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Course Failure in Dual Enrollment and the Impact on College-Going

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We find that socioeconomically disadvantaged students are more likely to fail DE courses at every level of prior academic achievement, and that this gap widens among higher-achieving students. This pattern, which we term the preparation paradox, suggests that differences in prior academic preparation cannot fully explain observed disparities in outcomes. We then examine the consequences of failure and find that failing a DE course is associated with a substantial reduction in college enrollment. However, these consequences are similar across socioeconomic groups. Finally, we show that students who attempt DE and fail are still more likely to enroll in college than comparable students who never enroll in DE at all.

Taken together, the results suggest that the central challenge in dual enrollment is not that failure is more harmful for disadvantaged students, but that these students face a higher probability of failure regardless of prior preparation. The findings point to the importance of support structures that enable academically capable students to succeed, rather than policies that restrict access based on perceived readiness.

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Abstract

Dual enrollment (DE) has expanded rapidly as a strategy to broaden access to college-level coursework, particularly for students historically excluded from advanced academic opportunities. This study examines the characteristics of students who fail dual enrollment, the consequences of failure, and whether attempting DE retains value even for students who do not succeed. Using administrative data on approximately 1.74 million California public high school students, we analyze how failure risk varies across the prior achievement distribution and whether patterns differ by socioeconomic status.

We find that socioeconomically disadvantaged students are more likely to fail DE courses at every level of prior academic achievement, and that this gap widens among higher-achieving students. This pattern, which we term the *preparation paradox*, suggests that differences in prior academic preparation cannot fully explain observed disparities in outcomes. We then examine the consequences of failure and find that failing a DE course is associated with a substantial reduction in college enrollment. However, these consequences are similar across socioeconomic groups. Finally, we show that students who attempt DE and fail are still more likely to enroll in college than comparable students who never enroll in DE at all.

Taken together, the results suggest that the central challenge in dual enrollment is not that failure is more harmful for disadvantaged students, but that these students face a higher probability of failure regardless of prior preparation. The findings point to the importance of support structures that enable academically capable students to succeed, rather than policies that restrict access based on perceived readiness.

Introduction

Expanding access to rigorous academic experiences has become a central strategy for improving students' transitions from high school to college. Dual enrollment (DE), which allows students to take college courses while still in high school, has emerged as a key mechanism for doing so. A large body of research shows that participation in DE is associated with higher rates of college enrollment and persistence, leading to widespread policy efforts to increase access, particularly for students who have historically been underrepresented in advanced coursework.

These expansion efforts, however, have surfaced an important tension. Broadening access to college-level coursework inevitably introduces greater variation in students' academic backgrounds and institutional supports. As participation expands, so too does concern about course failure and its potential consequences. For students, failing a college course during high school may carry academic, psychological, and signaling effects that shape subsequent educational decisions. For policymakers and practitioners, this raises a fundamental question: when access expands, who bears the risk of failure, and what are the consequences of that risk?

Our analysis yields three central insights. First, gaps in failure are not confined to students with lower prior achievement. Instead, students from socioeconomically disadvantaged backgrounds are more likely to fail at every point in the achievement distribution, and these differences persist, and in some cases grow among higher-achieving students. This pattern suggests that differences in preparation alone cannot account for observed disparities.

Second, failing a dual enrollment course is associated with a substantial reduction in the likelihood of enrolling in college. However, these consequences are similar across socioeconomic groups, indicating that disparities in outcomes are not driven by differential penalties once failure occurs. Third, even when students fail, participation in dual enrollment remains associated with higher college enrollment compared to similar students who never enroll, suggesting that attempting DE retains value relative to non-participation.

Taken together, these findings shift the focus of the policy problem. The central challenge is not that failure is more harmful for some students than others, but that some students face a higher probability of failure even when they appear academically prepared. This distinction has important implications. Efforts to restrict access based on perceived readiness may do little to address the underlying sources of disparity and may instead limit opportunities for students who could succeed under different conditions. A more effective approach may lie in understanding and addressing the factors that shape students' experiences within dual enrollment once access is granted.

Literature Review

Dual enrollment (also referred to in some contexts as dual credit) describes programs that allow high school students to enroll in college coursework while still in high school. The literature commonly frames these programs as a strategy to bridge secondary and postsecondary education by exposing students to college-level expectations, potentially strengthening the transition to college and supporting longer-term educational attainment.

Research has found many positive effects of dual enrollment on student outcomes at both the high school and postsecondary levels (An, 2013; Berger et al., 2013; Edmunds et al., 2017; Giani et al., 2014; Morales et al., 2023; Song et al., 2021; Struhl & Vargas, 2012). Many of these studies use quasi-experimental methods, often through a matching strategy, to estimate impacts of dual enrollment participation on student outcomes. Studies using RCTs or RDDs are rare and often focus on more specialized advanced coursework structures such as Early College High Schools (Edmunds et al., 2017; Speroni, 2011). Current studies on dual enrollment have demonstrated promising evidence of improving students' postsecondary outcomes. For example, participation in dual enrollment has improved students' likelihood of enrollment in college (Miller et al., 2018). Liu et al. (2020) found that participating in dual enrollment courses influenced students' college application behaviors and outcomes, with dual enrollment students applying to a larger number of colleges and more selective colleges. Other studies have corroborated these findings (An, 2013; Giani et al., 2014; Liu et al., 2020; Morales et al., 2023; Speroni, 2011). Morales (2023) found that dual enrolled students were almost 2.5 times more likely to enroll in a postsecondary institution than students who did not take dual enrollment courses. Furthermore, once students reach postsecondary institutions, they are more likely to accumulate credits and attain a degree if they have prior experience in dual enrollment programs (Miller et al., 2018; Morales et al., 2023).

At the same time, the literature cautions that benefits are not automatic. Concerns reported in the dual credit literature include issues related to access, funding, academic rigor, and student readiness (including maturity). A key theme across dual enrollment discussions is that participation and success may be constrained by structural and student-level barriers. Gronlund (2017) indicates that barriers to participation are essential to understanding “accessibility issues that may limit the effectiveness of legislative policy,” suggesting that policy intent can be undermined if eligibility, advising, transportation, scheduling, or other constraints prevent equitable participation. These concerns indicate that program design and student supports may mediate whether dual enrollment leads to improved academic and postsecondary outcomes.

Equity in Dual Enrollment

Access is particularly of interest because not all students have equitable opportunities to participate. Nationally, schools with higher percentages of students eligible for free or reduced-price lunch were less likely to offer dual enrollment options (Taie & Lewis, 2020), and students from less advantaged backgrounds are less likely to participate in dual enrollment, even compared to students with similar academic achievement (Rivera et al., 2019). Black and Hispanic students are also less likely to participate than their White counterparts (Estacion et al., 2011; Kurlaender et al., 2021; Morales et al., 2023). The observed racial gaps have been correlated to prior academic preparation, family socioeconomic background, and residential patterns related to where dual enrollment options are offered (Liu & Xu, 2021; Miller et al., 2018; Rivera et al., 2019; Shivji & Wilson, 2019). DE can potentially increase college access and completion for underserved students, but current DE systems often reproduce existing inequities. Barriers to access include cost, restrictive instructor qualifications, overreliance on placement tests, passive outreach, and biased mindsets that limit who is encouraged to participate (Fink, 2023).

While students generally benefit from dual enrollment, the evidence is mixed as to whether those benefits accrue equally to all groups of students. Studies of Illinois and Texas students found that low-income students received less benefit from dual enrollment than did their higher-income peers (Miller et al., 2018; Taylor, 2015), while other studies have found that low-income students see equal or greater benefits of dual enrollment compared to their peers (An, 2013). In terms of the racial heterogeneity of dual enrollment effects, studies have found that

Black students who participate in dual enrollment are more likely to apply to and enroll in a college compared to their peers, even though they are less likely to participate (Liu et al., 2022; Morales et al., 2023).

Equity-focused guidance specific to dual enrollment mathematics further underscores that historically underserved students may face additional challenges connected to academic literacy demands embedded in math coursework. The “Equity-Focused Dual Enrollment Mathematics” resource recommends structured literacy supports—such as scaffolded reading prompts tied to vocabulary, “big ideas,” clarifying questions, and connections to prior learning—to improve students’ understanding of assigned texts. This guidance identifies common breakdowns such as textbook reading levels exceeding students’ current levels and the time required to interpret and re-read texts, both of which can reduce time available for learning math content. The document also emphasizes supporting factors like instructor planning time and collaboration with high school literacy staff to anticipate barriers, highlighting the role of institutional coordination in equitable student outcomes.

Beyond access and enrollment, student persistence in dual credit emerges as a critical outcome. Lee (2023) synthesizes practical factors that can inhibit persistence, including not completing assignments, lack of maturity, weak time-management skills, underestimating the course load, not utilizing available resources, and not asking for help. These factors suggest that persistence is shaped by both student preparedness and the availability/visibility of support structures that encourage help-seeking and effective study behaviors. Lee (2023) also points to practices that may improve outcomes, such as meeting with struggling students, using a counselor as a liaison, and providing an upfront explanation of what dual credit is and what participation involves; mental health considerations are also explicitly noted as part of effective practice considerations.

Failing Dual Enrollment

While DE courses generally show high pass rates—since many programs enroll only students deemed college-ready—some students struggle, and it is a common belief that poor experiences can harm college aspirations and choices. Although DE is broadly associated with positive postsecondary outcomes, higher-SES and higher-achieving students often receive larger benefits, and low-SES or lower-achieving students sometimes see limited or even negative effects (Giani et al., 2025). Similarly, English learners are sometimes advised by their teachers and counselors to avoid more rigorous coursework in high school to protect them from failure (Kanno & Kangas, 2014).

