

Career and Technical Education in San Diego: A Statistical Analysis of Course Availability, Students' Course-Taking Patterns, and Relationships with High School and Postsecondary Outcomes

EXECUTIVE SUMMARY

Evaluation of the Outcomes of Career and Technical Education in the San Diego CA School District

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April 2014

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We are indebted to Shawn Loescher and Virginia Eves, current and former Director, College, Career & Technical Education, (CCTE) SDUSD, Lynn McConville, Program Manager Curriculum and Program Development, CCTE, Dr. Karen Bachofer, former Executive Director of the Research and Evaluation Division, SDUSD, Dr. Peter Bell, Director, Research and Reporting Department, SDUSD, Mr. Ron Rode, Director, Research and Evaluation Division, SDUSD, and their colleagues for many helpful conversations throughout this project. We thank Michael Fong, Jay Noell and members of the NACTE Independent Advisory Panel for helpful comments. Any errors are the responsibility of the authors alone.

Summary

The study examines career and technical education (CTE) in San Diego Unified School District (SDUSD), as part of the National Assessment of Career and Technical Education (NACTE). SDUSD is the second largest district in California and one of the largest nationally. It is demographically quite representative of the public school population of California as a whole.

The four overall goals of this research project were to study how schools vary in offerings of CTE courses, who enrolls in CTE courses, the relationship between taking CTE courses and academic outcomes in high school, and the corresponding relationship between CTE and postsecondary educational outcomes.

CTE Course Offerings and Variations across Schools

SDUSD offers a rich and varied array of CTE coursework across its schools. We define a CTE course as one where the course title closely matches a similar course title in the 2007 CTE Secondary School Taxonomy. About 85 percent of CTE courses are occupationally focused, just under 30 percent are eligible for community-college credit, and, similar to what a national study by Bozick and Dalton (2007) has found, about 4 percent focus on primarily engineering courses often referred to as STEM (science, technology, engineering, and math) courses, even though many of the other courses incorporate some elements of STEM.

Variations in the total number of CTE offerings across schools are related primarily to school size. CTE courses as a percentage of all courses offered show moderate variations across schools. These variations matter, as students at schools with a higher percentage of courses that are CTE are more likely to take more CTE courses. Other aspects of schools are also associated with CTE course-taking. Students attending charter schools that were created by converting traditional public schools had lower rates of CTE course-taking. (We lacked the transcript data for startup charter schools to make any conclusion about them.) Other aspects of schools that appear to matter at least to some degree are teachers' level of education, teacher race and the demographic makeup of the student body.

Who Takes CTE Courses?

Average participation rates in CTE education in SDUSD closely match the rates calculated in a recent national study by Bozick and Dalton (2007).

The National Assessment of Vocational Education (NAVE) (United States Department of Education, 2004) created various methods of characterizing the depth of student coursework in CTE areas. Following the NAVE terminology, this report examines the percentage of students who participate in CTE by taking at least one year-long course—*participants*; at least 3 courses in any occupational area or areas—*investors*; or at least 2 or 3 courses in a single occupational area—*concentrators*. We found that 38.8 percent of students have completed at least 3 CTE courses in occupational and non-occupational areas by grade 12, thus qualifying as CTE investors. We found that only 8.2 percent of students had become three-course CTE concentrators by grade 12. CTE explorers, whom the NAVE identifies as students who complete

three or more CTE courses but in more than one occupational area, make up the difference between the large number of CTE investors and the relatively small number of CTE concentrators. (Thus, 30.6%, or 38.8%-8.2%, of grade 12 students in San Diego are CTE explorers). Some recent research has used an alternative definition of concentrators: those who have taken at least 2 CTE courses in a given occupational cluster. We found that 26.9 percent of students have become “two-course” concentrators.

We also examined the relation between CTE concentrators and students who complete the New Basics – key academic coursework prescribed by the National Commission on Excellence in Education (1983).¹ We did not find evidence that one pattern of coursework crowds out the other. Indeed, students who complete CTE concentrations tend to have a greater probability of having completed the New Basics.

Variations in CTE course-taking are associated with individual students’ demographics and the characteristics of their high schools. For instance, female students, African-American and Hispanic students, special education students and English Learner (EL) students are less likely than other students to become CTE concentrators, defined as students who complete at least three year-long CTE courses. We found, in particular, sharp variations between male and female students in the choice of occupational clusters.

