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The Effect of Linked Learning Certified Pathways on Selected Student Outcomes

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The Effect of Linked Learning Certified Pathways on Selected Student Outcomes

Prepared for the
U.S. Department of Education
Office of Career, Technical, and Adult Education

NATIONAL CENTER FOR INNOVATION IN CAREER AND TECHNICAL EDUCATION

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ABBREVIATIONS

a–g	Courses and related grade point average required for admission to the University of California and the California State University systems
ATT	Average treatment effect on the treated
AY	Academic year
CCD	Common Core of Data
CDE	California Department of Education
ConnectEd	ConnectEd: The California Center for College and Career
CST	California Standards Test
CSU	California State University system
ELL	English language learner
GPA	Grade point average
IDEA	*Individuals with Disabilities Education Act*
IEP	Individualized education plan
LLCP	Linked Learning certified pathway
LLDI	Linked Learning District Initiative
NSC	National Student Clearinghouse
NSLP	National School Lunch Program
OLS	Ordinary least squares
PSE	Postsecondary education
PSM	Propensity score matching
RCT	Randomized controlled trial
TES	Transcript Evaluation Service, University of California Office of the President
UC	University of California system
WWC	What Works Clearinghouse

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EXECUTIVE SUMMARY

This report examines outcomes for grade-12 students in academic years (AY) 2010–11, 2011–12, and 2012–13 who were enrolled in a Linked Learning certified pathway (LLCP)[1] in California. Outcomes include student engagement in learning, measured by high school attendance and discipline events, as well as college readiness and postsecondary enrollment. The analyses in this report are conducted using observational data. Therefore, quasi-experimental statistical methods are used along with crosstabular analysis to compare outcomes for these students with outcomes for similar students who did not participate in a pathway program.[2]

Linked Learning pathways are offered in California Partnership Academies, National Academy Foundation academies, small theme-based high schools, and small learning communities within comprehensive high schools. Linked Learning pathway programs may elect to undergo certification by ConnectEd: The California Center for College and Career (ConnectEd)[3] and its partners, the College and Career Academy Support Network (CCASN), the National Career Academy Coalition (NCAC), the National Academy Foundation (NAF), and Education Trust-West.[4] The certification process involves the submission of documentation on program implementation, staff characteristics and practices, student selection, and program outcomes as well as onsite classroom observations and interviews with students and their parents, staff, and local business partners.[5] Outcomes for students attending an LLCP are the focus of this report.

Data for the analyses are drawn from the Linked Learning District Initiative (LLDI),[6] which provides grants to nine California school districts for the development and implementation of Linked Learning pathways. The LLDI collects data about student academic and demographic characteristics and a variety of high school and postsecondary outcomes. These student-level data were supplemented by school-level information from the California Department of

[1] http://www.connectedcalifornia.org/schools_districts/certification
[2] The statistical approach is described in the section on Statistical Approach–Matching.
[3] http://www.connectedcalifornia.org/home
[4] The National Center for Innovation in Career and Technical Education (NCICTE) draws on the expertise of nationally recognized education researchers and practitioners from a range of organizations. ConnectEd is one of the team members included in the center partnership. To preserve objectivity in the conduct of this study, ConnectEd was excluded from the development and review of the study and its products.
[5] The certification criteria are shown in appendix H.
[6] http://www.connectedcalifornia.org/schools_districts/district_initiative

Education (CDE) on school enrollment, the percentage of students eligible to participate in the National School Lunch Program (NSLP) (an indicator of family poverty), the percentage of English Language Learners (ELLs) enrolled, the percentage of racial and ethnic minority students, and teachers' average number of years of experience. The federal Common Core of Data (CCD)[7] provided information on the urbanicity of the school.

Data for six of the nine LLDI districts[8] were used in the analyses conducted for this report. Because student participation in a Linked Learning pathway is voluntary, the characteristics of the students who participate are likely different from the characteristics of those who do not. Differences between these groups suggest that they are not equivalent, making comparisons between them inappropriate. Propensity score matching (PSM) is a quasi-experimental statistical method to correct for these differences by matching intervention participants to students who did not participate in the intervention, based on the probability of participation.[9] In the present study, propensity scores (i.e., the probability of participating in a Linked Learning pathway) were estimated for all students, and then used to match LLCP students with other students with similar propensities for participation. The result of this matching process is a group of LLCP students and a comparison group that are similar on observable characteristics, such as pre-high school academic achievement, measured by scores on grade-eight California Standards Tests (CSTs) in mathematics and English, demographic characteristics, such as race/ethnicity, disability status, gender, and participation in the federal NSLP, among other factors.

Although PSM can produce groups that are similar to each other (balanced) on these characteristics, matching does not necessarily produce groups balanced on unobservable characteristics, such as student motivation, parental encouragement, and other factors, unless these characteristics are strongly correlated with observable measures included in the statistical models. This is the problem of self-selection, namely that participation in an intervention and performance in that intervention may be accounted for by the unmeasured characteristics of participants rather than the program intervention. Thus, while the outcomes reported here are suggestive, they are not conclusive. It is possible that other factors not included in the models account for both participation in an LLCP and the differences in outcomes. Readers should keep this limitation in mind when evaluating the evidence of the efficacy of the LLCPs reported here.

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[7] https://nces.ed.gov/ccd/

[8] The six districts are Antioch Unified School District, Long Beach Unified School District, Oakland Unified School District, Pasadena Unified School District, Porterville Unified School District, and West Contra Costa Unified School District.

[9] PSM was described by Rosenbaum and Rubin in their 1983 article, "The Central Role of the Propensity Score in Observational Studies for Causal Effects." *Biometrika*, 70: 41–55.

There were a number of outcomes with high levels of missing data; for some measures all information from an LLDI district was missing for a particular cohort and in others, information was missing for large proportions of the comparison group. No substitution or imputation for missing data was done for model covariates or outcome variables. Some models had high rates of missing data resulting from a missing variable at the district-level. In such instances, results are presented both including and excluding the district in question. The gaps resulting from missing data may affect some of the results reported here. In addition, students in the LLCPs and the matched comparison were not necessarily enrolled in the same high schools,[10] so participation in an LLCP may be confounded with school quality (for example, if LLCP students attended better schools than did comparison group students). Further, three of the LLCPs (in the Long Beach Unified School District) may use grade-eight GPA as an admissions requirement.[11] To the degree that GPA is unrelated to other measures included in the statistical models used in this report, results for these three LLCPs may be confounded with students' preexisting academic ability.

This report shows the outcomes for students who participated in an LLCP, defined as having been enrolled in the same LLCP in both grades 11 and 12 in the same high school, compared with a matched comparison group of similar students (on observable characteristics) who were not enrolled in any pathway. This study excludes students enrolled in any Linked Learning pathway that had not been certified, as well as those students enrolled in an LLCP for only one year (e.g., grade 11 or grade 12). Including such students in the study would confound results, because these students fail to meet the definition of either an LLPC student or a student not enrolled in any pathway. Both LLCP and matched comparison groups were restricted to those who had valid pre-high school (grade eight) scores on the CST mathematics and English assessments. Outcomes include attendance, suspension, high school graduation, progress toward completing the admissions requirements for the University of California (UC) and the California State University (CSU) systems, and postsecondary enrollment and persistence.[12]

[10] This is more likely for comparison group students than for LLCP students. The percentage of LLCP students enrolled in high schools that also provided comparison group students in the three cohorts were 91 percent, 64 percent, and 67 percent for the AY 2010–11, AY 2011–12, and AY 2012–13 cohorts. The equivalent percentages for comparison group students were 30 percent, 18 percent, and 17 percent, respectively.

[11] Only one of the three, the Community of Musicians, Performers, Artists, and Social Scientists (COMPASS) requires a minimum GPA (2.5). The other two may use a "recommended" GPA as one of the entrance requirements.

[12] In this report, differences are determined by the results of Student's *t*-tests or other statistical tests in which the probability of a type 2 error, or the alpha level, is generally set at $p \leq .05$. Occasionally the text notes differences that approach but do not reach that threshold of significance but are substantively noteworthy.

OUTCOMES FOR STUDENTS PARTICIPATING IN LINKED LEARNING CERTIFIED PATHWAYS

Propensity score matching and regression adjustment[13] for differences in baseline characteristics between the LLCP and the matched comparison group that fell between .05 and .25 standard deviations were used to compare the two groups of grade-12 students (those in an LLCP and those who were not) in three AY cohorts. Among the highlights of the analyses conducted for this report are the following:

- There were mixed findings for the association between participation in an LLCP and measures of student engagement as measured by attendance and disciplinary events in grade 12. LLCP students had better attendance in AY 2011–12, but there was no difference between these students and the matched comparison group of students in 2010–11 or 2012–13. AY 2011–12 LLCP students were less likely to be suspended during their senior year. Although LLCP students appeared to be less likely to be suspended compared to their matched comparison group peers in AY 2012–13, the difference was not statistically significant at the .05 level but it was at the .08 level (tables 4 and 5).
- Grade-12 students in all three cohorts who participated in an LLCP had a higher probability of graduating from high school than students in the matched comparison group. However, both LLPC and matched comparison groups had relatively high graduation rates (89.5 and 89.3 percent, respectively) (table 6).
- Completion of the a–g admissions requirements, a set of 15 courses and a related grade point average (GPA) required for admission to the UC and CSU public university systems, were only available for the AY 2011–12 and AY 2012–13 cohorts. Although districts were supposed to provide transcripts for all high school students to assess their preparation for admission to a California public university, there were large proportions of missing information for two districts (Long Beach Unified and Oakland Unified). Analyses including these two districts showed that grade-12 LLCP students in the AY 2011–12 cohort were more likely to complete the course work and GPA requirements for admission to both the UC and CSU than matched comparison group students, while among AY 2012–13 students,

[13] Regression adjustment was used for any characteristic of LLCP and comparison group students that differed by more than .05 standard deviation but less than or equal to .25 standard deviation at baseline to conform to the What Works Clearinghouse (2014) standards. After matching on the propensity score, the matched sample was used to assess the association between participation in an LLCP and the outcome of interest by regressing the outcome on the variables requiring adjustment along with a variable that indicated participation in an LLCP.

LLCP participants were more likely to complete these requirements for admission to a CSU than the comparison group. Excluding the districts with high proportions of missing information showed that LLCP students in the AY 2011–12 cohort were still more likely than the comparison group to meet the CSU course and GPA requirements but there was no difference between the two groups in UC eligibility. Among the AY 2012–13 cohort, LLCP participants had a lower probability of completing the a–g requirements for the UC (table 7).

- There were contradictory findings for UC and CSU grade point averages calculated without respect to whether a student completed the 15 courses necessary for admission. Although none of the four comparisons for the AY 2011–12 cohort met the .05 statistical significance level, all were statistically significant at the $p<.1$ level. Though the differences were small, the UC and CSU GPAs for the AY 2011–12 LLCP senior cohort were higher than those of the matched comparison group students, regardless of whether the two districts with large proportions of missing information were included or excluded from the analyses. This relationship was reversed for students in the AY 2012–13 cohort. Again, regardless of whether the districts with large proportions of missing information were included or excluded, LLCP participants had lower GPAs than students in the comparison group (table 8).
- Postsecondary enrollment data were only available for 2011 and 2012 graduates. There was no difference in the probability of enrolling in postsecondary education for AY 2010–11 LLCP graduates and matched comparison group students. However, AY 2011–12 LLCP students were more likely than comparison group students to have enrolled in postsecondary education. There were no differences between the two groups in immediate enrollment after high school graduation, a factor associated with successful postsecondary degree completion, nor was there any difference in short-term (one-year) persistence (table 9).

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INTRODUCTION

> *California is not alone in its efforts to address improvements in secondary schools. Transforming high schools and preparing more students for success in postsecondary educational and career pursuits are national issues. The statistics for persistently high dropout rates and low student achievement, including a troubling achievement gap, point to a national crisis in secondary education. Across the country, policy makers and educators are grappling with the issue of how to improve our secondary schools and better prepare young people for life and work in the twenty-first century.* (California Department of Education 2010, p. 3)

Linked Learning refers to a high school reform effort that places equal emphasis on preparation for college and career by combining (1) rigorous academics, (2) technical education, and (3) exposure to real-world work experiences, which are organized around one or more of 15 specific industry sectors.[1] A Linked Learning pathway may be offered in a variety of settings, including career academies, small schools, charter schools, or as a program within a comprehensive high school. As was noted in a recent report from the University of California at Los Angeles, "…pathways are shaped by existing school structures and capacity, local opportunities for partnerships and support, the skills and backgrounds of instructional staff, and much more" (Saunders et al. 2013). Regardless of the setting, a Linked Learning pathway has four core components:[2]

1. Rigorous academics that prepare students to enroll at a two- or four-year California public college or university, in an apprenticeship, or in another postsecondary program after graduating from high school.
2. Career-based learning in the classroom that delivers concrete knowledge and skills through a cluster of three or more courses, emphasizing the practical application of academic learning and preparing students for high-skill, high-wage employment.

[1] The 15 sectors are agriculture and natural resources; arts, media, and entertainment; building trades and construction; education, child development, and family services; energy and utilities; engineering and design; fashion and interior design; finance and business; health sciences and medical technology; hospitality, tourism, and recreation; information technology; manufacturing and product development; marketing, sales, and service; public services; and transportation.
[2] http://linkedlearning.org/about/

3. Work-based learning in real-world workplaces via job shadowing, apprenticeships, internships, and professional skill-building opportunities.
4. Personalized support services that include counseling and supplemental instruction in reading, writing, and mathematics to help students master the rigorous academic and professional skills necessary for success in college and career.

According to the Linked Learning Alliance, there are four guiding principles for a Linked Learning pathway:[3]

1. Linked Learning prepares students to succeed in college, career, and life.
2. Linked Learning prepares high school students for a full range of post-graduation opportunities.
3. Linked Learning connects academics to real-world applications.
4. Linked Learning improves student engagement.

The California Legislature and the California Department of Education (CDE) have shown increasing support for Linked Learning as a promising approach to transform California high schools. In 2008, then-governor Arnold Schwarzenegger signed Assembly Bill (AB) 2648, which called for the creation of a report examining the feasibility of expanding multiple pathways in California schools. That report, *Multiple Pathways to Student Success: Envisioning the New California High School*,[4] was released in 2010. In 2011, AB 790 allocated funds for a Linked Learning pilot program and revised the education code to define a Linked Learning program.[5]

With hundreds of schools in California implementing pathways to improve outcomes for students, fidelity of implementation is likely to vary according to each district's capacity to implement the Linked Learning model. In 2006, the James Irvine Foundation funded ConnectEd: The California Center for College and Career.[6] ConnectEd works with districts to create policies that support effective Linked Learning pathways, provides professional

[3] http://linkedlearning.org/about/
[4] Executive Summary is available at https:/www.wested.org/resources/multiple-pathways-to-student-success/ Footnote 2 of the report states: "Some educators now prefer the name 'linked learning.' To be consistent with the legislation, this report uses the original terminology in the legislation: multiple pathways."
[5] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120AB790
[6] The National Center for Innovation in Career and Technical Education (NCICTE) draws on the expertise of nationally recognized education researchers and practitioners from a range of organizations. ConnectEd is one of the team members included in the Center partnership. To preserve objectivity in the conduct of this study, ConnectEd was excluded from development and review of the study and its products.

development to school and district staff, and publishes guides and model curricula to assist districts in developing and implementing Linked Learning pathways.[7]

With support from the James Irvine Foundation, ConnectEd and its partners, the College and Career Academy Support Network (CCASN), the National Career Academy Coalition (NCAC), the National Academy Foundation (NAF), and Education Trust-West, developed guidance for certifying pathway design and conducting a formal review process that covers the following (Dayton, Laplante, and Fender 2012):[8]

- pathway design and governance;
- curriculum, instruction, assessment, and project- and work-based learning;
- system supports such as school and district policies, leadership, professional development, qualified staff, and partnerships; and
- use of data and evaluation of program impact.

The certification process involves an intensive review of 40 criteria, which are shown in appendix H. Information about outcomes for students who participated in a Linked Learning certified pathway (LLCP) provides a starting point for evaluating the effectiveness of the Linked Learning approach, because certification likely reflects a higher degree of fidelity to the Linked Learning model than noncertified pathways. Data from the Linked Learning District Initiative (LLDI), which includes information on students who participate in an LLCP and students who do not, allow for such an evaluation.

THE LINKED LEARNING DISTRICT INITIATIVE

In 2009, the James Irvine Foundation funded the LLDI to "(provide) financial support, technical assistance, and coaching to help nine medium and large, rural and urban school districts in California to plan and implement systems of high-quality pathways that are accessible to any student in the district."[9]

The nine districts participating in the LLDI are Antioch Unified School District, Long Beach Unified School District, Local District 4 of the Los Angeles Unified School District, Montebello Unified School District, Oakland Unified School District, Pasadena Unified

[7] See http://www.connectedcalifornia.org/curriculum for sample curricula for pathways.
[8] There are 37 LLCPs in California. The certification process is currently under review and may be changed in the future.
[9] http://www.connectedcalifornia.org/schools_districts/certified_linked_learning_pathways

School District, Porterville Unified School District, Sacramento City Unified School District, and West Contra Costa Unified School District.

The LLDI includes technical assistance provided by ConnectEd and the Los Angeles Small Schools Center (now the Center for Powerful Public Schools), Stanford University's Center for Opportunity Policy in Education, San Diego State University's School of Education, CCASN, and NAF.[10] Other organizations supporting the LLDI include the Institute for Evidence Based Change (IEBC), which is developing a database and an online tool for schools and districts to review information about student progress, and SRI International, which is conducting an overall evaluation of the Initiative.[11]

Each of the LLDI-participating districts provides information for all students in their respective high schools about students' academic and demographic characteristics, attendance, coursetaking, scores on state assessments, progress toward meeting the entrance requirements to California's public universities, and a measure of participation in an LLCP.[12] These data provide the basis for the analyses reported here.

[10] Examples of technical and programmatic assistance can be found at http://casn.berkeley.edu/resources.php?r=497&c=; http://powerfuled.org/ourservices/linked-learning; http://edpolicy.stanford.edu/projects/193; and http://go.sdsu.edu/education/ste/cohort_linked_learning_in_detail.aspx?

[11] A description of the LLDI can be found at http://www.connectedcalifornia.org/schools_districts/district_initiative. SRI's most recent interim report can be found at https://www.sri.com/work/publications/taking-stock-california-linked-learning-district-initiative-fifth-year-evaluation.

[12] Among the nine districts included in the LLDI, three districts—Montebello Unified School District, San Diego Unified School District, and Sacramento City Unified School District—either did not sign a Memorandum of Understanding allowing use of their data (San Diego and Sacramento) or did not have an LLCP at the time of the study (Montebello) and are not included in this report. See the Data and Methodology section for a detailed description of the data used in this report.

PURPOSE OF THIS REPORT

Linked Learning pathways have garnered considerable attention from local, state, and private funding sources,[13] so there is an interest in examining how well students enrolled in these pathways do both while in high school and after they leave to enter the workforce or postsecondary education. An examination of outcomes for students enrolled in an LLCP—which has been assessed for how well the pathway adheres to core components and principles and evaluated for implementation, ongoing monitoring of student progress, and student, parent, school staff, and business community support—provides an ideal sample for this preliminary investigation.

Throughout the report, the grade-12 AY is used to identify the three cohorts (i.e., AY 2010–11 grade-12 students, AY 2011–12 grade-12 students, and AY 2012–13 grade-12 students).

This report addresses four research questions:

1. What is the relationship between enrollment in an LLCP and on-time graduation, attendance rates, and disciplinary incidents during grade 12?
2. What is the relationship between enrollment in an LLCP and completion of high school course requirements (a–g courses) for admission to one of California's public universities (CSU and UC systems) for the graduating classes of 2012 and 2013?
3. What is the relationship between enrollment in an LLCP and enrollment in a postsecondary institution for graduates of the classes of 2011 and 2012?
4. What is the difference in these outcomes for students participating in an LLCP compared with outcomes for students not participating in an LLCP?

[13] The California legislature in 2011 passed AB 790, which created a Linked Learning pilot program in 63 local education agencies (http://linkedlearning.org/about/where-linked-learning-is-happening/pilot-program/). In May 2014, the California Department of Education awarded $250 million for Career Pathways Trust grants to create "sustained career pathways programs that connect businesses, k–12 schools, and community colleges to better prepare students for the 21st century workplace." The James Irvine Foundation has supported the development and expansion of Linked Learning with over $163 million in grants since 2009 (personal communication from Jessica Hickok, grants manager, the James Irvine Foundation, July 1, 2015). See http://linkedlearning.org/linked-learning-alliance/our-members/ for business and other organizations that participate in the Linked Learning Alliance.

