# Postsecondary Preparation and Remediation: Examining the Effect of the Early Assessment Program at California State University

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***Abstract***

*In this paper we investigate how participation in the Early Assessment Program, which provides California high school juniors with information about their academic readiness for college-level work at California State University campuses, affects their college-going behavior and need for remediation in college. Using administrative records from California State University,–Sacramento and the California Department of Education, we find that participation in the Early Assessment Program reduces the average student's probability of needing remediation at California State University by 6.1 percentage points in English and 4.1 percentage points in mathematics. Rather than discouraging poorly prepared students from applying to Sacramento State, EAP appears to lead students to increase their academic preparation while still in high school. © 2010 by the Association for Public Policy Analysis and Management.*

## INTRODUCTION

College participation rates are at an all-time high, with nearly three out of four high school students attending college. Despite increases in the share of high school graduates continuing on to college, college completion rates have remained relatively stagnant for the past several decades—around 66 percent for those who achieve at least 10 credits at a baccalaureate-granting institution and substantially less for the entire population of postsecondary entrants who aspire to a baccalaureate degree (Adelman, 2006; Turner, 2005). Moreover, graduation rates remain significantly lower for minorities and for those who come from poor or modest economic backgrounds than for white and relatively advantaged students (U.S. Department of Education, 2006).

In its review of the state of higher education in America, the Spellings Commission asserts that "[i]n an era when intellectual capital is increasingly prized, both for individuals and for the nation, postsecondary education has never been more important" (U.S. Department of Education, 2006). More recently, President Obama went even further in a speech on March 10, 2009, stating that "part of America's education strategy is providing every American with a quality higher education."[1] Despite the pressing need to ensure that more students obtain a postsecondary

[1] http://www.whitehouse.gov/the_press_office/Remarks-of-the-President-to-the-United-States-Hispanic-Chamber-of-Commerce.

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degree, we know surprisingly little about what leads to college readiness and degree completion.

Although several studies have demonstrated that many students are relatively uninformed about what it takes to succeed in college (Person, Rosenbaum, & Deil-Amen, 2006; Rosenbaum, 2001; Venezia, Kirst, & Antonio, 2003), the question of how we might effectively enrich the information on which students base their post-secondary decisions remains largely unexplored. In this paper we evaluate the extent to which an intervention designed to increase the quality of the information about academic preparedness available to high school students affects students' decisions to apply to a public university and their need for remediation once enrolled.

The Early Assessment Program provides participating California high school juniors with information about their academic readiness for college-level work at California State University (CSU) campuses. We ask: *Does providing high school juniors with early information about their academic preparation reduce their probability of requiring remediation in college? And, if so, what can we learn about the mechanism by which such an intervention influences remediation patterns at California State University?*

The paper is organized as follows. Section 2 describes prior research on academic preparation for college, specifically students' expectations and the role of information, K–12 and higher education alignment, and the effect of college remediation on college persistence and degree completion. Section 3 describes the California Early Assessment Program. Section 4 describes the data and our methodological approach, including a discussion of the selection by schools to encourage students to participate in the Early Assessment Program and by students to actually do so. In section 5 we present empirical results and then conduct robustness checks and tests for selection bias associated with the voluntary nature of the program. Section 6 discusses possible mechanisms of the impact of the intervention on changes in remediation rates at CSU. Finally, section 7 concludes by offering several policy implications of our findings as well as avenues for future research.

## CONTEXT AND PREVIOUS RESEARCH

Academic skills and preparation in high school are important determinants of college success (Horn & Kojaku, 2001; Kirst & Venezia, 2004). Two influential Department of Education analyses authored by Clifford Adelman, "Toolbox I" (1999) and "Toolbox Revisited" (2006), find that the intensity of a student's high school curriculum is the single best predictor of college graduation. Using High School and Beyond (HS&B) and National Educational Longitudinal Study (NELS) data to investigate the pathways that affect college completion in more detail than any other researcher to date, Adelman (1999, 2006) points to important junctions in the pathway to a college degree that merit closer investigation. Not surprisingly, students with higher levels of measured academic skills are more likely to graduate from college than their less able peers. Our own analysis of the NELS data indicates that, among the highest achieving students in high school, college completion rates among students who begin at a four-year college are 77 percent. Among the lowest achieving students, 37 percent of those who enter a four-year college graduate by age 26.

Nearly one in three first-time freshmen are enrolled in some remedial course at their college or university (U.S. Department of Education, 2003). Although the large majority of these students attend two-year institutions, the remediation rate among first-time freshmen attending four-year colleges is also on the rise (U.S. Department of Education, 2003). Rates of remedial course enrollment vary substantially across colleges and universities, with some institutions not offering remedial courses and others enrolling upwards of 80 percent of their incoming students in remedial classes (U.S. Department of Education, 2003). Although some believe that these courses serve as an important bridge between poor K–12 schooling opportunities and

college readiness, others argue that remediation is the role of secondary schools or community colleges, not baccalaureate-granting colleges and universities. Current estimates of the cost of remediation suggest that public four-year colleges and universities spent in the range of $435 to $543 million dollars in 2004/2005 on remedial instruction, and that the total cost to students attending two-year or four-year institutions in the same year was about $708 to $886 million in remedial education tuition and fees (Strong American Schools, 2008).

In recent years, many states have been questioning the role of remedial courses in their postsecondary institutions (Venezia et al., 2005). Responsibility for reforming high schools to improve the college readiness of their graduates falls primarily at the state level, and a variety of state approaches have surfaced. To address the discrepancy between students' K–12 academic preparation and the demands of postsecondary schooling, many states have implemented or are considering K–16 or Pre-K–20 initiatives, albeit with a wide range of purposes, relationships, and end goals (U.S. General Accounting Office, 2003; Venezia et al., 2005). An early example is Indiana's Twenty-First Century Scholars Program, a state financial aid program that began in 1990 and promises middle school students (those who qualify for the federal free/reduced lunch program) free tuition at Indiana public universities upon meeting college preparatory requirements. Other states, such as Kentucky, provide an example of how state accountability systems have expanded to include postsecondary schooling, with an explicit focus on improving enrollments, reducing remediation, and increasing degree completion (Venezia, Finney, & Callan, 2007). Most recently, many states, as part of the American Diploma Project, have committed to align high school graduation requirements with the demands of college and the workplace (see American Diploma Project Network of Achieve, Inc.).[2] Finally, several states, including California, have instituted college remediation assessments while students are still in high school (Long & Riley, 2007). However, the success of these efforts (for example, California State University's Early Assessment Program) in improving college readiness has not been investigated.

Contrary to the certitude that characterizes much of the rhetoric around remediation, there is relatively little evidence on the effect of taking remedial courses on college persistence and degree completion. Part of the difficulty in isolating a remediation effect is the selection into remedial coursework. Several recent studies employ a variety of econometric approaches to address the selectivity bias inherent in remediation placement. In one such study, Bettinger and Long (2008) exploit the variation in remedial placement policies across Ohio higher education institutions and proximity of college choice to instrument for remediation. They find that remediation has a positive impact on students' college outcomes; students placed in remedial courses were more likely to persist in college and more likely to obtain a degree within four to six years than observationally similar students who were not required to take such classes.

In two additional recent studies, researchers find no effects of remediation for students at the margin of passing a remediation exam attending public two-year and four-year institutions in Texas (Martorell & McFarlin, 2009), and some positive effects on early persistence and overall credits among remediated students attending public community colleges in Florida (Calcagno & Long, 2008). Both studies evaluate the impact of remediation in academic subjects on student outcomes such as total credits, persistence, subsequent performance in academic subjects, and transfer to four-year institutions among community college entrants. In neither study did researchers find much benefit to remedial instruction for students at the margin of the remediation placement test on these outcomes, though a negative effect was not obvious either. Of course, these studies are not able to evaluate the impact of remediation for lower ability students who may be far from the cutoff utilized in the

[2] http://www.achieve.org/StateProfiles.

regression discontinuity research design without imposing assumptions about the functional form of the relationship between the assignment criterion and student outcomes. Moreover, the impacts of specific remediation strategies on a variety of student outcomes have not been directly tested.

Why do so many college students appear to require remediation? Part of the explanation for the large share of remedial students in American colleges and universities may be a combination of limited information possessed by students regarding what they need to do to succeed in college and the (arguably) mistaken perception that everyone must at least attend—if not complete—college to succeed in the labor market. A majority of high school students, regardless of their academic performance, report that they will attend college. In fact, academic performance accounts for little of the variance in students' *expected* levels of educational attainment. Reynolds et al. (2006) find that between 1976 and 2000 the percentage of high school seniors indicating that they probably or definitely would complete *at least* a baccalaureate degree increased from 50 percent to 78 percent. At the same time, not surprisingly, the explanatory power of self-reported grades and participation in a college preparatory program have declined appreciably (Reynolds et al., 2006). These findings are consistent with those of Rosenbaum and his colleagues, who report that high school seniors have little understanding of what it takes to succeed in higher education (Rosenbaum, 2001). Given changes in the marginal distribution of those expecting to attend college, it should come as no surprise that the level of secondary academic preparation among college entrants has declined over time (Bound, Lovenheim, & Turner, 2007).

## THE EARLY ASSESSMENT PROGRAM

The Early Assessment Program (EAP) is an academic preparation program developed by the California Department of Education (CDE), the State Board of Education, and California State University (CSU). The stated purpose of the program, now in its sixth year, is to bridge the gap between K–12 educational standards in English and mathematics and the requirements and expectations of postsecondary education at California State University. The development of EAP was motivated by a desire to increase the English and math proficiency of entering freshmen at CSU campuses, thereby reducing high system-wide remedial course-taking rates. The information provided by EAP may reduce remedial course enrollments at CSU campuses by increasing the academic readiness of incoming students and/or by reducing the likelihood that would-be remedial students choose to apply to and enroll in a CSU.