However, some states and districts have changed their requirements to access DE courses, replacing tests with grades, for example, which resulted not only in an increase in participation of students without meaningful changes in course pass rates (Fink, 2023), demonstrating that there is room in what most define as “college ready”.

Dual Enrollment in CA

California has made a conscious effort to expand DE in high school with the mindset that DE is a tool to close equity gaps in education attainment. However, a report from Wheelhouse in 2021 found that disparities in participation persist across racial/ethnic groups and across high schools; opportunity often depends on the high school attended.

The Present Study

California's dual enrollment expansion (DE) has been explicitly framed as an equity initiative. The College and Career Access Pathways (CCAP) Act of 2016 (AB288) was designed to extend college-level coursework to students historically underrepresented in advanced academic tracks — students who are disproportionately low-income, students of color, and first-generation college-going. By bringing community college coursework directly to high school campuses and removing prerequisite barriers, CCAP sought to create a new pathway to post-secondary education for students who had not historically had access to one. Expanding access and participation in challenging coursework for underrepresented students often raises concerns about the impacts of potential unintended negative consequences.

Against that backdrop, questions about who fails DE, what failure costs, and whether attempting DE still carries value for those who fail are not simply questions about program effectiveness. They are equity questions. If failure risk is concentrated among the students the program was designed to serve, and if those students face greater consequences when they fail, then open-access DE policy may be producing harm alongside benefit. Alternatively, if the costs and benefits of DE participation are distributed more equitably than the raw failure rate suggests, the case for open access is considerably stronger than a focus on failure rates alone would imply. This study addresses three related research questions:

- **RQ1:** Among students who enroll in dual enrollment, how does the probability of course failure vary across the prior academic achievement distribution?
- **RQ2:** Among DE participants, what is the effect of receiving a failing grade on the probability of enrolling in college within 18 months of high school completion?
- **RQ3:** Among students who enroll in DE and fail, does their probability of college enrollment exceed that of comparable students who never enrolled in DE at all?

For each research question, we examine whether findings differ by socioeconomic disadvantage status. California's DE expansion was explicitly designed to serve socioeconomically disadvantaged students, and equity in the distribution, consequences, and residual value of DE failure is therefore central to evaluating whether the program is achieving its intended goals. Findings that differ by SED status would indicate that the program's equity promise is complicated by differential failure risk or differential failure consequences; findings that do not differ by SED status would support a more targeted interpretation; that is, the problem lies in a specific, addressable dimension of the student experience rather than in open access itself.

Data and Sample

Data Source and Key Variables

This study draws on California Longitudinal Pupil Achievement Data System (CALPADS) administrative data from the California Department of Education (CDE) covering the population of students who entered 9th grade in California public high schools in cohorts 2015-16, 2016-17, 2017-18, and 2018-19. The analytic sample includes approximately 1.74 million students. College enrollment outcomes are derived from National Student Clearinghouse data linked to high school records and capture enrollment in any postsecondary institution within 18 months of high school completion. All analyses are conducted at the student level and include district fixed effects to absorb time-invariant differences in district-level DE program characteristics, institutional partnerships that are inherent in the California dual enrollment model, and student population composition.

Dual enrollment participation is defined as ever enrolling in at least one DE course during high school. DE course failure is defined as ever receiving a failing grade in at least one DE course. These are constructed as binary indicators capturing whether a student had any DE participation or failure experience across all four high school years. College enrollment — the primary outcome — is a binary indicator for enrollment in any postsecondary institution within 18 months of high school completion, derived from National Student Clearinghouse records and is inclusive of nearly all postsecondary institutions in the U.S.

Socioeconomic disadvantage is a binary indicator and follows the California state definition, which includes students who qualify for free or reduced-price lunch, whose parents did not receive a high school diploma, or who meet other state-specified criteria (California Department of Education, 2025). Prior academic achievement is measured by 8th grade math assessment percentile rank, which is available for the full student population and is measured prior to high school entry, and therefore prior to any DE enrollment, addressing concerns about endogeneity in achievement measurement. Our team also had access to 8th grade English assessment, though these two scores were highly correlated ($r = 0.90$). We use indicators to capture DE course dosage: separate indicators for taking exactly one DE course and exactly two DE courses, with three or more courses as the reference category. Cohort indicators for 2015-16, 2016-17, and 2017-18 (with 2018-19 as the reference cohort) are included throughout.

Sample Characteristics

Table 1 presents descriptive statistics for the full analytic sample and separately for three groups defined by DE participation and outcome: students who never enrolled in DE (Never DE), students who took DE and never failed a course (Passed DE), and students who took DE and failed at least one course (Ever Failed DE).

The full sample includes 1,742,620 high school students across cohorts 2015-16 through 2018-19. The majority of the sample is Hispanic (54.5%) and is 73.0% socioeconomically disadvantaged, reflecting California's student demographics. The overall 12-month college enrollment rate is 63.0%, consistent with public records of postsecondary enrollment in California. Students who never enrolled in DE are similar to the full sample on most characteristics, reflecting the fact that they constitute the large majority of the analytic population. They are slightly more likely to be SED (73.1%) than the full sample and have a somewhat lower mean math percentile (49.4 vs the sample median of 50, by definition). Their college enrollment rate is 62.1%.

Students who took DE and passed all their courses are more academically prepared on average (61st math percentile) and less likely to be SED (68.0%) than either never-DE students or students who failed DE. They are more likely to be Asian (17.1% vs. 12.2% full sample) and White (24.9%), and less likely to be Hispanic (50.5%) or Black (3.7%). Their college enrollment rate is notably higher at 78.6%, consistent with the positive participation effects documented in the prior literature. These students constitute 83.2% of DE participants; that is, most students who enter DE succeed in their coursework.

Students who ever failed a DE course show a strikingly different demographic and academic profile. They are majority Hispanic (65.0%), substantially more likely to be SED (82.6% vs. 68.0% for DE students who only passed), lower achieving on average (46th vs. 61st math percentile), more likely to be male (51.2% vs. 43.3%), and notably less likely to be White (18.5% vs. 24.9%) or Asian (7.5% vs. 17.1%). Their college enrollment rate of 58.4% is below the sample average, the rate of DE students who only passed, and never-DE students. At face value this creates a concerning picture of DE failure, but this work emphasizes comparing these students to those who are objectively similar groups, for instance, contain some students who passed AP courses, and they are likely to be comparatively overrepresented in the group of students passing DE.

Table 1. Descriptive Statistics by DE Participation and Outcome Status

	Full Sample		Never DE		Passed DE		Ever Failed DE	
N	1,742,620		1,630,892		93,011		18,717	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Demographics								
Male	.509	(.500)	.513	(.500)	.433	(.496)	.512	(.500)
Asian	.122	(.328)	.120	(.325)	.171	(.376)	.075	(.263)
Black	.057	(.232)	.058	(.234)	.037	(.188)	.052	(.222)
Hispanic	.545	(.498)	.546	(.498)	.505	(.500)	.650	(.477)
White	.240	(.427)	.240	(.427)	.249	(.432)	.185	(.388)
Am. Indian/AK Native	.005	(.074)	.006	(.074)	.004	(.066)	.006	(.075)
Pacific Islander	.005	(.070)	.005	(.071)	.004	(.061)	.006	(.075)
Multiracial	.026	(.159)	.026	(.158)	.030	(.172)	.027	(.162)

Socioeconomically Disadvantaged	.730	(.444)	.731	(.443)	.680	(.466)	.826	(.379)
Academic Preparation								
8th Grade Math Percentile	49.9	(28.8)	49.4	(28.8)	60.5	(26.8)	46.0	(25.8)
Cohort								
2015-16	.248	(.432)	.254	(.435)	.168	(.374)	.136	(.342)
2016-17	.248	(.432)	.249	(.433)	.239	(.426)	.212	(.408)
2017-18	.253	(.435)	.250	(.433)	.296	(.457)	.306	(.461)
2018-19 (ref.)	.251	—	.247	—	.297	—	.346	—
Outcome								
College Enrollment (18 months)	.630	(.483)	.621	(.485)	.786	(.410)	.584	(.493)

Notes: Means reported. Standard deviations in parentheses. Full sample N = 1,742,620 students who entered 9th grade in California public high schools in cohorts 2015-16 through 2018-19. Never DE = students who never enrolled in a dual enrollment course (includes AP students). Passed DE = students who enrolled in at least one DE course and never received a failing grade (83.2% of DE participants). Ever Failed DE = students who enrolled in at least one DE course and received a failing grade in at least one DE course (16.8% of DE participants). Cohort 2018-19 serves as the reference category. College enrollment measured within 18 months of high school completion via National Student Clearinghouse linkage. 8th grade math percentile measured prior to high school entry. Source: Authors' Analysis of California Department of Education CALPADS Administrative Data.

Methods

This study uses two complementary analytic approaches to address its three research questions. For RQ1, we estimate a logit regression model on the full dual enrollment participant sample to characterize how the probability of course failure varies across the 8th grade math achievement distribution for socioeconomically disadvantaged and non-disadvantaged students. For RQ2 and RQ3, we use propensity score matching (PSM) and inverse probability weighting (IPW) to construct comparison groups that are observationally similar on measured pre-treatment characteristics, thereby reducing bias from selection into DE participation and failure. Consistent with prior DE research using quasi-experimental matching approaches (e.g., Edmunds et al., 2022; Giani et al., 2014), outcome models are estimated as logit regressions with district fixed effects and as linear probability models, with average marginal effects (percentage points) as the primary reported estimate. We additionally confirm the established positive effect of DE participation on college enrollment as a methodological validation check; DE participation is associated with an 8.5 percentage point increase in college enrollment probability, consistent with prior literature. These results are presented in Appendix A.