DATA AND METHODOLOGY

OVERVIEW OF THE DATA

To support the LLDI, the IEBC developed a database and an online tool for the participating LLDI districts. Districts were asked to upload and review data on each high school student and to indicate whether the student was enrolled in a certified or uncertified Linked Learning pathway or no pathway at all. The database includes academic and demographic information, including course enrollments, results on statewide assessments, attendance, and suspension information from each district's student information system.

Districts also sent IEBC information on students' eligibility for admission to the CSU and UC systems. The admissions data were prepared by the Transcript Evaluation Service (TES) of the University of California Office of the President. Each year, TES processed the transcripts for all students in grades nine to 12 submitted by the districts. TES staff reviewed the transcripts and evaluated whether each student was "on-track" to meet the required a–g course requirements for admission. The a–g requirements include 15 approved college-preparatory courses organized into seven subject matter areas labeled "a–g." In addition, TES evaluated whether students met the minimum required GPA for the a–g courses.[14]

Postsecondary enrollment data were collected from the National Student Clearinghouse (NSC). Each LLDI district submitted a list of all grade-12 students who were scheduled to graduate in June 2011 and 2012, respectively. The students were matched to the NSC database of postsecondary student enrollment and attainment records, and the matched records were entered into the IEBC database.

Information about each student's high school was available from the CDE website for the AYs included in this report.[15] Student-level records were supplemented with information on the teachers' average number of years of experience. School-level averages of the percentage of students with different racial/ethnic backgrounds; the percentage of the student body eligible to participate in the National School Lunch Program (NSLP), a measure of economic disadvantage; and total enrollment were appended to the student data, as was the

[14] The a–g courses are listed below in the section on findings for the Completion of University of California and California State University A–G Requirements.
[15] Teacher data were unavailable for AY 2012–13. Models for the AY 2012–13 cohort that included teacher experience used the value for the preceding AY.

school's locale, a measure of urbanicity, from the Common Core of Data (CCD). The individual yearly data files were combined into a single analysis file, which included all students in the six Linked Learning districts in the study.

THE OVERALL ANALYSIS SAMPLE

To be included in the overall analysis sample,[16] students had to meet all the following eligibility criteria. They were required to have been

- enrolled at the same high school during grade 11 and grade 12;
- classified as a grade-12 student in AYs 2010–11, 2011–12, or 2012–13;
- classified as a grade-11 student during the previous AY;
- had a valid scale score for the CST in grade eight in mathematics or English; and
- enrolled in the same LLCP in grades 11 and 12 if they were participants in an LLCP.[17]

Students who did not meet the above criteria were excluded from the analysis file.[18]

The final analysis sample included a total of 12,136 students based on three cohorts of high school seniors scheduled to graduate as members of the classes of 2011 (2,719 students), 2012 (4,824 students), and 2013 (4,593 students). Each cohort was analyzed separately. The cohorts, as mentioned earlier, are referred to using the appropriate AY (i.e., AY 2010–11 grade-12 cohort, AY 2011–12 grade-12 cohort, and AY 2012–13 grade-12 cohort) throughout the remainder of the report.

[16] The term "overall analysis sample" is used to differentiate the pool of LLCP and comparison group students from the subset of these students used in the analytic samples created by propensity score matching.

[17] The LLDI had participating districts return a "Custom File" that contained one record for each grade-nine to grade-12 student that indicated which, if any, pathway the student attended. Each pathway code was further linked to a "pathways type and model" file that provided a pathway type variable that distinguished Linked Learning certified pathways from other types of pathways. The data files prepared by IEBC for use in this study included a variable derived from the pathway type indicating that the student was enrolled in an LLCP or in a noncertified pathway or was not enrolled in any pathway. This variable was used along with an indicator of which specific LLCP the student was enrolled in to determine who was a Linked Learning certified pathway participant.

[18] The Linked Learning sample represents 74 percent of all Linked Learning students in the six LLDI districts included in the study.

Table 1 presents the number and percentage of students in the LLCP and comparison groups for each grade-12 cohort year. Table 2 presents the number and percentage of students in each LLCP for all three cohorts combined and separately for each grade-12 cohort.

Table 1: Number and percentage of students in the Linked Learning certified pathway and comparison groups in the overall sample for the AY 2010–11, AY 2011–12, and AY 2012–13 cohorts

		Grade-12 cohort year					
		AY 2010–11[a]		AY 2011–12		AY 2012–13	
	All years	Number	Percent	Number	Percent	Number	Percent
Total	**12,136**	**2,719**	**100.0**	**4,824**	**100.0**	**4,593**	**100.0**
Comparison	9,586	2,091	76.9	3,924	81.3	3,571	77.7
Linked Learning	2,550	628	23.1	900	18.7	1,022	22.3

[a] Data for Long Beach, Pasadena, and Porterville only. Other districts did not have a Linked Learning certified pathway in academic year (AY) 2010–11.
SOURCE: Data collected by the Linked Learning District Initiative.

Table 2: Number and percentage distribution of students in the overall sample who were in Linked Learning certified pathways, by type of pathway for the AY 2010–11, AY 2011–12, and AY 2012–13 cohorts

	Grade-12 cohort year							
	All cohorts		AY 2010–11[a]		AY 2011–12		AY 2012–13	
Linked Learning certified pathway	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total	**2,550**	**100.0**	**628**	**100.0**	**900**	**100.0**	**1,022**	**100.0**
Antioch Unified Schools								
Dozier-Libbey Medical High School[b]	226	8.9	0	0.0	116	12.9	110	10.8
Long Beach Unified Schools								
Architecture, Construction, & Engineering (ACE)	141	5.5	52	8.3	36	4.0	53	5.2
CA Academy of Mathematics and Science (CAMS)	143	5.6	56	8.9	39	4.3	48	4.7
Community of Musicians, Performers, Artists, and Social Scientists (COMPASS)	399	15.7	135	21.5	131	14.6	133	13.0
Personal Success through Empowerment, Academic Achievement, Conflict Resolution, and Ethics in Action (PEACE)	477	18.7	160	25.5	154	17.1	163	16.0
Pasadena Unified Schools								
Arts, Entertainment, and Media Academy (AEM)	157	6.2	44	7.0	45	5.0	68	6.7
Business and Entrepreneurship Academy	141	5.5	35	5.6	63	7.0	43	4.2
Creative Arts, Media, and Design Pathway (CAMAD)	151	5.9	48	7.6	41	4.6	62	6.1
Engineering and Environmental Science Academy (EESA)	136	5.3	58	9.2	21	2.3	57	5.6
Porterville Unified Schools								
Partnership Academy of Business (PAB)	68	2.7	23	3.7	20	2.2	25	2.5
Academy of Engineering[b]	13	0.5	0	0.0	4	0.4	9	0.9
Health Careers Academy	59	2.3	12	1.9	20	2.2	27	2.6
Academy of Performing Arts[b]	5	0.2	0	0.0	1	0.1	4	0.4
Digital Design and Communications (DDC)[c]	1	0.0	1	0.2	0	0.0	0	0.0
Multimedia and Technology Academy (MTA)[b]	24	0.9	0	0.0	14	1.6	6	0.6
Oakland Unified Schools								
Skyline Education Academy[b]	51	2.0	0	0.0	10	1.1	41	4.0
Life Academy of Health & Bioscience[b]	81	3.2	0	0.0	37	4.1	44	4.3
West Contra Costa Unified Schools								
Engineering Academy[b]	66	2.6	0	0.0	28	3.1	38	3.7
Law Academy[b]	78	3.1	0	0.0	39	4.3	39	3.8
Multimedia Academy	133	5.2	4	0.6	81	9.0	52	5.1

[a] Data for Long Beach, Pasadena, and Porterville only. Other districts did not have a Linked Learning certified pathway in academic year (AY) 2010–11.
[b] Pathway was not available in AY 2010–11.
[c] Pathway was not available in AY 2011–12 or AY 2012–13.
NOTE: Detail may not sum to totals due to rounding.
SOURCE: Data collected by the Linked Learning District Initiative.

In addition to the measures described previously, the following additional information about each student was included in the analysis files:

- Demographic characteristics for each student, such as
  - sex, race/ethnicity, ELL status in high school, and disability status;
  - NSLP eligibility;
  - whether the student had an individualized education program (IEP) prepared according to the requirements of the *Individuals with Disability Education Act* (*IDEA*);[19] and
  - parents' highest education level.
- Student academic information, such as
  - proficiency levels based on scale scores for the grade-eight CST mathematics and English tests;
  - the number of days during AYs that the student was suspended;
  - whether the student graduated high school and the type of credential earned;
  - whether the student successfully completed the a–g course requirements for admission to CSU system schools;[20]
  - a measure as to whether the student successfully completed the a–g course requirements for admission to UC system schools;
  - the student's GPA based on a–g courses required for admission to CSU system schools; and
  - the student's GPA based on a–g courses required for admission to UC system schools.

[19] Under section 602(14) of the *IDEA*, the term "individualized education program" or "IEP" means a written statement for each child with a disability that is developed, reviewed, and revised in accordance with section 614(d) of *IDEA*.
[20] The a–g course requirements vary for the UC and CSU systems, as does the required minimum GPA. For UC admissions, a GPA of 3.0 in a–g courses is the standard, while a GPA of 2.0 in a–g courses is required for CSU admissions.

Data from the CDE provided school-level variables for each high school in LLDI districts, such as

- the average number of years of teaching experience;
- the percentage of the student population who were NSLP-eligible; and
- the sex, race/ethnicity, and total enrollment of the student population.

Data from the CCD included the school's location (in an urban, suburban, town, or rural area).[21]

Derived variables were created to identify characteristics about the postsecondary institution at which students were first enrolled after high school. These derived variables included whether the student enrolled immediately after high school, more than one year after high school, or had not enrolled as of the last date the NSC provided match data.

Characteristics of the Samples

Table 3 shows the distributions of student demographic and academic characteristics for the overall samples and selected characteristics of the schools that students attended according to whether they were in the LLCP or comparison group.[22]

[21] The "urban-centric" locale codes as shown in https://nces.ed.gov/ccd/rural_locales.asp were recoded. See appendix C.
[22] The overall samples included students from 24, 54, and 47 high schools in the AY 2010–11, AY 2011–12, and AY 2012–13 grade-12 cohorts, respectively.

Table 3: Demographic and academic characteristics of students and selected school-level characteristics for the AY 2010–11, AY 2011–12, and AY 2012–13 cohorts overall (prior to matching)

	Grade-12 cohort year								
	AY 2010–11[a]			AY 2011–12			AY 2012–13		
Student-level characteristics	Linked Learning	Comparison	*t* -value	Linked Learning	Comparison	*t* -value	Linked Learning	Comparison	*t* -value
Sex									
Male	45.1	49.6	2.01	47.2	50.6	1.83	46.4	51.4	2.82
Female	54.9	50.4	-2.01	52.8	49.4	-1.83	53.6	48.6	-2.82
Race/ethnicity									
Asian	7.6	14.6	4.75	9.2	14.1	3.90	8.5	14.5	5.01
Black	14.2	21.0	3.99	12.9	17.8	3.56	11.3	17.8	5.01
Hispanic	58.3	43.2	-7.12	59.4	46.0	-7.33	62.9	45.8	-9.74
White	17.0	18.7	0.98	16.7	19.2	1.75	15.0	18.7	2.75
Other[b]	2.9	2.5	-0.50	1.8	2.9	1.92	2.4	3.2	1.35
English Language Learner	26.0	35.4	4.44	24.7	22.0	-1.75	39.1	27.1	-7.48
Percent eligible for National School Lunch Program	68.2	67.8	-0.16	70.1	64.3	-3.31	73.4	66.7	-4.03
Ever identified as student with disability[c]	8.1	10.9	2.02	8.0	13.3	4.34	10.7	16.0	3.95
CST math scale score	344.8	331.8	-4.65	339.3	332.3	-2.82	346.4	332.5	-5.72
CST English scale score	345.8	337.5	-3.28	343.0	340.0	-1.48	351.5	340.6	-5.21
CST math proficiency[d]									
Far below basic	4.3	8.1	3.22	6.4	10.6	3.80	6.8	10.8	3.79
Below basic	18.0	26.2	4.22	20.1	25.2	3.20	18.8	26.5	5.06
Basic	36.8	30.7	-2.87	31.7	29.7	-2.41	28.7	27.0	-1.08
Proficient	32.5	27.0	-2.21	32.7	26.0	-4.03	34.0	24.3	-6.17
Advanced	9.1	7.7	-1.16	9.0	10.4	1.25	11.6	11.2	0.39
CST English proficiency[d]									
Far below basic	5.7	10.4	3.55	7.7	11.0	2.97	6.4	10.6	4.04
Below basic	11.0	18.1	4.22	11.1	13.9	2.25	10.8	15.8	4.03
Basic	38.5	31.6	-3.26	35.8	30.2	-3.26	32.7	30.0	-1.65
Proficient	30.3	23.7	-3.31	29.3	27.4	-1.14	28.6	24.8	-2.47
Advanced	14.5	16.2	1.04	16.1	17.4	0.91	21.5	18.6	-2.08
CST math subject	47.0	50.1	1.37	61.2	62.4	0.70	66.8	67.0	0.12

See notes at end of table.

Table 3: Demographic and academic characteristics of students and selected school-level characteristics for the AY 2010–11, AY 2011–12, and AY 2012–13 cohorts overall (prior to matching)—Continued

	Grade-12 cohort year								
	AY 2010–11[a]			AY 2011–12			AY 2012–13		
School-level characteristics	Linked Learning	Comparison	*t* -value	Linked Learning	Comparison	*t* -value	Linked Learning	Comparison	*t* -value
Percent minority students	73.5	67.9	-10.86	73.9	66.5	-16.24	74.6	67.1	-17.02
Percent eligible for National School Lunch Program	67.9	64.3	-5.94	65.9	62.9	-5.58	67.9	60.9	-7.72
Average number of years of teacher experience[e]	13.1	14.5	25.36	13.8	14.6	11.94	—	—	—
Locale									
Urban	99.8	88.1	-9.07	70.1	61.0	-5.09	75.3	63.4	-7.13
Suburban	0.0	5.0	5.09	17.0	33.5	9.80	13.9	31.9	11.46
Town or rural	0.2	7.9	7.19	12.9	5.5	-8.02	10.8	4.7	-7.20
School District									
Antioch Unified[f]	—	—	—	12.9	16.6	2.78	10.8	17.0	4.83
Long Beach Unified	64.2	59.5	-2.08	40.0	24.7	-9.33	38.8	25.8	-8.15
Oakland Unified[f]	—	—	—	5.2	15.4	8.09	8.3	13.7	4.63
Pasadena Unified	29.5	23.6	-2.97	18.9	16.5	-1.71	22.5	17.8	-3.37
Porterville Unified	6.4	16.8	6.60	6.6	10.0	3.24	6.9	10.8	3.66
West Contra Costa Unified[f]	—	—	—	16.4	16.7	0.20	12.6	14.8	1.72

—Not available.

[a] Data for Long Beach, Pasadena, and Porterville only. Other districts did not have a Linked Learning certified pathway in academic year (AY) 2010–11.

[b] Other includes American Indian, Pacific Islander, Filipino, and two or more races.

[c] A student identified with a disability under the *Individuals With Disabilities Education Act*

[d] Proficiency levels are based on scale scores for the grade-eight CST mathematics tests and grade-eight CST English tests.

[e] Teacher data were unavailable for AY 2012–13.

[f] District had no LLCP in AY 2010–11.

NOTE: Detail may not sum to 100 due to rounding. Statistical significance determined by a Student's *t*-test. The *t*-value is the difference between two estimates divided by the standard error of the difference. T-values whose absolute values are greater than or equal to 1.96 are statistically significant at the $p \leq .05$ level. In this table CST means the California Standards Test.

SOURCE: Data collected by the Linked Learning District Initiative.

There were differences between the unadjusted characteristics of LLCP students and students in the comparison group (those without any pathway experience) in the overall samples for the three grade-12 cohorts. Generally, LLCPs had higher percentages of female students.[23] They also had greater percentages of Hispanic students and lower percentages of Asians and African-Americans. LLCP participants were more likely to be NSLP-eligible, a measure of economic disadvantage. Although there was a higher percentage of ELL students among the comparison group in the AY 2010–11 cohort (35 versus 26 percent), higher percentages of ELL students were in the treatment group in the AY 2011–12 and AY 2012–13 cohorts (25 versus 22 percent and 39 versus 27 percent).

The AY 2010–11 and AY 2012–13 grade-12 LLCP students had higher grade-eight CST scale scores in English and mathematics. In addition, higher percentages of these students were rated proficient than comparison group students.

LLCP students attended schools that differed in several noticeable ways from schools that comparison group students attended. LLCP students attended schools with higher percentages of African-American, Hispanic, and Native American students; had higher percentages of NSLP-eligible students; had teachers with fewer years of teaching experience; and were more likely to attend high schools in urban areas.

The wide range of differences between students enrolled in an LLCP and comparison group students required an analytic approach that could create groups better matched on observable differences at baseline before program effects were assessed. PSM was used to create these better matched samples to reduce the possibility that any preexisting differences between LLCP and comparison group students were mistaken for effects of participation in an LLCP.

DATA QUALITY AND DATA LIMITATIONS

While IEBC serves as a custodian for the LLDI data, LLDI districts provided the student data to IEBC.[24] Given that districts have varying interest, capacity, and resources to devote to submitting and reviewing their data, the quality and completeness of the data may vary from district to district and from one cohort to the next. For some measures, data were

[23] In this report, differences are determined by the results of Student's *t*-tests or other statistical tests in which the probability of a type-2 error, or the alpha level, is generally set at .05. Occasionally the text notes differences that approach but do not reach that threshold of significance but are substantively noteworthy.
[24] This is changing as more information becomes available from California's state longitudinal data system (CALPADS).

unavailable because the source of the information was a non-LLDI district for which there was no data-sharing agreement. For example, if a student transferred to an LLDI district from a private school or a public school in a non-LLDI district after grade eight, the LLDI district might have only limited data on the student prior to the transfer. This was the case for grade-eight CST data for Porterville.

Other information may be unavailable due to when an LLCP was certified. Data for AY 2010–11 included only three of the six LLDI districts because three districts did not have an LLCP in this year. Thus, the AY 2010–11 senior cohort includes approximately half the number of cases as the AY 2011–12 grade-12 and AY 2012–13 grade-12 cohorts.

Occasionally, data for an entire district are missing for one or more cohorts. Pasadena, for example, has no NSC data for the two cohorts (AY 2010–11 and AY 2011–12) used to examine postsecondary outcomes. Other districts are missing information on attendance, suspensions or TES outcomes for all students or particular groups of students. To ensure that readers are aware of which groups may or may not have been included in a particular analysis, notes to each table specify the appropriate groups.

The absence of grade-eight assessment data was considered especially important, because grade-eight assessments were the only measure of pre-high school academic achievement. Therefore, in addition to requiring that students had to have attended the same high school during their junior and senior years, it was also required that students have grade-eight assessment results.

No substitution or imputation for missing data was done for covariates or outcome measures.

STATISTICAL APPROACH—MATCHING

PROPENSITY SCORE MATCHING

A randomized controlled trial (RCT) creates groups that are, in expectation, equivalent on both measured and unmeasured characteristics, although even in an RCT, there may be differences between the treatment and comparison groups on some covariates. Such differences are not systematic, however, and reflect random error.

The goal of matching methods is to create groups as similar as possible to those created by an RCT, given observational data. If the two groups are equal on all measured and unmeasured factors, any differences in outcomes could be ascribed to the treatment that one group received and the other did not. Unless unmeasured factors are highly correlated with measured attributes, potential bias is always a possibility that places restrictions on drawing causal conclusions. Unlike an RCT, analysts using observational data cannot assign subjects to treatment, so the possibility that treatment assignment and the outcome are correlated requires attention.

