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The Effect of Dual Credit On College Enrollment and Degree Completion

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University of Texas at San Antonio

Executive Summary

This study examines the effect of dual credit (DC) on college enrollment and degree completion for less academically prepared students who attended public high schools in Texas. We employ a propensity score matching method to reduce selection bias from DC participation and supplement the analysis with a bounds test. The results show that DC students were predicted to have a higher likelihood of entering college immediately after high school and completing a degree within four and eight years of high school graduation, compared to similar students who did not take DC courses. This evidence suggests that that DC programs contributed to a reduction in educational inequities in college access and degree attainment for students at risk of academic failure. On the other hand, students who were racial or ethnic minorities and students from low-income families were not only less likely to participate in DC programs but were also predicted to have smaller participation effects on college degree attainment than their counterparts, stressing the need for higher education institutions and partnering school districts to provide more robust support to these underserved students for participating in DC programs and making a successful transition into college.

What We Studied

Dual credit (DC) programs, also known as dual enrollment or concurrent enrollment, provide high school students with opportunity to take college-level courses and simultaneously earn high school and college credits. Proponents of the programs claim that DC participation can *i*) increase a student's self-efficacy and confidence in ability to complete college-level coursework and succeed in college; *ii*) offer opportunity to engage in a broader variety of academic and career courses, enabling to expand students' knowledge on new or particular fields of interest; *iii*) expose students to college norms, rules, and practices, making college familiar; *iv*) reduce the financial and time costs of attaining college degree by earning college credits while in high school, and *v*) signal to colleges that the student is capable and will be successful in college. A comprehensive review of explanations about how DC could influence students' educational outcomes is given in An and Taylor (2019).

Previous empirical studies supported the efficacy of DC programs by showing that DC participation was positively associated with high school graduation, college enrollment, academic performance in college, and college persistence and degree completion (e.g., Allen & Dadgar, 2012; An, 2013a; Bailey, Hughes, & Karp, 2002; Giani, 2014; Karp et al., 2007). These findings have motivated education policymakers, legislatures, and practitioners to accelerate learning opportunities through the expansion of DC programs. According to the National Center for Education Statistics (NCES), 8 in 10 public high schools reported that their students enrolled in DC courses in the 2010-2011 school year, an 15.5% increase in high schools that offered DC courses in 2002-2003. Additionally, the total enrollment in DC courses grew by 76% from 1.2 million in 2002-2003 to 2 million in 2010-2011 (NCES, 2005; NCES, 2013).

However, despite the rapid expansion of DC programs, only a handful of studies have investigated whether DC provides equally effective college preparatory experiences for students from diverse academic and social groups, and much of these research efforts were limited to students from low socio-economic status (SES) backgrounds (e.g., An, 2013b; Cowan & Goldhaber, 2015; Karp et al., 2007; Miller et al., 2017, 2018). Furthermore, given the identical social groups and academic achievement levels, the studies yielded considerably different DC results, attributed by heterogenous program policies (e.g., tuition and fees, secondary/postsecondary partnerships, and eligibility requirements), practices (e.g., delivery modalities, counseling/advising, and course quality), or other unique characteristics in schools (districts) or states where students belonged to. Such discrepancies in program implementation and research findings failed to guide educators and students in various settings to make decisions on DC participation and intensity levels, raising the need for further research in this area.

In this study, we examine the effect of DC participation on college enrollment immediately after high school (henceforth, immediate college enrollment) and degree completion within four and eight years of high school graduation for less academically prepared students in the context of Texas public schools. DC was initially targeted for high-achieving students to develop academic skills and practices by taking rigorous (college) coursework while in high school. Therefore, it is not surprising that high-achieving and high socio-economic status (SES) students were overrepresenting among DC students (Museus, Lutovsky, & Colbeck, 2007). Thus, the findings of DC effects,

generated from this student population (comprising a substantial proportion of students with above-average academic abilities) may not be inferred to lower-achieving students. To fill this gap in the literature, we use data from three cohorts of students who graduated from public high school in Texas between the school years 2008-2009 and 2010-2011. For the purpose of this study, we limit our study sample to less academically prepared students who scored below the median of the cohort on both state-mandated mathematics and reading exams taken in their 10th grade. This study also assesses whether underrepresented (low-income or racially or ethnically minoritized) students at risk of academic failure equally benefit from DC programs. Lastly, we investigate differential DC effects by the number of college credits students earned through DE.