Propensity Score Matching Analyses

For the two primary causal analyses (RQ2 and RQ3), we construct matched comparison groups using propensity score methods. In both cases, propensity scores are estimated using probit regression, and balance is assessed using the What Works Clearinghouse (WWC) baseline equivalence standards (What Works Clearinghouse, 2022). We include all matching covariates in the outcome models as controls.

Predicting Dual Enrollment Failure (RQ1)

To understand how failure risk varies across the achievement distribution and student characteristics (RQ1), we estimate a logit model on the full DE participant sample (N = 150,594). This broader sample is appropriate for the descriptive purpose of RQ1 because it includes all DE participants regardless of whether complete covariate data are available for the PSM analyses. The outcome is a binary indicator for ever receiving a failing grade in at least one DE course. Predictors include 8th grade math achievement percentile, 8th grade ELA achievement percentile, indicators for traditionally underrepresented racial/ethnic group membership (UR) and socioeconomic disadvantage, interactions between each of these group indicators and 8th grade math percentile, gender, cohort indicators, and district fixed effects. Standard errors are clustered at the school level. The SED-by-math-achievement interaction is the key specification: a positive and significant coefficient indicates that the SED failure gap widens as achievement increases — the preparation paradox. Predicted probabilities are computed using the Stata margins command across the math achievement distribution separately for SED and non-SED students, holding all other variables at their means.

The failure likelihood model (Model 1) takes the following form:

$$\begin{aligned} Model\ 1\text{: } P(Fail = 1) \\ &= \Lambda(\alpha + \beta_1 Math_i + \beta_2 UR_i + \beta_3 (Math_i\ x\ UR_i) + \beta_4 SED_i \\ &+ \beta_5 (Math_i\ x\ SED_i) + \beta_6 ELA_i + B_7 Female_i + \gamma_c + \delta_d + \varepsilon_i) \end{aligned}$$

where Λ is the logistic function, Math and ELA are 8th grade assessment percentiles, UR and SED are binary indicators, γc are cohort fixed effects, δ_d are district fixed effects and standard errors are clustered at the school level. The key parameters are β3 and β5: positive and significant values indicate that the UR and SED failure gaps widen as prior achievement increases.

This model uses a different analytic sample and includes ELA achievement and gender as covariates that are not present in the PSM matching models; these specifications are not intended to be directly comparable. The failure likelihood model is descriptive and diagnostic. Our goal is to characterize the population at risk for this research question.

Impact of Dual Enrollment Failure on Enrolling in College (RQ2)

Our RQ2 PSM failed to achieve adequate pre-match balance for the comparison of DE students who failed and students who passed (never failed), which reflects the stark differences between students who pass and fail DE (see Appendix B, Table B1). Instead, we use inverse probability weighting (IPW) as the primary estimation strategy for RQ2. IPW reweights the observed sample to create a pseudo-population in which treatment assignment (in this case, DE failure) is independent of observed covariates, thereby approximating what would be observed in a randomized study (Dehejia & Wahba, 2002). Propensity scores are estimated using a probit model predicting DE failure from demographics, SED status, 8th grade math achievement, cohort, district fixed effects, and indicators for DE course count. Stabilized IPW weights are constructed separately for the treated (failing) and control (passing) groups and trimmed at the 1st and 99th percentiles of the weight distribution to reduce the influence of extreme weights; this trimming reduces the analytic sample from 110,068 to 107,868 observations[1].

Post-weighting balance is assessed by regressing each covariate on the treatment indicator using trimmed IPW weights; all variables achieve standardized differences below 0.25 after weighting (Table 2).

[1] We reach post-match balance for RQ3 analysis on all covariates with the exception of Hispanic ethnicity (post-match Hedges' g = 0.353), which exceeds the WWC threshold of g = 0.25. Hispanic ethnicity is included as a covariate in all outcome models. Sensitivity analyses restricting the sample to non-Hispanic students yield substantively identical estimates, suggesting the Hispanic imbalance does not materially affect the overall findings.

Table 2. Baseline Equivalence: RQ2 IPW — Failed DE vs. Passed DE (Pre- and Post-Weighting)

	Post-Weighting (IPW)		
Variable	**Failed DE Mean**	**Passed DE Mean**	**Hedges' g**
Male	0.475	0.445	**0.061**
Asian	0.100	0.158	**-0.173**
Black	0.050	0.040	0.049
Hispanic	0.596	0.525	**0.142**
Am. Indian/AK Native	0.005	0.005	0.002
Pacific Islander	0.005	0.004	0.014
Multiracial	0.031	0.030	0.008
Socioeconomically Disadvantaged	0.777	0.702	**0.171**
8th Grade Math Pctile.	52.2	58.4	**-0.236**
Cohort 2015-16	0.154	0.164	-0.026
Cohort 2016-17	0.231	0.236	-0.013
Cohort 2017-18	0.297	0.297	0.001
Took One DE Course	0.489	0.486	0.006
Took Two DE Courses	0.311	0.322	-0.023

Notes: Reference categories omitted from the table: White (race/ethnicity), Female (gender), Cohort 2018-19. Hedges' g computed as (mean_treat − mean_control) / pooled SD. WWC standard: $|g| < 0.05$ = no adjustment needed (black); $0.05 \leq |g| < 0.25$ = covariate adjustment required (amber); $|g| \geq 0.25$ = fails standard (red). Post-weighting: weighted means using trimmed stabilized IPW weights ($N = 107{,}868$). All variables meet WWC standard after weighting; variables with $|g| \geq 0.05$ post-weighting are included as covariates in all outcome models.

The outcome model (Model 2) takes the following form:

$$Model\ 2: P(Enroll_i = 1) = \Lambda(\alpha + \tau Fail_i + \chi_i'\beta + \delta_d + \varepsilon_i)[\omega_i]$$

where $\Lambda(\cdot)$ is the logistic function, τ is the treatment effect of DE failure on college enrollment, χ_i' includes all matching covariates plus DE course count indicators as controls, δ_d are district fixed effects, and ω_i are the trimmed IPW weights. The primary reported estimate is the average marginal effect (AME) of $Fail_i$ on $P(Enroll_i = 1)$, computed via the Stata margins command immediately after estimation.

For the outcome equity analysis (Model 3), we augment the outcome model with a SED interaction term:

$$\begin{aligned} Model\ 3: P(Enroll_i = 1) \\ = \Lambda(\alpha + \tau_1 Fail_i + \tau_2 SED_i + \tau_3(Fail_i * SED_i) + \chi_i'\beta + \delta_d + \varepsilon_i)[\omega_i] \end{aligned}$$

Value of Attempting Dual Enrollment (RQ3)

To estimate whether having attempted DE still carries enrollment value for students who fail (RQ3), we use nearest-neighbor PSM without replacement. The analytic design reflects a deliberate theoretical choice about the appropriate counterfactual population. California's DE expansion was designed to reach students who would not otherwise access advanced coursework — students for whom DE represented the only available pathway into college-level work. This motivates restricting both groups to non-AP students: the treatment group consists of DE students who failed that never took AP (N = 10,750), and the control pool consists of students who never enrolled in DE and never took AP. The approximately 42.6% of students who failed DE who also took AP are excluded because they had access to an alternative advanced coursework pathway, for whom the appropriate counterfactual is a different question. The students included in this analysis are the marginal DE enrollees for whom the policy question of net enrollment value is most consequential.

Propensity scores are estimated using a probit model predicting DE participation from demographics, SED status, 8th grade math achievement percentile, and cohort. Table 3 provides baseline equivalence information. Nearest-neighbor matching without replacement yields 10,750 matched pairs (N = 21,500). Most matching variables achieve Hedges' g below 0.05 post-match, meeting the WWC standard without covariate adjustment. Hispanic ethnicity is an exception (post-match g = 0.354, failing the WWC standard) and is included as a covariate in all outcome models to address residual imbalance.

Table 3. Baseline Equivalence: RQ3 PSM — Failed DE vs. Never DE (Pre- and Post-Match)

	Post-Match (PSM)		
Variable	**Failed DE (Treatment)**	**Never DE (Control)**	**Hedges' g**
Male	0.568	0.551	0.033
Asian	0.059	0.098	**-0.146**
Black	0.058	0.088	**-0.116**
Hispanic	0.654	0.482	**0.354**
Am. Indian/AK Native	0.007	0.010	-0.034
Pacific Islander	0.006	0.008	-0.025

Multiracial	0.024	0.040	**-0.088**
Socioeconomically Disadvantaged	0.845	0.761	**0.214**
8th Grade Math Pctile.	38.6	42.0	**-0.134**
Cohort 2015-16	0.136	0.166	**-0.090**
Cohort 2016-17	0.212	0.231	-0.047
Cohort 2017-18	0.306	0.292	0.031

Notes: Reference categories omitted from the table: White (race/ethnicity), Female (gender), Cohort 2018-19. Hedges' g computed as (mean_treat − mean_control) / pooled SD. WWC standard: |g| < 0.05 = no adjustment needed (black); 0.05 ≤ |g| < 0.25 = covariate adjustment required (amber); |g| ≥ 0.25 = fails standard (red). Post-match: nearest-neighbor PSM matched sample (N = 21,500; 10,750 matched pairs). Sample restricted to non-AP students in both treatment and control groups. Hispanic ethnicity fails the WWC standard post-match (g = 0.354); it is included as a covariate in all outcome models to address residual imbalance. All other variables meet WWC standard post-match.