The voluntary nature of student participation in an LLCP means that any analysis of the relationship between participation in a certified pathway and student outcomes needs to address selection bias. For example, students who enroll in an LLCP may differ from other students according to a variety of observed and unobserved characteristics that affect their participation in an LLCP and performance on the outcomes of interest. This study uses propensity score matching (PSM), which provides a framework that allows for strong inferences to be drawn from observational data.[25]

A propensity score is the probability that a subject will receive treatment, conditional on measured covariates. Let $\mathbf{X}$ represent the vector of covariates for each subject, $\mathbf{Z}$ a treatment indicator (1=treated, 0=control), then the propensity score, e($\mathbf{X}$), is

$$e(\mathbf{X}) = \text{prob}(\mathbf{Z} = 1|\mathbf{X}).$$

The propensity score provides a single measure that can represent any number of measured covariates and overcome the "curse of dimensionality" in matching. For example, if one wanted to match two groups on eight different measures, and each measure was a "yes/no"

[25] PSM was first described by Rosenbaum and Rubin (1983). For a comprehensive presentation of the key assumptions of matching methods, see Guo and Fraser (2015) and Stuart (2010).

dummy variable, there are 2^8 or 256 different categories on which subjects need to be matched. Given a large number of covariates, even with a large sample, the likelihood of finding subjects for each category is small. Rosenbaum and Rubin (1983) showed that matching on the propensity score creates groups that have the same average distributions on covariates as they would have if the individual covariates had been used for the matching. Instead of having to match eight variables, propensity score analysis requires matching on only one measure, the propensity score.[26]

PSM matches LLCP students with comparison group students who have similar propensity scores, but did not enroll in an LLCP. Effective matching often results in a group of LLCP students that is similar to the group of comparison students across those characteristics used to estimate the propensity scores. Without employing a statistical method, such as PSM, it would not be appropriate to ascribe differences in academic outcomes on whether or not a student enrolled in an LLCP. The steps of the matching process used in the present analysis are described in the following section.

Analytic Approach

The analytic approach begins by estimating a propensity score using logistic regression. The true propensity score is unknown and needs to be estimated. Generally, logit or probit models are used to estimate the conditional probability of treatment assignment.[27] The covariates selected for the model are included because they are suspected of affecting either the likelihood of treatment or the outcome. Although the choice of covariates may be influenced by the known association between a covariate and the outcome of interest, the outcome does not play a part in estimating the propensity score. One of the strengths of propensity score analysis is that there is a separation between the creation of the propensity score and the analysis of the outcome, similar to an RCT where assignment to treatment is independent of the outcome. Variables included in the propensity score model may include measures that are constant over time (gender, race/ethnicity) or occur before the treatment (grade-eight test scores). The model must not include variables that could be affected by the outcome.

[26] As Joffe and Rosenbaum (1999, p. 328) note, "the balance on the observed covariates **X** that is obtained by matching or stratifying on an estimated propensity score is of course imperfect, but it is typically somewhat better than the balance on **X** obtained by random assignment of treatments."
[27] Logit and probit are nonlinear statistical methods for analyzing qualitative dependent variables, usually a variable with only two categories. Both methods generally provide similar estimates but differ in how the error term is distributed (for probit, normal distribution with mean 0, variance 1; for logit, logistic distribution with mean 0, variance=$\pi^2/3$).

The models estimated for this report use the estimated logit in place of the estimated probability because the logit has an approximately normal distribution.[28]

Unless there is overlap in the estimated propensity scores, some LLCP students will not have a matched comparison and will need to be dropped from the analysis. The overlap is illustrated using histograms showing the distribution of estimated propensities for the LLCP and comparison group students before and after matching and report the number of LLCP cases that were removed from the analytic samples for overlap failure.

Second, after estimating the propensity score, a matching algorithm is applied. In this report, nearest-neighbor caliper matching on the propensity score is used. Nearest-neighbor matching selects a treated subject and finds the comparison group subject or subjects with the closest set of covariate scores to the treated subject. Nearest-neighbor matching can lead to bad matches if the nearest comparison group score is far from the treated subject's. To avoid this, a caliper (.25 times the standard deviation—or .25*SD—of the propensity score logit) minimizes bad matches.[29] To increase the efficiency of the estimates, two or more comparison group students were matched to each LLCP student (Smith 1997).[30]

Appendix D shows the estimated coefficients for the logit models used to generate the propensity scores for the three grade-12 cohorts. The tables show the covariates used to estimate participation in an LLCP, such as gender, race/ethnicity, parent education, whether the student was classified as ELL in high school, eligibility for participation in NSLP, and whether the student ever had a disability. Statewide assessments in mathematics and English administered in grade eight are also included. While the English assessment is the same for all grade-eight students, grade-eight students take a variety of mathematics courses (e.g., Algebra I or geometry in place of general math). To allow for different levels of course difficulty, the type of mathematics subject was dichotomized into standard and advanced, which included Algebra I, Algebra II, and geometry, and this variable was included in the estimation equation.

Creating the propensity score models is an iterative process that involves specifying models with covariates suspected of affecting the outcome and the likelihood of participation in an LLCP, matching on the propensity score, and evaluating the post-matching covariate balance. Whenever balance was less than desired, the models were modified in an attempt to improve the balance. These modifications include creating interactions among covariates,

[28] The logit is equal to $ln\left(\frac{P_i}{(1-P_i)}\right)$, where P_i is the probability of assignment to the treatment.

[29] Both Guo and Fraser (2015) and Rosenbaum and Rubin (1983) suggest setting the caliper to a quarter of the standard deviations of the propensity score.

[30] More than two matches may occur when comparison group students are tied on the estimated propensity score.

transforming some (for example, using the natural logarithm of continuous variables such as total school enrollment) or including quadratic terms. Thus, some logit models include interaction effects for combinations of proficiency and type of math course assessed or proficiency and scale scores in English. Several school-level measures, such as the percentage of minority students in the school, the percentage of the student body eligible for NSLP, and teachers' average number of years of experience could also be included in logarithmic form. In two of the three models, indicator variables for district were included, while in the third (AY 2010–11), school locale was used, recoded as urban versus all other locations. The tables indicate the reference category for categorical variables. Besides the coefficients, their standard errors, and the statistical significance of the coefficient, the number of cases used in the logit analysis appears at the bottom of the table.

PSM is used to estimate the average treatment effect on the treated (ATT), which estimates the average change in an outcome among LLCP students only. An alternative method for calculating treatment effects is the average treatment effect (ATE), which describes the average change in an outcome among all students. Given the focus of the current study is the relationship between participation in an LLCP and academic outcomes, the ATT is the appropriate measure of treatment effect. The user-written Stata program *psmatch2* (Leuven and Sianesi 2003) was used to calculate the ATT. *Psmatch2* also calculated normalized weights that represent the number of times a comparison group case was used in the matching (which were used in the statistical adjustment models described below).

Since some LLCP students may have propensity scores outside the range of scores for comparison group students, the matched sample excludes any LLCP student whose propensity score is greater than the maximum and less than the minimum of scores for the comparison group. Requiring common support reduced the number of LLCP students in the matched sample by 65 (out of 565) in the AY 2010–11 grade-12 cohort and 46 (out of 809) in AY 2011–12 grade-12 cohort; there were no LLCP cases removed from the AY 2012–13 grade-12 cohort. The histograms in Appendix F show the distribution for the propensity scores for the LLCP and the comparison group students before and after matching and help demonstrate the overlap in scores for the two groups.

Pstest, part of the Stata program *psmatch2*, is used to evaluate how well the matching process balanced the covariates in the LLCP and comparison groups of students in the baseline analytic samples. Since matching may not be able to achieve satisfactory balance for every covariate, the What Works Clearinghouse (WWC) provided guidance for determining how much imbalance is acceptable and statistically adjust the estimated effects of participation in an LLCP for any remaining imbalance. Balance is assessed using the WWC's absolute effect size difference (2014, p.15). For a continuous variable, such as an assessment scale score, the absolute effect size for continuous variables is equal to the absolute value of the difference in

the means between the LLCP students and the matched comparison group students, divided by the pooled standard deviation:

$$\left| \frac{(M_{LL} - M_C)}{\sqrt{\frac{S_{LL}^2 + S_C^2}{2}}} \right|$$

where M_{LL} and M_C are the means for the Linked Learning and comparison group students, respectively, and the S^2 are the respective variances. For categorical variables, the absolute effect size is based on the difference in proportions divided by the pooled standard deviation.

The baseline equivalence tables (Appendix E) show the means, the absolute effect size, and the *t*-value for the difference in means for each covariate in the propensity score model after matching.[31] The post-matching absolute effect size represents the distribution of covariates for the LLCP students and the group of matched comparison students at baseline prior to assessing the effect of participation in an LLCP. The *WWC Procedures and Standards Handbook* (2014, p.15) exempts studies using quasi-experimental designs, such as PSM, from needing to adopt special measures to statistically adjust program effects for covariates with absolute effect size differences of less than .05. Covariates with differences greater than .05 and less than .25 must be included in models estimating program outcomes. This study uses a weighted regression adjustment to estimate differences in outcomes for LLCP students—logistic regression for binary outcomes and ordinary least squares (OLS) regression for continuous outcomes—when any of the covariates in the propensity score matched sample had absolute effect sizes requiring adjustment. The weights used in the regression models are calculated by *psmatch2* and represent the number of times a case was used as a match (all LLCP cases have a weight of 1.0). The weights allow the regression results to represent the average treatment effect on the treated (ATT) for participation in an LLCP. An example of estimating a propensity score for an outcome and the diagnostics for PSM follows.

Appendix table D1 shows the logistic regression results estimating participation in an LLCP for all three grade-12 cohorts. The columns show the results for AY 2010–11, 2011–12, and 2012–13 cohorts. Appendix tables E1, E2, and E3 show the corresponding baseline differences for the LLCP and comparison group students in each cohort after matching on the propensity scores derived from the logit models in appendix table D1. For example,

[31] The *t*-test results are shown for readers who may be interested in the statistical significance of the remaining differences between the LLCP and matched comparison group students. However, the significance of these differences is affected by sample size, which is generally reduced by matching; thus the WWC focuses on the absolute effect size for determining the adequacy of the matching to produce equal groups at baseline.

appendix table E3 indicates that at baseline, before any outcomes are evaluated, the proportion of female students in the LLCP group in the AY 2012–13 cohort is .548. The proportion of female students in the matched comparison group is .556. The difference between the proportions represents an absolute effect size difference of .016. This difference, however, is not statistically significant (p=.737). Since the absolute effect size is less than .05, gender is not included in models estimating the effect of participation in an LLCP on outcomes for the AY 2012–13 grade-12 cohort.

There are several covariates that have absolute effect size differences greater than .05 and less than or equal to .25 that do require statistical adjustment per the WWC procedures and guidelines. These are shown in bold font in the appendix E tables. For the AY 2012–13 cohort, for example, these include total school enrollment, and indicators for students attending schools in Oakland and Pasadena. All three grade-12 cohorts had one or more covariates that required statistical adjustment. [32]

Once the best propensity score match is created and the covariates needing adjustment are identified, weighted logistic or OLS regression (depending on whether the outcome was categorical or continuous) is used with the matched sample to estimate the difference in outcomes associated with participation in an LLCP. The outcome is regressed on the indicator for participation in an LLCP and any of the covariates whose absolute effect size requires their inclusion.

The outcomes reported are marginal effects or the change in the outcome for a change in the covariate, and in particular, a change in the variable indicating participation in an LLCP. For continuous covariates the marginal effect is the OLS regression coefficient for the variable indicating participation in an LLCP. Marginal effects for categorical covariates, such as the dummy variable representing whether a student was in an LLCP or in the comparison group, represent discrete change as the value of the variable goes from 0 (comparison group) to 1 (LLCP participant). For categorical outcomes, such as graduated high school, met the UC and CSU a–g requirements, etc., the marginal effect represents the change in probability in the outcome for LLCP students compared to comparison group students. Unlike OLS regression, calculating marginal effects for nonlinear models such as logistic regression depends on the values of other variables included in the model, which requires assumptions about what values to use. For this study, marginal effects are estimated setting other covariates at their mean values. As such, the results indicate the treatment effect for a theoretical average LLCP student compared to the average student in the comparison group.

[32] Appendix table G1 shows the distributions for the outcome measures for the overall sample and matched sample used for estimating the difference associated with participation in an LLCP.

RESULTS

> *Pathways are intended to increase student engagement, reduce high school dropout rates, improve student achievement, increase high school completion and postsecondary transition rates, and boost students' earning power after high school—in short, transform the high school experience and prepare students for both college and career, not just one or the other.* (Clark et al. 2012)

ATTENDANCE

> *Students need to attend school daily to succeed. The good news . . . is that being in school leads to succeeding in school. Achievement, especially in math, is very sensitive to attendance, and absence of even two weeks during one school year matters. Attendance also strongly affects standardized test scores and graduation and dropout rates. Educators and policymakers cannot truly understand achievement gaps or efforts to close them without considering chronic absenteeism.* (Balfanz and Byrnes 2012)

Attendance has been shown to be an important predictor of high school completion, particularly in grade nine (Allensworth and Easton 2007). Attendance is a measure of student engagement, which has been linked to academic achievement. Although estimating the relationship between participation in an LLCP and grade-nine attendance was not feasible, the attendance ratio (days present to days enrolled) was available for attendance in grade 12 for all three cohorts (table 4).

Table 4: Adjusted marginal effects of participation in a Linked Learning certified pathway on grade-12 attendance (days attended as a proportion of days enrolled) for the AY 2010–11, AY 2011–12, and AY 2012–13 Linked Learning certified pathway and matched comparison group students

	Cohort	Number of students	Marginal Effect[a]	Robust Standard error	*t*[b]	Significance
Attendance[c]	AY 2010–11[d, e]	1,916	0.003	0.003	1.01	0.311
	AY 2011–12[f, g]	3,534	0.013	0.004	3.56	0.006
	AY 2012–13[f, h]	3,666	-0.002	0.004	-0.47	0.638

[a] Marginal effects for estimated average treatment on treated from ordinary least squares regression of attendance on indicator for students participating in a Linked Learning certified pathway compared to matched comparison group students.
[b] The *t*-value is the difference between two estimates divided by the standard error of the difference.
[c] Ratio of days attended to days enrolled.
[d] Data for Long Beach and Pasadena for academic year (AY) 2010–11. The remaining districts did not have Linked Learning certified pathways in AY 2010–11.
[e] Estimate adjusted for race/ethnicity equals black; log percent of school enrollment of students who are black, Hispanic, and Native American; and log percent of school eligible for the National School Lunch Program per What Works Clearinghouse (2014) guidelines.
[f] Includes data for Antioch, Long Beach, Oakland, Pasadena, Porterville, and West Contra Costa for AY 2011–12 and AY 2012–13.
[g] Estimate adjusted for districts equal to Long Beach, Oakland, and West Contra Costa, log enrollment, percent of school enrollment of students who are black, Hispanic, and Native American squared; which grade-eight California Standards Test (CST) mathematics subject assessment (advanced mathematics—Algebra I, Geometry, Algebra II—or general mathematics) was taken and the interaction of the grade-eight mathematics subject; and the grade-eight CST mathematics scale score per What Works Clearinghouse (2014) guidelines.
[h] Estimate adjusted for school enrollment, and district equal to Oakland or Pasadena per What Works Clearinghouse (2014) guidelines.
SOURCE: Data collected by the Linked Learning District Initiative.

There was no consistent pattern of higher attendance for LLCP students. The difference between LLCP students and their matched comparison peers was statistically significant in AY 2011–12 but not in AY 2010–11 or AY 2012–13. The marginal effect of an LLCP on attendance was small, even when the difference was statistically significant. Based on the results for the AY 2011–12 cohort, LLCP students would have attended 2.3 days more than students in the comparison group based on a standard 180-day school year.

In the future, as more data from the LLDI become available, grade-nine attendance should be a focus for further investigation. Many LLCPs start in grade nine, and attendance in that grade has been linked to academic failure and increased risk of dropping out of high school. By grade 12, many students who were at risk may have already dropped out so that any positive associations between LLCP participation and attendance may be less meaningful than those occurring in grade nine.

SUSPENSION

Attendance and suspension can be viewed as proxies for student engagement with schooling. Table 5 shows the difference in the probability of LLCP students and their matched peers

being suspended during grade 12. Recently, suspensions and other disciplinary action have been the focus of statewide attention in California and nationally, particularly the disproportionate distribution of disciplinary events for minority students (U.S. Department of Education 2012).

The LLDI dataset includes a count of the number of days a student was suspended. This measure was recoded to a zero/one indicator, with one indicating a student had been suspended at least once in grade 12.[33] As table 5 shows, there was no difference in the probability of suspension for AY 2010–11 LLCP and comparison group students. However, AY 2011–12 grade-12 LLCP students were about 4 percent less likely (or -.04 probability) than matched comparison group students of being suspended. The apparent difference for AY 2012–13 grade-12 LLCP and comparison group students (about 1.6 percent less likely to have been suspended) was not significant at the .05 statistical significance level though it was at the .082 level.

Table 5: Adjusted marginal effects of participation in a Linked Learning certified pathway on the probability of ever being suspended during grade 12 for the AY 2010–11, AY 2011–12, and AY 2012–13 cohorts

	Cohort	Number of students	Marginal Effect[a]	Robust Standard error	z[b]	Significance
Ever suspended[c]	AY 2010–11[d, e]	1,916	0.001	0.008	0.16	0.875
	AY 2011–12[f, g]	2,865	-0.040	0.012	-3.31	0.001
	AY 2012–13[h, i]	3,465	-0.016	0.009	-1.74	0.082

[a] Marginal effects for estimated average treatment on treated from logistic regression of ever suspended on indicator of participation in a Linked Learning certified pathway compared to matched comparison group students. Marginal effects represent difference for Linked Learning certified pathway students holding covariates at their mean values.
[b] The *z*-value is the difference between two estimates divided by the standard error of the difference with a normal distribution.
[c] "Ever suspended" indicates that the student was suspended from school for at least one day during grade 12.
[d] Data for Long Beach and Pasadena for academic year (AY) 2010–11. The remaining districts did not have Linked Learning certified pathways in AY 2010–11.
[e] Estimate adjusted for race/ethnicity black; log percent of school enrollment of students who are black, Hispanic, and Native American; and log percent of school enrollment of students eligible for the National School Lunch Program per What Works Clearinghouse (2014) guidelines.
[f] Includes data for Long Beach, Oakland, Pasadena, Porterville, and West Contra Costa for AY 2011–12. Antioch did not have Linked Learning certified pathways in AY 2011–12.
[g] Estimate adjusted for districts equal to Long Beach, Oakland, and West Contra Costa; log enrollment; percent of school enrollment of students who are black, Hispanic, and Native American squared; which grade-eight California Standards Test (CST) mathematics subject assessment (advanced mathematics—Algebra I, Geometry, Algebra II—or general mathematics) was taken; and the interaction of the grade-eight mathematics subject and the grade-eight CST mathematics scale score per What Works Clearinghouse (2014) guidelines.
[h] Includes data for Antioch, Long Beach, Pasadena, Porterville, and West Contra Costa.
[i] Estimate adjusted for school enrollment, and district equal to Pasadena per What Works Clearinghouse (2014) guidelines.
SOURCE: Data collected by the Linked Learning District Initiative.

[33] Students who have serious disciplinary histories may have dropped out of high school before grade 12, so the results reported here may not be generalizable to student behaviors occurring earlier in high school.

The reasons for these lower probabilities of suspension cannot be derived from the data available for this report. There are several structural characteristics of LLCPs that may be worthy of future research. These include the setting—an LLCP can be offered in career academies, small high schools, and charter schools, and they typically serve 250 to 500 students (Atterbury 2013, p. 3). A core principle of the Linked Learning model—and one of the four core elements that is evaluated as part of the certification process—is student support, which may be easier to deliver in a smaller setting. In addition, teachers, business partners, and other adults involved with an LLCP may be especially interested in working with LLCP students, and that interest may include offering high levels of support and monitoring that affect the likelihood of students engaging in behaviors leading to suspension. Further research into the specific reasons why LLCP students appear to have lower rates of serious disciplinary events will require integrating observational studies along with systematic information from students, parents, teachers, and other school staff.

