

Advanced Placement Programs and Engineering Undergraduate First-Year GPA

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Abstract

Over the past years, researchers and educators have focused on preparing high school students to enter and succeed in college. One strategy that has been imposed to fill the gap between high school and college is the Advanced Placement (AP) program which allows high school students to take college-level courses in high school. However, not all high school students have access to these programs. Besides, many students may not choose to get enrolled in these programs. Previous research has reported both positive and negative effects off these programs on students' academic outcomes.

A subset of data from a large Midwest university was used to estimate the average effect of taking AP credits on GPA computed at the end of the first year. To reduce the bias, propensity score methods were used to analyze the data. A doubly robust approach was used to estimate the average effect. The findings show that students who come into engineering with AP credits have a first-year college GPA that is 0.222 higher, on average, than those who do not come into engineering with AP credits.

Background

In 1952 the Advanced Placement Program, also known as AP, was initiated by the College Board. The goal has been to offer high school students with college level courses to close the gap between high school and college[1]. These courses are offered in a majority of high schools across the nation, however, not all of these schools offer the same number of AP courses. High school students choose to take these courses. At the end of each academic year those who take these courses, can choose to take the exam. Upon their enrollment in college, if they meet their institution's criteria, they may bypass some of the courses in college[2].

In 2016, according to a 2018 report produced by the administrator sources at a Midwest public university, there was 33% increase in number of transfer courses coming to the university over the four academic years [2013-2017]. In 2017, about 32% of transfer credits were from AP and other exams. The number of students enrolling in AP courses and taking the test has been increasing over time. In 2019 a total of 5.1 million AP exams were taken by 2.8 million students[3]. over the past years, there has been an increase in the number AP programs offered in high schools and the number of students enrolling in these programs. The numbers mentioned above were 4.9 million exams and 2.7 students in 2017. Among the various STEM courses offered in high schools, mathematic courses such as calculus and statistics are the most popular courses students take. With the increase in these programs, it is worth revisiting the potential benefits they may have on students' career and academic future. However, with the wide spread of AP courses there are students who do not have access to AP courses due to their location.

The potential benefits of AP courses rise the concern of the equity and access of these courses. Students' exposure to AP courses depends on the students and their school characteristics. It is the school that makes the initial decision on the number of AP credits they offer in their schools, which depends on the available resources they have. After offering a course, it is the students who decide whether to enroll in these courses and whether to take the test or not. Research conducted in recent years has focused on the equity and fairness issues in relation with AP courses. The accessibility and equity issues can be seen among marginalized subgroups such as rural students[4], English language learners [5], diverse students[6], students with low socio-economic status[6], and female students[1]. For instance, De Urquidi [4] compared the accessibility of high school students based on school's rurality. Her results showed that AP courses are offered less in rural areas compared to other locales. Also, the percentage of students applying for college is less in comparison to other locales. Kanno and Kangas [5] showed that students with English as their second language prefer English AP courses over other courses.

Although it is believed that AP credits provide benefits to students who aim to pursue a college degree, a recent study shows that a majority of students who take AP credits fail in passing these courses, therefore they are less likely to enter college[7]. Nevertheless, for those who manage to achieve high grades and enter college, tend to be more successful in college [8] and are more likely to graduate from college compared to their peers[9] who enter college without AP credits. Moreover, students with AP credits have a smoother transition from high school to college. The AP credits that students bring to college also reduces their course load and increases the likelihood of earning a degree within four years[10]. It has also been shown that students who take AP courses in high school are more likely to pursue a major in a related course in college. Past studies show that students who are exposed to mathematic AP courses are more likely to pursue a major in STEM [11] and are more successful in the job market after graduation [12] compared to their peers.

In addition to the equity issues, there are critiques on the quality of AP credits offered in high schools as well. One being the level of these course and whether these courses can be a substitute for college courses. Although most of the students take the courses in the senior and junior courses, but a subset of students takes the courses in younger ages. This raises the concern that how these courses and test's function, and whether these courses are truly college level course or not, and if they are, is a 14-years-old student ready for a college-level courses.

Besides, these courses are taught by high school teachers which may not be trained to teach advanced level courses. Until ten years ago, teachers were provided with a guidebook which included a curriculum outline and sample exams[13]. This guidebook is no longer provided to the teachers. Although for a course to be classified as an AP course, it should go through an AP course audit, teachers are free to pick their own textbook which may not cover all the required content of its equivalent college course.

Both the inconsistent quality and experience that students may have in comparison to college courses and the inequities of AP course availability have resulted in an increasing number of schools limiting the consideration of AP scores in their admissions and placement processes. Related to this, some pre-college schools have stopped offering AP courses [14].

