their AP preparation. In fact, under-represented minority students in each year studied averaged fewer than 10 AP credits, which is the level associated with more successful academic performance and persistence in engineering in this study at Notre Dame.





Moreover, as shown in Figure 7, under-represented minority students are more likely to come to Notre Dame with no AP credit at all, a level associated with the lowest level of academic performance and persistence in engineering.



This preparation gaps does seem to have a negative effect on under-represented minority students. For the Classes of 2004 through 2009, under-represented minority students have comprised approximately 10 percent of each class, but have comprised between 21 and 57 percent of students earning a first-semester GPA of 2.5 or below, and only 2 to 4 percent of students earning a first-semester GPA of 3.5 or above, as Table 3 shows.

**Table 3**  
**Academic Performance of URM Students in the First Semester**

	2004	2005	2006	2007	2008	2009
% URM in Class	8%	7%	8%	11%	11%	11%
% URM among GPA $\leq$ 2.5	21%	21%	22%	57%	33%	41%
% URM among GPA $\geq$ 3.5	2%	3%	3%	2%	2%	4%

Again, the effects of this preparation gap present an area of potential further exploration.

### **Benefits of AP Credit**

Substituting AP credit for required classes gives students more flexibility within a tightly structured engineering curriculum. For example, in our current senior class (Class of 2007), students with high levels of AP credit are more likely to participate in international study than students with little or no AP credit. Looking at these 213 seniors reveals that only 17 of the 88 students with fewer than 10 AP credits (19.3%) participated in a semester or more of international study, compared with 32 of the 125 students with more than 10 AP credits (25.6%). Moreover, for students with fewer than 6 AP credits (that is, 0, 3 or 4 credits, which places them out of either no or only one required class), only four of 27 (14.8%) studied abroad for a semester, and two of those four had to take summer-school classes to remain on track for graduation in four years. On the other hand, of the 89 students with more than 15 AP credits, 25 (28.1%) studied abroad for a semester.

Substituting AP credit for required classes also allows students to take fewer required classes as seniors. Among the 88 current seniors with fewer than 10 AP credits, 27 (30.7%) are taking 12 credits (the minimum needed for full-time status) or fewer in their final semester, compared with 40% of the 125 current seniors with 10 or more AP credits. Others, presumably, are either taking advanced classes within their major, or other classes outside their major and beyond their degree requirements.

### **Conclusions**

The controversy over the use of AP credits in college in general, and in an engineering curriculum in particular, will not end with this paper. But the data presented here do point out that the practice of awarding AP credit can be likened to a double-edged sword. Examining the effects of awarding AP credit on a group of students admitted to a highly selective university, where students' academic credentials on admission are more homogenous than at a larger public university, illustrates the beneficial and detrimental effects of Advanced Placement.

AP credits certainly do benefit those students who have performed well enough on the AP exam to earn college-level credit. At Notre Dame, in Calculus III, those students who arrived with AP credit for the first two calculus courses outperformed those students who took Calculus I and II courses at the University. Thus, awarding these students AP credit did not hamper their

academic achievement. Further, it allowed these students to skip eight credit hours in a curriculum that typically requires 129-130 credit hours. This gives these students the opportunity to take additional classes within or outside their engineering major, to have a lighter course load at some point or to have some scheduling flexibility to allow for research, international study or work experiences. Students who earn AP credits in other required courses have even more such flexibility.

On the other hand, we have identified a gap in AP achievement between under-represented minority students and the rest of the class. Given Notre Dame's admissions practices, which do not penalize a student for lack of AP classes on the student's record when the student's high school does not offer such classes, it stands to reason that a disproportionately large segment of even the under-represented minority population with the academic background to attend our highly selective university still lacks access to classes that could both enhance the high school experience and provide curricular flexibility in the demanding college engineering experience. This contributes to an achievement gap and a persistence gap that remain areas of concern.

Clearly, this issue requires further study to determine, for example, whether the results for Calculus III hold true in other courses. It also presents some interesting data regarding the academic preparation and achievement/persistence of certain subgroups of engineering students, which should lead to further examination of ways to offer these students the same enriching experiences that students with AP credit can enjoy as part of their demanding engineering curriculum.

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