HIGH SCHOOL GRADUATION

Research has shown that dropping out of high school is associated with a range of adverse employment and life outcomes.[(1)] Young people who do not complete high school are more likely to be unemployed, live in poverty, be dependent on welfare benefits, have poor physical and mental health, and engage in criminal activity than those with higher education levels.[(1)] Though many individuals who do not receive a high school diploma go on to earn an equivalency degree, such as a GED, this credential also is associated with lower earning potential than a traditional diploma.[(2)] The economic consequences of dropping out of high school do not stop with the individual. Society also faces costs in terms of greater spending on public assistance, higher crime rates, and lower tax revenues.[(2)] One study estimated that if those who dropped out of high school in 2011 had graduated instead, the nation's economy would benefit by about $154 billion over their lifetimes.[34]

The Linked Learning model emphasizes preparation for college and career, both of which depend on the successful completion of high school. Table 6 shows that LLCP students had a higher probability of graduating on time than their matched comparison group peers. The estimated advantage for pathway participants ranged from about 4.7 percent among 2011–12 grade-12 students to 5.4 and 6.4 percent for AY 2010–11 and AY 2012–2013 grade-12 students. Note that the models generating the estimated differences between LLCP students

[34] Sources for this passage may be found in Lucille Packard Foundation for Children's Health (2014).

and comparison group students were estimated on samples that matched each LLCP student with comparison group students who had similar pre-high school academic achievement in grade eight, student race/ethnicity, economic disadvantage, and other factors associated with successful completion of high school.

Table 6: Adjusted marginal effects of participation in a Linked Learning certified pathway on the probability of high school graduation for the AY 2010–11, AY 2011–12, and AY 2012–13 cohorts

Cohort	Number of students	Marginal Effect[a]	Robust Standard error	z[b]	Significance
AY 2010–11[c, d]	2,269	0.054	0.010	5.62	0.000
AY 2011–12[e, f]	3,968	0.047	0.009	5.11	0.000
AY 2012–13[e, g]	3,863	0.064	0.009	7.23	0.000

[a] Marginal effects for estimated average treatment on treated from logistic regression of high school graduation on indicator of participation in a Linked Learning certified pathway compared to matched comparison group students. Marginal effects represent difference for Linked Learning certified pathway students holding covariates at their mean values.
[b] The *z*-value is the difference between two estimates divided by the standard error of the difference with a normal distribution.
[c] Data for Long Beach, Pasadena, and Porterville for academic year (AY) 2010–11.
[d] Estimate adjusted for race/ethnicity equals black; log percent of school enrollment of students who are black, Hispanic, and Native American; and log percent of school eligible for the National School Lunch Program per What Works Clearinghouse (2014) guidelines.
[e] Includes data for Antioch, Long Beach, Oakland, Pasadena, Porterville, and West Contra Costa for AY 2011–12 and AY 2012–13.
[f] Estimate adjusted for districts equal to Long Beach, Oakland, and West Contra Costa; log enrollment; percent of school enrollment of students who are black, Hispanic, and Native American squared; which grade-eight California Standards Test (CST) mathematics subject assessment (advanced mathematics—Algebra I, Geometry, Algebra II—or general mathematics) was taken; and the interaction of the grade-eight mathematics subject and the grade-eight CST mathematics scale score per What Works Clearinghouse (2014) guidelines.
[g] Estimate adjusted for school enrollment, and district equal to Oakland or Pasadena per What Works Clearinghouse (2014) guidelines.
SOURCE: Data collected by the Linked Learning District Initiative.

COMPLETION OF UNIVERSITY OF CALIFORNIA AND CALIFORNIA STATE UNIVERSITY A–G REQUIREMENTS

Admission to the UC or the CSU system requires applicants to successfully complete a series of 15 yearlong courses organized into seven subject areas labeled "a–g" and meet a minimum GPA in these courses.[35] According to the Office of the President (2014), these courses include the following:

[35] Admission to a California community college does not require meeting the a–g subject or GPA requirements.

- **History/social science ("a")** - *Two years*, including one year of world history, cultures, and historical geography and one year of U.S. history, or one-half year of U.S. history and one-half year of American government or civics
- **English ("b")** - *Four years* of college preparatory English that integrates reading of classic and modern literature, frequent and regular writing, and practice listening and speaking
- **Mathematics ("c")** - *Three years* of college-preparatory mathematics that includes or integrates the topics covered in elementary and advanced algebra and two- and three-dimensional geometry
- **Laboratory science ("d")** - *Two years* of laboratory science providing fundamental knowledge in at least two of the three disciplines of biology, chemistry, and physics
- **Language other than English ("e")** - *Two years* of the same language other than English or equivalent to the second-level of high school instruction
- **Visual and performing arts ("f")** - *One year* chosen from dance, drama/theater, music, or visual art
- **College-preparatory elective ("g")** - *One year* chosen from the "a–f" courses beyond those used to satisfy the requirements above, or courses that have been approved solely in the elective area

Course content is specified by UC faculty, and high schools must receive approval before any course can be authorized for a–g credit.[36] In addition to completing the required a–g courses, students must also meet a minimum GPA in these courses (2.0 or C for the CSU system and 3.0 or B for the UC system). TES data, the source for a–g outcomes, were available for the AY 2011–12 and AY 2012–13 cohorts. [37]

Districts participating in the LLDI were asked to submit transcripts for students in all high schools, but districts appear to have responded to this request differently. Long Beach, for example, is missing information on about two-thirds of students in both the AY 2011–12 and AY 2012–13 cohorts, while Oakland is missing information on over half the AY 2012–13 cohort. Almost all of the missing TES data are for schools that had only comparison group students so the districts may have misunderstood the request to send all high school student transcripts to TES, not just transcripts for Linked Learning participants.

[36] The University of California Office of the President maintains a website that provides lists of all a–g courses that have been certified. The site is searchable using several criteria including district and school name. See https://hs-articulation.ucop.edu/agcourselist#/list/search/all.
[37] There were too few schools participating in TES to include the AY 2010–11 cohort.

The large amount and nonrandom character of this missing information for the two districts presents an analytic problem: Whether to remove all students from these districts or to assume that the comparison group students who remain in the sample, both from the two districts and the other four districts in the sample, are equivalent to those students whose information is not included. Results were calculated including and excluding Long Beach Unified students and Oakland Unified students. These comparisons allow readers to evaluate bounds on the associations between participation in an LLCP and the TES outcomes.

There were mixed findings for participation in an LLCP and completion of the UC a–g requirements. In the sample that included Long Beach and Oakland, students in the AY 2011–12 cohort had a greater probability of completing the a–g requirements for both the UC and CSU. LLCP students had a 6 percent greater probability of completing the UC a–g requirements than comparison group students and about a 16 percent greater probability of completing the CSU a–g requirements (table 7). Excluding Long Beach and Oakland there was no difference between the two groups in this cohort in the probability of completing the UC requirements though LLCP students still had about a 13 percent greater probability of completing the CSU a–g requirements.

Table 7: Adjusted marginal effects of participation in a Linked Learning certified pathway on the probability of completing the University of California and California State University a–g requirements (both subject and GPA requirements) for AY 2011–12 and AY 2012–13 cohorts

Including Long Beach (AY 2011–12, AY 2012–13) and Oakland (AY 2011–12, AY 2012–13)

Outcome	Cohort	Number of students	Marginal Effect[a]	Robust Standard error	z[b]	Significance
UC a-g	AY 2011–12[c, d]	2,648	0.062	0.028	2.25	0.024
	AY 2012–13[c, e]	2,578	0.007	0.024	0.29	0.771
CSU a-g	AY 2011–12[c, d]	2,648	0.155	0.034	4.50	0.000
	AY 2012–13[c, e]	2,578	0.072	0.025	2.83	0.005

Excluding Long Beach (AY 2011–12, AY 2012–13) and Oakland (AY 2011–12, AY 2012–13)

Outcome	Cohort	Number of students	Marginal Effect[a]	Robust Standard error	z[b]	Significance
UC a-g	AY 2011–12[f, g]	2,262	0.024	0.030	0.79	0.429
	AY 2012–13[h, i]	1,977	-0.066	0.032	-2.04	0.041
CSU a-g	AY 2011–12[f, g]	2,262	0.130	0.036	3.57	0.000
	AY 2012–13[h, i]	1,977	-0.036	0.034	-1.05	0.292

[a] Marginal effects for estimated average treatment on treated from logistic regression of UC/CSU a–g course requirements on indicator of participation in a Linked Learning certified pathway compared to matched comparison group students. Marginal effects represent difference for Linked Learning certified pathway students holding covariates at their mean values.
[b] The *z*-value is the difference between two estimates divided by the standard error of the difference with a normal distribution.
[c] Data for Antioch, Long Beach, Oakland, Pasadena, Porterville, and West Contra Costa for academic year (AY) 2011–12 and AY 2012–13.
[d] Estimate adjusted for districts equal to Long Beach, Oakland, and West Contra Costa; log enrollment; percent of school enrollment of students who are black, Hispanic, and Native American squared; which grade-eight California Standards Test (CST) mathematics subject assessment (advanced mathematics—Algebra I, Geometry, Algebra II—or general mathematics) was taken; and the interaction of the grade-eight mathematics subject and the grade-eight CST mathematics scale score per What Works Clearinghouse (2014) guidelines.
[e] Estimate adjusted for school enrollment, and district equal to Oakland or Pasadena per What Works Clearinghouse (2014) guidelines.
[f] Includes data for Antioch, Oakland, Pasadena, Porterville, and West Contra Costa for AY 2011–12.
[g] Estimate adjusted for districts equal to Oakland, and West Contra Costa; log enrollment; percent of school enrollment of students who are black, Hispanic, and Native American squared; which grade-eight CST mathematics subject assessment (advanced mathematics—Algebra I, Geometry, Algebra II—or general mathematics) was taken; and the interaction of the grade-eight mathematics subject and the grade-eight CST mathematics scale score per What Works Clearinghouse (2014) guidelines.
[h] Includes data for Antioch, Pasadena, Porterville, and West Contra Costa for AY 2012–13.
[i] Estimate adjusted for school enrollment, and district equal to Pasadena per What Works Clearinghouse (2014) guidelines.
SOURCE: Data collected by the Linked Learning District Initiative.

The results for the AY 2012–13 cohort were different. When Long Beach and Oakland were included there was no difference between LLCP and comparison group students in UC a–g completions, but LLCP students had a higher probability (.072 or 7.2 percent) of completing the CSU a–g requirements. Thus, in both cohorts LLCP students were more likely than comparison group students to meet the CSU a–g requirements.

After removing Long Beach and Oakland students from the analytic sample, LLCP students in AY 2012–13 were about 7 percent less likely than students in the comparison group to complete the UC a–g requirements; there was no statistically significant difference between the two groups in the probability of completing the CSU a–g requirements.

Table 7, in conjunction with table 6, provides conflicting evidence that LLCP students were better prepared for admission to a California public university than their matched comparison group peers. When the Long Beach students were included in the analysis for the AY 2011–12 cohort, LLCP participants appeared well prepared for admission to a California public university, since they were 6 percent more likely to complete the UC a–g requirements and almost 16 percent more likely to complete the CSU a–g requirements.

For the AY 2012–13 cohort, including Long Beach and Oakland students, LLCP students were about 7 percent more likely than comparison students to complete the CSU a–g requirements; LLCP and comparison group students had the same probability of completing the UC a–g requirements.

Alternatively, if Long Beach students in the AY 2011–12 cohort were not included, LLCP participants were no more likely than comparison group students to complete the UC a–g requirements, but they were 13 percent more likely to complete the CSU a–g requirements. When Long Beach and Oakland students in the AY 2012–13 cohort were not included, LLCP participants were about 7 percent less likely to complete the UC a–g requirements and no more likely than comparison group students to complete the CSU a–g requirements.

These contrasting results when the two districts without complete TES data were included or excluded underline the importance of working closely with districts to ensure that the information necessary to evaluate the outcomes for participation in an LLCP are available.

AVERAGE GPA FOR UNIVERSITY OF CALIFORNIA AND CALIFORNIA STATE UNIVERSITY A–G COURSES

The GPA analysis includes students regardless of whether or not they met the a–g subject requirements. TES calculates UC and CSU GPAs for all a–g courses on submitted transcripts. To ensure that GPAs were compared based on consistent criteria, this report used the TES-calculated UC and CSU GPAs rather than any high school-calculated GPAs. As with the overall a–g completion analyses described in the previous section, two separate GPA analyses were conducted for each of the AY 2011–12 and AY 2012–13 cohorts. For AY 2011–12 one analysis includes Long Beach students, while the second excluded them. Similarly, for the AY 2012–13 cohort, one analysis included students from Long Beach and Oakland, while the second excluded them. The results are shown in Table 8.[38]

[38] These results are based on data provided by TES. There were too few schools participating in TES to include the AY 2010–11 cohort.

Table 8: Adjusted marginal effects of participation in a Linked Learning certified pathway for grade-12 students on the average GPAs calculated for University of California and California State University a–g courses for the AY 2011–12 and AY 2012–13 grade-12 Linked Learning certified pathway and matched comparison group students

Including Long Beach (AY 2011–12, AY 2012–13) and Oakland (AY 2011–12, AY 2012–13)

Outcome	Cohort	Number of students	Marginal Effect[a]	Robust Standard error	*t*[b]	Significance
UC GPA	AY 2011–12[c, d]	2,648	0.08	0.05	1.83	0.068
	AY 2012–13[c, e]	2,578	-0.07	0.04	-1.77	0.076
CSU GPA	AY 2011–12[c, d]	2,648	0.09	0.05	1.77	0.077
	AY 2012–13[c, e]	2,578	-0.07	0.04	-1.77	0.076

Excluding Long Beach (AY 2011–12, AY 2012–13) and Oakland (AY 2011–12, AY 2012–13)

Outcome	Cohort	Number of students	Marginal Effect[a]	Robust Standard error	*t*[b]	Significance
UC GPA	AY 2011–12[f, g]	2,262	0.08	0.05	1.77	0.076
	AY 2012–13[f, h]	1,977	-0.26	0.05	-4.71	0.000
CSU GPA	AY 2011–12[f, g]	2,262	0.08	0.05	1.68	0.093
	AY 2012–13[f, h]	1,977	-0.26	0.05	-4.75	0.000

[a] Marginal effects for estimated average treatment on treated from ordinary least squares regression of UC/CSU GPA requirement on indicator for students participating in a Linked Learning certified pathway compared to matched comparison group students.
[b] The *t*-value is the difference between two estimates divided by the standard error of the difference.
[c] Data for Antioch, Oakland, Pasadena, Porterville, and West Contra Costa for academic year (AY) 2011–12 and AY 2012–13.
[d] Estimate adjusted for districts equal to Long Beach, Oakland, and West Contra Costa; log enrollment; percent of school enrollment of students who are black, Hispanic, and Native American squared; which grade-eight California Standards Test (CST) mathematics subject assessment (advanced mathematics—Algebra I, Geometry, Algebra II—or general mathematics) was taken; and the interaction of the grade-eight mathematics subject and the grade-eight CST mathematics scale score per What Works Clearinghouse (2014) guidelines.
[e] Estimate adjusted for school enrollment, and district equal to Oakland or Pasadena per What Works Clearinghouse (2014) guidelines.
[f] Includes data for Antioch, Oakland, Pasadena, Porterville, and West Contra Costa for AY 2011–12 and AY 2012–13.
[g] Estimate adjusted for districts equal to Oakland, and West Contra Costa; log enrollment; percent of school enrollment of students who are black, Hispanic, and Native American squared; which grade-eight CST mathematics subject assessment (advanced mathematics—Algebra I, Geometry, Algebra II—or general mathematics) was taken; and the interaction of the grade-eight mathematics subject and the grade-eight CST mathematics scale score per What Works Clearinghouse (2014) guidelines.
[h] Estimate adjusted for school enrollment, and district equal to Pasadena per What Works Clearinghouse (2014) guidelines.
SOURCE: Data collected by the Linked Learning District Initiative.

The estimated marginal effects for the AY 2011–12 cohort were of similar magnitude for both the UC and CSU GPAs regardless of whether Long Beach was included or excluded from the analytic sample. The apparent advantage for participation in an LLCP (about .08 GPA point) as compared with the average GPA for comparison group students was not statistically significant at the .05 level but it was at the $p \leq .1$ level.

Among members of the AY 2012–13 cohort, the positive associations between LLCP participation and GPA were reversed in the analyses that included and excluded Long Beach and Oakland. When Long Beach and Oakland were included, LLCP students had average UC and CSU GPAs that appeared to be .07 lower than comparison group students. These differences were not statistically significant at the .05 level, but they were both significant at the $p \leq .08$ level. When Long Beach and Oakland were excluded, LLCP students' GPAs were just over one-quarter of a GPA point (-.26) lower than the comparison group's GPAs.

The data available for this report do not provide an explanation for why TES outcomes varied from one cohort to the next. PSM ensures that the two groups of students, LLCP and matched comparisons, are equivalent on observable characteristics, but there are other factors, such as conflicting demands placed on LLCP students to meet both an academic and technical education curriculum or changes in the context in which Linked Learning was delivered, among other factors that may have come into play and affected student performance. More detailed observational information would be helpful in investigating these possible differences. In addition, the large amount of missing data for TES outcomes and the concomitant decision to include or exclude information for students in affected districts also affects estimates of the association between LLCP participation and outcomes. The LLDI works within constraints imposed by a district's ability and willingness to supply information. The differing TES outcomes for analyses, including and excluding districts with large amounts of missing information, demonstrate the importance assigned to persuading districts to supply complete information and the need for ongoing monitoring of data that are submitted.

ENROLLMENT AND PERSISTENCE IN POSTSECONDARY EDUCATION

Tables 6 through 8 show that LLCP students had higher rates of high school graduation and mixed experiences meeting eligibility criteria for admission to a California public university than their matched comparison group peers. Table 9 presents information on the association between participation in an LLCP and several postsecondary outcomes: the probability of enrollment any time after high school graduation, immediate enrollment after high school graduation, and one-year persistence.

Postsecondary outcomes were available for the AY 2010–11 and AY 2011–12 grade-12 cohorts and based on information provided by NSC for Antioch, Long Beach, Porterville, and West Contra Costa as of spring 2013. NSC data were unavailable for Pasadena students in the AY 2010–11 cohort, so outcomes were limited to only two districts, Long Beach and Porterville, in this year. In addition, Oakland used a different source for its postsecondary outcomes information. Since Oakland postsecondary enrollment information was not based on NSC data, marginal effects were estimated with and without Oakland for the AY 2011–12 cohort in order to provide a sense of how the results varied according to the use of a different source of postsecondary enrollment data for this district.[39] Oakland did not have an LLCP in AY 2010–11.

[39] Unlike the data for the other districts provided by NSC, for example, all of the Oakland students who had any postsecondary attendance were shown as entering immediately after graduating high school.

Table 9: Adjusted marginal effects of participation in a Linked Learning certified pathway for grade-12 students on the probability of postsecondary enrollment and persistence for the AY 2010–11, AY 2011–12 and AY 2012–13 grade-12 Linked Learning certified pathway and matched comparison group students

Outcome	Cohort	Number of students	Marginal Effect[a]	Robust Standard error	z[b]	Significance
Any Postsecondary enrollment[c]	AY 2010–11[d, e]	1,433	-0.028	0.03	-0.98	0.328
	AY 2011–12[f, g]	3,006	0.054	0.03	2.08	0.038
	AY 2011–12[h, i]	2,566	0.061	0.03	2.21	0.027
Immediate enrollment[j]	AY 2010–11[d, e]	1,052	0.018	0.03	0.60	0.551
	AY 2011–12[f, g]	2,151	0.010	0.02	0.51	0.607
	AY 2011–12[h, k]	1,711	0.005	0.02	0.27	0.790
One-year persistence[l]	AY 2010–11[d, e]	1,122	0.008	0.04	0.20	0.838

[a] Marginal effects for estimated average treatment on treated from logistic regression of postsecondary education measures indicators of participation in a Linked Learning certified pathway compared to matched comparison group students. Marginal effects represent difference for Linked Learning certified pathway students holding covariates at their mean values.
[b] The *z*-value is the difference between two estimates divided by the standard error of the difference with a normal distribution.
[c] "Any postsecondary enrollment" identifies students who enrolled at a postsecondary institution after leaving high school based on data from the National Student Clearinghouse for Antioch, Long Beach, Porterville, and West Contra Costa. Data for Oakland provided by a different source.
[d] Data for Long Beach and Porterville for academic year (AY) 2010–11
[e] Estimate adjusted for race/ethnicity equals black; log percent of school enrollment of students who are black, Hispanic, and Native American; and log percent of school eligible for the National School Lunch Program per What Works Clearinghouse (2014) guidelines.
[f] Includes data for Antioch, Long Beach, Oakland, Porterville, and West Contra Costa for AY 2011–12.
[g] Estimate adjusted for districts equal to Long Beach, Oakland, and West Contra Costa; log enrollment; percent of school enrollment of students who are black, Hispanic, and Native American squared; which grade-eight California Standards Test (CST) mathematics subject assessment (advanced mathematics—Algebra I, Geometry, Algebra II—or general mathematics) was taken; and the interaction of the grade-eight mathematics subject and the grade-eight CST mathematics scale score per What Works Clearinghouse (2014) guidelines.
[h] Includes data for Antioch, Long Beach, Porterville, and West Contra Costa for AY 2011–12.
[i] Estimate adjusted for districts equal to Long Beach, and West Contra Costa; log enrollment; percent of school enrollment of students who are black, Hispanic, and Native American squared; which grade-eight CST mathematics subject assessment (advanced mathematics—Algebra I, Geometry, Algebra II—or general mathematics) was taken; and the interaction of the grade-eight mathematics subject and the grade-eight CST mathematics scale score per What Works Clearinghouse (2014) guidelines.
[j] Immediate enrollment: Identifies students who enrolled at a postsecondary institution during the first summer or fall after leaving high school based on data from the National Student Clearinghouse for Antioch, Long Beach, Porterville, and West Contra Costa. Data for Oakland provided by a different source.
[k] Estimate adjusted for districts equal to Long Beach and West Contra Costa; log enrollment; percent school enrollment of students who are black, Hispanic, and Native American squared; which grade-eight CST mathematics subject assessment (advanced mathematics—Algebra I, Geometry, Algebra II—or general mathematics) was taken; and the interaction of the grade-eight mathematics subject and the grade-eight CST mathematics scale score per What Works Clearinghouse (2014) guidelines.
[l] "One-year persistence" identifies students who were continuously enrolled at a postsecondary institution for at least one year after leaving high school based on data from the National Student Clearinghouse for Long Beach and Porterville.
SOURCE: Data collected by the Linked Learning District Initiative.