The three explicit goals of the Early Assessment program are as follows: (1) identify students *before* their senior year who need additional coursework or preparation in English and/or mathematics to succeed at a CSU; (2) provide students, parents, teachers, and administrators with information about their students' college readiness, and then partner with those parties to increase the quality of academic preparation; and (3) motivate students to take steps in their senior year to achieve readiness for college-level work.[3] The program has three components: an 11th grade test to identify students' preparedness to undertake college-level work, a professional development component to aid high school teachers in facilitating improved college readiness among their students, and supplemental preparation for students in their senior year.[4] All three components of the program are voluntary, a point to which we return below.

[3] Information retrieved at http://www.calstate.edu/eap/documents/presentation_cde.ppt#302.

[4] The teacher development component includes CSU-sponsored reading institutes (led by teacher-education faculty) through which high school teachers might improve their skills in helping students to read and write effectively. The supplemental student preparation component enables students to pinpoint their individual strengths and weaknesses by using the CSU Diagnostic Writing Service or the Mathematics Diagnostic Testing Project. Students who need better skills in expository reading and writing can take a specially designed 12th grade course, developed jointly by teachers from high schools and the faculty at CSU. Students who need to upgrade their mathematics skills have access to interactive online programs called "CSU Math Success" during their senior year.

The first component of the program, and the one we investigate in this paper, is an early assessment of English and math skills among California 11th graders that was first offered in the spring of 2004. The basic nature of the intervention is to add 15 optional multiple choice questions to each of the mandatory California Standards Tests (CST) in 11th grade English and mathematics.[5,6] These additional test items were developed by CSU and K–12 faculty to reflect both California high school standards and CSU placement standards. They appear at the end of the 11th grade CST, accompanied by the CSU logo and text indicating that completion of those items is optional. Composite scores from the exam are computed based on a subset of CST questions augmented with the EAP items.

Students who elect to complete the additional test items receive a letter in the summer before their senior year in high school with one of three messages. If their score exceeds an upper threshold, they are exempted from remedial coursework and the CSU placement exam. Students whose score falls below a lower threshold are required to take the CSU remediation exam should they enroll in a CSU. They are advised about what courses to take in their senior year and directed to additional resources to improve their readiness for CSU coursework following high school graduation.[7] While there is only one threshold in English to distinguish the exempt and non-exempt outcomes, the mathematics EAP also includes a middle range for scores that yields an outcome of exempt *conditional* on completing certain courses during their senior year in high school with a grade of "C" or higher. Appendix Figures A1 and A2[8] illustrate the specific paths by which EAP operates to determine college readiness; note that EAP is not the only way to gain exemption from the CSU placement exam and/or avoid remedial coursework. Students may earn an exemption through achieving sufficiently high SAT, ACT, or relevant AP test scores.

Given that EAP is voluntary (above and beyond the mandatory CST testing in 11th grade), how many students participate? There are several different ways of defining participation in EAP. Table 1 shows that 66.7 percent of all California juniors who took the mandatory California state standards test also sat for the English EAP exam in the first year of the program, but only 36.6 percent actually completed the exam (a little over half of those who signed up). For the math EAP, 74.6 percent of eligible juniors sat for the exam, and 72.7 percent actually completed the exam in the first year of the program. However, it is important to note that, unlike the English EAP, which is available to all high school juniors, the mathematics EAP is only available to those juniors who have completed at least Algebra II and are currently enrolled in a math class. Thus, this effectively reduces math EAP eligibility to those taking either the Algebra II or Summative Math CST exam. In this paper, we define participation in EAP as completion of the exam because only those who complete the EAP questions receive explicit early information about college readiness.

There are a number of reasons why students who sit for the exam do not actually complete it. Students may have planned to complete the extra set of questions at one point in time and then changed their minds prior to sitting for the exam, or students may begin the exam and then decide they don't want to complete it. The English EAP test also requires the completion of an essay that is administered in a separate

[5] The English EAP also requires that students complete an essay in a separate 45-minute session.

[6] The CSTs are essentially untimed tests, although most students complete the test for each subject within some suggested amount of time, which is 185 minutes in English and 195 minutes in math for 11th graders (see www.cde.ca.gov/ta/tg/sr/documents/star09itmtmchrt.doc). Although the CSTs have no direct ramifications for students, there exists important empirical evidence from National Assessment of Educational Progress (NAEP) testing that finds, "NAEP results do not seriously understate student performance due to the low-stakes nature of the assessment" (Linn, Koretz, & Baker, 1996, p. 15).

[7] For additional information, see CSU-developed online resources to help students and their families make sense of their EAP results and what to do to prepare for CSU (http://www.csusuccess.org).

[8] All appendices are available at the end of this article as it appears in JPAM online. Go to the publisher's Web site and use the search engine to locate the article at http://www3.interscience.wiley.com/cgi-bin/jhome/34787.

**Table 1.** Statewide participation rates in EAP among eligible 11th grade students since program inception, by subject.

| | English | | Math | |
|---|---|---|---|---|
| | Sat for | Completed | Sat for | Completed |
| Year 1 (2003/2004) | 66.7% | 36.6% | 74.6% | 72.7% |
| Year 2 (2004/2005) | 68.9% | 42.7% | 71.0% | 69.1% |
| Year 3 (2005/2006) | 70.9% | 47.6% | 74.1% | 72.6% |

*Note:* All 11th grade students taking the English CST are eligible to participate in the English EAP, but only those students taking either the Algebra II or Summative Math CST exams are eligible to participate in the mathematics EAP.

*Source:* Authors' calculations based on data from the California Department of Education.

45-minute session. According to those involved in administering the EAP, this additional requirement likely explains the large gap between the proportion of students who begin the English EAP and the proportion who finish it and the fact that there is not a similar gap in math participation. Table 1 also shows that EAP participation has increased over time in English, but has remained fairly flat in math.

How do students perform on the EAP exam? Over three quarters (77 percent) of those who completed the English EAP were deemed not exempt from CSU remedial placement exams in English. Nearly half (44.5 percent) of those who completed the math EAP were deemed not exempt from CSU remedial placement exams in math. The seemingly higher level of math preparation among examinees stems from the fact that math EAP participants have already achieved a greater level of academic preparation in math than the average high school junior. It is important to reiterate that students may gain exemption from taking the remediation placement exams and remedial courses at CSU by other means than EAP (see Appendix Figures A1 and A2, referred to above).

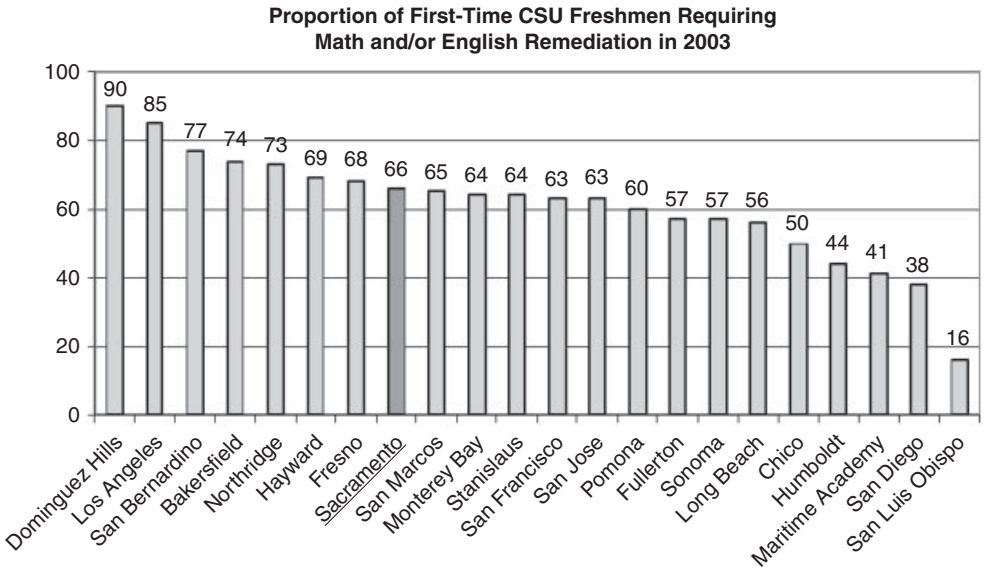
## DATA AND METHODOLOGY

Does providing high school juniors with early information regarding their academic preparedness for college-level work reduce their probability of requiring remediation in college? Answering this question requires individual-level data on remediation need and its determinants, as well as information on EAP participation.

### Data Description

Our study focuses on one CSU campus, Sacramento (CSUS). In 2003, over two-thirds of all CSU first-time freshmen were enrolled in a remedial math or English course, with the vast majority of campuses at over 50 percent, and the Sacramento campus at 66 percent (Figure 1). This is substantially higher than the national average, which includes selective four-year campuses (Parsad & Lewis, 2003). Whether the discrepancy from national statistics reflects higher standards in California (and thus lower thresholds for remediation) or lower levels of academic preparedness among California's college matriculants relative to the average college matriculant in the nation, the fact that two out of three CSU freshmen require remediation speaks to the magnitude of the challenge educators in California face with respect to postsecondary preparation.

Despite our focus on one campus, we believe that this study is applicable to the entire 23-campus CSU system (serving over 350,000 undergraduates annually) for several reasons. First, the English and mathematics placement tests and standards are




*Source:* Authors' calculations based on data from the California State University Chancellor's Office, Division of Analytic Studies.