As for academic grades measured in grade 8 and student behavior as reported on grade 5 report cards, it is students in the “middle” of both distributions who are the most likely to take CTE courses. Students at the bottom and top ends of the distributions for grades and behavior take fewer CTE courses.

School characteristics are also associated with the probability that students become CTE concentrators. For instance, variations in the percentage of courses offered that are CTE are systematically and positively related to the proportion of students who become CTE “concentrators”. As another example students at schools that convert to charter school status are less likely to become CTE concentrators. (We cannot say anything about the many “startup” charter schools in San Diego because the district does not gather transcript data for these schools.) Demographics of the student body and of the student’s high school math and English teachers also appear to matter to some degree. By this we mean that higher percentages of certain student and teacher characteristics are associated with an increased likelihood of being a CTE concentrator. These associations are not necessarily causal.

Although variations in CTE course-taking across students do exist, 92.5 percent of grade 12 students have taken at least some CTE-coursework, and 38.8 percent have taken three or more CTE courses. In that sense, the choice between academic and occupationally oriented coursework is a question of degree, not a question of “either or”. In San Diego, career and technical education is an essential part of mainstream education.

The Relation between CTE Coursework and High School Academic Outcomes

The study pre-committed to two confirmatory analyses of annual academic outcomes, namely, changes in math and reading achievement. In the domain of cumulative academic outcomes, the study focused on the probability of graduating from high school within five years

¹ National Center for Education Statistics (2008), p. 47.

of starting grade 9 as the confirmatory analysis. The study conducts numerous exploratory analyses of related annual and cumulative high school outcomes.

A key issue is whether we can consider regression results as conveying a causal relation between CTE coursework and academic outcomes or merely a correlation. For instance, if unobserved variations across students in ability or motivation or other characteristics determine both the number of CTE courses the students take and their academic outcomes, then CTE coursework is endogenous, and the estimated effects of CTE coursework on outcomes could be compromised by those factors.

For annual outcomes, our main strategy for reducing endogeneity bias is to estimate student fixed-effect models, which remove inter-student variation, and instead identify the relation between CTE and academic outcomes by variations over years in the CTE courses each student takes and his or her academic outcomes. Second, we also estimate instrumental variable (IV) versions of these fixed effect models to reduce further the endogeneity of CTE coursework. Our instrument is the percentage of all courses offered at a high school in a given year that are CTE. Because we control for school and year effects separately, we are in effect using within-school variations in CTE course offerings over time, and relative from district trends, to identify the effect of CTE course-taking on student outcomes. This instrumental variable should be unrelated to individual characteristics.

For “once-only” academic outcomes that measure students’ cumulative academic performance, such as the probability of graduating from high school, we cannot use student fixed effects because there is only one observation per student. In this case we emphasize the IV estimates because they are likely to reduce bias due to endogeneity of CTE coursework.

For the annual variables, the instruments did not have strong explanatory power in first-stage models of the number of CTE courses a student took, in the cases where we modeled gains in reading and math scores. But the instruments performed well for all other models of annual outcomes. (The main reasons why the instrument works well except for test scores are that students are not tested in grade 12, which lowers sample size for the test score models, and second, the instrument is particularly good at predicting CTE course-taking in grade 12, which is outside the testing window.) Thus for the reading and math models we focus on the fixed-effect results without IV’s; for all of the other annual outcomes we focus on the fixed-effect results with IVs, because in those cases the instruments had good first-stage explanatory power. For the cumulative variables, the instruments in all cases (except for models of outcomes on the high school exit exam) had good first-stage explanatory power and so in these models we focus on the IV results.

Among the annual academic outcomes, our two confirmatory analyses were changes in reading and math scores. The number of CTE courses taken had a small and marginally statistically significant negative relation with reading score changes, but no statistically significant relation to changes in math scores. In the case of reading, a student who took one additional (year-long) CTE course was predicted to lower changes in reading scores by 0.004 of a standard deviation, which is a tiny effect. For instance, for a student who was initially the median student in reading, a drop of this size would lower his or her ranking from 500th out of 1000 to about 502nd. This effect is perhaps best regarded as insignificantly different from zero as it is significant at only the 10% level.