The top panel of table 9 shows that LLCP students in the AY 2010–11 cohort were no more likely than their matched comparison group peers to attend a postsecondary institution by spring 2013. However, among AY 2011–12 students, LLCP students had a 5 or 6 percent

(with and without Oakland data, respectively) greater probability of enrolling in a postsecondary institution by spring 2013 than did comparison group students.

Students who delay enrollment in postsecondary education do so for a variety of reasons, but the evidence shows that students who delay are less likely to complete a degree than students who enter postsecondary education immediately after high school (Horn, Cataldi, and Sikora 2005; Bozick and DeLuca 2005).

The middle panel of table 9 shows the estimated difference between LLCP students and their matched comparison peers in the probability that grade-12 students enrolled in a postsecondary institution immediately after high school graduation. For this analysis, immediate entry was defined as enrolling by the fall following graduation (fall 2011 for the AY 2010–11 cohort and fall 2012 for the AY 2011–12 cohort). There were no differences in immediate enrollment for LLCP and comparison group students in either cohort nor was there any difference whether Oakland data were included or excluded.

The bottom panel of table 9 presents the results for persisting in postsecondary education one year after first enrolling. Among the AY 2010–11 students who enrolled in postsecondary education in fall 2011, there was no difference in postsecondary persistence into fall 2012 between LLCP students and their matched comparison group peers.

In sum, participation in an LLCP was associated with higher participation rates in postsecondary education for the AY 2011–12 cohort, and this finding was robust whether a single (NSC only) or a mixed data source was used for the analysis. There was no evidence of any positive association between LLCP participation and immediate enrollment in postsecondary education or in short-term (i.e., one-year) persistence between LLCP students and matched comparison group students.

Over time, these results may change as students who started their postsecondary studies after the cutoff date for the NSC data used in this report (spring 2013) enroll in postsecondary education. As the LLDI continues to collect data for new and existing cohorts, a more comprehensive assessment of the effects of an LLCP on the range of postsecondary outcomes will become available.

SUMMARY OF FINDINGS AND STUDY LIMITATIONS

This report is a secondary analysis of data collected as part of the LLDI. The analyses examined outcomes for three cohorts of grade-12 students—in AYs 2010–11, 2011–12, and 2012–13—in six California school districts. Data for the AY 2010–11 cohort were limited to three of the six districts and to only two districts for the postsecondary education outcomes. The analysis sample included students who participated in the same LLCP in grade 11 and grade 12, and compared their outcomes with those of their peers who attended the same high school in grades 11 and 12 but who were not in an LLCP. As the number of certified pathways—and the number of high school students enrolled in an LLCP—increases, research on the effects of LLCPs on academic outcomes should continue. Further, because many Linked Learning pathways often begin in grade nine, future studies should include students in grade nine and track their academic progress through high school and beyond. Doing so will provide a more accurate picture of the effects of certified Linked Learning Pathways.

PSM was employed to create groups of LLCP students and comparison group students who were similar on measured characteristics, such as gender, race/ethnicity, disability, and pre-high school achievement, and school characteristics, such as total enrollment, the percentage of students eligible for NSLP, the percentage of minority students, and teacher experience. Although PSM can create treatment and comparison groups that are similar to each other on measured characteristics, PSM is not as strong as an RCT in creating groups that are similar on both observable and unobservable factors. Thus, while the outcomes reported here are suggestive, they are not conclusive. It is possible that other factors not included in the models account for both participation in an LLCP and the differences in outcomes.

Differences in school quality may also have affected the findings. Students in the LLCPs and the matched comparison were not necessarily enrolled in the same high schools,[40] so participation in an LLCP may be confounded with school quality (for example, if LLCP

[40] This is more likely for comparison group students than for LLCP students. The percentage of LLCP students enrolled in high schools that also provided comparison group students in the three cohorts were 91 percent, 64 percent, and 67 percent for the AY 2010–11, AY 2011–12, and AY 2012–13 cohorts. The equivalent percentages for comparison group students were 30 percent, 18 percent, and 17 percent, respectively.

students attended better schools than did comparison group students). Further, three of the LLCPs (in the Long Beach Unified School District) may use grade-eight GPA as an admissions requirement.[41] To the degree that GPA is unrelated to other measures included in the statistical models used in this report, results for these three LLCPs may be confounded with students' preexisting academic ability.

There were a number of outcomes with high levels of missing data; for some measures all information from an LLDI district was missing for a particular cohort and in others, information was missing for large proportions of the comparison group. These gaps may affect some of the results reported here. In addition, the analyses do not include direct measures of student engagement in learning, and there are no measures of teacher characteristics or experience. There are no data linking students with particular teachers or classrooms—information that could be valuable in articulating how various aspects of an LLCP affects student outcomes.

Other studies currently under way will incorporate some of the information that was unavailable for this study, which in combination with the results reported here, will provide a more in-depth portrait of student participation in an LLCP.

With these limitations in mind, this study found some positive though inconsistent associations for LLCP participation on measures of student engagement, including attendance and disciplinary events. With respect to some of the key goals of Linked Learning, successful completion of high school and preparation for and enrollment in postsecondary education, there was mixed evidence.[42] For all three cohorts, LLCP students had a higher probability of completing high school. Including Long Beach in the analysis, LLCP students in the AY 2011–12 cohort had a higher probability of meeting overall UC/CSU a–g requirements (both subject and GPA) than matched comparison group students. And although LLCP students in the AY 2012–13 cohort were no more likely than comparison group students to complete the UC a–g requirements, LLCP students were about 7 percent more likely to meet the CSU a–g requirements. If districts with high proportions of missing TES data are excluded (Long Beach and Oakland), LLCP students in the AY 2012–13 cohort were about 6.6 percent less likely to meet the UC a–g requirements than comparison students. LLCP students in the AY 2011–12 cohort were 13 percent more likely than comparison group students to complete the CSU a–g requirements, even after excluding students from Long Beach, which accounted for a large proportion of the missing

[41] Only of the three, the Community of Musicians, Performers, Artists, and Social Scientists (COMPASS) requires a minimum GPA (2.5). The other two may use a "recommended" GPA as one of the entrance requirements.
[42] This study was unable to evaluate how well LLCPs prepared students for a career, which is considered equally as important as preparation for postsecondary education.

data. The results for UC and CSU GPAs were more consistent for each cohort. Regardless of whether districts with large proportions of missing data were included or excluded, LLCP students in the AY 2011–12 cohort had higher GPAs than did comparison group students, though these differences were small (about a .08 GPA point). Similarly, there was a consistent pattern of lower GPAs for LLCP students in the AY 2012–13 cohort for both the UC and CSU GPA measures. For the analyses excluding the two districts with large proportions of missing data in the AY 2012–13 cohort, the estimated effect for LLCP students was lower by about a quarter of a GPA point.

Two years of postsecondary enrollment data were examined. For the AY 2010–11 cohort, there was no difference between LLCP and comparison group students in the probability of enrolling in a postsecondary institution by spring 2013. For the AY 2012–13 cohort, however, LLCP students had a 5 percent greater probability of enrolling in a postsecondary institution by spring 2013 and this finding was robust whether or not data from Oakland, which reported postsecondary enrollment information from a different source than NSC, were used in the analysis. Other measures of postsecondary education, including immediate enrollment after high school graduation, and short-term (i.e., one-year) persistence, showed no differences between the LLCP and comparison group students.

IMPLICATIONS FOR POLICY AND PRACTICE

This report has shown mixed results for grade-12 students who participated in an LLCP and similar students who did not participate in an LLCP on measures of student engagement and preparation for postsecondary education, and positive differences for high school graduation. For one of the two years for which postsecondary enrollment data were available, LLCP students had a greater probability of enrolling than did comparison group students. There was no difference, however, in the probability of immediate enrollment or one-year persistence for the one cohort for which data were available (AY 2010–11). Educators and policymakers interested in improving high school student outcomes may find these results useful in evaluating the applicability of Linked Learning to their own context.

Unlike some high school reforms, Linked Learning has a well-developed infrastructure to support its growth and development. The voluntary certification process for Linked Learning pathways provides measurable standards against which pathways can be evaluated for adherence to the core components and principles of the Linked Learning model. Certification is one way that fidelity of implementation to the model can be achieved. At the same time, Linked Learning pathways are not required to undergo certification, and the specific implementation of particular programs may differ from the model incorporated in the certification process. In addition, the commitment of school and district staff to the Linked Learning model, the resources that individual districts have at hand, and their interest in allocating funds to develop and sustain a Linked Learning pathway will influence the benefits accruing to students. These factors were not evaluated in this study, so the results reported here should be viewed cautiously.

Linked Learning has gained broad support within California. The Linked Learning Alliance, a coalition of California educators, local education agencies, businesses, and community organizations supports the growth of Linked Learning in the state.[43] Both the California Department of Education and the California State Legislature have supported the wider development of the Linked Learning approach.

[43] Member organizations are listed at http://linkedlearning.org/linked–learning–alliance/our–members/

Districts and schools interested in developing pathways, as well as maintaining and improving existing ones, can draw upon the technical assistance provided by ConnectEd and its partners. ConnectEd has developed model curricula and made them available. Whether ConnectEd or a similar organization that can serve as a "standard bearer" to ensure fidelity of implementation is necessary to realize the apparent benefits of the Linked Learning approach is an open question, but it is one that should be considered. Similarly, as more schools and districts adopt Linked Learning there is a possibility that the extensive support early adopters have been offered by ConnectEd may be reduced.

This study was unable to address a number of important questions that should be part of a research agenda for assessing the value of Linked Learning to improve student outcomes. First, although the analyses conducted for this report were able to document several positive outcomes for participants in an LLCP, they could not identify what components of the LLCP are the most effective in improving these outcomes. Close, systematic observation of LLCPs is needed to tease out the role of different elements in the Linked Learning model. Second, individual LLCPs were not examined here, so the effectiveness of one type of LLCP compared with another remains an open question. As more students enroll in pathways, the number of cases will increase accordingly, permitting these comparisons to be examined quantitatively as well as qualitatively. Third, the "fit" of particular types of Linked Learning pathways for particular types of students is of interest. Educators with diverse student bodies that have multiple industry sectors as potential partners in their communities will want evidence about whether particular types of Linked Learning pathways are associated with better outcomes for their students.

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APPENDIX A. LIST OF LINKED LEARNING CERTIFIED PATHWAYS INCLUDED IN THE ANALYSES BY DISTRICT

Antioch Unified School District

- Dozier–Libbey Medical High School

Long Beach Unified School District

- Architecture, Construction, and Engineering Academy (ACE at Jordan High School)
- California Academy of Mathematics and Science (CAMS)
- Community of Musicians, Performers, Artists, and Social Scientists (COMPASS at Millikan High School)
- Personal Success Through Empowerment, Academic Achievement, Conflict Resolution, and Ethics in Action (PEACE at Millikan High School)

Oakland Unified School District

- Skyline Education Academy (Skyline High School)
- Life Academy of Health and Bioscience

Pasadena Unified School District

- Arts, Entertainment, and Media Academy (AEM at John Muir High School)
- Business and Entrepreneurship Academy (BE at John Muir High School)
- Creative Arts, Media, and Design Academy (CAMAD at Pasadena High School)
- Engineering and Environmental Science Academy (EESA at John Muir High School)

Porterville Unified School District

- Academy of Engineering (Harmony Magnet Academy)
- Academy of Performing Arts (Harmony Magnet Academy)
- Digital Design and Communication Academy (DDC at Granite Hills High School)
- Multimedia and Technology Academy (MTA at Monache High School)
- Partnership Academy of Business (PAB at Porterville High School)
- Health Careers Academy (Porterville High School)

West Contra Costa Unified School District

- Engineering Academy (Richmond High School)
- Law Academy (Richmond High School)
- Multimedia Academy (Richmond High School)

APPENDIX B. DESCRIPTION OF LINKED LEARNING CERTIFIED PATHWAYS INCLUDED IN THE STUDY

The following information was drawn primarily from school websites and news articles.

ANTIOCH UNIFIED SCHOOL DISTRICT

Dozier-Libbey Medical High School

The Dozier-Libbey Medical High School, an autonomous, stand-alone high school, opened in August 2008 and currently serves 640 students in grades nine through 12. Enrollment is determined through a district-wide application and lottery system. The Health Science and Medical Technology Pathway at Dozier-Libbey Medical High School received Linked Learning certification in the 2010–11 AY.

The curriculum prepares students for careers in health-related fields by offering specialized courses and projects exploring medical careers, ethical and legal practices, global medicine, and employability skills. Each year's curriculum is structured around a particular theme: nutrition and fitness (grade nine), complementary and alternative medicine (grade 10), life cycle (grade 11), and medical ethics (grade 12). In grade nine, students also take a medical terminology course offered by Los Medanos Community College and may receive up to three college credits in receipt of a B grade or higher. Throughout their four years, students take courses in advanced math and two additional years of science, which exceeds the University of California (UC) "a–g" course requirements. The recommended four-year course sequence is as follows:

- Grade nine—English 9, Algebra I or Geometry, Biology, Foreign Language or Visual/Performing Arts, Physical Education, Health Science 1, Explorations, Guided Study Tours
- Grade 10—English 10 or Honors English, Geometry or Algebra II, Chemistry or Honors Chemistry, Foreign Language or Visual/Performing Art, World History or AP World History, Physical Education/Health Education, Health Science 2, Explorations, Guided Study Tours, Community Service/Service Learning, e–mentoring

- Grade 11—English 11 or AP English, Algebra II/Trig or Pre-Calculus, Human Anatomy Physiology, AP Biology (elective), Regional Occupational Programs (ROP) (Emergency Medical Care, Sports Medicine, Veterinary Science), Foreign Language or Visual/Performing Arts, U.S. History or AP U.S. History, Health Science 3, Community Service/Service Learning, Summer Externships, Job Shadowing
- Grade 12—English 12 or AP English, Pre-Calculus/AP Calculus/AP Statistics/Medical Math, Physics, AP Biology (elective), ROP (Emergency Medical Care, Sports Medicine, Veterinary Science), Government/Civics Economics, Medical Ethics, Integrated Externships, Internships, Community Service/Service Learning, Volunteer Activity, Employment

Throughout the four-year program, students engage in various work-based learning activities, such as guided study tours, guest speakers, internships, job shadowing, and community service learning. The biannual Career, College, and Community (C3) Day is an opportunity for students to hear, speak with, and learn from college representatives, college students, and health professionals. The school also strongly encourages student membership in the Health Occupations Students of America (HOSA).

Dozier-Libbey Medical High School partners with many local industry businesses and organizations, including Los Medanos College; Facing History and Ourselves; Kaiser Permanente, Antioch; Emerald HPC International, Inc.; California State University (CSU), East Bay; Sutter Delta Medical Center; Labor Occupational Health Program, UC Berkeley; Community Clinic Consortium/California Area Health Education Center Program; John Muir Health; Health Occupation Students of America (HOSA): Future Health Professionals; Costa Medical Career College; and Contra Costa County Office of Education.

LONG BEACH UNIFIED SCHOOL DISTRICT

Architecture, Construction, and Engineering Academy (ACE) at Jordan High School

Established in 2007, the Architecture, Construction, and Engineering Academy (ACE) operates as a school-within-a-school at Jordan High School. The ACE Academy serves approximately 280 students in grades nine through 12. A California Partnership Academy, the ACE Academy received Linked Learning certification in 2010. Prospective students must apply to ACE as a secondary specialized program through Long Beach Unified School District's School of Choice application, complete an additional supplemental application, and hold at least a 2.0 GPA.

The curriculum at ACE Academy meets the UC "a–g" course sequence requirements while also preparing students for a variety of post-graduation pathways, including college, trade and technical certification programs, apprenticeships, and entry-level jobs. All courses offered at the ACE Academy, including the academic core, are available only to students enrolled in the academy. Every year, students in each grade must work collaboratively to complete an interdisciplinary, environmentally-based project, such as the grade-nine "WIND" project turbine. Students in grades 11 and 12 have the opportunity to dual enroll at CSU Long Beach and Long Beach Community College.

ACE Academy's sequence of courses is as follows:

- Grade nine—English 1–2; Biology 1–2; Reading or Literature Workshop; Core Career and Technical Education (CTE) Wheel: Architecture, Construction, or Engineering (one semester); ACE Algebra 1–2 or ACE Geometry 1–2; Health (one semester); Physical Education
- Grade 10—English 3–4; Environmental Science; Modern World History; Core CTE: Construction 1–2; ACE Major: Architecture 1–2, Construction 3–4, or Engineering 1–2; ACE Geometry 1–2 or ACE Algebra III; Foreign Language; Physical Education or Athletics
- Grade 11—English 5–6; ACE Chemistry; U.S. History; Core CTE: Architecture 1–2; ACE Major: Architecture 3–4, Construction 5–6, or Engineering 3–4; ACE Algebra II or ACE Pre–Calculus; Foreign Language
- Grade 12—Rhetoric and Composition; ACE Government and Economics; ACE Physics; Core CTE: Engineering 1–2; ACE Major: Architecture 5–6, Construction 7–8, or Engineering 5–6; ACE Pre–Calculus or ACE Calculus; Foreign Language

Among the work-based learning opportunities provided to ACE students are field trips—past trips have been to construction sites to observe "green" building and to wetlands to study wildlife preservation—guest speakers, mentorships, and internships for the academy's grade-11 and 12- students. ACE, in partnership with the Port of Long Beach, CSU Long Beach, and Long Beach Community College, also hosts a variety of lectures and workshops aimed at building students' employability skills and introducing them to various career paths in the fields of architecture, construction, and engineering. Prior to graduation, students are also required to have completed at least 40 hours of community service.

ACE partners include Turner Construction; CSULB–Division of Academic Affairs; IBEW Local II Los Angeles Electricians; JCA Resources, Inc.; LBCC School of Trades and Industrial Technologies; Pacific Gateway Workforce Investment Network; SimonGlover Inc.; UA Local 250 of So. Ca. Steamfitters/AC/Refrigeration.

California Academy of Math and Science (CAMS)

The California Academy of Math and Science (CAMS), a magnet school located on the CSU Dominguez Hills campus, was established in 1990 and serves approximately 670 students in grades nine through 12. The Engineering and BioScience Pathway at CAMS received Linked Learning certification in the 2010–11 AY. Incoming grade-nine students with at least a 3.0 GPA are eligible for CAMS enrollment. Students may apply to CAMS as a Secondary Specialized Program through Long Beach Unified School District's School of Choice application and must also complete an additional supplemental application. Since CAMS is located on the CSU Dominguez Hills campus, students may dual enroll in college courses.