**Figure 1.** Proportion of First-Time CSU Freshmen Requiring Math and/or English Remediation in 2003.

employed uniformly across all CSU campuses. Second, the average characteristics of students attending the Sacramento campus place them toward the middle of the distribution of those characteristics across the 23 campuses that make up the CSU system.[9] It is among the largest of the 23 CSU campuses, enrolling approximately 24,000 undergraduate students, or 7 percent of all undergraduate CSU students.[10] Finally, EAP was implemented statewide in 2004, removing the possibility of learning effects that might have differentially influenced specific campuses, regions of the state, or high schools. It is worth noting that CSUS also appears to be similar along many dimensions to a variety of campuses that are part of large public flagship systems in other states, including the University of North Carolina–Charlotte, the University of Texas–Arlington, Ohio's Bowling Green State University, and the University of Central Oklahoma.[11]

This study relies on longitudinal student-level data for California public high school students who were in the 11th grade between the 2001/2002 and 2004/2005 academic years. Some analyses include information for the population of 11th graders attending public schools in California; others restrict the sample to students who enrolled in CSUS for the first time during our period of observation. The data come from two sources and span four academic years, including two years prior to and two years following the implementation of EAP.[12] The California Department

[9] These characteristics include student body racial/ethnic composition, college entrance exam scores, admission and yield rates, the share of students receiving financial aid, and retention and graduation rates.
[10] See http://www.calstate.edu/as/stat_reports/fall_summary.shtml for enrollment figures.
[11] Comparisons were conducted with the IPEDS Peer Institution Analysis using the institutional dimensions listed in footnote 9 above.
[12] Appendix Figure A3 depicts the EAP timeline to clarify which cohorts of students had access to EAP. In particular, note that the first EAP cohort can be thought of in terms of the high school junior class in 2003/2004 or the first-time college freshmen class in 2005/2006. To alleviate confusion, all date references are based on when members of a cohort were juniors in high school. (All appendices are available at the end of this article as it appears in JPAM online. Go to the publisher's Web site and use the search engine to locate the article at http://www3.interscience.wiley.com/cgi-bin/jhome/34787.)

**Table 2.** Summary statistics for CSUS enrollees, by year.

| Variable | 2001/2002 | 2002/2003 | 2003/2004 | 2004/2005 |
|---|---|---|---|---|
| Male | 0.394 | 0.390 | 0.383 | 0.390 |
| *Race/Ethnicity* | | | | |
| White | 0.500 | 0.481 | 0.466 | 0.438 |
| Black | 0.084 | 0.093 | 0.098 | 0.113 |
| Hispanic | 0.166 | 0.167 | 0.174 | 0.163 |
| Asian | 0.155 | 0.158 | 0.170 | 0.186 |
| Other | 0.093 | 0.099 | 0.091 | 0.100 |
| *Parental Education* | | | | |
| Mom—HS grad | 0.552 | 0.551 | 0.547 | 0.565 |
| Mom—college grad | 0.268 | 0.255 | 0.242 | 0.248 |
| Dad—HS grad | 0.515 | 0.483 | 0.528 | 0.523 |
| Dad—college grad | 0.305 | 0.324 | 0.272 | 0.282 |
| Math proficient | 0.523 | 0.550 | 0.574 | 0.527 |
| English proficient | 0.417 | 0.413 | 0.435 | 0.438 |
| ELM test (math) | 43.2 | 43.4 | 43.1 | 42.2 |
| Proportion nonzero | 0.699 | 0.696 | 0.652 | 0.682 |
| EPT test (English) | 144.7 | 144.1 | 143.9 | 144.0 |
| Proportion nonzero | 0.792 | 0.790 | 0.730 | 0.737 |
| SAT | 966 | 961 | 969 | 955 |
| Proportion nonzero | 0.832 | 0.849 | 0.807 | 0.800 |
| ACT | 20 | 19 | 19 | 19 |
| Proportion nonzero | 0.220 | 0.219 | 0.218 | 0.181 |
| High school GPA | 3.2 | 3.2 | 3.2 | 3.2 |
| *N* | 1,796 | 1,726 | 1,872 | 1,917 |

*Note:* High school juniors in 2001/2002 and 2002/2003 were CSUS first-time freshmen in fall 2003 and fall 2004, respectively, and did not have access to EAP; those in 2003/2004 and 2004/2005 were CSUS first-time freshmen in fall 2005 and 2006, respectively, and did have access to EAP. See timeline in Appendix Figure A3 for clarification. (All appendices are available at the end of this article as it appears in JPAM online. Go to the publisher's Web site and use the search engine to locate the article at http://www3.interscience.wiley.com/cgi-bin/jhome/34787.)

of Education (CDE) supplied information on all California 11th graders enrolled in public high schools in the state as well as attributes of those schools. Data from CDE include individual-level indicators for EAP participation in the first two years that EAP was offered (2003/2004 and 2004/2005), student demographic measures, and high school codes. CDE merged these data with a file of all CSUS applicants provided to us by the California State University, Sacramento Office of Institutional Research for four cohorts of first-time freshman applicants in the fall 2003, 2004, 2005, and 2006, which correspond to data on the four cohorts of high school juniors provided by CDE. The match was based on student name, date of birth, gender, and high school attended.[13] In the final data set, we observe student gender, race/ethnicity, academic preparation and ability measures, including high school GPA and scores on the 11th grade California state standards tests, in addition to their EAP participation. Table 2 includes the summary statistics for four cohorts of enrollees at CSUS. Our investigation of EAP effects focuses on enrollees at CSUS because these are the individuals for whom we have remedial placement information. Although we can predict this information for applicants and admitted students, the timing of the remediation tests and of notification of other exemption methods

[13] CDE's matching process was not perfect; they were only able to successfully match 85 percent of CSUS applicants in the original sample because they do not maintain a numeric identifier. Analysis of the matched sample indicates that it is more white and less Asian than the original pool of CSUS applicants, presumably because of complications involved in matching on student name.

**Table 3.** Means across California high schools since Early Assessment Program inception (standard deviation in parentheses).

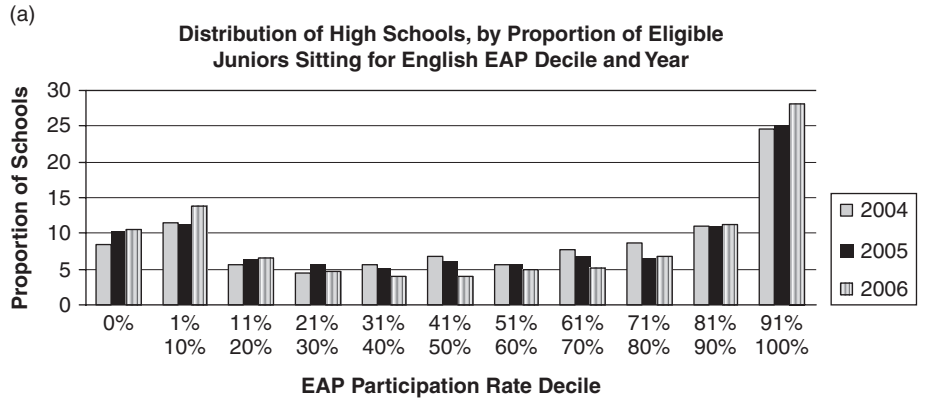
| Variable | 2003/2004 | 2004/2005 | 2005/2006 |
|---|---|---|---|
| Academic Performance Index | 669.86 (93.34) | 685.02 (96.56) | 694.07 (93.69) |
| Enrollment (in 00s) | 16.72 (10.77) | 16.34 (11.07) | 15.95 (11.13) |
| *School Junior Proportion* | | | |
| Participating in English EAP | 0.267 (0.299) | 0.299 (0.314) | 0.332 (0.331) |
| Participating in math EAP | 0.647 (0.308) | 0.587 (0.317) | 0.623 (0.320) |
| Parent is high school graduate | 0.353 (0.174) | 0.367 (0.162) | 0.373 (0.172) |
| Parent is college graduate | 0.214 (0.178) | 0.219 (0.179) | 0.218 (0.180) |
| UC and CSU eligible | 0.064 (0.047) | 0.065 (0.048) | 0.065 (0.048) |
| Black or Hispanic | 0.433 (0.284) | 0.448 (0.286) | 0.462 (0.288) |
| Free/reduced lunch eligible | 0.337 (0.253) | 0.354 (0.251) | 0.350 (0.273) |
| *N* | 1,042 | 1,097 | 1,149 |

*Source:* Authors' calculations based on data from the California Department of Education and the Common Core of Data.