Exploratory analyses of a number of other annual academic outcomes were conducted. In most cases the instrumental variables performed well on the relevant samples. The instrumental variable models found no relation between CTE coursework and absences or the probability of being promoted to the next grade. However, the models that did not use the IV approach but still used student fixed-effects suggest that in years in which a student took more CTE courses, absence rates fell slightly, and the probability of being promoted rose mildly.

Models of A-G course completion were one case where the instrument did not produce precise estimates. (“A-G” is California’s designation of specific high school courses in designated subjects that must be completed in order for students to become potentially eligible to attend either of the state’s public university systems.) Although the IV model suggested no effect of CTE courses on the number of A-G courses completed that year, the estimate is quite imprecise. The student fixed-effect model that did not use the IV approach suggests that the number of A-G courses completed falls very slightly, by about 0.14 course, for every CTE course taken. This may be a genuine effect, resulting from the fact that only 7% of CTE courses taken qualify as A-G, compared to 45% of non-CTE courses.

Both the regular models with student fixed effects and the corresponding models that use instrumental variables suggest an increase in annual GPA for each additional one-year CTE course taken. The effects are particularly large (0.3 grade point) in the IV model. However this gain derives from the fact that in San Diego students tend to earn higher grades on CTE courses than on more academic courses.

Our overall conclusion is that taking a CTE course might do minor harm to reading achievement but the effect is only weakly significant. CTE coursework has no effect on math test scores. As for the exploratory models of other annual outcomes, CTE coursework is not strongly related to absences, or grade promotion, but there may be a weak negative effect on completion of college preparatory courses.

The study also considered a number of cumulative academic outcomes, designed to measure a student’s overall level of success while in high school. We estimated two distinct specifications of all of the models of these cumulative degree outcomes. In the first specification, which we emphasize below, we model outcomes as a function of the cumulative number of CTE courses completed. In the second specification, we replaced the cumulative number of CTE courses with an indicator for whether the person became a three-course concentrator, defined as having completed three year-long CTE courses in a single occupational cluster. This specification is important for two reasons. First, this measure has been used widely in recent studies of CTE (see e.g. United States Department of Education, 2004, and Bozick and Dalton, 2007). It is important to test whether becoming a concentrator predicts academic outcomes for students. Second, from a statistical standpoint, modeling outcomes as a function of whether the student is a concentrator provides a test for non-linearities in the relation between CTE course-taking and the overall degree of success a student has in high school. That said, the total number of courses taken in some senses provides fuller information than a simple binary indicator for concentrator status. The additional information in the concentrator variable that is not encapsulated in pure course counts is whether courses are clustered together within one occupational field.

The sole confirmatory analysis in this section of the report consisted of a model of the probability that a student graduated from high school within five years of starting grade 9.

Although models that condition only on grade 8 characteristics of students suggest a positive relation between CTE coursework and the probability of graduation, this is likely not a causal relation: those who were going to graduate anyway likely had time in their grade 12 schedule to take CTE courses.

The IV version of the confirmatory model suggested that taking one additional year-long CTE course has no effect on the probability of graduating from high school.

Our exploratory analyses of other cumulative high school outcomes, when we use the IV method to control for the endogeneity of CTE course-taking suggested some negative effects on the completion of the A-G courses required for students to become eligible to attend either of California's public university systems, but no effects of CTE coursework on passage of the California High School Exit Exam or career GPA (overall or for non-CTE courses). We find that concentrator status is insignificant in almost all of these models as well.

A few notable differences among the various types of CTE courses emerged. In the IV model for completing the New Basics curriculum, there is a negative estimated effect from taking regular CTE courses, but taking ROP courses had no overall effect. One potential explanation for these differences is that capstone (ROP) course takers have higher average cumulative GPAs and a slightly higher on time graduation rate than other students

The models of cumulative academic outcomes such as high school graduation exhibited considerable evidence that it is important to control for endogeneity of CTE course-taking by using instrumental variables. In the model of high school graduation, the coefficient on CTE courses changes from positive and highly significant without the IV approach to negative and insignificant in the model that uses the IV approach. Thus the IV method instead suggests no causal relation. It is likely that the model that does not use an instrument has an upward bias because empirically we find that struggling students are likely to take fewer CTE courses. We found a highly non-linear relationship between a student's grade 8 GPA and the number of CTE courses taken in high school. Students with a GPA below 2.0 (roughly a C) take considerably fewer CTE courses than other students. Because students who are struggling to such an extent in grade 8 are likely to fare poorly in high school, a positive but non-causal relation between the number of CTE courses taken and high school outcomes could emerge. This finding may have broader implications for the analysis of the "effect" of taking CTE courses in other regions of the country.