The core curriculum is as follows:

- Grade nine—Geometry, Accelerated Biology, Engineering Design, Accelerated English, Computer Science, Foreign Language
- Grade 10—Intermediate Algebra, Biotechnology 1–2, Principles of Engineering, Accelerated English, Accelerated Modern World History, Foreign Language
- Grade 11—Pre–Calculus, Honors Chemistry, Biotechnology 3–4, Honors English, Honors U.S. History, Foreign Language (recommended)
- Grade 12—AP Calculus, Physics/AP Physics/University Physics, AP English Literature, U.S. Government and Economics, Foreign Language (recommended)

Community of Musicians, Performers, Artists, and Social Scientists (COMPASS) at Millikan High School

A Secondary Specialized Program at Robert A. Millikan High School, the Community of Musicians, Performers, Artists, and Social Scientists (COMPASS) integrates a college preparatory curriculum with social sciences and the arts to support students interested in careers in the arts, media, and entertainment. Granted Linked Learning certification in the 2010–11 AY, COMPASS serves approximately 660 students in grades nine through 12. Students with at least a 2.5 GPA are eligible to apply to COMPASS as a Secondary Specialized Program through Long Beach Unified School District's School of Choice application.

In addition to the UC a–g course sequence, students enrolled in COMPASS take specialized courses related to the pathway students select in grade nine to pursue throughout the four-year curriculum. Students may select one of the six following pathways in visual or performing arts: fine arts, graphic arts, drama, dance, instrumental music, and vocal music. The recommended four-year course sequence for the core curriculum is as follows:

- Grade nine—English 1–2; Algebra 1–2 or AB Geometry 1–2; Earth Lab Science; German 1–2, Spanish 1–2, French 1–2, or Italian 1–2; Physical Education; Health or Computer Applications
- Grade 10—Modern World History or AP World History; English 3–4; Geometry 1–2 or Intermediate Algebra; Biology; German 3–4, Spanish 3–4, French 3–4, or Italian 3–4; Physical Education
- Grade 11—U.S. History or AP U.S. History; English 5–6 or AP English Language; Intermediate Algebra or Pre-Calculus; Chemistry; German, Spanish, French, or Italian (recommended)
- Grade 12—Government or Economics (AP options available); Rhetoric and Composition, Multicultural Literature, Film Analysis, or AP English Literature; fourth year of math (recommended); fourth year of science (recommended)

The recommended CTE and elective courses by pathway are as follows:

Visual Arts: Fine Arts

- Grade nine—Drawing and Painting 1–2
- Grade 10—Drawing and Painting 3–4 or 3–D Art 1–2
- Grade 11—Drawing and Painting 5–6 or 3–D Art 1–2 or 3–4
- Grade 12—Drawing and Painting 7–8 or AP Art Studio

Performing Arts: Drama

- Grade nine—Drama 1–2
- Grade 10—Advanced Drama
- Grades 11 and 12—Advanced Drama or Play Production

Performing Arts: Dance

- Grades nine and 10—Beginning Dance, Intermediate Dance, or Advanced Dance
- Grades 11 and 12—Intermediate Dance or Advanced Dance

Performing Arts: Vocal Music

- Grade nine—Cecilian Singers 1–2, Varsity Chorale 1–2, or Voice/Chorus
- Grade 10—Cecilian Singers 3–4, Varsity Chorale 3–4, or Concert Choir/Vocal Ensemble
- Grade 11—Cecilian Singers 5–6, Varsity Chorale 3–4, or Concert Choir/Vocal Ensemble
- Grade 12—Cecilian Singers 7–8, Varsity Chorale 3–4, or Concert Choir/Vocal Ensemble

Performing Arts: Instrumental Music

- All four years—Jazz Ensemble, Symphonic Winds, Concert Band, Orchestra, or Marching Band (one semester)
- Ideological Capstone and Suggested Social Science Electives
- Grade 11—AP Psychology, Creative Writing, AP Music Theory, AP Art History, or Yearbook Production
- Grade 12—Sociology and Current Events (Capstone course), Creative Writing, AP Psychology, AP Art History, or Yearbook Production

Community service and enrichment opportunities are also integral to the COMPASS programming. Opportunities include an arts partnership with Emerson Parkside Academy Charter School for grade-nine students, a visit to the World War I Museum in grade 10, arts partnerships with Mary Bethune Transitional Center for the Homeless and Comprehensive Child Development Center in grade 12, and volunteering as Beach Walk organizers for the Children's Hospital, also in grade 12. In addition, work-based learning courses are available to students in grades 11 and 12 and include careers with children and graphic design.

Personal Success through Empowerment, Academic Achievement, Conflict Resolution, and Ethics in Action (PEACE) at Millikan High School

A small learning community within Millikan High School, Personal Success through Empowerment, Academic Achievement, Conflict Resolution, and Ethics in Action (PEACE) serves approximately 750 students in grades nine through 12. Granted Linked Learning certification in the 2010–11 AY, PEACE emphasizes careers in government, nonprofit organizations, and legal services. Students with at least a 2.75 GPA are eligible for enrollment at PEACE. Students may apply to PEACE as a secondary specialized program through Long Beach Unified School District's School of Choice application.

PEACE's specialized curriculum focuses on classes and projects designed to highlight current social issues, community involvement, leadership, and collaboration. While PEACE students take core curriculum classes (English, history, math, and science) with their PEACE classmates, they take their elective classes (PE, visual/performing arts, foreign language) with the entire high school cohort. Students complete one major project every year that integrates academics with the public service pathway: Energy Project (grade nine); Heifer International Project (grade 10); Mock Trial Project (grade 11); ELEVATE Senior Project (grade 12). The standard course sequence is as follows:

- Grade nine—English 1–2, Algebra 1–2 or Geometry 1–2, Earth Lab Science, World Languages 1–2 (Spanish, French, German, or Italian), Visual/Performing Arts elective, Physical Education or sports. In addition, grade-nine students can take Geography or Computer Applications as college-preparatory electives.

- Grade 10—Modern World History: International Negotiations or AP World History, English 3–4, Geometry 1–2 or Intermediate Algebra, Biology, World Languages 3–4, Visual/Performing Arts elective, Physical Education or sports. College-preparatory electives available to grade-10 students are Sociology and Intro to Public Service (Career Exploration), both one-semester long.

- Grade 11—U.S. History: Focus on Women or AP U.S. History, English 5–6: Focus on Women or AP English Language, Intermediate Algebra or Pre-Calculus, Chemistry, World Languages 5–6. Grade 11-students may take Criminal/Civil Law and/or Psychology as one-semester long college-preparatory electives.

- Grade 12—one semester of Economics: International Negotiations or AP Economics, one semester of Government or AP Government (U.S. or Comparative), ERWIC (College prep reading and writing) or AP English Literature, Pre-Calculus or AP Calculus, Science elective, World Languages 6–7 or AP World Language (Spanish

Language, Spanish Literature, French, or German). Grade-12 students have the option to take Forensics as a college-preparatory elective, but all seniors must complete a Philosophy Capstone their senior year in order to graduate.

Work-based learning opportunities extend throughout the four-year curriculum and include various service learning projects, career days, and guest speakers. Students are also expected to complete at least 115 hours of community service by graduation.

PEACE's partners include Heifer International, Mary Bethune Transitional Center for the Homeless, Boeing, Long Beach Education Foundation, Long Beach Rescue Mission, and Miller's Children's Hospital.

OAKLAND UNIFIED SCHOOL DISTRICT

Skyline Education Academy at Skyline High School

Skyline Education Academy, a California Partnership Academy, is a small learning community at Skyline High School. Through a three-year program, serving approximately 130 students in grades 10 through 12, the academy aims to prepare students for a variety of careers in education and child and family psychology. Skyline Education Academy received Linked Learning certification in the 2011–12 AY. Enrollment is determined through Oakland Unified School District's Options Enrollment, which uses a ranking and lottery system to place students in district high schools.

The academy's core and elective classes are available exclusively to students enrolled in the academy. The sequence of courses is as follows:

- Grade 10—English 2, World History, Chemistry, Introduction to Education
- Grade 11—English 3, U.S. History, Educational Psychology
- Grade 12—English 4, Government/Economics, Peer Education

Through Exploring College, Career and Community Options (ECCCO), the Skyline Education Academy provides its students with college and career preparation through career explorations, college readiness, and internships, which students participate in during grade 12.

Skyline Education Academy partners include Teach Tomorrow in Oakland, Junior Achievement, One Land One People Youth Center, Oakland Kids First PASS Program, Merritt College Department of Child Development, Mills College Department of Education, Tobacco Use Prevention Education (TUPE), buildOn, and TRIO.

Life Academy of Health and Bioscience

Established in fall 2001, Life Academy is a small, autonomous public high school that serves approximately 170 students in grades nine through 12. A California Partnership Academy, Life Academy received Linked Learning certification in January 2011 for its Life Academy of Health and Biosciences Pathway. Student enrollment at Life Academy is determined through the Oakland Unified School District's (OUSD) Options Enrollment. In the 2013–14 AY, Life Academy additionally served grades six and seven, and expansion to additional middle school grades will continue in future years.

Graduation requirements at Life Academy are aligned to UC and CSU entrance requirements. Students at Life Academy select one of three career pathways to specialize in: medicine,

biotechnology, or mental health. In grades 11 and 12, students are required to complete internships related to their chosen pathway and present on their internships at the Spring Health Fair and Internship Expo. In order to complete each academic course, students must pass assessments called "certifications," which can be in the form of tests, projects, or presentations. Students must also successfully pass two major performance reviews called "defenses" in grade 10 and grade 12. The grade 10 defense is an interdisciplinary presentation centered on a topic in mental illness, and the grade 12 defense, the Senior Investigative Project, is a research project and oral presentation on a topic related to the students' internships. Additionally, students are required to take two science courses in grades 11 and 12. A typical four-year course sequence is as follows:

- Grade nine—English, Social Science, Algebra or Geometry, Biology, Physical Education or Art, Ethnic Studies
- Grade 10—Humanities, Geometry or Algebra II, Advanced Biology, Physical Education or Art, Spanish I
- Grade 11—Humanities, Algebra II or Pre-Calculus, Chemistry, Physiology I, Internship, Spanish II
- Grade 12—English, College Writing, Government/Economics, Physics, Physiology II, Internship, AP Spanish (optional)

Life Academy's industry partners include Oakland Children's Hospital, Youth Bridge of Alta Bates, Highland Hospital, FACES for the Future, Planned Parenthood, Home Project: A Program of Alternatives in Action, Mercy Retirement and Care Center, Chabot Space and Science Center, Alternatives in Action, and the Native American Health Center.

PASADENA UNIFIED SCHOOL DISTRICT

Arts, Entertainment, and Media Academy (AEM) at John Muir High School

A small learning community within John Muir High School, the Arts, Entertainment, and Media Academy (AEM) was established in fall 2008 and serves approximately 470 students in grades nine through 12. Students enroll in one of the school's three Linked Learning pathways. Students may apply to the AEM Academy through Pasadena Unified School District's Open Enrollment program. A California Partnership Academy, the AEM Academy received Linked Learning certification in the 2010–11 AY.

The AEM Academy curriculum exceeds the a–g course requirements for UC admissions. Specialized courses and electives center on the exploration of three relevant career pathways: performance, film and video production, and graphic design and visual fine art. The standard course sequence is as follows:

- Grade nine—English 1/Puente English 1, Algebra 1/Geometry, Biology, Introduction to Art and Media Design, Physical Education
    - Support Courses/Additional Electives: Algebra Applications, Music Appreciation, Journalism News, Achievement via Individual Determination program (AVID) 9, English 1 Extension
- Grade 10—English 2/Puente English 2, Algebra 1/Geometry/Algebra 2, Biology/Chemistry, World History/AP European History, Film and Video Production, Physical Education, World Language (Spanish 1–3/Spanish Native Speaker 2–3/AP Spanish), Visual/Performing Art (Chorus, Advanced Chorus, Beginning Band, Advanced Band, Music Appreciation)
    - Support Courses/Additional Electives: Composition II, AVID 10, Animation, Graphic Design, Government Fund (ASB), Graphic Design 2 (Yearbook), Journalism News
- Grade 11—English 3/AP English Language, Geometry/Algebra 2/Advanced Math/AP Calculus, Chemistry/Physics/Biotech/AP Biology/AP Chemistry, US History/AP US History, Film and Video Production, World Language (Spanish 1–3/Spanish Native Speaker 2–3/AP Spanish), Visual/Performing Art (Chorus, Advanced Chorus, Beginning Band, Advanced Band, Music Appreciation)

  - Support Courses/Additional Electives: Composition III, Studio Art, Ceramics, AP Studio Art, AVID 11, Animation, Graphic Design, Government Fund (ASB), Graphic Design 2 (Yearbook), Journalism News

- Grade 12—English 4/AP English Language, Geometry/Algebra 2/Advanced Math/AP Calculus, Chemistry/Physics/Biotech/AP Biology/AP Chemistry, Government, Film and Video Production 2, World Language (Spanish 1–3/Spanish Native Speaker 2–3/AP Spanish), Visual/Performing Art (Chorus, Advanced Chorus, Beginning Band, Advanced Band, Music Appreciation)
  - Support Courses/Additional Electives: Composition III, Studio Art, Ceramics, AP Studio Art, AVID 12, Animation, Graphic Design, Government Fund (ASB), Graphic Design 2 (Yearbook), Journalism News

Beginning in grade 10, students begin to build their portfolios, which include a resume and samples of course-based projects. Students are also expected to complete 100 hours of community service by the end of grade 10. In grade 11, students begin an internship program, which extends through the end of grade 12. In addition to completing both their internship and portfolio, grade-12 students must complete a senior project. They are also encouraged to take courses at Pasadena City College. Upon successful completion of the AEM curriculum, students receive both an AEM medallion and a specialized high school diploma.

Guest speakers, field trips, job shadows, and technical guidance are offered to students each year. The academy also offers the ECCCO curriculum, which provides students with a Career Development and a Career Exploration Visit to a local business each year in grades 10 through 12, as well as a college visit in grades 10 and 11 and an internship in grade 12. CTE Career Essentials are offered to students all four years. Students also take a specialized work-based learning course every year: Career Awareness (grade nine); Career Exploration (grade 10); Career Preparation: Practicum and Internships (grade 11); and Career Training (grade 12).

Business and Entrepreneurship Academy (BE) at John Muir High School

Established in fall 2008 as a small learning community at John Muir High School, the Business and Entrepreneurship Academy (BE) serves approximately 350 students in grades nine through 12. Students apply to BE through Pasadena Unified School District's Open Enrollment program. All students attending John Muir High School are enrolled in one of the three Linked Learning pathways. A California Partnership Academy, the Business and Entrepreneurship Academy received Linked Learning certification in the 2010–11 AY.

The curriculum at the Business and Entrepreneurship Academy is modeled after the National Academy Foundation (NAF) curriculum, providing its students with coursework aligned to the UC "a–g" course sequence requirements and additional specialized courses designed to develop students' business and entrepreneurial skills. Specialized CTE courses cover the following topics: Accounting; Business Communications; Business Management; Finance; Financial Literacy; Introduction to Business; Marketing; Small Business Ownership; and Stocks, Bonds, and Investments. The standard course sequence is as follows:

- Grade nine—English 1/Puente English 1, Algebra 1/Geometry, Biology, Principles of Finance, Physical Education
    - Support Courses/Additional Electives: Algebra Applications, Spanish 1, Spanish Native Speaker 2, AVID 9, English 1 Extension
- Grade 10—English 2/Puente English 2, Algebra 1/Geometry/Algebra 2, Biology/Chemistry, World History/AP European History, Principles of Finance, Physical Education, World Language (Spanish 1–3/Spanish Native Speaker 2–3/AP Spanish), Visual/Performing Art (Chorus, Advanced Chorus, Beginning Band, Advanced Band, Music Appreciation)
    - Support Courses/Additional Electives: Composition II, AVID 10, Animation, Graphic Design, Government Fund (ASB), Graphic Design 2 (Yearbook), Journalism News
- Grade 11—English 3/AP English Language, Geometry/Algebra 2/Advanced Math/AP Calculus, Chemistry/Physics/Biotech/AP Biology/AP Chemistry, US History/AP US History, Principles of Finance, World Language (Spanish 1–3/ Spanish Native Speaker 2–3/AP Spanish), Visual/Performing Art (Chorus, Advanced Chorus, Beginning Band, Advanced Band, Music Appreciation)
    - Support Courses/Additional Electives: Composition III, Studio Art, Ceramics, AP Studio Art, AVID 11, Animation, Graphic Design, Government Fund (ASB), Graphic Design 2 (Yearbook), Journalism News
- Grade 12—English 4/AP English Language, Geometry/Algebra 2/Advanced Math/AP Calculus, Chemistry/Physics/Biotech/AP Biology/AP Chemistry, Economics, Business Management/Entrepreneurship, World Language (Spanish 1–3/Spanish Native Speaker 2–3/AP Spanish), Visual/Performing Art (Chorus, Advanced Chorus, Beginning Band, Advanced Band, Music Appreciation)
    - Support Courses/Additional Electives: Composition III, Studio Art, Ceramics, AP Studio Art, AVID 12, Animation, Graphic Design, Government Fund (ASB), Graphic Design 2 (Yearbook), Journalism News

Students progress through the four–year program as a cohort and complete specialized projects, which include the development and presentation of small business plans, creation and marketing of novel products, and opportunities in job shadowing, mentorships, and internships. In addition, students have the opportunity to work on Muir Ranch, an on-campus urban farm that teaches students business skills through paid internships and community service hours. The academy also offers the ECCCO curriculum, which provides students with a Career Development and a Career Exploration Visit to a local business each year for grades 10 through 12, as well as a college visit in grades 10 and 11 and an internship in grade 12. CTE Career Essentials are offered to students all four years of the curriculum. Students also take a specialized work-based learning course every year: Career Awareness (grade nine), Career Exploration (Grade 10), Career Preparation: Practicum and Internships (Grade 11), and Career Training (Grade 12). Upon successful completion of the BE curriculum, students receive both a BE medallion and a specialized high school diploma.

Creative Arts, Media and Design Pathway (CAMAD) at Pasadena High School

The Creative Arts, Media and Design Pathway (CAMAD) at Pasadena High School serves approximately 330 students in grades nine through 12. CAMAD received Linked Learning certification in the 2010–11 AY. Students apply to CAMAD through Pasadena Unified School District's Open Enrollment program.

In Grade 10, students select one of two concentrations: Visual Arts (CTE VADA) and Design or Graphic Communications (CTE GCA). Special opportunities available to CAMAD students include the opportunity to work in the student-run print shop, create artwork for public display, and become familiar with Adobe Creative Suite software. Scholarship and internship opportunities with pathway partners and local organization are also available. The standard course sequence is as follows:

- Grade nine—English 1/English 1 Honors, Algebra 1/Geometry, Biology/AP Biology, Computer Applications, Physical Education, Spanish 1/French 1
    - Support Services: Sycamores, Pasadena LEARNs, Safe School Teams, Learning Resource Lab
- Grade 10—English 2/English 2 Honors, Geometry/Algebra 2/Career Math, Biology/Chemistry, World History/World History Honors/AP European History, Studio Art 1 [CTE VADA]/ Graphic Design 1 [CTE GCA], Spanish 2/French 2
    - Support Services: Sycamores, Pasadena LEARNs, SST's, Learning Resource Lab, Teacher Mentoring, Online classes

- Grade 11—English 3/English 3 Honors/AP English Language, Algebra 2/ Advanced Math, Chemistry/Physics, US History/US History Honors/AP US History, Studio Art 2 [CTE VADA]/ Graphic Design 2 [CTE GCA], Spanish 3/French 3
    - Support Services: Sycamores, Pasadena LEARNs, SST's, Learning Resource Lab, Teacher Mentoring, Online classes
- Grade 12—English 4/English 4 Honors/AP English Literature, Advanced Math/ AP Calculus, Physics/AP Physics/AP Biology, American Government/American Government Honors/AP Government/Economics/ Economics Honors, Portfolio Development [CTE VADA]/Printmaking Occupations [CTE GCA], Physical Education, AP Spanish, AP Art
    - Support Services: Sycamores, Pasadena LEARNs, SST's, Learning Resource Lab, Teacher Mentoring, Online classes

The academy also offers the ECCCO curriculum, which provides students with a Career Development and a Career Exploration Visit to a local business each year for grades 10 through 12, as well as a college visit in grades 10 and 11 and an internship in grade 12. CTE Career Essentials are offered to students all four years of the curriculum. Students also take a specialized work-based learning course every year: Career Awareness (grade nine); Career Exploration (grade 10); Career Preparation: Practicum and Internships (grade 11); and Career Training (grade 12).