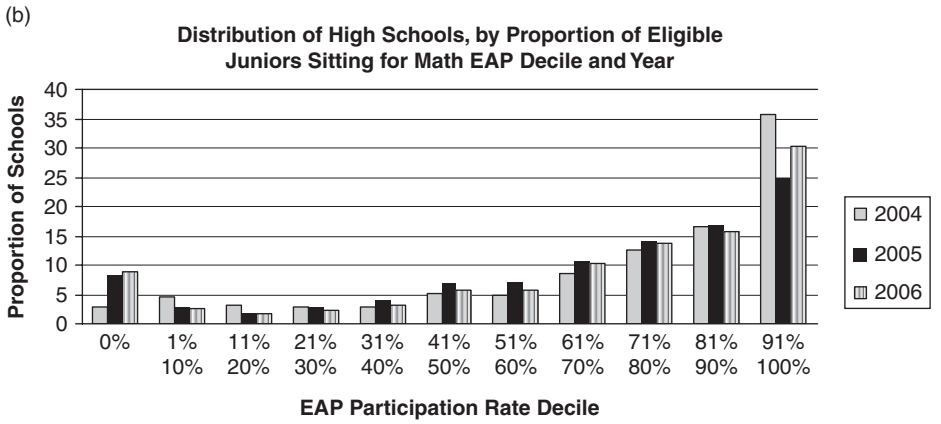
are such that we are only *certain* of final remediation need for enrollees. The pre-EAP years are the cohorts of juniors in 2001/2002 and 2002/2003 (entering CSUS in 2003 and 2004), and the post-EAP years are the cohorts of juniors in 2003/2004 and 2004/2005 (entering CSUS in 2005 and 2006). Comparing variable means pre- and post-EAP suggests that the CSUS enrollee samples have not changed in statistically significant ways over this time period. Table 2 reveals a roughly 4-percentage-point drop in the proportion of students taking the CSU remediation placement exams in math (ELM) between 2002/2003 and 2003/2004, and a roughly 6-percentage-point drop in the proportion of students taking the CSU remediation placement exams in English (EPT), which could certainly be because of the availability of EAP as an additional means of exemption from these exams, while other avenues for gaining exemption remained unchanged.

In addition to student characteristics, we observe a number of school characteristics that may be related to EAP participation and/or the probability that a student would require remediation should she choose to attend a CSU. These characteristics include high school size, demographic composition, and academic performance indicators based on data from the California Department of Education and the U.S. Department of Education's Common Core of Data. Table 3 provides summary statistics for the high school attributes that we utilize in the analysis. California high schools display considerable variability in size of student body, racial/ethnic composition, socioeconomic status (SES), and academic performance. We operationalize SES as the share of students eligible to participate in the federal free and reduced lunch program based on family income. We proxy school academic achievement based on the school's Academic Performance Index (API) and the share of students eligible for admission to a UC or CSU campus, which is determined based solely on the courses they complete.[14] The API summarizes a school's performance on the

[14] In order to be eligible to either the CSU or UC system, a high school student must complete a specific set of course requirements (called "a-g"). Each course represents a one-year college preparatory class. The requirements include two history or social science (one on the U.S. and one on the world), four English language arts, three math, two laboratory science (one biological and one physical), two foreign language, one visual or performing arts, and one elective from the above subjects. Eligibility is additionally based on high school grades, performance on college admissions exams, advanced coursework, and (for some campuses) personal attributes. For more information, see http://www.calstate.edu/SAS/documents/CSU-UC_a-g_SubjectRequirements2008-09.pdf. By design of the California Master Plan, 35 percent of all California public high school graduates are UC and CSU eligible and 13 percent enroll in CSUs (http://www.calstate.edu/AS/stat_reports/2008-2009/fnse27.htm).




*Note:* 6.63 percent of schools in 2003/2004, 6.68 percent of schools in 2004/2005, and 7.15 percent of schools in 2005/2006 have English EAP participation of 100 percent.




*Note:* 11.19 percent of schools in 2003/2004, 8.14 percent of schools in 2004/2005, and 9.22 percent of schools in 2005/2006 have math EAP participation of 100 percent.

**Figure 2a–b.** Distribution of High Schools, by Proportion of Eligible Juniors Sitting for English EAP Decile and Year.

assessments that make up California's Standardized Testing and Reporting (STAR) Program and the California High School Exit Examination (CAHSEE).[15]

### School-Level EAP Participation Rates

Although EAP is available to all 11th grade students in the state, schools vary widely in the proportion of their juniors who participate in EAP (Table 3). Figures 2a and 2b provide information on the proportion of high schools that have EAP

[15] State legislation, the Public Schools Accountability Act (PSAA) of 1999 (Chapter 3, Statutes), established the Academic Performance Index (API), which summarizes a school's or local educational agency's (LEA) academic performance and progress on a variety of statewide assessments. For more information, see http://www.cde.ca.gov/ta/ac/ap/index.asp.

participation rates falling into each decile over the first three years of the program. Here we define EAP participation as simply sitting for and not necessarily completing the exam, in order to describe possible school differences in students' exposure to the EAP. In each of the first three years of EAP, approximately 10 percent of all high schools had no students participating in the English EAP. However, there is evidence of an increase over time in the proportion of high schools with greater than 80 percent English EAP participation rates. Less than 10 percent of all high schools have no students participating in the math EAP, and strong math EAP participation is clearly much more common relative to English. Math EAP participation rates in excess of 80 percent are evident in over one-quarter of all high schools in all three years of the program. Additionally, a nontrivial proportion of high schools have 100 percent EAP participation in math and/or English.

The observed variation in EAP participation rates across high schools depicted in Figures 2a and 2b highlights the importance of high schools as a potential source of selection bias in our estimates of the effects of EAP. If school levels of participation in EAP are related to the probability that students ultimately require remediation, then estimates of EAP effects based on these observational data may be biased. We return to this point after discussing our substantive models and outline our strategies for addressing school and student self-selection in our data.

### The Effect of EAP on Remediation Need

The quasi-experimental nature of the data enables us to employ a treatment-comparison research design to evaluate the effect of EAP on the probability of needing remediation in college. We estimate two types of treatment effects in this paper. First, by taking advantage of the temporal disjuncture in the availability of the EAP program along with measures of other covariates, we estimate the intent to treat effect (ITT) by comparing remediation rates for students eligible to participate in EAP by virtue of the year they entered 11th grade (in 2003/2004 or 2004/2005) and those ineligible to participate because the program was not yet available (in 2001/2002 or 2002/2003). The intent to treat effect captures changes in rates of remediation due to the introduction of the *opportunity* to participate in EAP regardless of whether or not individual students actually participate in the program. While we expect the main benefits of EAP to accrue to students who actually complete the assessment, those who fail to complete the assessment may benefit indirectly through changes in curriculum and professional development that some schools choose to implement as part of EAP or through increased awareness of the potential need for and costs of postsecondary remediation among peers (spillover effects). ITT effects are important for policymakers, as those effects capture the average contribution of a policy to its intended outcome across both program participants and nonparticipants, or simply the degree to which introduction of a policy has the desired effects at the population level.

We estimate the ITT effect based on an interrupted time series model in which we compare conditional rates of remediation before and after EAP became available. We have perfect compliance among the control group for our ITT estimates because (1) no high school junior could have participated in EAP prior to the 2003/2004 school year, and (2) no student who had been a junior prior to the EAP program could have participated at a later date since the EAP is attached to the California Standards Test taken by high school juniors. The model is identified on the assumption that, conditional on other observed covariates included in the model, temporal changes in the outcome are driven solely by the availability of EAP. We know of no other change in policy over this period that could affect remediation need but recognize that changes in the composition of incoming cohorts could contribute to changes

in the probability of requiring remediation. To address the latter source of change we control for both student and high school attributes that may be associated with the need for remediation.

To estimate the effect of the introduction of EAP (ITT), we specify a model where an individual student's latent probability of requiring remediation in subject $s$, $Y_{is}^*$, is a function of individual characteristics, $X_i$, attributes of the individual's high school, $Z_i$, and a variable to indicate whether individual $i$ had EAP available during their junior year, $PostEAP_i$. An identically distributed error term, $\varepsilon_{is}$, is permitted to be correlated within but not between schools.

$$Y_{is}^* = \beta X_i + \gamma Z_i + \alpha_1 PostEAP_i + \varepsilon_{is} \tag{1}$$

Although $Y_{is}^*$ in Equation (1) is unobserved, we do observe a binary indicator, $Y_{is}$, which is equal to 1 when $Y_{is}^* > 0$ and 0 otherwise. When combined with the assumption that $\varepsilon_{is}$ is logistically distributed, we use logistic regression to examine the effect of EAP on the probability that student $i$ requires remediation in subject $s$. The individual characteristics in the vector $X_i$ include gender, race/ethnicity, several measures of academic ability, and parental educational attainment. The $\beta$ parameters capture the effects of these student characteristics on the latent propensity of requiring remediation in subject $s$ at CSUS. The high school attributes in the vector $Z_i$ include API, the proportion of students who are CSU and UC eligible by virtue of the courses they complete, the proportion of students who are black and Hispanic, and the proportion eligible for the free and reduced-priced lunch program. The $\gamma$ parameters capture the effect of these high school characteristics on remediation need. Holding all of these student and school factors constant, the parameter on $PostEAP_i$, $\alpha_1$, identifies the effect of making available the Early Assessment Program on the latent propensity that a student requires remediation at CSUS, the intent to treat effect (ITT).

Where the ITT estimator reflects both effects of the intervention on participants and nonparticipants, the effect of the treatment on the treated (TT) disregards potential effects for those who choose not to participate and focuses exclusively on changes in the outcome realized by program participants. The counterfactual is thus not those who were not able to participate (as in the ITT) but otherwise identical individuals who, for whatever reason, *chose* not to participate. Identification of the TT estimator is achieved by making exposure to the treatment conditionally random, or making the decision to opt in to treatment one that is unrelated to both the effects of the treatment and the outcome. We identify this model by adjusting for covariates we know to be related to both the decision to participate in EAP and the probability of requiring postsecondary remediation. We check the robustness of our covariate adjustment strategy by restricting the sample to a set of schools in which virtually all students participate in EAP (removing student choice from the process), matching program participants to nonparticipants on their propensity to participate, and utilizing a difference-in-differences strategy. We discuss these alternative specifications in section 5 of the paper but note here that all of these approaches produce similar results.