In other exploratory analyses, we tested for differences in the association between the various outcomes and regular CTE courses, Tech Prep CTE courses (which are eligible for community college credit) and Regional Occupational Program (ROP) CTE courses. The latter, also known as capstone courses, are courses that under California's Regional Occupational Program represent the culmination of study in one of many occupational specialties.

In the IV model for completing the New Basics curriculum, there is a negative estimated effect from taking regular CTE courses, but taking ROP courses had no overall effect. One potential explanation for these differences is that capstone (ROP) course takers have higher average cumulative GPAs and a slightly higher on time graduation rate than other students. Capstone course takers are also older and would likely have more space in their schedule. Since CTE course are largely elective, those without space in their schedule would not have taken those courses. We did not find big variations for other cumulative outcomes. In the models of annual outcomes there were a few cases in which Tech Prep or ROP courses appeared to have

significantly different effects from regular CTE courses. Usually these differential effects were small.

Overall, CTE coursework appears neither to divert students strongly away from academic coursework, nor to motivate students dramatically to redouble their efforts on academic coursework.

CTE Coursework and Postsecondary Outcomes

We conceptualized postsecondary outcomes as consisting of two domains: enrollment and the level of degree that student ultimately obtain. We pre-committed to one confirmatory analysis in the domain of postsecondary enrollment and one in the domain of postsecondary attainment. For enrollment, the confirmatory analysis was a model of the number of years of postsecondary enrollment in the first four years after high school graduation. For postsecondary attainment, the confirmatory model was a linear regression of the highest level of educational attainment.

We found a quite striking difference between the models that used and did not use instrumental variables. The latter models, which implicitly assume that conditional upon characteristics of students in grade 8, students do not endogenously choose how many CTE courses to take, suggest a negative relation between taking CTE courses in high school and postsecondary outcomes. Particularly illuminating in this regard are ordered probit models of the highest level of postsecondary attainment, which suggest a positive correlation between taking CTE courses in high school and the probabilities of the highest attainment observed four years after high school graduation being “high school graduation” or “some two-year college”, and lowered probabilities that highest attainment would be a two-year degree, some four-year college, or a Bachelor’s degree.

In contrast, the instrumental variable model of postsecondary enrollment, which attempts to estimate the causal effect of taking additional CTE courses, suggests that taking one additional CTE course in high school leads to an increase of 0.12 years of postsecondary enrollment.

The IV version of our confirmatory model of the highest level of educational attainment four years after high school graduation suggests no significant link to the highest level of attainment.

Notably, the IV models produced far more positive results than the models that did not take the possible endogeneity of CTE coursework into account. For both of the outcomes listed above, models that merely controlled for student characteristics in grade 8 found significant negative associations between the number of CTE courses taken and both years enrolled in postsecondary education and the highest level of postsecondary attainment.

This pattern of negative conditional correlations between CTE courses taken and a variety of measures of postsecondary outcomes, but of positive or zero relations resulting once we instrumented for CTE coursework, also occurred for many of our exploratory models of postsecondary enrollment and attainment. One obvious interpretation of this pattern is that unobserved factors such as students’ interests and motivation induce some high school students both to enroll in high school CTE courses and to enroll less in postsecondary institutions. This likely causes the correlation between CTE coursework and postsecondary success to be negative. The instrumental variable approach instead uses variation from year to year in CTE course

offerings at the student's high school to identify the causal effect of taking more CTE courses on postsecondary outcomes. To the extent that this source of variation is not related to the unobserved factors that endogenously determine CTE and postsecondary enrollment, we would expect a bigger, more positive result to emerge.

Another way of thinking of the IV result is that it attempts to provide an unbiased estimate of the causal effect of taking an additional CTE course when students are induced to do so by a school expanding its CTE offerings. This is a question of obvious policy relevance.

We also studied the relation between becoming a CTE concentrator and postsecondary outcomes. Mostly due to the limited variation in the CTE concentrator variable, the instrumental variable approach was not as effective in controlling for endogeneity when this was our explanatory variable, unfortunately. The non-IV models suggest no link between concentrator status and the number of years of postsecondary education in which students enroll. As for our main attainment measure, again no significant relationship with concentrator status emerged, although in this model some evidence emerged of negative relations between taking any ROP or Tech Prep classes and highest level of educational attainment.