Outcome models are estimated as logit regressions and linear probability models with district fixed effects on the matched sample. All matching variables are included as covariates in the outcome model. The outcome model takes the following form:

$$Model\ 4: P(Enroll_i = 1) = \Lambda(\alpha + \tau Treated_i) + \chi_i'\beta + \delta_d + \varepsilon_i)$$

where $Treated_i$ =1 for DE students who failed and 0 for matched never-DE students, and the AME of $Treated_i$ is the primary estimate of the residual benefit of having attempted DE. The equity analysis follows the equation above with treated replaced by Fail.

$$Model\ 5: P(Enroll_i = 1) = \Lambda(\alpha + \tau Fail_i) + \chi_i'\beta + \delta_d + \varepsilon_i)$$

Equity Analysis

For both RQ2 and RQ3, we examine whether the treatment effect differs by SED status using two complementary approaches. First, we estimate average marginal effects separately for SED and non-SED students using margins in Stata. Second, we formally test whether the SED and non-SED marginal effects are statistically distinguishable using a contrast specification. This produces a direct estimate of the difference in marginal effects across groups with its associated standard error and p-value and is our primary test of differential treatment effects by SED status.

Limitations

Several limitations apply to these analyses. First, all analyses are observational and rely on matching on observed characteristics; unobserved confounders cannot be ruled out. The most consequential concern for RQ3 is that students who try DE despite eventual failure may be systematically more motivated than students who never try, which would upwardly bias the residual benefit estimate. We note that the matched samples are well-balanced on all observed predictors of motivation, including prior achievement and SED status.

Second, 8th grade math achievement is measured prior to high school entry and therefore prior to any DE enrollment, which addresses endogeneity concerns but may not fully capture academic growth occurring between 8th grade and the point of DE enrollment. This limitation may cause the preparation paradox finding to be conservative if high-achieving SED students have grown substantially since 8th grade.

Third, college enrollment is measured within 18 months of high school completion. Students who delay enrollment, a pattern that may be more common among SED students, are not captured in this outcome window. Our estimates of both the failure penalty and the residual benefit are therefore lower bounds if failure induces delay rather than permanent non-enrollment.

Fourth, our data do not include course-level characteristics such as subject matter, instructional modality, course location, or instructor type. We investigated the role of some course characteristics, like subject area, within our analysis. There was a great deal of variation across types of courses students took, and we did not find compelling patterns in failure in our initial analysis, though further investigation is likely worthwhile. Prior research suggests these features influence DE outcomes (Ryu et al., 2023); we cannot account for heterogeneity in DE program quality within or across districts beyond what is absorbed by district fixed effects.

Fifth, the generalizability of findings is shaped by California's specific policy context during a period of active DE expansion. The 16-17% student-level failure rate observed in our data is consistent with California community college system records for this period (data from the CCCCO Management Information Systems Datamart indicates about 20% failure or withdrawal rates at the course-level state-wide), but states with more selective DE eligibility requirements or different institutional partnership structures may show different patterns. However, we believe the analytical contribution (i.e., the preparation paradox) is expected to travel beyond California even where specific magnitudes may differ.

Results

Who Fails Dual Enrollment? The Preparation Paradox (RQ1)

Overall, 17.1% of students who enrolled in at least one DE course during the study period received a failing grade in at least one course (N = 25,728 out of 150,594 DE participants in the full analytic sample). Failure is not uniformly distributed across the DE population. Students who fail are more likely to be male, Hispanic, and socioeconomically disadvantaged, and they tend to have lower prior academic achievement on average than students who pass their DE courses. These descriptive patterns are consistent with broader equity concerns about differential access to academic and navigational supports within DE programs. Table 4 presents observed failure rates by SED status and 8th grade math achievement percentile, illustrating how failure risk varies jointly across these two dimensions.

Table 4. Observed DE Failure Rates by SED Status and 8th Grade Math Achievement

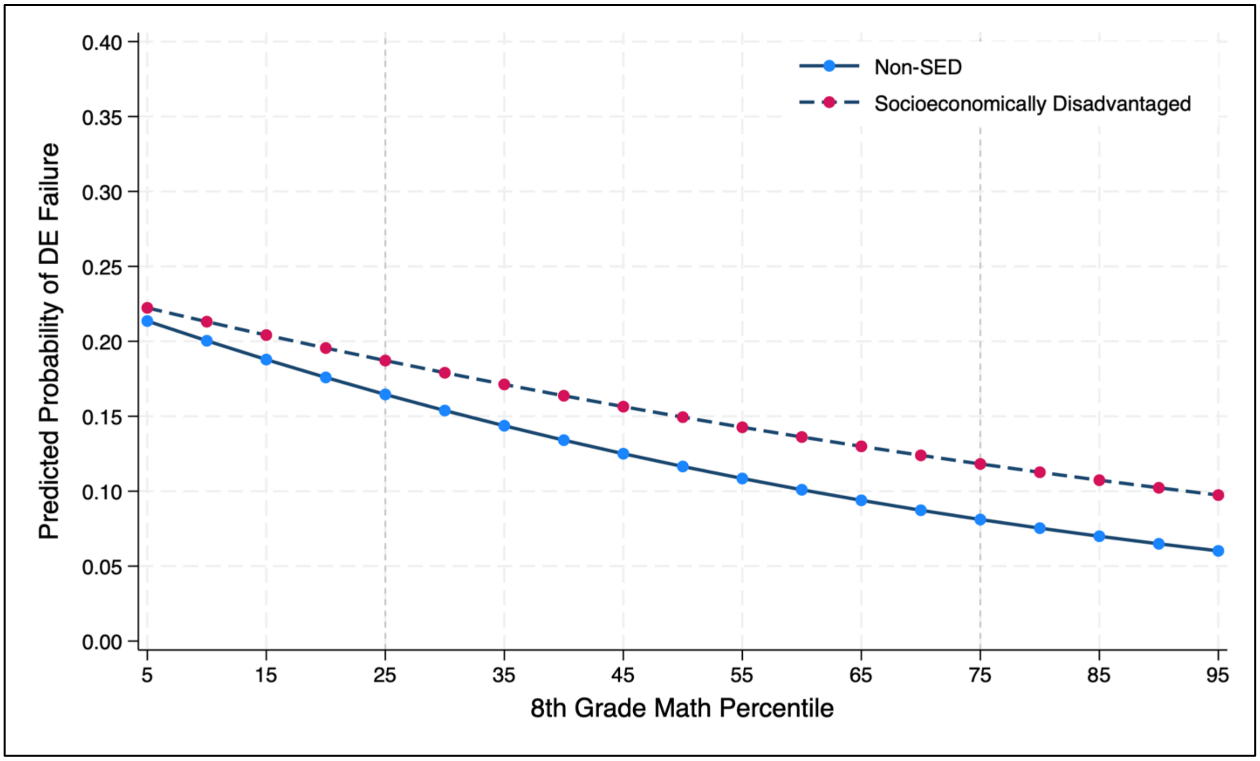
	Non-SED		Socioeconomically Disadvantaged		SED–Non-SED Gap (pp)
8th Grade Math Achievement Bin	**DE Participants (N)**	**Failure Rate (%)**	**DE Participants (N)**	**Failure Rate (%)**	
5th–15th percentile	597	25.5%	7,990	28.8%	**+3.3**
15th–25th percentile	1,129	23.5%	9,761	26.7%	**+3.3**
25th–35th percentile	1,626	19.9%	10,733	25.2%	**+5.3**
35th–45th percentile	2,284	17.1%	11,635	23.1%	**+6.0**
45th–55th percentile	3,178	15.7%	12,249	21.4%	**+5.7**
55th–65th percentile	4,441	13.8%	12,632	19.0%	**+5.2**
65th–75th percentile	5,963	10.8%	12,683	16.0%	**+5.2**
75th–85th percentile	7,855	8.5%	12,073	13.9%	**+5.4**
85th–95th percentile	9,971	5.8%	9,999	10.5%	**+4.6**

Notes: Observed failure rates among DE participants by SED status and 8th grade math achievement bin. Each bin spans approximately 10 percentile points. Non-SED and SED each combine underrepresented and non-underrepresented subgroups. N reflects the number of DE participants in each cell. Gap = SED failure rate minus non-SED failure rate. Gaps at or above 3.0 pp shown in bold. Source: California Department of Education CALPADS Administrative Data; N = 150,594 DE participants.

Table 4 reveals a pattern with important equity implications: while both SED and non-SED students become less likely to fail as prior achievement increases, the SED failure rate declines more slowly and the gap between groups grows substantially across the achievement distribution. Among students in the lowest achievement bin (5th–15th percentile), the gap between SED and non-SED failure rates is already present but modest — 28.8% vs. 25.5%, a gap of 3.3 percentage points. As achievement rises, this gap widens consistently. It peaks at approximately 6 percentage points around the 35th–45th percentile and remains elevated throughout the top of the distribution: among students in the highest achievement bin (85th–95th percentile), non-SED students fail at 5.8% while SED students fail at 10.5%, a gap of 4.6 percentage points that persists even among the most academically prepared DE participants.

Figure 1 presents model-predicted failure probabilities from the logit regression described in Model 1, plotting the probability of DE failure across the math achievement distribution separately for SED and non-SED students, holding all other variables at their sample means. The model-based estimates confirm and sharpen the descriptive pattern. At the 5th percentile, the predicted failure probability is similar for SED (22.2%) and non-SED (21.4%) students, a gap of less than 1 percentage point. As math achievement increases, the non-SED line declines steeply while the SED line remains elevated. By the 50th percentile, the gap has grown to 3.3 percentage points (non-SED: 11.6%; SED: 14.9%). By the 75th percentile, a level of academic preparation at which both groups should be well-positioned for college-level coursework, the gap reaches 3.7 percentage points (non-SED: 8.1%; SED: 11.8%). At the 90th percentile, non-SED students fail at 6.5% while SED students fail at 10.2%.