Engineering and Environmental Science Academy (EESA) at John Muir High School

Established in fall 2008, the Engineering and Environmental Science Academy (ESSA) at John Muir High School serves approximately 350 students in grades nine through 12 and received Linked Learning certification in the 2012–13 AY. Students apply to EESA through Pasadena Unified School District's Open Enrollment program. All students at John Muir High School are enrolled in one of the three Linked Learning pathways offered at the school.

EESA is modeled after the National Academy Foundation's Engineering Academy, which adopts the engineering curriculum developed by Project Lead the Way (PLTW). Specialized CTE courses available are Building and Construction, Environmental Science 1 (dual enrollment with Pasadena City College), Introduction to Engineering Design, and Principles of Engineering. The standard course sequence is as follows:

- Grade nine—English 1, World Geography/Composition, Physics, Algebra 1/Geometry, Biology, Introduction to Engineering Design, Physical Education

- Support Courses/Additional Electives: Algebra 1 Extension, Seminar 9 (Introduction to Engineering Design Extension)

- Grade 10—English 2, World History, Biology, Algebra 2/Geometry, Biology, Principles of Engineering, Physical Education
  - Support Courses/Additional Electives: Studio Art, Music, Spanish, AVID/Composition

- Grade 11—English 3/AP Language, US History/AP US History, Chemistry/Biotech, Algebra 2/Advanced Math, Digital Electronics, Physical Education
  - Support Courses/Additional Electives: Studio Art, Music, Spanish, Construction, Auto Tech, PLTW Concentration Course, Civil and Architectural Engineering, Aerospace Engineering

- Grade 12—English 4/AP Literature, Government/Economics, AP Biology/AP Chemistry/Environmental Science 1, Advanced Math/AP Calculus, Engineering Design and Development, Physical Education
  - Support Courses/Additional Electives: AP Studio Art, Music, AP Spanish, Construction, Auto Tech, PLTW Concentration Course, Digital Electronics, Civil and Architectural Engineering, Aerospace Engineering

Students progress through the four-year program as a cohort and complete special projects, receive technical mentoring, and participate in field trips, job shadowing, and internship opportunities. Upon successful completion of the EESA curriculum, students receive both an EESA medallion and a specialized high school diploma.

PORTERVILLE UNIFIED SCHOOL DISTRICT

Academy of Engineering at Harmony Magnet Academy

Harmony Magnet Academy opened in 2008 and serves approximately 500 students in grades nine through 12. Enrollment at Harmony Magnet Academy is determined through Porterville Unified School District's Pathway Programs application, which relies on a ranking and lottery system to place students in district pathways. Students at Harmony Magnet Academy choose one of two pathways in which to enroll: the Academy of Engineering or the Academy of Performing Arts. The Academy of Engineering received Linked Learning certification in the 2010–11 AY and serves approximately 280 students. Supported by NAF, the Academy of Engineering offers a STEM-rich curriculum developed by Project Lead the Way. The typical course sequence is as follows. College preparatory courses are designated by a "P":

- Grade nine—English 1P Composition or Accelerated; Integrated Math 1P or Geometry P; Earth Science P or Chemistry P/AP; Spanish 1P, Chinese 1P, or French 1P; Physical Education 1 or Health; Introduction to Engineering Design P
- Grade 10—English 2P Composition or Honors; Algebra 2P or Geometry P; Biology P/AP; World History P or Honors; Spanish 2P, Chinese 2P, or French 2P; Physical Education 2; Digital Electronics P or Civil Engineering and Architecture P
- Grade 11—English 3P Composition or AP English; Algebra 2P or Pre-Calculus P; Chemistry P/AP, Physiology P, or Physics P/AP; U.S. History P/AP; Spanish 3P, Chinese 3P, or French 3P; Physical Education 2; Aerospace Engineering P or Principles of Engineering P
- Grade 12—Expository Reading and Writing P, English 4P Composition, or AP English; Pre-Calculus P, Calculus P/AP, Statistics P/AP, Chemistry P/AP, Physics P/AP, or Biology P/AP; Spanish 4P or French 4P; Physical Education 2; Civics P/AP or Economics P; Biotechnical Engineering P or Computer Integrated Manufacturing P

Academy of Performing Arts at Harmony Magnet Academy

Harmony Magnet Academy, located in the Porterville Unified School District, opened in 2008 and serves approximately 500 students in grades nine through 12. Enrollment at Harmony Magnet Academy is determined through Porterville Unified School District's Pathway Programs application, which relies on a ranking and lottery system to place students in district pathways. Students at Harmony Magnet Academy choose one of two pathways in which to enroll: the Academy of Engineering or the Academy of Performing Arts. The Academy of Performing Arts received Linked Learning certification in the 2011–12 AY and serves approximately 200 students. The typical course sequence is as follows:

- Grade nine—English 1P Composition or Accelerated; Integrated Math 1P or Geometry P; Earth Science P or Chemistry P/AP; Spanish 1P, Chinese 1P, or French 1P; Physical Education 1 or Health; Orchestra, Dance Elements, Fundamentals of Guitar P, Keyboarding, Band, or Choir; Introduction to Stagecraft P (required Academy course); Graphic Design Production Principles P (required Academy course)
- Grade 10—English 2P Composition or Honors; Algebra 2P or Geometry P; Biology P/AP; World History P or Honors; Spanish 2P, Chinese 2P, or French 2P; Physical Education 2; Introduction to Video Production, Intermediate or Advanced Orchestra P, Musical Theatre Production P, Theatre Technology P, Fundamentals of Guitar II P, Keyboarding Skills II, Band, or Choir; Dance Elements and Interpretation P (required Academy course)
- Grade 11—English 3P Composition or AP English; Algebra 2P or Pre-Calculus P; Chemistry P/AP, Physiology P, or Physics P/AP; U.S. History P/AP; Spanish 3P, Chinese 3P, or French 3P; Physical Education 2; Motion Graphics, Advanced Orchestra P, Dance Technologies II P, Musical Theatre Production II P, Technical Theatre II, Fundamentals of Guitar II P, Keyboarding Skills II, Band, or Choir; Music Theory P (required Academy course)
- Grade 12—Expository Reading and Writing P, English 4P Composition, or AP English; Pre-Calculus P, Calculus P/AP, Statistics P/AP, Chemistry P/AP, Physics P/AP, or Biology P/AP; Spanish 4P or French 4P; Physical Education 2; Civics P/AP or Economics P; Advanced Motion Graphics, Advanced Orchestra P, Dance Technologies III P, Musical Theatre Production III, Fundamentals of Guitar II P, Keyboarding Skills II, Band, or Choir; Music Theory P (required Academy course); Performing Arts Capstone P (required Academy course)

Digital Design and Communication Academy (DDC) at Granite Hills High School

The Digital Design and Communication Academy (DDC) at Granite Hills High School was established in 2009 and serves approximately 100 students in grades nine through 12. DDC received Linked Learning certification in the 2012–13 AY. Enrollment at DDC is determined through Porterville Unified School District's Pathway Programs application, which relies on a ranking and lottery system to place students in district pathways.

With an emphasis on communication, DDC offers a specialized curriculum that explores journalism, video production, and graphic design. Several of the elective courses offered at DDC are courses developed by NAF. The sequence of courses is as follows:

- Grade nine
    - Core classes—English 1P Composition or Accelerated; Integrated Math 1P or Geometry P; Integrated Science 1P or Chemistry P; Spanish 1P, Spanish Literature 1P, or French 1P; Physical Education 1; Band, Choir or Engineering Design 1
    - Electives (all required Academy courses)—Freshman Seminar; Principles of Information Technology (NAF course); Digital Video; Graphic Design (NAF course)
- Grade 10
    - Core classes—English 2P Composition or Honors; Algebra 2P or Geometry P; Biology P; World History P or Honors; Spanish 2P, Spanish Literature 2P, French 2P; Physical Education 2; Band, Choir, Art 2P, Computer Graphic Animation, Architectural Design 1P, or Engineering Design 1/2
    - Electives—Video Production (NAF course); Web Design (required Academy course, NAF course); Beginning Journalism (required Academy course)
- Grade 11
    - Core classes—English 3P Composition or AP; Algebra 2P, Pre–Calculus P, Introduction to Probability and Statistics P; Chemistry P, Earth Science P, Physiology P, Biology P/AP; U.S. History P/AP; Spanish 3P, Spanish Literature and Culture 3P/AP, French 3P; Physical Education 2; Band, Choir, Art 2P/3P, Architectural Design 1P/2, Engineering Design 1/2, Photography P, Art History P/AP, or 3-Dimensional Design P
    - Electives—Advanced Journalism, Advanced Video Production, Foundations in Visual Arts and Design P, Web Page Design P, Video Production

- Grade 12
  - Core classes—Expository Reading and Writing P, English 4P Composition or P/AP, Humanities P; Pre-Calculus P, Calculus P/AP, Introduction to Probability and Statistics P; Environmental Science P/AP, Physics P/AP, Physiology P; Spanish 4P, Spanish Literature and Culture 4P/AP, or French 4P; Physical Education 2, Civics P/AP, Economics P, or Psychology P/AP; Band, Choir, Architectural Design 2, Engineering Design 2, Photography P, Art 2P/3P, Art History P/AP, or 3-Dimensional Design P
  - Electives—Advanced Journalism, Advanced Video Production, Foundations in Visual Arts and Design P, Web Page Design P

Multimedia and Technology Academy (MTA) at Monache High School

The Multimedia and Technology Academy (MTA) at Monache High School is a California Partnership Academy serving nearly 200 students in grades nine through 12. MTA received Linked Learning certification in the 2011–12 AY. The Multimedia and Technology Academy is also supported by NAF. Enrollment at MTA is determined through Porterville Unified School District's Pathway Programs application, which relies on a ranking and lottery system to place students in district pathways. Work-based learning opportunities at MTA include field trips, guest speakers, college and worksite visits, internships, and mentorships. Students are also given the opportunity to participate in an on-site video production stage, website design, marketing opportunities with local businesses, and working with the school-wide news broadcast, MTV. The standard course sequence at MTA is as follows:

- Grade nine—MTA English 1P Composition or Accelerated; Algebra 1P or Geometry P; MTA Integrated Science; Spanish 1P, Spanish Literature 1P, or French 1P; Principles of Information Technology (one semester); Pathway Studies (one semester)
- Grade 10—MTA English 2P Composition or Honors; Algebra 2P or Geometry P; MTA Biology P/Honors/AP; MTA World History P/Honors; Spanish 2P, Spanish Literature 2P, or French 2P; Foundations in Visual Art and Design or Computer Graphics; Computer Systems (one semester); Computer Graphics (one semester)
- Grade 11—MTA English 3P Composition or AP English 3P Language or Composition; Algebra 2P or Pre-Calculus P; MTA Chemistry P/AP or Earth Science; MTA U.S. History P/AP; Photography P or Animation (MAYA); Video Production (Capstone course); Web Page Design (Capstone course); Computer Networking; Yearbook or Journalism

- Grade 12—MTA English 4P Composition, AP English 4P Language or Composition, or Humanities; Pre-Calculus P, Calculus P/AP (AB or BC), or Introduction to Probability or Statistics; Environmental Science P/AP, Physics P/AP, or Physiology; Civics or Economics P/AP; Advanced Photography P or Advanced Animation (MAYA); Video Production (Capstone course); Web Page Design (Capstone course); Computer Networking

Partnership Academy of Business (PAB) at Porterville High School

The Partnership Academy of Business (PAB) is a small learning community at Porterville High School serving approximately 200 students. Enrollment at PAB is determined through Porterville Unified School District's Pathway Programs application, which relies on a ranking and lottery system to place students in district pathways. Granted Linked Learning certification in the 2010–11 AY, the Partnership Academy of Business is both a California Partnership Academy and a NAF-supported pathway. The standard course sequence at PAB is as follows:

- Grade nine—English 1P Composition or Accelerated; Integrated Math 1P or Geometry P; Earth Science P or Chemistry P/AP; Spanish 1P or French 1P; Physical Education 1; Band, Choir, or Art 1; Principles of Finance or Basic Computer Tech
- Grade 10—English 2P Composition or Honors; Algebra 2P or Geometry P; Biology P/AP; World History P or Honors; Spanish 2P or French 2P; Physical Education 2; Band, Choir or Art 2P; Financial Services or Financial Planning
- Grade 11—English 3P Composition or AP; Business Algebra P, Algebra 2P, Pre-Calculus P, or Statistics P/AP; Chemistry P/AP; U.S. History P/AP; Spanish 3P or French 3P; Physical Education 2; Band, Choir, or Art 3P; Computer Accounting 1
- Grade 12—Expository Reading and Writing P, English 4P Composition, or AP English; Pre-Calculus P, Calculus P/AP, or Statistics P/AP; Chemistry P/AP, Physics P/AP, Biology P/AP, Physiology P, or Earth Science P; Spanish 4P/AP Spanish or French 4P/AP; Physical Education 2; Civics P/AP Civics or Economics P; Band, Choir, or Art 3P; Applied Finance, Computer Accounting II, Retail Sales, Entrepreneurship, or Occupational Ethics P

Health Careers Academy at Porterville High School

Established in 1989, the Health Careers Academy at Porterville High School serves approximately 300 students in grades nine through 12 and received Linked Learning certification in the 2011–12 AY. The academy is both a California Partnership Academy and NAF-supported pathway. Enrollment at the Health Careers Academy is determined through

Porterville Unified School District's Pathway Programs application, which relies on a ranking and lottery system to place students in district pathways.

The Health Careers Academy's curriculum is designed to allow students to become licensed nursing assistants and gain hospital and health career field certifications. Career exploration opportunities, such as mentoring, job shadowing, internships, college campus tours, and medical site visits, are available to students throughout their four years. In grades 11 and 12, students are eligible to participate in a selection of health career certification programs. Although these programs are available to all Porterville High School students, enrollment in the Health Careers Academy is preferred. In grade 11, students may also enroll in the Nursing Assistant Program, which involves a minimum of 50 hours of classroom instruction and 100 hours of clinical experience over two semesters. After the program has been completed, students are qualified to take the national certification examination to become a certified nursing assistant. In grade 12, students are eligible to enroll in the emergency medical technician (EMT-1) training program. Upon completion of the instructional courses and clinical hours, students are qualified to take the national EMT certification examination.

The standard course sequence at the Health Careers Academy is as follows:

- Grade nine—Algebra 1 or Geometry; English 1P; Careers and Integrated Health Sciences; Physical Education; Foreign Language; Band/Choir/Art
- Grade 10—Geometry or Algebra 2; English 2P; Biology; World History; Beginning Health Occupations; Band/Choir/Art; Ethics in the Workplace/Computers
- Grade 11—Algebra 2 or Pre-Calculus; English 3P; Chemistry; U.S. History; Health Occupations 2: Sports Medicine/Athletic Training, Certified Nursing Assistant, or Sports Therapy/Fitness Tech; Band/Choir/Art
- Grade 12—Pre-Calculus or Calculus AP/P or Statistics; English 3P; Civics/Economics; Band/Choir/Art; Anatomy/Physiology, Biochemistry, or Psychology

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Engineering Academy at Richmond High School

Established in fall 2011 as one of the five pathways offered at Richmond High School, the Engineering Academy serves approximately 100 students in grades nine through 12. The academy received Linked Learning certification in the 2011–12 AY. Enrollment in the pathway is determined in grade 10 through a ranking system.

The curriculum at the Engineering Academy was developed by PLTW, which includes the following fundamental and specialized courses:

- Fundamental Courses
  - Introduction to Engineering Design
  - Principles of Engineering
- Specialized Courses
  - Aerospace Engineering
  - Biological Engineering
  - Civil Engineering and Architecture
  - Computer Integrated Manufacturing
  - Computer Science and Software Engineering
  - Digital Electronics

Capstone Course—Engineering Design and Development

Law Academy at Richmond High School

The Law Academy, one of five pathways offered at Richmond High School, received Linked Learning certification in the 2010–11 AY. A California Partnership Academy, the Law Academy serves approximately 200 students. Enrollment in the pathway is determined in grade 10 through a ranking system.

The Law Academy's curriculum meets the UC a–g course sequence requirements as well as offering specialized courses and various project- and work-based opportunities. The Law Academy adopts the Law and Justice curriculum, developed under the Learning and Teaching Division at Education Development Center, Inc., which explores topics and careers in the legal field and judicial system. Additionally, Journey for Justice in America is a special CTE/ROP course offered to grade-12 students that explores the foundations and

structures of the American government. CTE/ROP is the Contra Costa County Office of Education's career training program designed for grades 11 and 12.

The Law Academy course framework is as follows:

- Grade 10—Introduction to Law, English 2, Math, World History, Foreign Language, Chemistry
- Grade 11—Law and Justice, English 3, Math, U.S. History, Foreign Language, Elective/Physical Education
- Grade 12—Journey for Justice in America, English 4, Math/Elective, Economics, Elective/Physical Education, Psychology

The three-year program provides students with field trips, guest speakers, job shadowing, and internship opportunities. Field trips are designed as opportunities to explore various legal careers and have included trips to City Hall and the Appeals Court of San Francisco, the Richmond Police Department and Dispatch Center, and a crime lab in Martinez. The program also offers students specialized hands-on activities, including crime scene investigations in grades nine and 10 and mock trials, which occur during all three years of the program. In grade 11, students also participate in Mentor Lunches, where they can engage with their peers and legal professionals. The Law Academy also organizes career fairs and summer internships for its students.

Multimedia Academy at Richmond High School

The Multimedia Academy is one of five pathways offered at Richmond High School that serves approximately 300 students in grades 10 through 12. A California Partnership Academy, the Multimedia Academy received Linked Learning certification in the 2010 –11 AY. Enrollment in the pathway is determined in grade 10 through a ranking system.

The Multimedia Academy offers several CTE/ROP courses to its students that provide explorations into different forms of media while strengthening students' creativity, communication, and storytelling skills. CTE/ROP is the Contra Costa County Office of Education's career training program designed for high school juniors and seniors. The CTE/ROP Art and Animation course provides theoretical and hands-on training in art fundamentals as well as an introduction to computer graphics imaging. Studies in computer graphics are expanded upon in the CTE/ROP Computer Graphics Arts course. Through the CTE/ROP Photography/Advanced Photography/Advanced Digital Photography course, students become familiar with the fundamentals of film and digital photography. In addition to the CTE/ROP course offerings, the Multimedia Academy curriculum also includes the following electives: Multimedia 1, Multimedia 2, Photography, Theater 1, and Journalism.