We also subdivided CTE concentrators by cluster, and found some evidence that cross-cutting patterns among occupational areas may be hidden by the overall findings of little linkage between CTE concentrator status and postsecondary outcomes. For instance three-course concentrators in Construction were significantly less likely to obtain a two-year or four-year degree than those who did not become CTE concentrators. Because these models do not use instrumental variables, the coefficients should be thought of as conditional correlations, but they nonetheless shed light on the degree of heterogeneity in CTE education.

Policy Implications

In 2010 the Obama administration announced a series of interventions designed to boost college readiness, especially in underperforming high schools from which students tend to drop out. Plans announced in March 2010 called for a *College Pathways Program* designed to make college more readily accessible to all students. For instance, the program would increase student access to college-level, dual credit, and other accelerated courses in high-need high schools.

Plans to make college more accessible are laudable. At the same time, the focus on college readiness, and therefore college preparatory courses, raises major questions about the future of CTE.

For instance, in San Diego, CTE courses are only about one sixth as likely to be recognized as college preparatory ("A-G") as are non-CTE courses. Seen in this light, is an emphasis on CTE coursework an impediment to college readiness?

Closely related to this issue is the seldom spoken but widely circulated stereotype of CTE coursework as a consolation prize for those who are not likely to attend college. If this were true, would a school or district that expanded its CTE course offerings be responding to students' underlying job aspirations, or merely shunting marginal students into a track that makes a college degree all but impossible to attain?

The findings in this report provide an antidote to concerns that CTE coursework and creating college readiness are antithetical goals. First, it is not the least academically strong

students who take the most CTE courses in high school. It is students in the middle of the achievement distribution who invest the most in CTE coursework. Second, the vast majority of students take at least one CTE course by the time they graduate, and about four in ten students take at least three CTE courses by the time they graduate.

CTE coursework is not an isolated activity limited to the lowest performing students, by any stretch of the imagination.

While it is true that relatively few CTE courses qualify as a UC ‘A-G’ course in San Diego, taking CTE courses is only weakly negatively related to completing all of the A-G course requirements by the end of high school. For the most part, there appear to be few if any negative academic consequences in high school from taking CTE coursework.

But if this is true, shouldn’t it be the case that those who take CTE courses enroll in and complete postsecondary education at similar rates as those high school students who take fewer CTE courses? Our analyses suggest that in reality there is a negative correlation between taking a CTE course in high school and a variety of postsecondary outcomes. But these negative correlations are probably not causal. That is, unobserved differences among students, perhaps related to career aspirations and motivation, may induce this negative pattern.

Our instrumental variable models of postsecondary outcomes attempt to derive the true causal impact of offering a greater number of CTE courses at a high school on students’ subsequent postsecondary outcomes. In these models, we can explain the number of CTE courses students take in terms of the high school’s course offerings.

Importantly, we no longer find a negative link between CTE coursework and postsecondary outcomes. The average effect of taking one more CTE course is about a 0.1 year increase in postsecondary attendance during the first four years after high school graduation. The IV models also suggest no significant positive link between CTE coursework and the level of educational attainment four years after high school graduation, rather than a negative link.

These findings are important because they suggest that schools and districts should not think of the provision of CTE programs as working against college readiness. CTE coursework causes few if any observable blemishes on achievement during the high school years, and may in fact induce some students to attend college.

Finally, our results may provide some insight into calls from the Obama administration for strengthening links between high school and college education, for instance through providing college credit for high school courses. Our analysis focused on just one form of such an innovation. Tech Prep classes are CTE classes that are sufficiently advanced to earn the student community college credit. We did not find that students who had taken more Tech Prep classes in high school were more likely to enroll in two-year or four-year colleges than otherwise identical students who had taken the same number of regular CTE courses. Nor did students who took Tech Prep classes have a higher level of educational attainment four years after high school than those who had taken regular CTE courses. These findings do not imply that Tech Prep has no effect on postsecondary outcomes; rather, they have the same slightly positive effect as regular CTE courses that do not garner high school students any community college credit. This somewhat surprising result hints that it will take a considerable amount of effort to transform various programs that generate postsecondary credit for high school students into a higher rate of college enrollment and completion.