Figure 1. Predicted probability of DE failure by 8th grade math achievement percentile and SED status.



Notes: Lines show model-predicted failure probabilities holding all other covariates at their sample means. District fixed effects included; standard errors clustered at the school level. Logit model on full DE participant sample (N = 150,594); see Model 1.

These patterns are confirmed by the formal interaction test in the failure likelihood model. The coefficient on the SED-by-math interaction term is positive and statistically significant (β = 0.0052, SE = 0.0010, $p < 0.001$), indicating that the failure gap between SED and non-SED students widens as 8th grade math achievement increases. This is exactly the opposite of what a preparation-only explanation would predict. If academic preparation were the primary driver of failure, the SED gap should narrow at higher achievement levels as preparation converges. Instead, it persists and grows. A parallel result holds for students traditionally underrepresented by race/ethnicity, for whom the race/ethnicity-by-math interaction is similarly positive and significant (β = 0.0060, SE = 0.0009, $p < 0.001$); the corresponding figure is presented in Appendix C as Figure C1.

We term this pattern the preparation paradox: academic preparation protects non-disadvantaged students from DE failure as their achievement rises but does not equally protect socioeconomically disadvantaged students. Among the most academically prepared DE participants (i.e., those at the 90th percentile of prior math achievement) SED students still fail at a rate 58% higher than their similarly prepared non-SED peers (10.2% vs. 6.5%). This divergence cannot be explained by differences in academic readiness. It points instead to the role of non-academic factors such as academic and social belonging, navigational resources, financial pressures, and access to support infrastructure that disadvantaged students face regardless of their prior preparation level.

This finding is consequential for policy. If the preparation gap were the primary driver of differential failure, the appropriate intervention should target students with the lowest prior achievement through academic remediation or stricter eligibility requirements. The preparation paradox suggests the opposite: the students most poorly served by the current system are disadvantaged students who are academically capable of succeeding in DE but failing at elevated rates because they lack the non-academic supports their non-disadvantaged peers draw upon. This is the population for whom support infrastructure, not gatekeeping, is the appropriate policy response.

The Cost of Failure (RQ2)

Having established that failure risk is systematically concentrated among socioeconomically disadvantaged students across the achievement distribution, we turn to the consequences of failure for postsecondary enrollment. The central question for RQ2 is: *conditional on having enrolled in DE, how much does receiving a failing grade reduce a student's probability of enrolling in college within 18 months of high school completion?*

Overall Failure Penalty

Failing at least one DE course is associated with a substantial and statistically significant reduction in college enrollment probability. The primary specification, an IPW linear probability model with DE course count covariates, yields an average marginal effect of −12.2 percentage points (SE = 0.004, $p < 0.001$). The logit IPW specification produces a closely consistent estimate of −10.9 percentage points (SE = 0.003, $p < 0.001$). The PSM robustness check presented in Appendix B yields −10.4 percentage points, confirming robustness across estimation strategies.

This magnitude is substantively large. A 12.2 percentage point reduction represents approximately a 15% decline in enrollment probability relative to baseline for students who passed DE of 78.6%. Put differently, a student who enrolls in DE and fails is left with an enrollment rate (58.4%) that falls below the rate of students who never enrolled in DE at all (62.1%, though this group includes other important populations like students who took AP and not DE). This descriptive pattern, visible in Table 1, is confirmed by the IPW analysis to reflect genuine treatment effects rather than pre-existing differences between groups. The full interaction specification yields a consistent estimate of −9.7 percentage points (Appendix C, Table C1).

Table 5. Effect of DE Failure on College Enrollment: RQ2 Primary Specification (IPW Linear Probability Model)

	College Enrollment (18 months) Percentage Point Effect	
Variable	**Coeff.**	**(SE)**
Treatment		
Failed DE	**-0.122*** **	*(0.004)*
Demographics (ref. = White)		
Male	**-0.089*** **	*(0.003)*
Asian	**0.037*** **	*(0.004)*
Black	**0.033*** **	*(0.008)*
Hispanic	0.005	*(0.004)*
Am. Indian/Alaska Native	-0.046*	*(0.021)*
Pacific Islander	-0.034	*(0.021)*
Multiracial	0.005	*(0.007)*
Socioeconomic Status		
Socioeconomically Disadvantaged	**-0.063*** **	*(0.003)*
Academic Preparation		
8th Grade Math Percentile	**0.004*** **	*(0.000)*
Cohort (ref. = 2018-19)		
Cohort 2015-16	**0.036*** **	*(0.004)*
Cohort 2016-17	**0.022*** **	*(0.004)*
Cohort 2017-18	-0.002	*(0.003)*
DE Course Dosage (ref. = 3+ courses)		
Took One DE Course	**-0.069*** **	*(0.004)*
Took Two DE Courses	**-0.044*** **	*(0.004)*
Model Statistics		
Constant	0.846***	

Observations	107,868
District Fixed Effects	Yes (suppressed)
Weights	Trimmed IPW (1st–99th pct.)

*Notes: Coefficients are percentage point effects from a linear probability model estimated with trimmed inverse probability weights. Robust standard errors in parentheses. Treatment = ever failed at least one DE course. Control = took DE and never failed. Sample restricted to DE participants (N = 107,868 after weight trimming). District fixed effects included as covariates but suppressed from display. Reference categories: female, White, cohort 2018-19, took three or more DE courses. * p < 0.05 ** p < 0.01 *** p < 0.001.*

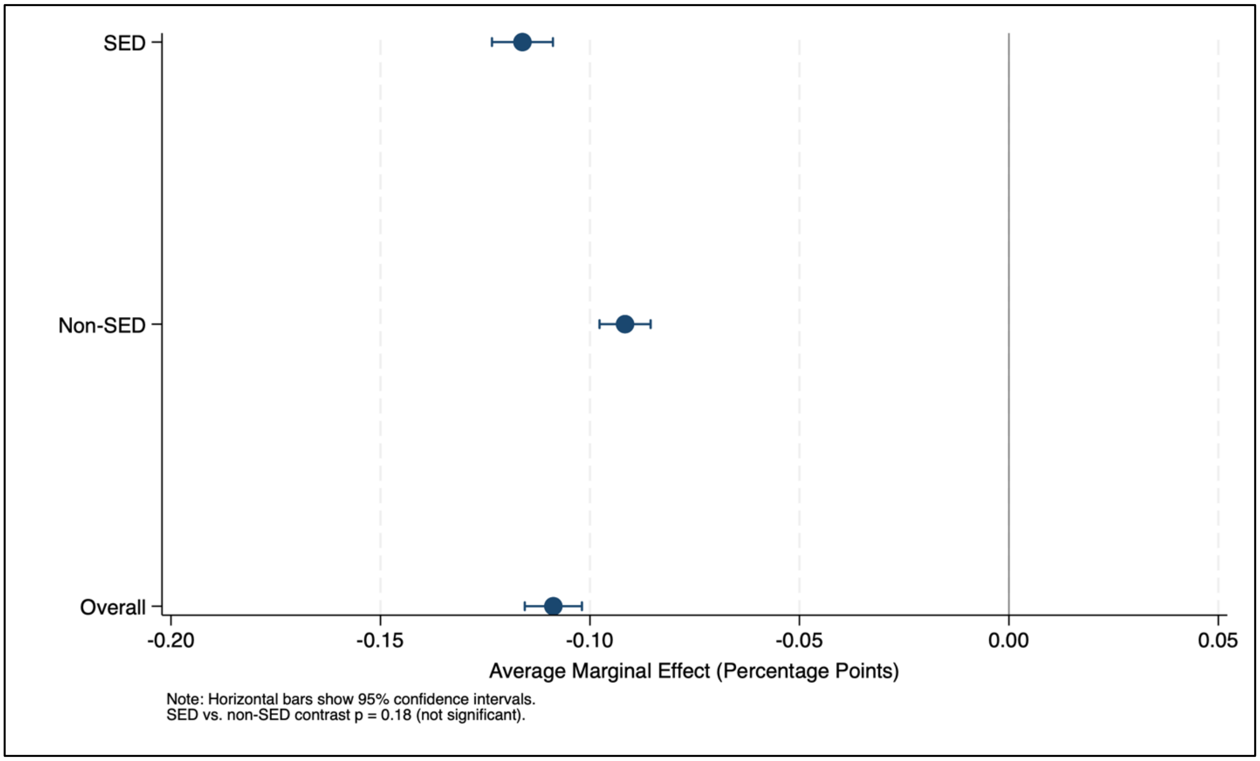
Equity in Failure Consequences

A central question for policy is whether the failure penalty falls disproportionately on socioeconomically disadvantaged students. If disadvantaged students bear both greater exposure to failure risk and greater consequences when they fail, the equity implications of open-access DE would be considerably more severe. The evidence does not support this pattern.

Estimated separately by SED status, the failure penalty is −9.2 percentage points for non-SED students (SE = 0.003, $p < 0.001$) and −11.6 percentage points for SED students (SE = 0.004, $p < 0.001$). While the point estimates differ by 2.4 percentage points, the formal contrast test yields a difference of −1.4 percentage points (95% CI: −3.5 to +0.7 pp, $p = 0.18$), which is not statistically distinguishable from zero. Full regression results for RQ2 analysis are presented in Appendix C, Table C1.