How We Analyzed the Data

To estimate the effects of DC participation on college enrollment and degree completion, we begin with the potential outcome framework (Rubin, 1974). Let Y^1 and Y^0 denote a potential outcome for a DC student ($T = 1$) and student who did not participate in DC programs (hereafter, referred to as traditional student) ($T = 0$), respectively. The observed outcome for a student i can be written as: $Y_i = Y_i^1 \cdot T_i + (1 - T_i) \cdot Y_i^0$; hence, the average effect of DC can be defined as: $\tau = E(Y_i|T = 1) - E(Y_i|T = 0)$. By making a naïve assumption that there was no difference in characteristics (either observed or unobserved) except DC participation between DC and traditional students, one can reveal the causal relationship by comparing the outcome between these two groups of students. However, this assumption is hardly realistic, and previous empirical studies considered DC participation as endogenous in postsecondary education models. Two factors that are impossible to be fully accounted for in higher education models are ability and motivation. Studies suggest that these traits–neither measurable nor quantifiable–are positively correlated with students' DC participation and educational outcomes, resulting in estimated DC effects overly-plagued with an upward bias (Attewell & Domina, 2008; Long et al., 2012). To reduce potential bias, we employ PSM to calculate counterfactual mean outcomes DC students would have accomplished in the absence of DC participation. PSM first calculates the propensity scores of DC participation using observed characteristics and pairs DC and traditional students based on the estimated propensity scores. It then compares the outcome of interest between these matched groups.

The robustness of the matching estimator relies on the conditional independence assumption (CIA), which states that conditional on observed characteristics (X), potential outcomes Y are independent of treatment, $(Y_i^T, Y_i^C) \perp T_i|X_i$. That is, the outcomes of interest are independent of DC participation if the matching estimation includes sufficient information determining program participation (Wooldridge, 2010). However, the theory also suggests that including characteristics that can themselves be influenced by treatment will cause the CIA assumption to fail. Exemplary candidates for matching covariates are variables measured prior to DC participation. Since Texas restricted students in 11th and 12th grades to take DC courses during this study's time period, we include pre-participation controls measured between 8th and 10th grades. We use a rich set of control variables in the matching estimation, including three years of standardized mathematics and reading exam scores, detailed levels of course-taking records, socio-economic and behavior characteristics, as well as high school and county-level variations. If the CIA holds, and if there is a sizable overlap in the propensity score distribution between DC and traditional students, the PSM estimator for the average treatment effect on the treated (ATT) can be written as: $\tau_{ATT} = E[Y_i|T = 1, P(X)] - E[Y_i|T = 0, P(X)]$, where $P(X)$ is the likelihood that each student participated in DC programs, based on the observed characteristics.

What We Discovered

Determinants of Students' DC Participation

We find that female students and students in gifted and talented programs tended to participate in DC programs, while racial or ethnic minority students and students with meal support were less likely to participate in the programs. The standardized exam scores were positively associated with DC participation, except mathematics exam score taken in 8th grade, and overall reading exam scores tended to exert larger influences on DC participation. Additionally, students who took Geometry, Algebra II or Pre-Calculus, English III or IV, or Physics, Chemistry, or IPC courses by the end of 10th grade–in which students often take in junior and senior years–were more likely to participate in DC programs. In contrast, students with at-risk designation and students who faced disciplinary action measured by expulsion and suspension records were less likely to participate in the programs. Attendance rates were positively associated with DC participation, and included random-effects terms are highly significant in the model.

DC Effects on College Enrollment and Completion

The results in Table 1 show that DC students were predicted to have a higher probability of attending any form of HEIs immediately after high school by 20.1 percentage points, relative to the matched traditional students with a group mean of 55.6%. Here, we find that immediate college enrollment for matched traditional students was 13.9% higher than the entire traditional student population. This finding indicates that DC students were matched to a subgroup of traditional students who were above average in college-going among all traditional students. DC students were more likely to earn a college degree within four and eight years of high school graduation by 7.1 and 14.2 percentage points, relative to matched traditional students, which had a degree completion rates of 7.8% and 19.5%, respectively. The matched comparison group's degree completion rates within four and eight years of graduation were 2.6 and 6.4 percentage points higher than the entire comparison group's rates, indicating that DC students were matched to a subgroup of traditional students who were above average in earning a college degree. The critical values for the outcomes are around 2, and it indicates that even more than doubling unobserved components would not alter the inference of the effect estimates. In other words, the effect estimates are less sensitive to unobserved heterogeneity.