To test the effect of actually participating in EAP (TT) on remediation need, we specify a model identical to Equation (1) where an individual student's latent probability of requiring remediation in subject $s$, $Y_{is}^*$ is a function of individual characteristics, $X_i$, attributes of the individual's high school, $Z_i$, a variable to indicate whether individual $i$ had EAP available during their junior year, $PostEAP_i$, and a separate variable to indicate whether individual $i$ actually participated in the EAP in subject $s$, $EAPpartic_{is}$. Only those who complete the EAP are considered here as participants. Students who complete part but not all of the assessment (that is, do not complete the essay for the English exam) are not considered as EAP participants.

An identically distributed error term, $\varepsilon_{is}$, is permitted to be correlated within but not between schools.

$$Y^{*}_{is} = \beta X_i + \gamma Z_i + \alpha_1 PostEAP_i + \alpha_2(PostEAP_i * EAPpartic_{is}) + \varepsilon_{is} \quad (2)$$

Again, we use logistic regression to examine the effect of EAP on the probability that student *i* requires remediation in subject *s*. Of primary interest is the parameter on ($PostEAP_i * EAPpartic_{is}$), $\alpha_2$, which captures the effect of participating in EAP on remediation need relative to those students who chose not to participate despite having EAP available to them, or the effect of treatment on the treated (TT). All other parameters can be interpreted as discussed in Equation (1), except here the parameter on $PostEAP_i$, $\alpha_1$, no longer identifies the intent to treat effect (ITT) directly, because upon inclusion of the interaction term ($PostEAP_i * EAPparic_{is}$), $\alpha_1$ now represents the difference in our outcome between post-EAP nonparticipants and pre-EAP students.

Finally, we unpack the mechanisms by which the treatment leads to the observed outcome of lower remediation rates for the treated by exploring the potentially differential effect of the treatment conditions (exempt, non-exempt, and, for math, conditionally exempt) on application to CSUS. The results suggest that the lower probabilities of remediation need among program participants are not due to diminished probabilities of applying to CSUS.

## RESULTS

Based on Equation (1), we find no statistically significant effect of EAP availability on remediation need in English, controlling for a variety of individual- and school-level covariates (see Table 4). In math, however, the availability of EAP is predicted to decrease the probability of math remediation need by 3.4 percentage points. Thus, the idea that the mere presence of EAP, without participation in the program (ITT), contributed to a *reduction* in the need for remediation appears not to be supported in English but is supported in math.[16]

As a check on our ITT estimates, we also estimate a difference-in-differences model comparing temporal changes in the need for remediation by the 11 percent of CSUS students who attended private high schools to changes in the need for remediation by CSUS students who graduated from public high schools in California.[17] Students attending private high schools in California do not sit for the CST and thus do not have the option of participating in EAP. If the change in remediation rates for private high school graduates is different from that of public school graduates, then we might worry that our ITT effects are, in part, driven by changes in state or CSU policies other than EAP, or perhaps that the effects we estimate masks some suppression of what would otherwise be an increase in rates of remediation. This is not the case, however; neither public nor private high school students witnessed a change in their average need for remediation after EAP became available to public school students. Given that the result from the difference-in-differences analysis does not confirm a statistically significant estimate in math, we interpret the math ITT effects cautiously.

Turning to our primary focus of the treatment on treated estimates, based on Equation (2), Table 5 shows the marginal effects of EAP availability, EAP participation, and individual- and school-level covariates on the probability of remediation

[16] These findings are consistent with probit and linear probability models, suggesting that our results are robust to assumptions about the error distribution.
[17] We thank a reviewer for suggesting this strategy to us.

**Table 4.** Marginal effects from intent to treat (ITT) model predicting remediation need as a function of EAP availability, by EAP subject.

| Variable | English | *z* | Math | *z* |
|---|---|---|---|---|
| *EAP and Time Characteristics* | | | | |
| Post-EAP | −0.0041 | −0.22 | −0.0342 | −1.92 |
| *Individual Characteristics* | | | | |
| Male | −0.0176 | −1.00 | −0.1856 | −12.26 |
| Black | 0.1557 | 5.96 | 0.1864 | 5.23 |
| Hispanic | 0.2062 | 10.19 | 0.0779 | 3.12 |
| Asian | 0.2420 | 12.05 | 0.0691 | 2.72 |
| Other race | 0.1859 | 7.88 | 0.0657 | 2.27 |
| High school GPA | −0.0874 | −4.08 | −0.1788 | −8.62 |
| CST score | 0.0103 | 20.97 | 0.0057 | 8.42 |
| CST score squared | −0.0000 | −27.34 | −0.0000 | −15.74 |
| Dad college grad | −0.0361 | −1.76 | −0.0020 | −0.11 |
| Mom college grad | −0.0491 | −2.30 | −0.0681 | −3.73 |
| *High School Characteristics* | | | | |
| Academic Perform. Index | −0.0002 | −0.89 | −0.0000 | −0.14 |
| % UC and CSU eligible | −0.5577 | −1.88 | −0.1632 | −0.61 |
| % black or Hispanic | 0.1288 | 1.71 | 0.1638 | 2.43 |
| % free/reduced lunch eligible | 0.1143 | 1.71 | 0.1610 | 2.73 |
| Pseudo *R*-squared | 0.3743 | | 0.2973 | |
| Predicted probability | 0.5873 | | 0.2943 | |
| *N* | 6,210 | | 4,796 | |

*Note:* Math analysis restricted to sample of students who took the Algebra II or Summative Math CST exams, which would have made them eligible to participate in EAP.

need for CSUS enrollees by subject. The marginal effects indicate the change in the probability of needing remediation associated with a change in each variable, holding all other variables constant at their sample means, where changes are from 0 to 1 for binary variables and 1 percentage point increases for continuous variables.

We find statistically significant effects of EAP participation on remediation need. Participation in EAP does appear to reduce the probability of remediation at CSU quite substantially—by 6.1 percentage points in English and by 4.1 percentage points in math. The EAP participation effect for math, however, only attains statistical significance at the 0.10 alpha level.[18,19]

As one would expect, higher high school GPAs are associated with lower probabilities of remediation, and this effect is bigger in math than in English. Higher CST scores and greater parental educational attainment are also associated with lower probabilities of needing remediation. Although not the primary focus of our research, we cannot help but be struck by the magnitude of the differences in the conditional probability of remediation need across important individual background characteristics. Even holding other measures constant at their sample means, we find pronounced racial/ethnic and gender differences in the probability of requiring

[18] Again, these findings are consistent with probit and linear probability models, suggesting that our results are robust to assumptions about the error distribution.

[19] In results not shown, we also employ a multinomial logit model to examine whether the existence of EAP and participation in EAP influence the *intensity* of remediation (number of remedial semesters required). Our results in Tables 4 and 5 are similar to the marginal effects we find for the probability of needing one semester of remediation in the multinomial model, and we find no statistically significant marginal effect of participation in EAP on the probability of needing two semesters of remediation (relative to none).

**Table 5.** Marginal effects from treatment on the treated (TT) model predicting remediation need, by EAP subject.

| Variable | English | *z* | Math | *z* |
|---|---|---|---|---|
| *EAP and Time Characteristics* | | | | |
| Post-EAP | 0.0346 | 1.36 | −0.0036 | −0.14 |
| EAP participation | −0.0610 | −2.45 | −0.0406 | −1.68 |
| *Individual Characteristics* | | | | |
| Male | −0.0181 | −1.03 | −0.1859 | −12.27 |
| Black | 0.1558 | 5.96 | 0.1854 | 5.20 |
| Hispanic | 0.2054 | 10.14 | 0.0769 | 3.08 |
| Asian | 0.2417 | 12.04 | 0.0685 | 2.70 |
| Other race | 0.1862 | 7.92 | 0.0659 | 2.27 |
| High school GPA | −0.0868 | −4.05 | −0.1786 | −8.60 |
| CST score | 0.0103 | 20.91 | 0.0057 | 8.42 |
| CST score squared | −0.0000 | −27.27 | −0.0000 | −15.73 |
| Dad college grad | −0.0358 | −1.75 | −0.0019 | −0.10 |
| Mom college grad | −0.0500 | −2.34 | −0.0684 | −3.75 |
| *High School Characteristics* | | | | |
| Academic Perform. Index | −0.0002 | −0.70 | −0.0000 | −0.07 |
| % UC and CSU eligible | −0.5860 | −1.97 | −0.1702 | −0.63 |
| % black or Hispanic | 0.1407 | 1.95 | 0.1684 | 2.49 |
| % free/reduced lunch eligible | 0.1205 | 1.80 | 0.1645 | 2.79 |
| Pseudo *R*-squared | 0.3750 | | 0.2977 | |
| Predicted probability | 0.5877 | | 0.2942 | |
| *N* | 6,210 | | 4,796 | |

*Note:* Math analysis restricted to sample of students who took the Algebra II or Summative Math CST exams, which would have made them eligible to participate in EAP.

remediation among Sacramento State enrollees. Across academic subjects, all nonwhite racial/ethnic groups are more likely to need remediation than whites. Differences in white/nonwhite conditional rates of remediation need are generally greater in English (at 15.6 percentage points to 24.2 percentage points) than in math (at 6.6 percentage points to 18.5 percentage points), consistent with potential racial/ethnic differences in first languages. Among black students, however, the difference in the probability of requiring remediation in math (18.5 percentage points greater than whites at the sample mean) is even greater than the difference for English (15.6 percentage points greater than whites at the sample mean). Given the emergent literature on the female advantage in higher education (Buchman & DiPrete, 2006), we find the gender difference in mathematics remediation especially surprising. Net of CST math scores and holding those scores and other covariates at the sample mean, we find that women attending Sacramento State are nearly 20 percentage points more likely to require math remediation than men.