This finding is central to the paper's equity reframe. The non-significant SED interaction does not mean that DE failure is equitable. It means that the inequity in dual enrollment is not primarily located in the consequences of failure. SED and non-SED students who fail face similar enrollment penalties. The inequity lies upstream, in the differential probability of failure itself. As documented in Table 4, socioeconomically disadvantaged students fail at substantially higher rates at every achievement level, and this gap widens as achievement increases. The appropriate policy response is therefore to prevent failure among high-risk students through proactive support structures, not to manage its consequences after the fact.

Figure X: Average marginal effect of DE failure on enrollment, overall and by SED status



Is There Still a Benefit from Failure? (RQ3)

The failure penalty documented under RQ 2 is estimated relative to students who enrolled in DE and passed. The central question for RQ3 is: for students who enrolled in DE and failed, does their college enrollment probability still exceed that of comparable students who never enrolled in DE at all? If so, attempting DE, even unsuccessfully, carries net value relative to the realistic alternative. If not, failure represents a harm with no offsetting benefit, and the open-access case weakens considerably.

The RQ3 analysis reflects a deliberate theoretical choice about the appropriate counterfactual population. California's dual enrollment expansion was explicitly designed as an equity intervention to extend college-level coursework to students underrepresented in existing advanced coursework tracks, particularly AP. DE and AP serve meaningfully different student populations in California: AP participation is concentrated among higher-achieving, less socioeconomically disadvantaged students. DE was designed to reach students who would not otherwise access college-level coursework. This distinction motivates the RQ3 sample restriction. The treatment group is restricted to DE students who failed that never took AP (N = 10,750), students for whom DE represented their only entry point into advanced coursework. The control pool is similarly restricted to never-DE, never-AP students. Students who took both AP and DE are excluded because they had access to an alternative advanced coursework pathway. The appropriate counterfactual for that population is a different question. The students included in this analysis can be thought of as the marginal DE enrollees not taking other rigorous coursework, those California's DE expansion was designed to reach, for whom the policy question of net enrollment value is most consequential. A sensitivity analysis using a broader control pool that includes AP students is reported in Appendix B.

Nearest-neighbor PSM yields 10,750 matched pairs (N = 21,500). Post-match mean bias is 0.4%. Most matching variables achieve Hedges' g below 0.05 post-match; Hispanic ethnicity is an exception (post-match g = 0.353, failing the WWC standard), and is included as a covariate in all outcome models to address residual imbalance.

A Meaningful Enrollment Advantage Persists

Among marginal DE enrollees, students for whom DE was the only available advanced coursework pathway, failing at least one DE course is associated with a statistically significant enrollment advantage relative to comparable students who never enrolled in DE. The logit PSM specification yields an average marginal effect of +6.4 percentage points (SE = 0.009, $p < 0.001$; N = 21,500), with OR = 1.348 indicating that DE students who failed are approximately 35% more likely to enroll in college than matched never-DE students. The interaction model yields a nearly identical estimate of +6.5 percentage points ($p < 0.001$), confirming robustness to additional controls. Full regression results are presented in Appendix C, Table C2.

This finding is substantial in context. The failure penalty relative to students who passed DE is approximately −12 percentage points (Table 5). The enrollment advantage relative to never-DE students is approximately +6 percentage points. Failure therefore nearly erases the enrollment advantage of having attempted DE, though not entirely. For the marginal DE student, attempting DE and failing is still meaningfully better than not having tried at all.

Table 6. Effect of Having Attempted DE on College Enrollment: RQ3 Primary Specification (PSM Linear Probability Model)

	College Enrollment (18 months) Percentage Point Effect	
Variable	**Coeff.**	**(SE)**
Treatment		

Failed DE (vs. Never DE)	**0.064*** **	*(0.009)*
Demographics (ref.=White)		
Male	**-0.109*** **	*(0.007)*
Asian	**0.091*** **	*(0.017)*
Black	**0.074*** **	*(0.017)*
Hispanic	0.010	*(0.011)*
Am. Indian/Alaska Native	0.030	*(0.044)*
Pacific Islander	-0.011	*(0.047)*
Multiracial	0.008	*(0.023)*
Socioeconomic Status		
Socioeconomically Disadvantaged	**-0.114*** **	*(0.011)*
Academic Preparation		
8th Grade Math Percentile	**0.003*** **	*(0.000)*
Cohort (ref. = 2018-19)		
Cohort 2015-16	0.027*	*(0.012)*
Cohort 2016-17	0.018	*(0.010)*
Cohort 2017-18	-0.016	*(0.009)*
Model Statistics		
Constant	0.346	
Observations	16,914	
Matched Pairs	10,750	
District Fixed Effects	Yes (suppressed)	
Sample	Non-AP students only	

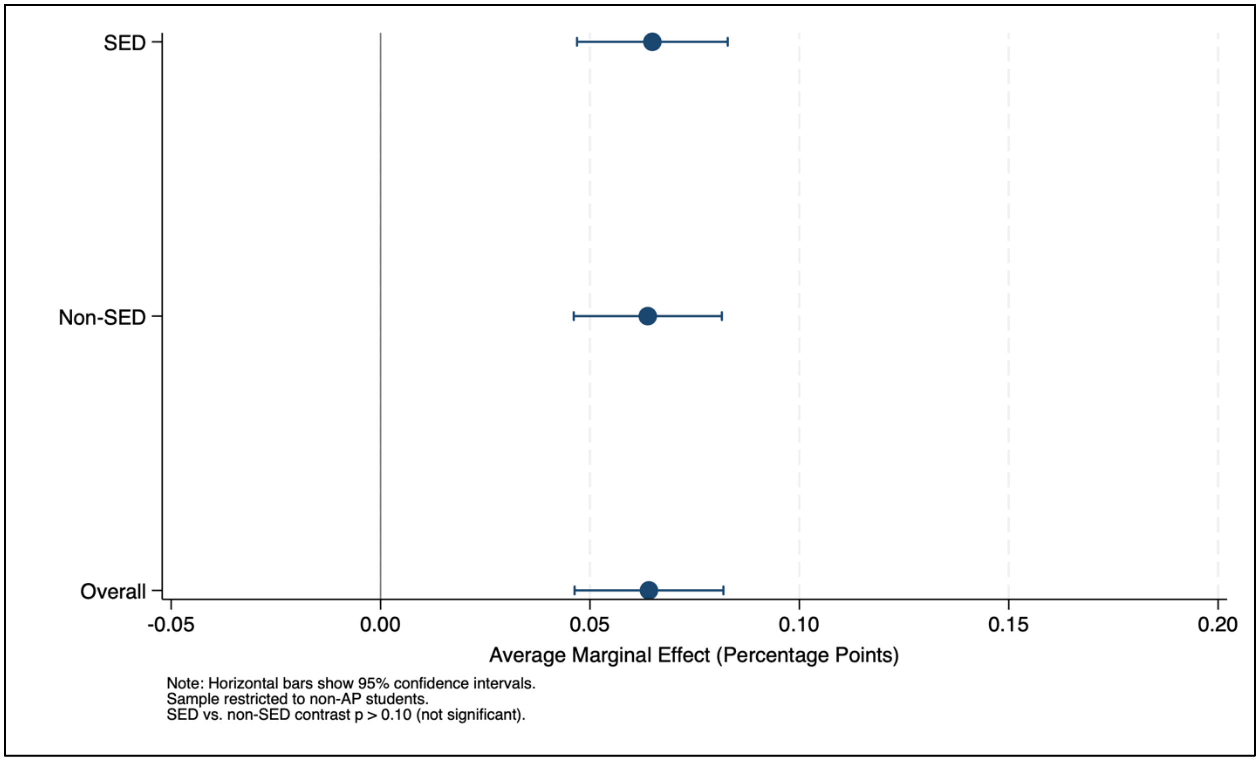
*Notes: Coefficients are percentage point effects from a linear probability model estimated on the propensity score matched sample. Standard errors in parentheses. Treatment = ever failed at least one DE course and never took AP. Control = never enrolled in DE and never took AP. Nearest-neighbor PSM without replacement; 10,750 matched pairs. Estimation sample N = 16,914 after district fixed effects absorption. District fixed effects included as covariates but suppressed from display. Reference categories: female, White, cohort 2018-19. Hispanic ethnicity post-match Hedges' g = 0.353; included as covariate to address residual imbalance. * p < 0.05 ** p < 0.01 *** p < 0.001.*

Equity in the Enrollment Advantage

The enrollment advantage of having attempted DE is equitably distributed across SED groups. Estimated separately, the advantage is +6.3 percentage points for non-SED students and +6.2 percentage points for SED students, substantively identical estimates that are statistically indistinguishable. The formal SED contrast is not significant ($p > 0.10$), confirming that the enrollment advantage of having attempted DE accrues equally to socioeconomically disadvantaged and non-disadvantaged students among the marginal DE population.

This equity result completes the paper's three-part evidentiary arc. SED students face higher failure rates at every achievement level, but when they fail, they face similar enrollment consequences to non-SED students, and they retain a similar enrollment advantage from having attempted DE. The inequity in dual enrollment is concentrated entirely in the probability of failure: not in its consequences, and not in the value of having tried.

Figure X: Average marginal effect of DE failure on college enrollment, overall and by SED status



. Sample restricted to non-AP students in both treatment and control groups. PSM logit specification; N = 21,500. Error bars show 95% confidence intervals. SED contrast p > 0.10. Note: Hispanic post-match g = 0.353 exceeds WWC threshold; Hispanic included as covariate in all outcome models.

Discussion

This study set out to understand how failure risk varies across the achievement distribution and student characteristics, what failure costs, and whether attempting DE still carries value even for those who fail. The three findings, taken together, produce a coherent and policy-consequential picture: failure in California's DE system is predictable, concentrated, and costly, but its costs fall with rough equity across socioeconomically disadvantaged and non-socioeconomically disadvantaged students, and for the marginal DE student not taking other rigorous coursework, having tried is still meaningfully better than never having enrolled at all.