Table 1: DC Effects on College Enrollment and Completion

	College Enrollment	College Degree Completion	
		Within 4 Years	Within 8 Years
	(1)	(2)	(3)
DE	0.913***	0.725***	0.742***
	(0.053)	(0.080)	(0.056)
Marginal effect	0.201	0.071	0.142
Matched comparison group mean	0.556	0.078	0.195
Entire comparison group mean	0.488	0.052	0.131
Critical value (Γ)	2.2-2.3	1.8-1.9	1.9-2.0
Observations	6,794	6,794	6,794

Notes. Weights calculated from single-NN matching are applied to estimate DC effects. Robust standard errors are reported in parenthesis. Critical values are obtained from the Mantel and Haenszel (MH) test.
* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

DC Effects on College Enrollment and Completion for Underrepresented Students

We also investigate whether underrepresented students benefitted differently from DC participation. The results in Table 2 show that students who received meal support and participated in DC programs were predicted to have a higher probability of immediate college enrollment by 21.8 percentage points than the matched comparison group. Put differently, DC students with meal support revealed a 45% higher probability of immediate enrollment than their matched comparison group, of which less than half of them enrolled in a college immediately. Additionally, students with and without meal support benefited on college completion from DC participation, but the students with meal support appeared to have slightly smaller effects than students without meal support. Similarly, DC students were more likely to attend college right after high school and complete a college degree regardless of racial and ethnic backgrounds, compared to those of the matched comparison counterparts, but the group's effect sizes for minority students are smaller than average DC effects from non-minority students. These findings are parallel to Miller et al. (2018) that underrepresented students benefitted less from DC participation when compared with traditionally advantaged students. The critical values are above 2 for immediate college enrollment and range between 1.7 and 2.1 for college completion within eight years, indicating that estimated effects are less sensitive to unobserved heterogeneity. On the other hand, a bit lower gamma values are found for college completion on time except non-minority students.

Table 2: DC Effects on College Enrollment and Completion for Underrepresenting Students

	Meal Support		Racial or Ethnic Minorities	
	Yes	No	Yes	No
College Enrollment				
DE	0.923***	0.922***	0.839***	0.931***
	(0.078)	(0.073)	(0.071)	(0.080)
Marginal effect	0.218	0.188	0.186	0.202

Matched comparison group mean	0.485	0.609	0.564	0.565
Critical value (Γ)	2.2-2.3	2.2-2.3	2.0-2.1	2.2-2.3
Observations	2,878	3,850	3,708	3,036
College Degree Completion				
Within 4 Years				
DE	0.702***	0.633***	0.650***	0.875***
	(0.131)	(0.100)	(0.114)	(0.116)
Marginal effect	0.060	0.069	0.057	0.094
Matched comparison group mean	0.068	0.094	0.072	0.081
Critical value (Γ)	1.6-1.7	1.5-1.6	1.5-1.6	1.9-2.0
Observations	2,878	3,850	3,708	3,036
Within 8 Years				
DE	0.862***	0.676***	0.706***	0.852***
	(0.096)	(0.071)	(0.078)	(0.083)
Marginal effect	0.138	0.142	0.128	0.171
Matched comparison group mean	0.139	0.238	0.181	0.202
Critical value (Γ)	2.0-2.1	1.7-1.8	1.7-1.8	2.0-2.1
Observations	2,878	3,850	3,708	3,036

Notes. Weights calculated from single-NN matching are applied to estimate DC effects. Robust standard errors are reported in parenthesis. Critical values are obtained from the Mantel and Haenszel (MH) test.
* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

DC Dosage Effects on College Enrollment and Completion

Table 3 shows that DC students who earned up to 3 college credits were predicted to have a higher probability of immediate college enrollment by 15.8 percentage points, compared to matched traditional students who had an enrollment rate of 57.3%. In addition, DC students who earned greater than 3 and up to 6 college credits were more likely to enroll in a college after high school by 9 percentage points than DC students who earned up to 3 college credits. On the other hand, we find no significant difference in immediate college enrollment between DC students who earned greater than 6 and up to 9 college credits and who earned greater than 3 and up to 6 college credits. The estimates also suggest that DC students who earned up to 3 college credits tended to have a higher likelihood of college completion on time by 3.9 percentage points, compared to matched traditional students who had a completion rate of 8.6%. In addition, DC students who earned greater than 3 and up to 6 college credits were more likely to complete a degree on time by 4 percentage points, relative to DC students who earned no more than 3 college credits. DC students who earned greater than 6 and up to 9 college credits showed a higher chance of college completion by 7.5 percentage points than DC students who earned greater than 3 and up to 6 college credits.