### Examination of Selection Effects

The treatment on the treated estimates on which we focus in Table 5 rely on the assumption that, conditional on other observed covariates, students who participate in the EAP are more or less identical to those who do not participate. Put another way, estimates of EAP treatment effects may be biased to the extent that student or school characteristics orthogonal to student GPA, standardized test scores, and other observed student characteristics influence both a student's probability of participating in the EAP and his probability of requiring remediation. As a result of the

**Table 6.** Marginal effects from model predicting individual EAP participation decisions, by EAP subject.

| Variable | English | *z* | Math | *z* |
|---|---|---|---|---|
| *Individual Characteristics* | | | | |
| Male | −0.0505 | −41.32 | −0.0367 | −27.36 |
| Black | −0.0022 | −0.85 | −0.0048 | −1.57 |
| Hispanic | −0.0022 | −1.27 | 0.0244 | 12.71 |
| Asian | 0.0828 | 37.58 | 0.0335 | 17.78 |
| Other race | 0.0400 | 14.19 | 0.0307 | 11.45 |
| CST score (same subject) | 0.0106 | 122.64 | 0.0023 | 32.31 |
| CST score squared | −1.14e−04 | −89.15 | −2.34e-06 | −21.90 |
| Parent is high school grad | 0.0188 | 12.83 | 0.0014 | 0.83 |
| Parent is college grad | 0.0464 | 27.20 | 0.0049 | 2.76 |
| *High School Characteristics* | | | | |
| Enrollment (in 00s) | −0.0002 | −3.44 | −0.0006 | −7.97 |
| Academic Performance Index | −0.0008 | −47.00 | −0.0002 | −10.76 |
| % UC and CSU eligible | −0.1108 | −5.54 | 0.0971 | 4.75 |
| % black and Hispanic | 0.0416 | 8.87 | 0.0155 | 2.83 |
| % free/reduced lunch eligible | −0.0017 | −0.39 | −0.0046 | −0.92 |
| Peer EAP participation rate | 1.42 | 475.28 | 0.9804 | 262.03 |
| $Year_{2004/05}$ dummy (EAP yr. 2) | 0.0183 | 11.83 | −0.0016 | −0.96 |
| $Year_{2005/06}$ dummy (EAP yr. 3) | 0.0295 | 18.58 | 0.0017 | 0.96 |
| Pseudo *R*-squared | 0.2956 | | 0.1784 | |
| Predicted probability | 0.4720 | | 0.7569 | |
| *N* | 1,054,397 | | 494,521 | |

*Note:* Model is estimated on the post-EAP sample only (11th grade students in 2003/2004, 2004/2005, and 2005/2006). Summary statistics for these variables provided in Appendix Table A1. (All appendices are available at the end of this article as it appears in JPAM online. Go to the publisher's Web site and use the search engine to locate the article at http://www3.interscience.wiley.com/cgi-bin/jhome/34787.)

voluntary nature of the program, one might be concerned that the results discussed above suffer from selection bias. In this section we examine individual student participation decisions and then present selection-corrected estimates of the effect of EAP on remediation. These analyses (discussed below) reveal that the logistic regression results we present in Table 5 are robust to both individual and school self-selection.

In order to examine the individual EAP participation decision, we fit a logistic regression model to the probability that the *i*th student participates in EAP in subject *s* as a function of student demographic characteristics in $X_i$, the attributes of their high school in $Z_i$, and year fixed effects.

$$EAP\ participation_{is} = \beta X_i + \gamma Z_i + \alpha_1 Yr_{2004/05} + \alpha_1 Yr_{2005/06} + \varepsilon_{is} \quad (3)$$

The variables included in $X_i$ and $Z_i$ are very similar to those included in Equations (1) and (2). Because we estimate Equation (3) with data on *all* California public high school juniors in the post-EAP years, we are constrained to the demographic information supplied by the California Department of Education on all California students.[20] Table 6 shows the marginal effects for the individual student participation

[20] Summary statistics for the sample of EAP-eligible students statewide are provided in Appendix Table A1. (All appendices are available at the end of this article as it appears in JPAM online. Go to the publisher's Web site and use the search engine to locate the article at http://www3.interscience.wiley.com/cgi-bin/jhome/34787.)

decisions modeled in Equation (3). From these models we note that males, on average, are less likely to participate in math and English EAP than are females, controlling for a variety of demographic, academic, and school characteristics. Moreover, there are some important differences by race in EAP participation decisions, suggesting that Asians are more likely to participate in EAP than their white counterparts, and that Hispanics are also, on average, more likely to participate in the math EAP than observationally similar white students. We note that higher achieving students, as measured by the CST exam, are also more likely to participate in EAP, but the effect of measured achievement on EAP participation is declining over CST scores. In addition, there are interesting school-level determinants of EAP participation; students from smaller, lower performing, and higher minority composition schools are, on average, more likely to participate in EAP. Finally, we note that, as expected, students enrolled in schools where there is greater EAP participation are more likely to participate in EAP themselves.

Having noted systematic differences in the probability of EAP participation conditional on observable characteristics, we next pursue several different strategies to address selection in our substantive models of the treatment effect on the treated. Note, however, that we already adjust for all of these same observable characteristics in the models presented in Tables 4 and 5. Another way to take account of student self-selection is to use propensity score matching to pair EAP participants with nonparticipants in the post-EAP years as a function of observable characteristics. We use 1:1 propensity score matching and estimate the effect of EAP participation on differences in the probability of requiring remediation within pairs of treated (participate in EAP) and control (did not participate in EAP) individuals using radius matching on the propensity score. The average treatment effect is computed by averaging the treatment effects across matched observations that lie within the radius.[21]

We can also address student self-selection by looking only at students attending schools in which selection is largely absent. In a second set of models we address selection into participation as a function of both individual and school characteristics by restricting the sample to schools with a rate of participation of over 90 percent. This virtually eliminates school-level noncompliance from the model, but at the potential cost of focusing on a set of schools that differ in systematic and unobserved ways from other schools in the population. We present the estimates of the effect of EAP participation on remediation need under these different specifications in Table 7.[22]

Table 7 allows us to compare our original results on remediation need (column 1 for English and column 4 for math) with two alternate strategies that attempt to correct for selection into the program. First, columns 2 and 5 present results from propensity score models, which adjust for individual selection into EAP by relying on observables. Results from these models reveal remarkably similar findings, a slightly larger effect of EAP participation in English (a 7.7-percentage-point reduction in the probability of English remediation need vs. 6.1 from the original model), and in math (a 4.3-percentage-point reduction in the probability of math remediation need vs. 4.1 from the original model). When comparing the results to models that correct for selection on individuals and schools (columns 3 and 6 of Table 7) where the sample is restricted to high EAP participation schools, we find slightly smaller effects for both English (5.5) and math (3.9). Overall, the estimated effect of EAP participation on remediation need across these different specifications is remarkably consistent, leading us to conclude that our results are fairly robust to student self-selection.

[21] We use the Stata pscore commands to generate average treatment effects using radius matching, where the radius on the propensity score is set to 0.1.

[22] In addition, we also estimate a school fixed effects model to eliminate the contribution of both observed and unobserved school attributes to variation in EAP participation, which resulted in consistently similar findings. The full estimates from all of these models, which are consistent with estimates shown in Table 7, are available from the authors upon request.

**Table 7.** Marginal effects from models predicting remediation need under different specifications, by EAP subject (standard errors in parentheses).

| | English | | | Math | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Variable | Original Model (Table 5) | Average Treatment Effect Using Propensity Score | Subsample of Schools with >90% EAP Participation | Original Model (Table 5) | Average Treatment Effect Using Propensity Score | Subsample of Schools with >90% EAP Participation |
| EAP partic. | −0.061 (0.025) | −0.077 (0.023) | −0.055 (0.032) | −0.041 (0.024) | −0.043 (0.025) | −0.039 (0.030) |
| *N* | 6,210 | 3,251 | 4,330 | 4,796 | 2,592 | 3,418 |

*Note:* Propensity score estimation is based on the covariates predicting individual EAP participation decisions presented in Table 5, and relies only on matched sample; additional information on propensity score estimation can be obtained from the authors.

## EXAMINATION OF EAP MECHANISM

Now that we have plausibly established that participation in EAP reduces the probability of needing remediation in college, we look more closely at the mechanism behind this effect. Does the information gained from participation in EAP encourage students to become better prepared for college or discourage students from applying at all? We do not observe students' course-taking behavior or performance in their senior year of high school; thus, to better tease out the mechanism by which EAP works, we examine the decision to apply to CSUS. If EAP participation has a negative effect on the decision to even apply to CSUS, then there is some support for the notion that EAP works as a sorting mechanism by discouraging students from attending. Furthermore, the effect of the information gained by participating in EAP may depend on the actual signal EAP participants receive. If students learn that they are exempt from remedial coursework, for example, we hypothesize that they would be more likely to apply to CSUS but less likely to apply upon receiving a non-exempt signal.[23]

We specify a model of the decision to apply to CSUS as a function of the four states into which post-EAP individuals might be categorized based on their observed choices and outcomes—exempt, conditionally exempt (in math only), not exempt, and nonparticipant—while also controlling for other student and school characteristics that influence college application decisions. Because all four of these categories only exist in the post-EAP period, the omitted category that serves as a reference group is pre-EAP individuals.

$$\begin{aligned} CSUS\ Applicant_{is} = {} & \beta X_i + \gamma Z_i + \alpha_1 Exempt_{is} + \alpha_2 ConditionallyExempt_{imath} \\ & + \alpha_3 NotExempt_{is} + \alpha_4 Nonparticipant_{is} + \varepsilon_{is} \end{aligned} \tag{4}$$

[23] A more precise analysis of application patterns in California as a result of EAP would distinguish among students who do not apply to college, those who apply to elite institutions, those who apply to other (non-elite) institutions, and those who choose to attend a community college. Due to data constraints, we necessarily merge these groups, lacking information on the postsecondary careers of students who chose not to apply to CSUS.