Objective

With the increase in high school students' enthusiasm in enrolling in AP programs and the controversial discussions around the effects of these courses on students' college performance, it is crucial to analyze these effects thoroughly. The necessity has been also raised by research [2]. Warne (2017) also points the fact that the AP participation is not a simple one stage process, rather it is dependent on three stages: I) a school's choice on which courses to offer. II) a student's choice on enrolling in those courses, and III) a student's choice to take the AP test. Considering these stages in the analysis is crucial in obtaining unbiased results. Therefore, in this paper we will use propensity score analysis to account for variables associated with these stages. The presented research investigates the effect of AP courses on students GPA at the end of their first year. We believe that the results will provide valuable information to students, school personnel, and high school and college advisors on the effectiveness of these courses. The school personnel could use the result in making decisions whether to invest in offering these courses or not. It helps students to better navigate their pathways through high school and it provides information to school and college advisor in better directing students.

Methods

We used propensity score weighting to analyze the effect of enrolling in engineering with AP credits on student outcomes. Propensity score methods [15] allow researchers to control for factors that affect selection into a treatment group. In our study, the treatment group members are students who come into university with AP credits. With this approach, we can control for confounding factors related to being in the treatment or control group which reduces the bias of the estimate for the treatment effect. In other words, propensity score weighting allows us to improve our estimate of the effect of taking and passing AP courses on engineering student outcomes by comparing students who are similar for all variables except the treatment variable.

Data

The data come from a large research-intensive public university in the Midwest. Academic records were obtained from the registrar's office for students between Fall 2008 and Fall 2013. From these records, we removed students who completed high school out-of-state, transfer students, and those enrolled part-time. We also limited the sample to students who started in the College of Engineering, leaving a total of 8,588 students. Descriptive statistics of the sample are presented in Table 1.

Table 1. Descriptive statistics

| | | Students with AP credits | | | | Students with no AP credits | | | |
|------------------|--------|--------------------------|----------|-----------------|----------------|-----------------------------|----------|-----------------|----------------|
| Group | | N | Mean SAT | Mean Calc Grade | First Year GPA | N | Mean SAT | Mean Calc Grade | First Year GPA |
| Sex | Female | 1122 | 1380 | .52 | 3.29 | 922 | 1310 | .78 | 2.98 |
| | Male | 3446 | 1400 | .43 | 3.24 | 3098 | 1333 | .75 | 2.87 |
| URM | Yes | 287 | 1398 | .49 | 3.07 | 382 | 1259 | .81 | 2.63 |
| | No | 4281 | 1351 | .45 | 3.27 | 3638 | 1335 | .75 | 2.92 |
| First Generation | Yes | 603 | 1357 | .53 | 3.10 | 747 | 1290 | .79 | 2.76 |
| | No | 3965 | 1401 | .44 | 3.28 | 3273 | 1336 | .75 | 2.92 |

Propensity score weighting was used to balance the sample in terms of those who came in with AP credits and those who did not. The variables used to balance the sample includes sex, URM status, first-generation status, SAT, course load, a flag for taking first year calculus, and high school variables. The high school variables include flags for charter schools and magnet schools, the title i status, the number of students with free and reduced lunch, the total number of students, and the urban centric locale. To analyze the covariate balancing, we used absolute standardized mean differences and Kolmogorov-Smirnov statistics. The results from the covariate balancing are displayed in Figure 1. These graphs show acceptable propensity score balancing, as both adjusted propensity scores are below their respective thresholds (dashed line). For the adjusted standardized mean differences, the only unbalanced covariates were for magnet schools and course load, and all covariates are balanced when looking at Kolmogorov-Smirnov statistics. With this acceptable balancing, we moved on to estimating the average treatment effect.