In sum, earing additional college credits through DC had a positive but diminishing marginal effect on students' probability of immediate college enrollment, indicating that marginal returns of taking additional college credits through DC programs became smaller as students earned up to 6 college credits and then became negligible when students earned greater than 6 and up to 9 college credits. In contrast, earning additional college credits had a positive and increasing marginal effect on students' probability of college completion on time. That is, marginal returns became larger as students earned additional college credits. Finally, although we find a significant and positive effect of earning additional college credits on college completion within eight years, estimated coefficients do not provide a clear pattern in relation to whether additional college credits had increasing or decreasing marginal influences, which require further research in this regard.

Table 3: DC Dosage Effects on College Enrollment and Completion

	College Enrollment	College Degree Completion	
		Within 4 Years	Within 8 Years
	(1)	(2)	(3)
Earned up to 3 college credits (Relative to traditional students)			
DE	0.708***	0.417***	0.559***
	(0.065)	(0.100)	(0.071)
Marginal effect	0.158	0.039	0.103

Matched comparison group mean	0.573	0.086	0.197
Critical value (Γ)	1.8-1.9	1.2-1.3	1.5-1.6
Observations	4,366	4,366	4,366
Earned greater than 3 and up to 6 college credits			
(Relative to students who earned up to 3 college credits)			
DE	0.502***	0.341*	0.326***
	(0.143)	(0.177)	(0.128)
Marginal effect	0.090	0.040	0.072
Matched comparison group mean	0.717	0.116	0.298
Critical value (Γ)	1.3-1.4	1.1-1.2	1.1-1.2
Observations	1,108	1,108	1,108
Earned greater than 6 and up to 9 college credits			
(Relative to students who earned greater than 3 and up to 6 college credits)			
DE	0.001	0.526**	0.473**
	(0.215)	(0.245)	(0.192)
Marginal effect	0.000	0.075	0.108
Matched comparison group mean	0.733	0.137	0.303
Critical value (Γ)	1.0-1.1	1.1-1.2	1.1-1.2
Observations	482	482	482

Notes. Weights calculated from single-NN matching are applied to estimate DC effects. Robust standard errors are reported in parenthesis. Critical values are obtained from the Mantel and Haenszel (MH) test.
* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

It is noteworthy to mention two issues. Since we decide not to continue this analysis beyond 9 college credits (due to the small sample size and poor matching quality), our findings do not provide any suggestion about whether earning 9 or more college credits benefits students' college outcomes. Additionally, our dosage analyses are conducted under the belief that the CIA condition is met, which may be a strong assumption to make in observational studies. Furthermore, bounds test results of the dosage analyses suggest that overall the estimates tend to be vulnerable to unobserved components. Although a low gamma value does not indicate the presence of unobervables and biased estimates, it is advisable to interpret the results with some cautions. Therefore, we suggest to interpret the results as potential associations, providing careful information to make decisions on whether to take additional DC courses or not. Our contribution of this analysis is to open up research on the dosage effects of DC participation, especially for less academically prepared students, on college access and completion rather than provide point estimates that can be relied upon for policy purposes.

Policy Recommendations

Our evidence shows that students who were typically classified as low-achieving based on the standardized mathematics and reading exam scores did benefit from DC participation. An implication of this finding is that students perceived as low-achieving should not be discouraged from DC participation due to the presumptions that their past test performance predicts their future capability to succeed in rigorous college courses. Philosophically, these assertions are untenable if we see students as in a constant state of becoming that a data snapshot in time cannot capture (Whitehead, 1979). Furthermore, protecting students from their own goals and decision-making capacity can run counter to the benefits of autonomously motivated learning. Finally, these assertions fail to recognize that the tools used to track students can ultimately harm their development and the original goal of expanding college access. An alternative DC enrollment process might start with encouraging students' self-confidence in learning more rigorous college materials and motivation towards higher education for those who are eligible to participate in DC courses as well as supporting their decision-making with quality information such as reviews from students and educators with prior experience with similar courses, and strengthening students' academic skills to better understand rigorous course materials. However, it is also noteworthy that students and academic advisors should understand an appropriate number of DC credits needed, depending on their higher education goals.

Disclaimer

The conclusions of this research do not necessarily reflect the opinion or official position of the Education Research Center, The University of Texas at San Antonio, the Texas Education Agency, the Texas Higher Education

Coordinating Board, the Texas Workforce Commission, or the State of Texas. Any errors are attributable to the authors.

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