The inequity in dual enrollment is located precisely at the point of entry into failure risk, not in what happens afterward.

The preparation paradox is the study's central empirical contribution. Prior research has documented persistent disparities in dual enrollment participation and outcomes by socioeconomic status, often attributing these gaps to differences in academic preparation, access to rigorous coursework, or student readiness (e.g., Rivera et al., 2019; Miller et al., 2018; Fink, 2023). At the same time, the literature highlights structural and institutional barriers—such as advising, course access, and support systems—that shape who participates and who succeeds. What this study adds is a more precise characterization of where the differential risk is concentrated. The gap is not largest at the low end of the achievement distribution, where differences in preparation would be most expected and where SED and non-SED students show relatively modest differences. Instead, it widens at the middle and high end, where academic preparation should provide protection for disadvantaged students but does not.

A student at the 90th percentile of prior math achievement who is socioeconomically disadvantaged still fails DE at a rate 58% higher than a similarly prepared non-disadvantaged peer. This pattern is inconsistent with a preparation-only explanation and instead aligns with prior evidence that non-academic barriers (access to information, time, financial resources, and institutional support) shape student success even among academically capable students. This is not a story about underprepared students struggling with college-level work. It is a story about prepared students encountering non-academic barriers that preparation alone cannot overcome. The implication is that eligibility requirements and prerequisite thresholds, the most common policy levers for managing failure risk, are likely targeting the wrong dimension of the problem.

The equity findings from RQ2 and RQ3 reframe the policy stakes of open-access DE in an important way. The concern that motivates selective enrollment policies is that failure disproportionately harms disadvantaged students and that opening access without adequate preparation creates a two-tiered system in which the consequences of failure are unequally distributed. This study provides no support for that concern: the failure penalty is statistically indistinguishable across SED groups, and the enrollment advantage of having attempted DE accrues equally to disadvantaged and non-disadvantaged students among the marginal DE population. What is unequal is the probability of failure itself. Disadvantaged students are more likely to encounter the failure penalty because they fail more often, not because failure costs them more. This distinction has direct implications for how policymakers and practitioners should respond. Policies that restrict access in order to prevent failure among disadvantaged students might be addressing the wrong part of the causal chain. Instead, we should focus on policies that invest in support infrastructure to reduce failure rates among high-risk students.

These findings connect to a broader tension in the DE literature between access and success. Proponents of open-access DE argue that expanding participation is intrinsically valuable and that failure risk should not be a barrier to enrollment (An, 2013; Struhl & Vargas, 2012; Fink, 2023). Critics argue that exposing underprepared students to college-level coursework without adequate support sets them up for failure experiences that may discourage future postsecondary enrollment (Giani et al., 2025; Kanno & Kangas (2014), Lee, 2023). The evidence here partially vindicates both positions. The failure penalty is real and substantial, roughly 10 to 12 percentage points, and for disadvantaged students who fail at elevated rates, the aggregate postsecondary enrollment cost is considerable. At the same time, for the marginal DE student for whom DE is the only available advanced coursework pathway, attempting DE and failing is still associated with a 6-percentage point enrollment advantage over never having tried. Open access carries both risk and benefit; the question for practitioners is not whether to open access but how to structure support so that the benefit is realized without the cost.

Several directions for future research follow naturally from this work. First, the mechanisms underlying the preparation paradox deserve direct investigation. The widening failure gap at higher achievement levels is consistent with non-academic explanations but this study cannot adjudicate among them. Qualitative or mixed-methods research examining the experiences of high-achieving disadvantaged DE students who fail would help identify intervention targets. Second, the analysis focuses on college enrollment as the primary outcome; future work should examine longer-term outcomes including degree completion and time to degree for which the failure penalty may be larger or smaller depending on the counterfactual. Third, the population of students that failed DE who also took AP, approximately 42.6% of students who fail DE in this sample, represents a distinct subgroup with access to multiple advanced coursework pathways; the consequences of DE failure for this group, relative to AP-only students, is a question that this analysis deliberately sets aside but that warrants its own examination.

Conclusion

The expansion of dual enrollment in California and nationally has been animated by an equity imperative: to extend the benefits of college-level coursework to students historically excluded from advanced academic tracks. This study asks a direct question: when students enroll in dual enrollment and fail, what happens to them? And who is most likely to be in that position? The answers have clear implications for how programs should be designed and who they are designed to serve.

Our key finding is that failure risk is not randomly distributed. It is concentrated among socioeconomically disadvantaged students at every level of prior academic achievement, and the concentration grows more severe as achievement rises. High-achieving disadvantaged students fail at rates that cannot be explained by their academic preparation. Something else is at work, and that something else is the proper target of policy intervention. Support infrastructure such as proactive advising, financial navigation, academic integration, not stricter eligibility thresholds, are a more appropriate response to this pattern.

At the same time, failure's consequences, while substantial, do not compound the inequity of failure's distribution. Disadvantaged and non-disadvantaged students who fail DE face similar enrollment penalties, and both groups retain a meaningful enrollment advantage over comparable students who never enrolled at all. The system is inequitable in how it distributes failure risk; it is not additionally inequitable in how it distributes failure's costs. This matters for policy because it means that expanding access, even knowing that some students will fail, is not a harm to the students most likely to fail. It is, at worst, a missed opportunity for students who could have succeeded with adequate support. The preparation paradox reframes what equity in dual enrollment requires. It is not enough to open the door. It is not enough to ensure that failure, when it occurs, carries equal consequences. What equity requires is reducing the probability that disadvantaged students fail in the first place.

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Appendix A. Validation Check: DE Participation Effect

This appendix presents results that compare students who ever enrolled in dual enrollment to observationally similar students who never enrolled. This analysis serves as a methodological validation check confirming the well-established positive effect of DE participation on college enrollment documented in the prior literature (Edmunds et al., 2022; Giani et al., 2026). Propensity score matching uses nearest-neighbor PSM without replacement on demographics, SED, 8th grade math, and cohort. The matched sample includes 223,456 students (111,728 matched pairs). All variables meet WWC baseline equivalence standards without covariate adjustment.

Table A1. Baseline Equivalence: Match 1 Post-Match Balance — DE Participants vs. Never DE

Variable	DE Participants (Treatment)	Matched Controls (Never DE)	Hedges' g	WWC Standard
Male	0.446	0.446	0.000	Met (no adj.)
Asian	0.154	0.155	-0.002	Met (no adj.)
Black	0.039	0.039	0.000	Met (no adj.)
Hispanic	0.529	0.530	-0.002	Met (no adj.)
Am. Indian/AK Native	0.005	0.004	0.015	Met (no adj.)
Pacific Islander	0.004	0.003	0.015	Met (no adj.)
Multiracial	0.030	0.030	0.002	Met (no adj.)
Socioec. Disadvantaged	0.705	0.705	-0.001	Met (no adj.)
8th Grade Math Pctile.	58.115	58.098	0.001	Met (no adj.)
Cohort 2015-16	0.163	0.163	-0.001	Met (no adj.)
Cohort 2016-17	0.234	0.234	0.000	Met (no adj.)
Cohort 2017-18	0.298	0.297	0.000	Met (no adj.)

Notes: Post-match balance on matched sample (N = 223,456; 111,728 matched pairs). All variables meet WWC standard (|g| < 0.05) without covariate adjustment. Reference categories omitted from display: White (race/ethnicity), Female (gender), Cohort 2018-19.

Table A2. Match 1 Regression Results: Effect of DE Participation on College Enrollment (Odds Ratios)

Variable	(1) Simple Model (Odds Ratios)	(2) Interaction Model (Odds Ratios)
Treatment		
DE Participation	**1.657*****	**1.578*****
	(0.020)	*(0.020)*
Demographics (ref. = White)		
Male	**0.570*****	**0.642*****
	(0.006)	*(0.007)*
Asian	**1.611*****	**1.391*****
	(0.035)	*(0.031)*

Black	**1.215*****	**1.120****
	(0.035)	*(0.044)*
Hispanic	**1.103*****	0.944
	(0.018)	*(0.030)*
Am. Indian/AK Native	0.891	**0.833***
	(0.069)	*(0.069)*
Pacific Islander	0.894	**0.815***
	(0.073)	*(0.072)*
Multiracial	1.049	0.943
	(0.036)	*(0.043)*
Socioeconomic Status		
Socioec. Disadvantaged	**0.560*****	**0.401*****
	(0.009)	*(0.015)*
Academic Preparation		
8th Grade Math Pctile.	**1.025*****	**1.010*****
	(0.000)	*(0.001)*
Cohort (ref. = 2018-19)		
Cohort 2015-16	**1.246*****	—
	(0.020)	
Cohort 2016-17	**1.202*****	—
	(0.017)	
Cohort 2017-18	1.014	—
	(0.013)	
Interaction Terms (Interaction Model only)		
SED × Math Pctile.	—	**1.006*****
		(0.001)
UR × Math Pctile.	—	**1.001****
		(0.000)
Ever Took AP	—	**3.054*****
		(0.037)
Model Statistics		
Constant	3.512	6.319
	(3.692)	*(6.702)*
Observations	223,370	223,370
District FE	Yes	Yes
AME (DE participation)	+8.5 pp	+7.3 pp
AME non-SED	+7.4 pp	+6.5 pp
AME SED	+9.1 pp	+7.7 pp

*Notes: Odds ratios reported. Standard errors in parentheses. Treatment = ever enrolled in at least one DE course. Control = never enrolled in DE (matched). Matched sample N = 223,370 after district FE absorption. Average marginal effects (AME) computed via Stata margins immediately after logit estimation. District fixed effects included but suppressed from display. Reference categories: White, Female, Cohort 2018-19. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$.*

Appendix B. PSM Robustness Check for RQ2

This appendix presents results from the PSM approach initially attempted for RQ2, which compares DE failers to observationally similar DE passers using nearest-neighbor propensity score matching. PSM failed to achieve adequate pre-match balance on four variables: 8th grade math achievement (g = −0.552), SED (g = 0.343), Hispanic (g = 0.297), and Asian (g = −0.295), and IPW is therefore the primary specification. PSM results are presented here as a robustness check. The PSM failure penalty estimate of approximately −10.4 percentage points is consistent with the IPW primary estimate of −10.9 percentage points, providing additional confidence in the robustness of the main finding.