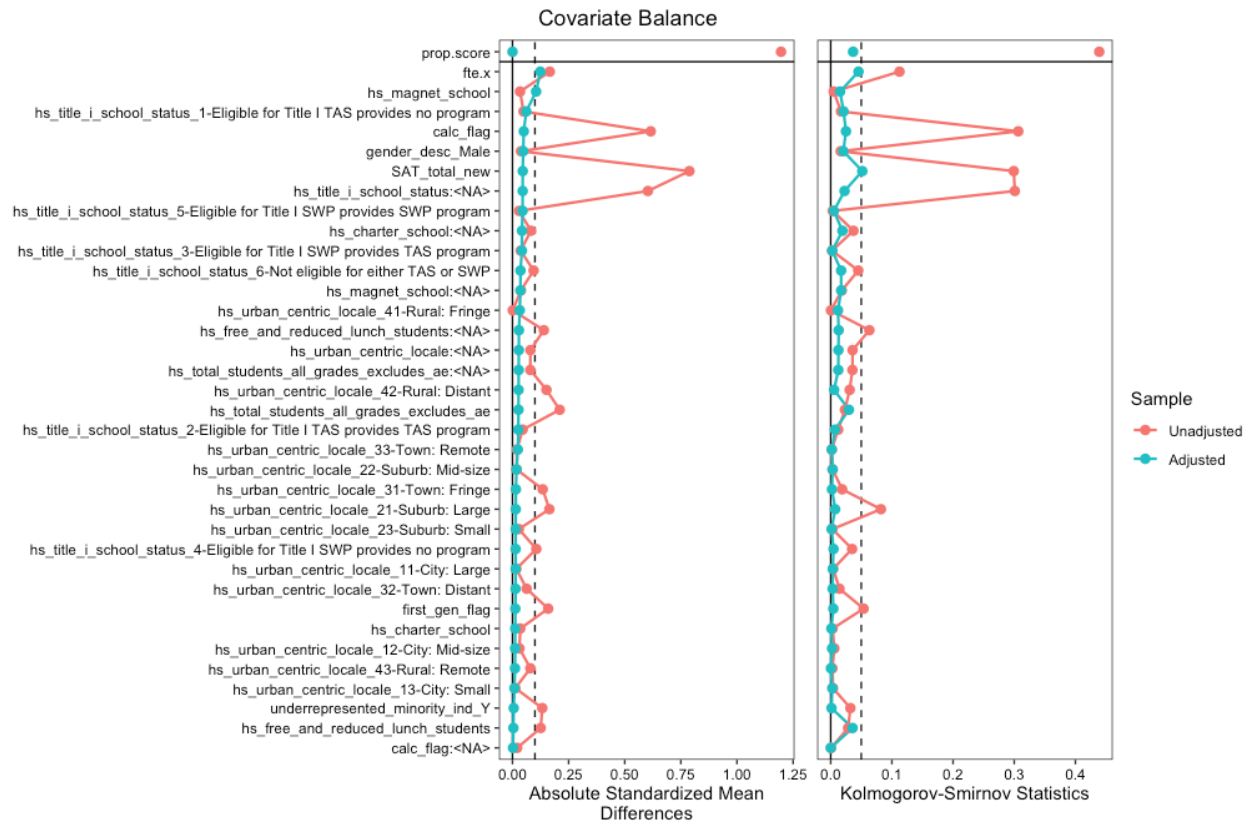


Figure 1. Covariate balancing results from propensity score weighting. The absolute standardized mean differences and Kolmogorov-Smirnov distances are measures of bias in the effect of AP credits on first-year GPA for each variable. The unadjusted metrics represent the bias before applying propensity score weights. Absolute standardized mean differences are acceptable when below 0.1 and Kolmogorov-Smirnov distances should be less than 0.05 (dashed lines).

We used a doubly robust approach to estimate the average treatment effect of coming into engineering with AP credits. A doubly robust method uses all covariates to estimate both the treatment effect and the propensity scores for the sample. This analysis resulted in a statistically significant treatment effect of 0.222, $p < .001$, with an R^2 of .134. This means that, on average, students who come into engineering with AP credits have a first-year college GPA that is 0.222 higher than those who do not come into engineering with AP credits. We only present the estimate for the treatment effect because the propensity score paradigm focuses on the treatment only, even when using doubly robust approaches.

Discussion

Based on the results presented above we can make few general conclusions that gives us a better understanding of the impacts of AP programs on students' college performance. These results can direct future research in this area. The overarching conclusion drawn from this research shows that AP credits do have influence on students' college performance at this institution. Our analysis

shows that the influence on their first year GPA is positive. This provides further evidence of the potential for inequity due to the lack of available AP courses at some schools.

Past research on AP programs generally focus on certain stages of AP programs. However, in this paper, we used propensity score methods using a doubly robust approach to reduce the bias related to access to and participation in AP courses. Based on our dataset, we used variables from each stage (high school characteristics and student characteristics) to control for confounding variables. This enabled us to account for variables which may affect the probability of a student getting exposed to AP courses.

Future Directions

Using larger datasets, in future research we aim to broaden the analysis to multi-institution studies. A multi-institutional research can provide another level of characteristics to the analyses. Considering institutional characteristics and policies, especially admission policies, can provide valuable information that may have not been considered in this research. In addition, future research should consider the type of AP programs and students' major.

Limitation

Due to data limitations, the data only includes students who take AP courses, take the AP test and have the option of using their AP score to claim college credit. There may be students who chose to enroll in the courses without taking the test or earning a low-grade test score, and therefore were not eligible to use it to bypass a course in college. Moreover, due to our data limitations, we did not consider disaggregate the findings by the type of AP courses that student took during high school, some of which are more related to performance in engineering coursework.

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