Estimating the parameters in Equation (4) with logistic regression indicates how student and school characteristics as well as EAP participation and outcomes influence the probability that the *i*th student applies to CSUS. These estimated parameters allow us to compare the marginal effect on application of nonparticipation or, for participants, receiving different outcomes on the EAP. Parameters $\alpha_1$, $\alpha_2$, and $\alpha_3$ capture the application behavior of students who participate in EAP and receive an exempt, conditionally exempt, or not exempt signal, respectively, in subject *s* relative to pre-EAP individuals. Because nonparticipation in the post-EAP period is an option, parameter $\alpha_4$ captures the application behavior of post-EAP individuals who choose not to participate in the subject *s* EAP exam relative to those pre-EAP individuals who did not have the program available. Following estimation, we examine the differences in how the exempt and not exempt signals compare in their effect on application probabilities.

Given differential feeder patterns and the selection issues discussed in section 5, we estimate the logistic regression model in Equation (4) using only Sacramento County high schools that directly feed CSUS and that have a 90 percent or greater EAP participation rate. This constraint has the effect of sacrificing external validity for internal validity. CSU campuses are largely regional colleges; most of the students they serve come from homes within a few hours' drive from campus. Thus, the students whose CSUS application patterns we expect to be most sensitive to changes in information about their college readiness are those attending high schools relatively close to CSUS. By restricting the sample to schools with near-universal rates of EAP participation, we also minimize the degree to which student self-selection into EAP affects our results.

The marginal effects from the logistic regression are presented in Table 8. We find that English participants with exempt outcomes actually had slightly lower probabilities of applying than their observationally similar counterparts in pre-EAP years (only significant at the 0.10 alpha level), while participants with a non-exempt outcome in English have slightly higher probabilities of applying to CSUS relative to pre-EAP individuals. English nonparticipants in the post-EAP period were 4.5 percentage points less likely to apply than their pre-EAP counterparts. This result is not surprising given that participation in EAP is in itself some indication of college interest, and therefore nonparticipants (particularly in this subsample of schools with nearly universal EAP participation rates) may be quite different. Finally, we note that, relative to those who were exempt in English, individuals who received a non-exempt outcome on the English EAP were approximately 2 percentage points more likely to apply to CSUS, and this difference is statistically significant. Thus, the mechanism by which the English EAP reduces remediation need does not appear to be through better sorting.

Turning to math, we find a somewhat different story. Students who receive an exempt or nonexempt outcome in math are not any more or less likely to apply to CSUS than are their counterparts for whom EAP was not available. Additionally, although the *signs* on the estimated parameters $\alpha_1$ and $\alpha_3$ are consistent with a sorting story, testing for a difference in these parameters reveals no statistically significant difference in the application behavior of exempt relative to non-exempt students in math. Thus, as in English, the mechanism by which the math EAP reduces remediation need does not appear to be through better sorting.

Table 8 indicates that, in math, all of the action appears to be among those individuals with a conditionally exempt outcome. Students with a conditional exemption on the math EAP are more likely to apply to CSUS than both their pre-EAP and exempt counterparts by a statistically significant difference of 5.1 and 5.4 percentage points, respectively. This finding, although tentative, has potentially important policy implications. The conditionally exempt category is distinct from exempt and non-exempt in that it offers students a pathway to success rather than a summary judgment. Conditionally exempt students may be disproportionately on the margin

**Table 8.** Marginal effects from model predicting CSUS application for subsample of schools with >90% EAP participation rates in Sacramento County.

| Variable | English | *z* | Math | *z* |
|---|---|---|---|---|
| *EAP Outcomes* | | | | |
| Exempt | −0.0103 | −1.79 | 0.0083 | 0.39 |
| Conditionally exempt (Math) | | | 0.0510 | 4.65 |
| Not exempt | 0.0095 | 2.25 | −0.0034 | −0.30 |
| Nonparticipant | −0.0454 | −10.96 | −0.0382 | −3.64 |
| *Individual Characteristics* | | | | |
| Male | −0.0291 | −8.74 | −0.0598 | −8.63 |
| Black | 0.0002 | 0.03 | 0.0168 | 1.21 |
| Hispanic | −0.0010 | −0.19 | 0.0283 | 2.11 |
| Asian | 0.0740 | 11.81 | 0.0568 | 5.63 |
| Other race | 0.0376 | 5.36 | 0.0518 | 3.62 |
| Parent is high school grad | 0.0037 | 0.92 | −0.0004 | −0.04 |
| Parent is college grad | 0.0159 | 3.67 | 0.0036 | 0.39 |
| CST score | 0.0015 | 2.88 | 0.0054 | 5.94 |
| CST score squared | −7.97e-07 | −1.03 | −7.99e-06 | −5.91 |
| *High School Characteristics* | | | | |
| Enrollment (in 00s) | 0.0015 | 5.90 | 0.0039 | 6.16 |
| Academic Performance Index | 0.0004 | 10.88 | 0.0003 | 3.34 |
| % UC and CSU eligible | 0.3020 | 5.55 | 0.1474 | 1.15 |
| % black and Hispanic | −0.0217 | −1.06 | −0.0138 | −0.29 |
| % free/reduced lunch eligible | 0.2131 | 12.78 | 0.1605 | 4.18 |
| Pseudo *R*-squared | 0.1020 | | 0.0270 | |
| Predicted probability | 0.1120 | | 0.2679 | |
| *N* | 37,125 | | 16,521 | |

*Note:* Model is estimated on subsample of California high school juniors who attended one of 38 Sacramento County high schools with 90 percent or higher EAP participation rates.

of applying to CSUS relative to students who receive other signals (or no signal at all). They may respond to the partially positive signal they receive from EAP, recognizing that with a little effort they can become "college material."

## CONCLUSION

Most, if not all, public secondary and postsecondary systems of education are badly misaligned (Kirst & Venezia, 2004). Standards for academic success vary both within and across sectors. This variation poses a significant challenge to students and policymakers, the consequence of which is a great deal of confusion and even ignorance among students about the academic demands of college. It is no wonder they are confused; among Sacramento State's students requiring remediation in either math or English in 2007, the average GPA they earned in high school in the subject for which they needed remediation was just above a 3.1.[24] Their high schools told them that they were successful B students, but their colleges told them that they were not ready to do college-level work. This troubling state of affairs is exacerbated by an ethos of college for all, with little regard to academic preparation.

The Early Assessment Program is an intervention designed to improve the quality of information students have regarding the California State University's standard for minimally acceptable levels of academic preparation in math and English.

[24] http://www.asd.calstate.edu/remediation/07/Rem_Sys_fall2007.htm.

By providing this information to high school juniors, the architects of the EAP give students the opportunity to make more informed decisions about their secondary school curriculum and postsecondary pathways. The signaling value of "conditionally exempt" may be especially powerful, as it provides a specific step forward in addition to diagnostic information. Future research should explore whether student course taking in the senior year accounts for the relatively greater impact of the conditionally exempt signal on college application.

In this paper we offer an empirical analysis of the degree to which the opportunity to participate in EAP and the decision to do so affects postsecondary remediation need for students who enroll in the California State University's Sacramento campus. Without the ability to randomly assign students to this intervention, we rely first on covariate adjustment to address the selection of schools and students into the program, where we have at our disposal a rich set of measures of academic preparation and demographic variables that are highly predictive of the need for postsecondary remediation. Furthermore, we offer a set of alternative specifications restricting the sample to schools with near universal participation and relaxing distributional assumptions by matching pairs of students on their propensity to participate in EAP. Our results are quite stable across these alternatives.

We have no way of knowing for sure that our treatment on the treated estimates are free from contamination of unobservable characteristics related to both program participation and the need for postsecondary remediation. If there is something about students that is orthogonal to their high school grades, math and English aptitude (as measured by a standardized, norm-referenced test), socioeconomic background, and attributes of the high schools they attend that predicts both program participation and remediation need, then our results will be biased as a function of these two unobserved correlations. Although we think that such a bias is likely to be minimal at worst, we recognize that, given the data available to us, we have no way of ruling out the possibility of bias entirely. Nonetheless, we believe that given the size and representativeness of the sample, the importance of the question, and the absence of experimental data, policymakers should take our results seriously.

Postponing secondary school preparation to the postsecondary level is both controversial and costly. While critics raise important questions about the appropriateness of colleges taking on the task of remediation, there is a dearth of empirical evidence on interventions that effectively reduce remedial course-taking, particularly at the less-selective four-year institutions, where remediation rates are quite substantial. This research indicates that participation in the Early Assessment Program is predicted to lower a student's probability of needing remediation by 6.1 percentage points in English and 4.1 percentage points in math when attending a typical campus in the CSU system. Moreover, our analysis of the mechanism by which EAP reduces remediation need rules out a simple sorting story. This suggests that the information about college readiness that EAP participants receive does not deter the students obtaining a "not college ready" signal from applying. Of course, additional work on whether and how EAP is promoting students to take advantage of their 12th grade year to become college ready is needed to more fully evaluate the program's intention.