Table B1. Baseline Equivalence: Match 2 PSM Pre-Match Balance — Failed DE vs. Passed DE

Variable	Failed DE (Treatment)	Passed DE (Control)	Hedges' g	WWC Standard
Male	0.512	0.433	**0.158**	Met (w/ adj.)
Asian	0.075	0.171	**-0.295**	FAILED
Black	0.052	0.037	**0.073**	Met (w/ adj.)
Hispanic	0.650	0.505	**0.297**	FAILED
Am. Indian/AK Native	0.006	0.004	0.018	Met (no adj.)
Pacific Islander	0.006	0.004	0.027	Met (no adj.)
Multiracial	0.027	0.030	-0.022	Met (no adj.)
Socioec. Disadvantaged	0.826	0.680	**0.343**	FAILED
8th Grade Math Pctile.	46.0	60.5	**-0.552**	FAILED
District	2,953,669	2,833,887	**0.092**	Met (w/ adj.)
Cohort 2015-16	0.136	0.168	**-0.091**	Met (w/ adj.)
Cohort 2016-17	0.212	0.239	**-0.065**	Met (w/ adj.)
Cohort 2017-18	0.306	0.296	0.021	Met (no adj.)
Took One DE Course	0.509	0.486	0.048	Met (no adj.)
Took Two DE Courses	0.290	0.324	**-0.074**	Met (w/ adj.)

Notes: Pre-match balance prior to PSM for RQ2 (N = 111,728 DE participants; 18,717 failed DE). Variables in red fail the WWC threshold of |g| ≥ 0.25: math achievement (g = −0.552), SED (g = 0.343), Hispanic (g = 0.297), and Asian (g = −0.295). Because PSM did not achieve adequate pre-match balance, IPW is used as the primary specification. Reference categories omitted from display: White (race/ethnicity), Female (gender), Cohort 2018-19.

Table B2. Match 2 PSM Robustness: Effect of DE Failure on College Enrollment (Odds Ratios)

Variable	(1) PSM Simple (Odds Ratios)	(2) PSM Interaction (Odds Ratios)
Treatment		
Failed DE	**0.505*** **	**0.548*** **
	(0.010)	*(0.011)*
Demographics (ref. = White)		
Male	**0.581*** **	**0.627*** **
	(0.009)	*(0.010)*

Asian	**1.433*** **	**1.314*** **
	(0.049)	*(0.045)*
Black	**1.267*** **	**1.155***
	(0.055)	*(0.067)*
Hispanic	**1.057***	**0.910***
	(0.026)	*(0.042)*
Am. Indian/AK Native	0.848	**0.780***
	(0.091)	*(0.090)*
Pacific Islander	0.857	**0.780***
	(0.100)	*(0.098)*
Multiracial	1.065	0.943
	(0.057)	*(0.065)*
Socioeconomic Status		
Socioec. Disadvantaged	**0.578*** **	**0.389*** **
	(0.014)	*(0.023)*
Academic Preparation		
8th Grade Math Pctile.	**1.021*** **	**1.009*** **
	(0.000)	*(0.001)*
Cohort (ref. = 2018-19)		
Cohort 2015-16	**1.261*** **	—
	(0.032)	
Cohort 2016-17	**1.159*** **	—
	(0.025)	
Cohort 2017-18	0.978	—
	(0.019)	
DE Course Dosage (ref. = 3+ courses)		
Took One DE Course	**0.629*** **	—
	(0.016)	
Took Two DE Courses	**0.747*** **	—
	(0.019)	
Interaction Terms (Model 2 only)		
SED × Math Pctile.	—	**1.007*** **
		(0.001)
UR × Math Pctile.	—	**1.002***
		(0.001)
Ever Took AP	—	**2.332*** **
		(0.042)
Model Statistics		
Constant	1.720	**2.212***
	(0.545)	*(0.713)*

Observations	111,303	111,303
District FE	Yes	Yes
AME (failure)	−10.4 pp	−8.9 pp

*Notes: Odds ratios reported. Standard errors in parentheses. Treatment = ever failed at least one DE course. Control = took DE and never failed. PSM matched sample N = 111,303. Average marginal effect (AME) of failure on college enrollment reported at bottom. PSM Simple AME (−10.4 pp) is consistent with IPW primary estimate (−10.9 pp). District fixed effects included but suppressed from display. Reference categories: White, Female, Cohort 2018-19, took three or more DE courses. * p < 0.05 ** p < 0.01 *** p < 0.001.*

Appendix C. Full Regression Results

This appendix presents full interaction model results for RQ2 and RQ3. The interaction models include SED-by-math and UR-by-math interaction terms and, for RQ2, AP-taking and additional cohort controls. These specifications provide additional context for the equity findings described under RQ2 and RQ3. The simplified models are presented in Tables 5 and 6 in the main text.

Table C1. RQ2 Equity Analysis: Effect of DE Failure on College Enrollment by SED Status (IPW Logit, Odds Ratios)

Variable	IPW SED Interaction Model (Odds Ratios)
Treatment	
Failed DE	**0.470*** **
	(0.028)
Failed DE × SED	**1.055**
	(0.067)
Demographics (ref. = White)	
Male	**0.575*** **
	(0.010)
Asian	**1.451*** **
	(0.053)
Black	**1.225*** **
	(0.058)
Hispanic	**1.045**
	(0.027)
Am. Indian/AK Native	**0.794* **
	(0.090)
Pacific Islander	**0.797**
	(0.099)
Multiracial	**1.065**
	(0.062)
Socioeconomic Status	
Socioec. Disadvantaged	**0.567*** **

	(0.015)
Academic Preparation	
8th Grade Math Pctile.	**1.021*****
	(0.000)
Cohort (ref. = 2018-19)	
Cohort 2015-16	**1.258*****
	(0.034)
Cohort 2016-17	**1.151*****
	(0.027)
Cohort 2017-18	**0.990**
	(0.021)
DE Course Dosage (ref. = 3+ courses)	
Took One DE Course	**0.625*****
	(0.017)
Took Two DE Courses	**0.724*****
	(0.020)
Model Statistics	
Constant	**1.724**
	(0.597)
Observations	107,654
District FE	Yes
AME (failure, non-SED)	−9.2 pp
AME (failure, SED)	−11.6 pp
*Notes: Odds ratios from IPW logit model with Fail×SED interaction term. Standard errors in parentheses. Treatment = ever failed at least one DE course. Control = took DE and never failed. IPW weights trimmed at 1st and 99th percentiles; N = 107,654 after trimming. AMEs estimated separately by SED status via Stata margins: −9.2 pp for non-SED students (SE = 0.003, p < 0.001) and −11.6 pp for SED students (SE = 0.004, p < 0.001). Formal contrast between SED and non-SED AMEs: −1.4 pp (95% CI: −3.5 to +0.7, p = 0.18), not statistically distinguishable from zero. District fixed effects included but suppressed. Reference categories: White, Female, Cohort 2018-19, took three or more DE courses. * p < 0.05 ** p < 0.01 *** p < 0.001.*	

Table C2. RQ3 Full Interaction Model: Effect of Having Attempted DE on College Enrollment (PSM Logit, Odds Ratios)

Variable	PSM Interaction Model (Odds Ratios)
Treatment	
Failed DE (vs. Never DE)	**1.352*****
	(0.057)
Demographics (ref. = White)	
Male	**0.601*****
	(0.021)
Asian	**1.540*****
	(0.121)
Black	**1.275***
	(0.135)

Hispanic	0.938
	(0.083)
Am. Indian/AK Native	1.032
	(0.229)
Pacific Islander	0.839
	(0.192)
Multiracial	0.927
	(0.121)
Socioeconomic Status	
Socioec. Disadvantaged	**0.462*****
	(0.048)
Academic Preparation	
8th Grade Math Pctile.	**1.009*****
	(0.002)
Interaction Terms	
SED × Math Pctile.	**1.005***
	(0.002)
UR × Math Pctile.	1.002
	(0.002)
Model Statistics	
Constant	0.759
	(0.966)
Observations	16,646
Matched Pairs	10,750
District FE	Yes
Sample	Non-AP students only
AME (enrollment advantage)	+6.5 pp

*Notes: Odds ratios from PSM logit interaction model. Standard errors in parentheses. Treatment = ever failed at least one DE course and never took AP. Control = never enrolled in DE and never took AP. Nearest-neighbor PSM; 10,750 matched pairs; N = 16,646 after district FE absorption. AME computed via Stata margins after logit estimation. Hispanic post-match g = 0.353; included as covariate. Reference categories: White, Female, Cohort 2018-19. * p < 0.05 ** p < 0.01 *** p < 0.001*

Figure C.1 Predicted probability of DE failure by 8th grade math achievement percentile and Traditionally Underrepresented Race/Ethnicity