Recent reports by the Government Accountability Office and the Spellings Commission call for more systematic research on the determinants of college attrition and time to degree. This research responds directly to their calls. Our study provides an evaluation of an early intervention program that may also improve college persistence and completion rates by reducing the need for remediation in college. With the EAP, California State University has articulated more directly to high school students what it takes to be college ready. Soon, the California Community College system will be following suit as a result of Senate Bill 946, passed by the

California legislature in September 2008, expanding the EAP to students entering the state's 110 community colleges.[25]

In 2007, nearly half of the 49,274 first-time freshmen entering the CSU system required remediation in English. Although not free to taxpayers, the EAP program is much less costly to the state or the student than remediation, particularly when weighed against the benefits of making more informed education decisions following high school. Decreases in remediation need of the magnitude we find in this study may yield a substantial reduction of remediation for the CSU system—the equivalent of about 3,000 students in English and 2,000 in math. Research on college persistence has consistently demonstrated that students with better academic preparation in high school are more likely to complete college. In addition to improving the transition into college for large numbers of high school graduates, we believe this intervention has the capacity to ultimately increase students' probability of successfully completing a baccalaureate degree.

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[25] For additional information see the Legislative Analyst's Office Report, "Back to Basics: Improving College Readiness of Community College Students," http://www.cos.edu/eli/files/ccc_readiness_0608.pdf.

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## APPENDIX

**Table A1.** Summary statistics for EAP-eligible 11th grade students statewide since Early Assessment Program inception, by subject.

| Variable | English | Math |
|---|---|---|
| *Individual Characteristics* | | |
| Male | 0.497 | 0.467 |
| Black | 0.074 | 0.057 |
| Hispanic | 0.388 | 0.280 |
| Asian | 0.107 | 0.171 |
| Other race | 0.055 | 0.063 |
| CST score (same subject) | 326.742 | 311.424 |
| Parent is high school grad | 0.355 | 0.313 |
| Parent is college grad | 0.288 | 0.397 |
| *High School Characteristics* | | |
| Enrollment (in 00s) | 23.772 | 23.587 |
| Academic Performance Index | 694.542 | 713.471 |
| % UC and CSU eligible | 0.071 | 0.081 |
| % black and Hispanic | 0.476 | 0.434 |
| % free/reduced lunch eligible | 0.346 | 0.313 |
| Peer EAP participation rate | 0.496 | 0.514 |
| *EAP and Time Characteristics* | | |
| EAP participation | 0.496 | 0.721 |
| 2003/04 cohort (EAP yr. 1) | 0.317 | 0.307 |
| 2004/05 cohort (EAP yr. 2) | 0.339 | 0.336 |
| 2005/06 cohort (EAP yr. 3) | 0.344 | 0.357 |
| *N* | 1,054,397 | 494,521 |

*Note:* Summary statistics are for the post-EAP sample only (11th grade students in 2003/2004, 2004/2005, and 2005/2006).

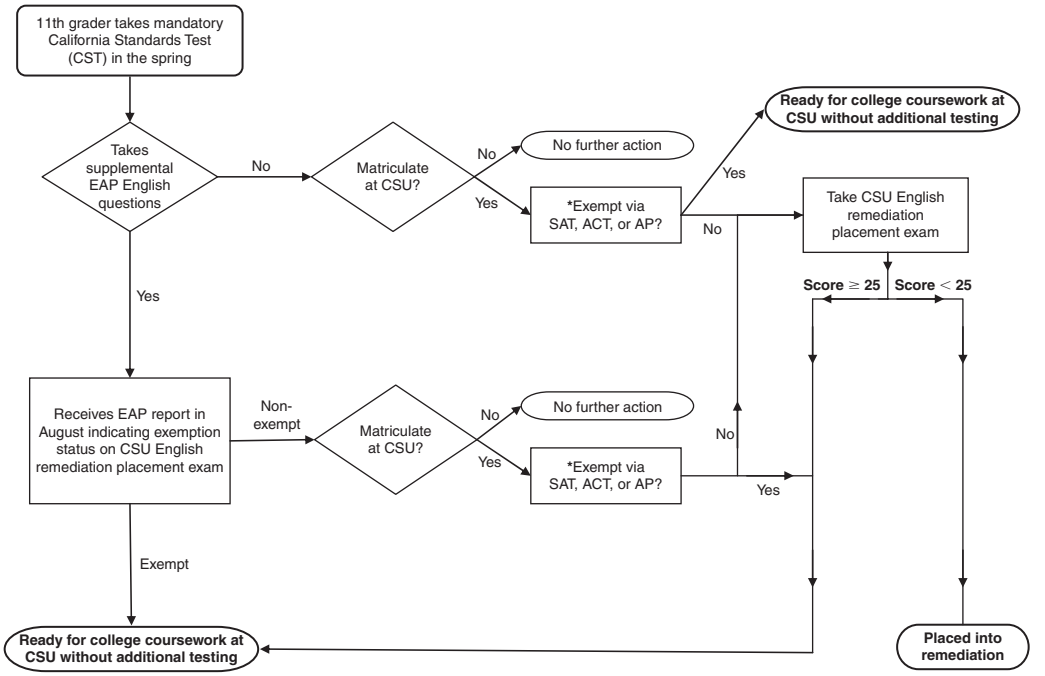


**Figure A1.** Paths to College Readiness or Remediation in English at California State University.

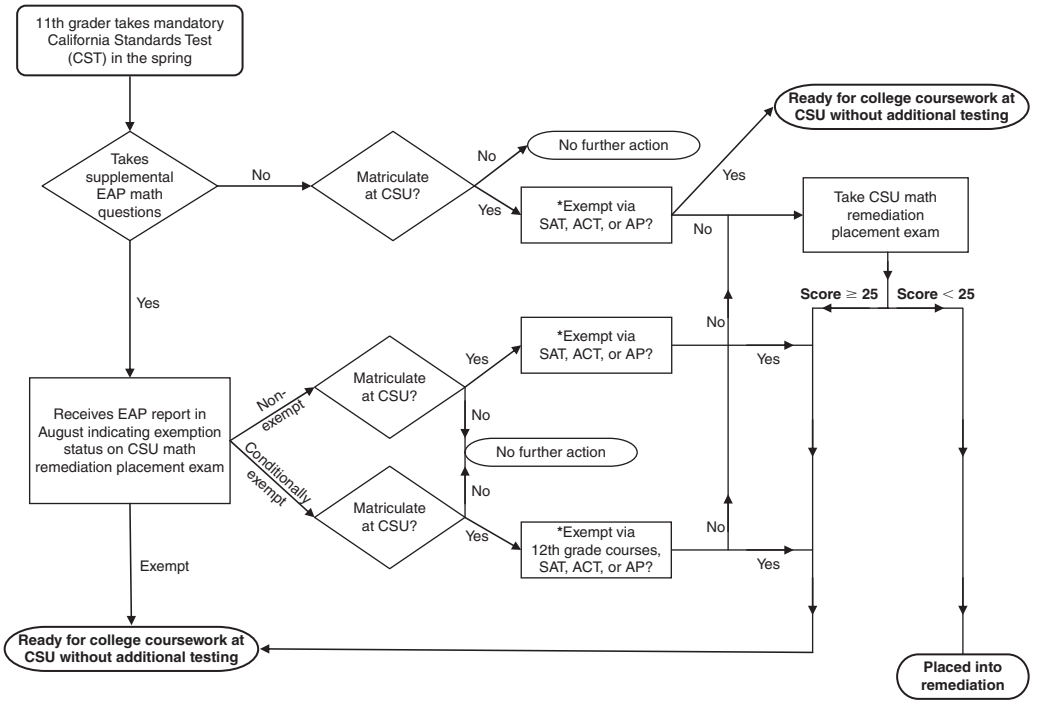


**Figure A2.** Paths to College Readiness or Remediation in Mathematics at California State University.

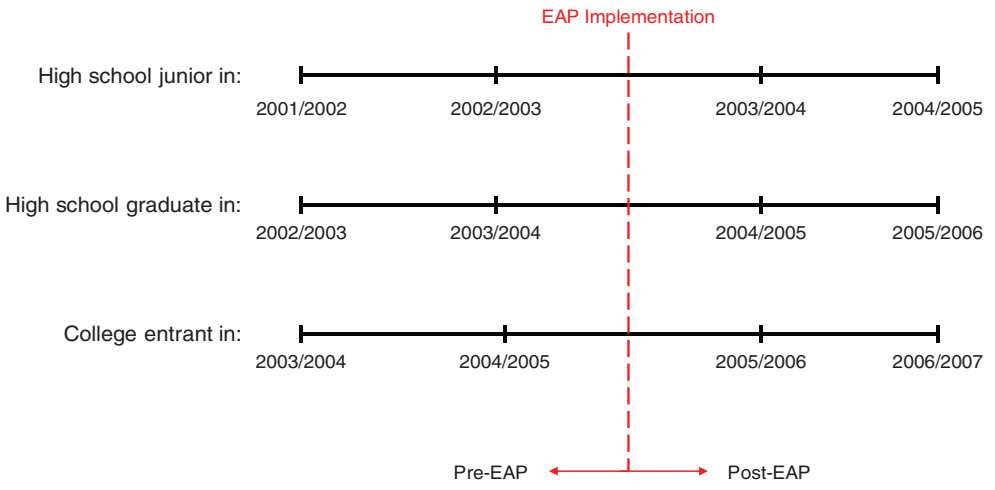


**Figure A3.** Timeline for EAP Participation and College Entrance.