APPENDIX C. VARIABLES USED IN ANALYSES

Variable	Definition
csuag	Indicates whether or not the student met the "a–g" course and grade point average (GPA) requirements for admission to the California State University (CSU) system, including 15 courses and a GPA of 2.0 or higher in these courses
ucag	Indicates whether or not the student met the "a–g" course and GPA requirements for admission to the University of California (UC), including 15 courses and a GPA of 3.0 or higher in these courses
csugpa	GPA calculated for "a–g" courses required for admission to CSU
ucgpa	GPA calculated for "a–g" courses required for admission to UC
hsgrad	Indicates whether the student earned a standard high school diploma or a CAHSEE exempt diploma
suspended	Whether the student was suspended for at least one day in his or her senior year
attendance	The ratio of the number of days the student was present in school to the total number of days enrolled
gender	Indicates whether the student is male or female
ethnicity	Indicates the student's race/ethnicity. Categories were coded to Asian, black, Hispanic, white, and other, which included students who were Hawaiian/Pacific Islander, Native American or who indicated multiple race/ethnicities
prnted_lvl	Indicates the highest level of education for the student's parents. Parent education was coded as less than high school graduate, high school graduate, some college or an associate's degree, college graduate, and graduate school or postgraduate education
hs_ell	Indicates whether or not the student was an English language learner (ELL) while in high school
nslp_hs	Indicates whether or not the student was eligible to participate in the National School Lunch Program
everdis	Indicates whether or not the student ever had a disability

Variable	Definition
mathtype	Indicates whether the student's grade-eight mathematics class was algebra I, geometry, algebra II or standard grade-eight mathematics
cstmathss	Scale score the student received on the grade-eight California Standards Test in mathematics
cstengss	Scale score the student received on the grade-eight California Standards Test in English
cstmathperf	Proficiency level achieved by the student on the grade-eight California Standards Test in mathematics. Categories are far below basic, below basic, basic, proficient, and advanced.
cstengperf	Proficiency level achieved by the student on the grade-eight California Stardards Test (CST) in English. Categories are far below basic, below basic, basic, proficient, and advanced.
schlminority	The percentage of a school's student population that is black, Hispanic, or Native American based on data from the California Department of Education
schl_frpm	The percent of the school's student population that is eligible for the National School Lunch Program based on data from the CDE
tch_aveyrs	Total years of public and/or private educational service. Includes services in the current district, other districts, other states, and countries. Does not include substitute teaching or classified staff service. The first year of service is counted as one year.
schl_locale	Whether the school is located in an urban, suburban, town, or rural environment. The CCD locale variable was recoded combining codes 11, 12, and 13 to "city;" codes 21, 22, and 23 to "suburb;" codes 31, 32, and 33 to "town;" and codes 41, 42, and 43 to "rural."
districtname	Provides the name of the school district in which the student was enrolled during high school

APPENDIX D. LOGIT REGRESSIONS USED TO ESTIMATE PROPENSITY SCORES

Table D1: Logit estimates for predicting participation in a Linked Learning certified pathway used in propensity score matching for the academic years 2010–11, 2011–12, and 2012–13 grade-12 cohorts

Variable	Cohort graduation year								
	AY 2010–11			AY 2011–12			AY 2012–13		
	Estimate	Standard error	Signifi-cance	Estimate	Standard error	Signifi-cance	Estimate	Standard error	Signifi-cance
Gender									
Males (reference)	—	—		—	—		—	—	
Females	0.620	(0.753)		-1.866	-0.68	***	-0.053	(0.578)	
Race/ethnicity									
Asian (reference)	—	—		—	—		—	—	
Black	-0.823	(0.384)	**	-0.632	(0.284)	**	-0.219	(0.272)	
Hispanic	0.037	(0.307)		0.128	(0.217)		0.203	(0.215)	
White	-0.250	(0.339)		-0.341	(0.254)		-0.407	(0.247)	*
Other	-0.756	(0.652)		0.514	(0.463)		-0.326	(0.491)	
Parents' education									
Did not graduate from high school (reference)	—	—		—	—		—	—	
High school graduate	0.155	(0.188)		-0.333	(0.157)	**	-0.074	(0.144)	
Some college or Associate's degree	0.452	(0.198)	**	-0.227	(0.162)		0.114	(0.152)	
College graduate	0.432	(0.196)	**	-0.156	(0.161)		-0.025	(0.154)	
Graduate school or postgraduate education	0.186	(0.217)		-0.129	(0.168)		0.426	(0.159)	***
English Language Learner in high school	-0.248	(0.148)	*	-0.078	(0.125)		-0.043	(0.117)	
Eligible for National School Lunch Program in high school	-0.083	(0.145)		0.087	(0.120)		0.051	(0.112)	
Ever identified as student with disability[a]	-0.197	(0.230)		-0.220	(0.182)		0.149	(0.147)	
Mathematics test type[b]									
General math (grades 8 & 9; reference)	—	—		—	—		—	—	
Algebra I or higher	0.092	(0.867)		3.174	(0.626)	***	2.244	(0.616)	***

See notes at end of table.

Table D1: Logit estimates for predicting participation in a Linked Learning certified pathway used in propensity score matching for the academic years 2010–11, 2011–12, and 2012–13 grade-12 cohorts—Continued

Variable	Cohort graduation year								
	AY 2010–11			AY 2011–12			AY 2012–13		
	Estimate	Standard error	Signifi-cance	Estimate	Standard error	Signifi-cance	Estimate	Standard error	Signifi-cance
CST mathematics scale score[b]	-0.006	(0.019)		-0.008	(0.012)		-0.006	(0.011)	
CST English scale score[b]	0.020	(0.020)		0.010	(0.011)		0.019	(0.013)	
CST mathematics proficiency level[b]									
Far below basic (reference)	—	—		—	—		—	—	
Below Basic	-6.112	(5.336)		-5.079	(3.525)		-3.962	(3.349)	
Basic	-4.483	(4.880)		-2.681	(3.413)		-3.697	(3.240)	
Proficient	-2.966	(4.760)		-3.603	(3.225)		-2.044	(2.681)	
Advanced[b]	-4.232	(4.753)		-4.437	(3.303)		—	—	
CST English proficiency level[b]									
Far below basic (reference)	—	—		—	—		—	—	
Below Basic	-0.098	(7.004)		3.576	(4.845)		-0.621	(5.139)	
Basic	2.612	(5.353)		1.935	(3.375)		3.669	(3.624)	
Proficient	9.124	(5.735)		3.439	(3.569)		5.365	(3.296)	
Advanced[c]	8.466	(5.408)		4.901	(3.353)		—	—	
Percent minority enrollment in school[d]	0.962	(0.764)		-0.066	(0.061)		0.103	(0.009)	***
Percentage of students eligible for National School Lunch Program in high school[e]	1.206	(0.662)	*	-10.720	(1.037)	***	-4.533	(0.775)	***
Average years of teaching experience[f]	-26.007	(9.879)	***	-0.275	(0.031)	***	-2.598	(0.257)	***
Average years of teaching experience (squared)	4.033	(1.901)	**	—	—		—	—	
School locale	3.958	(1.011)	***	—	—		—	—	
Student enrollment[g]	0.510	(0.127)	***	0.361	(0.079)	***	0.000	(0.000)	***
School district									
Antioch Unified (reference)	—	—		—	—		—	—	
Long Beach Unified	—	—		0.824	(0.172)		-0.134	(0.189)	
Oakland Unified	—	—		-2.625	(0.372)	***	-1.505	(0.256)	***
Pasadena Unified	—	—		-2.226	(0.264)	***	-1.212	(0.188)	***
Porterville Unified	—	—		-0.067	(0.242)		-0.671	(0.210)	***
West Contra Costa Unified	—	—		-2.680	(0.266)	***	-1.243	(0.215)	***

See notes at end of table.

Table D1: Logit estimates for predicting participation in a Linked Learning certified pathway used in propensity score matching for the academic years 2010–11, 2011–12, and 2012–13 grade-12 cohorts—Continued

Variable	Cohort graduation year								
	AY 2010–11			AY 2011–12			AY 2012–13		
	Estimate	Standard error	Signifi-cance	Estimate	Standard error	Signifi-cance	Estimate	Standard error	Signifi-cance
Interaction of mathematics test type and CST mathematics scale score[b]									
General math (grades 8 & 9; reference)	—	—		—	—		—	—	
Algebra I or higher and math score	-0.001	(0.003)		-0.008	(0.002)	***	-0.006	(0.002)	***
Interaction between gender and race[h]									
Female and Asian	-0.422	(0.841)		1.894	(0.734)	**	0.058	(0.633)	
Female and Black	-0.399	(0.815)		2.405	(0.725)	***	0.177	(0.627)	
Female and Hispanic	-0.422	(0.767)		1.902	(0.691)	***	0.342	(0.588)	
Female and white	-0.471	(0.789)		2.470	(0.709)	***	0.541	(0.609)	
Female and other	—	—		—	—		—	—	
Interaction between CST mathematics proficiency and CST mathematics scale score[b]									
Far below basic and math scale score (reference)	—	—		—	—		—	—	
Below Basic and math scale score	0.024	(0.021)		0.021	(0.014)		0.016	(0.013)	
Basic and math scale score	0.018	(0.020)		0.015	(0.013)		0.016	(0.012)	
Proficient and math scale score	0.012	(0.019)		0.017	(0.013)		0.011	(0.011)	
Advanced and math scale score[c]	0.015	(0.019)		0.018	(0.013)		—	—	

See notes at end of table.

Table D1: Logit estimates for predicting participation in a Linked Learning certified pathway used in propensity score matching for the academic years 2010–11, 2011–12, and 2012–13 grade-12 cohorts—Continued

Variable	Cohort graduation year								
	AY 2010–11			AY 2011–12			AY 2012–13		
	Estimate	Standard error	Signifi-cance	Estimate	Standard error	Signifi-cance	Estimate	Standard error	Signifi-cance
Interaction between CST English proficiency and CST English scale score[b]									
Far below basic and English scale score (reference)	—	—		—	—		—	—	
Below Basic and English scale score	-0.003	(0.026)		-0.013	(0.018)		-0.000	(0.019)	
Basic and English scale score	-0.010	(0.021)		-0.007	(0.013)		-0.014	(0.014)	
Proficient and English scale score	-0.030	(0.021)		-0.012	(0.013)		-0.019	(0.013)	
Advanced and English scale score[c]	-0.028	(0.020)		-0.015	(0.012)		—	—	
Percent minority enrollment in school squared	—	—		0.002	(0.000)	***	—	—	
Constant	23.587	(14.749)		1.239	(4.143)		-3.598	(4.030)	
Number of observations	2,391			4,193			3,938		

—Not available.
[a] A student identified with a disability under the Individuals With Disabilities Education Act
[b] Grade-eight California Standards Test (CST).
[c] Proficient and advanced combined for 2013 cohort; no recoding for 2011 and 2012 cohorts.
[d] Minority is defined as students who are black, Hispanic, or Native American.
[e] Estimate was transformed to a natural log of the estimate for 2011 cohort; no transformation made for 2012 and 2013 cohorts.
[f] Estimate was transformed to a natural log of the estimate for 2011 and 2013 cohorts; no transformation made for 2012 cohort.
[g] Estimate was transformed to a natural log of the estimate for 2011 and 2012 cohorts; no transformation made for 2013 cohort.
[h] Reference categories are the interaction of males with each race/ethnicity
NOTE: Detail may not sum to 100 due to rounding. CST math and English proficiency levels are based on categorization of the grade eight CST scale scores in these subjects. Statistical significance determined by Student's *t*-test *p<0.1, ** p<0.05, *** p<0.01
SOURCE: Data collected by the Linked Learning District Initiative.

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APPENDIX E. BASELINE EQUIVALENCE TABLES AFTER MATCHING ON THE PROPENSITY SCORE

Table E1: The absolute effect size of covariate means for Linked Learning certified pathway and matched comparison group students after balancing on the propensity score: Academic year 2010–11 grade-12 cohort

Variable	Linked Learning	Comparison Group	Absolute Effect Size[a]	$p>\|t\|$
Gender				
Male (reference)	–	–	–	–
Female	0.540	0.532	0.016	0.796
Race/ethnicity				
Asian (reference)	–	–	–	–
Black	0.130	0.109	**0.060** ^	0.316
Hispanic	0.560	0.570	0.020	0.751
White	0.202	0.211	0.023	0.723
Other	0.020	0.023	0.020	0.754
Race/ethnicity by gender				
Asian female (reference)	–	–	–	–
Black female	0.074	0.065	0.036	0.555
Hispanic female	0.292	0.295	0.006	0.926
White female	0.110	0.111	0.004	0.949
Other female	0.012	0.013	0.012	0.850
Parents' Education				
Less than high school graduate (reference)	–	–	–	–
High school graduate	0.212	0.207	0.013	0.842
Some college/AA degree	0.214	0.196	0.044	0.490
College graduate	0.272	0.278	0.014	0.833
Graduate school/postgraduate education	0.152	0.163	0.030	0.627
English Language Learner in high school	0.396	0.405	0.019	0.765
Eligible for National School Lunch Program	0.660	0.641	0.040	0.539
Ever identified as student with disability[b]	0.072	0.058	0.049	0.371
Type of CST Mathematics Test[c]				
General Math (reference)	–	–	–	–
Algebra I or higher	0.448	0.469	0.042	0.507
CST Mathematics Scale Score[c]	346.740	349.210	0.040	0.532
CST English Scale Score[c]	346.410	350.310	**0.073** ^	0.215
Interaction of CST Mathematics Test Type and CST Mathematics Scale Score[c]				
General Math (reference)	–	–	–	–
Algebra I or higher	163.170	170.390	0.039	0.544
CST Mathematics Proficiency Level				
Far below basic (reference)	–	–	–	–
Below basic	0.188	0.185	0.006	0.915
Basic	0.344	0.349	0.011	0.867
Proficient	0.316	0.321	0.010	0.878
Advanced	0.106	0.115	0.031	0.655

See notes at end of table.

Table E1: The absolute effect size of covariate means for Linked Learning certified pathway and matched comparison group students after balancing on the propensity score: Academic year 2010–11 grade-12 cohort—Continued

Variable	Linked Learning	Comparison Group	Absolute Effect Size[a]	$p>\|t\|$
CST English Proficiency Level				
Far below basic (reference)	–	–	–	–
Below basic	0.106	0.089	0.050	0.355
Basic	0.384	0.399	0.032	0.623
Proficient	0.284	0.298	0.032	0.628
Advanced	0.162	0.172	0.027	0.680
Interaction of CST Mathematics Proficiency Level and CST Mathematics Scale Score				
Far below basic (reference)	–	–	–	–
Below basic	53.144	52.570	0.005	0.935
Basic	112.250	113.800	0.010	0.875
Proficient	120.160	121.870	0.010	0.879
Advanced	50.268	53.793	0.026	0.708
Interaction of CST English Proficiency Level and CST English Scale Score				
Far below basic (reference)	–	–	–	–
Below basic	30.216	25.261	0.050	0.355
Basic	125.780	130.580	0.031	0.636
Proficient	105.280	110.640	0.033	0.616
Advanced	69.036	73.125	0.026	0.685
Log percent minority enrollment in school[d]	4.237	4.218	**0.111** ^	0.076
Log percent school eligible for National School Lunch Program	-0.433	-0.450	**0.094** ^	0.102
Log average number of years of teacher experience in school	2.644	2.651	0.039	0.516
Log teacher experience squared	7.021	7.055	0.038	0.528
Log school enrollment	7.902	7.894	0.011	0.859
Locale of school				
Other				
Urban	0.998	0.998	0.000	1.000

—Not available.
^ Absolute effect size is between .05 and .25 (also shown in bold).
[a] The absolute effect size for continuous variables is equal to the absolute value of the difference in the means between the LLCP students and the matched comparison group students, divided by the pooled standard deviation. For categorical variables, the absolute effect size is the difference in proportions divided by the pooled standard deviation.
[b] A student identified with a disability under the *Individuals With Disabilities Education Act*
[c] CST is the grade-eight California Standards Test.
[d] Minority is defined as students who are black, Hispanic, or Native American.
NOTE Reference categories are the interaction of males with each race/ethnicity. CST math and English proficiency levels are based on categorization of the grade-eight CST scale scores in these subjects.
SOURCE: Data collected by the Linked Learning District Initiative.

Table E2: The absolute effect size of covariate means for Linked Learning certified pathway and matched comparison group students after balancing on the propensity score: Academic year 2011–12 grade-12 cohort

Variable	Linked Learning	Comparison Group	Absolute Effect Size[a]	$p>\|t\|$
Gender				
Male (reference)	–	–	–	–
Female	0.52949	0.55145	0.044	0.39
Race/ethnicity				
Asian (reference)	–	–	–	–
Black	0.13499	0.13724	0.006	0.898
Hispanic	0.56619	0.5599	0.013	0.805
White	0.18218	0.1848	0.007	0.895
Other	0.01966	0.02086	0.008	0.867
Race/ethnicity by gender				
Asian female (reference)	–	–	–	–
Black female	0.08257	0.08663	0.015	0.776
Hispanic female	0.28309	0.29303	0.023	0.668
White female	0.11271	0.11883	0.020	0.709
Other female	0.00524	0.00521	0	0.993
Parents' Education				
Less than high school graduate (reference)	–	–	–	–
High school graduate	0.17955	0.16722	0.031	0.525
Some college/AA degree	0.20446	0.20774	0.008	0.874
College graduate	0.25819	0.25893	0.002	0.974
Graduate school/postgraduate education	0.19397	0.19034	0.010	0.857
English Language Learner in high school	0.45216	0.44359	0.017	0.737
Eligible for National School Lunch Program	0.66972	0.65479	0.032	0.538
Ever identified as student with disability[b]	0.07733	0.07063	0.022	0.618
Type of CST Mathematics Test[c]	–	–	–	–
General Math (reference)				
Algebra I or higher	0.61861	0.65042	**0.066** ^	0.197
CST Mathematics Scale Score[c]	341.19	341.36	0.003	0.959
CST English Scale Score[c]	344.94	346.16	0.022	0.648
Interaction of CST Mathematics Test Type and CST Mathematics Scale Score[c]				

See notes at end of table.

Table E2: The absolute effect size of covariate means for Linked Learning certified pathway and matched comparison group students after balancing on the propensity score: Academic year 2011–12 grade-12 cohort—Continued

Variable	Linked Learning	Comparison Group	Absolute Effect Size[a]	$p>\|t\|$
General Math (reference)	–	–	–	–
CST Mathematics Proficiency Level	211.62	221.66	**0.057** ^	0.258
CST Mathematics Proficiency Level				
Far below basic (reference)	–	–	–	–
Below basic	0.19921	0.19151	0.019	0.705
Basic	0.31193	0.31389	0.004	0.934
Proficient	0.32372	0.33549	0.026	0.625
Advanced	0.10092	0.09399	0.023	0.649
CST English Proficiency Level				
Far below basic (reference)	–	–	–	–
Below basic	0.1114	0.10812	0.010	0.838
Basic	0.34862	0.34199	0.014	0.785
Proficient	0.29227	0.30298	0.024	0.647
Advanced	0.17562	0.17865	0.008	0.877
Interaction of CST Mathematics Proficiency Level and CST Mathematics Scale Score				
Far below basic (reference)	–	–	–	–
Below basic	55.242	53.1	0.019	0.704
Basic	100.88	101.48	0.004	0.938
Proficient	123.21	127.86	0.027	0.613
Advanced	46.773	43.583	0.022	0.652
Interaction of CST English Proficiency Level and CST English Scale Score				
Far below basic (reference)	–	–	–	–
Below basic	31.582	30.674	0.010	0.842
Basic	113.62	111.61	0.013	0.8
Proficient	108.04	112.01	0.024	0.647
Advanced	74.076	75.145	0.007	0.897
Percent minority enrollment in school[d]	71.971	71.041	**0.070** ^	0.201
Percent school eligible for National School Lunch Program	0.64379	0.63708	0.046	0.381

See notes at end of table.

Table E2: The absolute effect size of covariate means for Linked Learning certified pathway and matched comparison group students after balancing on the propensity score: Academic year 2011–12 grade 12 cohort—Continued

Variable	Linked Learning	Comparison Group	Absolute Effect Size[a]	$p > \|t\|$
Average number of years of teacher experience in school	13.983	13.883	0.030	0.593
Log of School Enrollment	7.4577	7.3797	**0.096 ^**	0.082
District				
Antioch Unified (reference)	–	–	–	–
Long Beach Unified	0.45478	0.41359	**0.087 ^**	0.105
Oakland Unified	0.05898	0.09347	**0.114 ^**	0.011
Pasadena Unified	0.11796	0.10132	0.048	0.299
Porterville Unified	0.07733	0.08829	0.038	0.438
West Contra Costa Unified	0.15203	0.12438	**0.076 ^**	0.118
Percent minority enrollment squared[d]	5382.5	5246	**0.070 ^**	0.206

—Not available.
^ Absolute effect size is between .05 and .25 (also shown in bold).
[a] The absolute effect size for continuous variables is equal to the absolute value of the difference in the means between the LLCP students and the matched comparison group students, divided by the pooled standard deviation. For categorical variables, the absolute effect size is the difference in proportions divided by the pooled standard deviation.
[b] A student identified with a disability under the *Individuals With Disabilities Education Act.*
[c] CST is the grade-eight California Standards Test.
[d] Minority is defined as students who are black, Hispanic, or Native American.
NOTE: Reference categories are the interaction of males with each race/ethnicity CST math and English proficiency levels are based on categorization of the grade-eight CST scale scores in these subjects.
SOURCE: Data collected by the Linked Learning District Initiative.

Table E3: The absolute effect size of covariate means for Linked Learning certified pathway and matched comparison group students after balancing on the propensity score: Academic year 2012–13 grade-12 cohort

Variable	Linked Learning	Comparison Group	Absolute Effect Size[a]	$p>\|t\|$
Gender				
Male (reference)	–	–	–	–
Female	0.548	0.556	0.016	0.737
Race/ethnicity				
Asian (reference)	–	–	–	–
Black	0.118	0.115	0.009	0.833
Hispanic	0.607	0.601	0.013	0.787
White	0.160	0.157	0.008	0.860
Other	0.019	0.022	0.017	0.696
Race/ethnicity by gender				
Asian female (reference)	–	–	–	–
Black female	0.065	0.064	0.001	0.985
Hispanic female	0.327	0.328	0.002	0.970
White female	0.094	0.097	0.009	0.850
Other female	0.011	0.011	0.000	0.997
Parents' Education				
Less than high school graduate (reference)	–	–	–	–
High school graduate	0.192	0.193	0.004	0.935
Some college/AA degree	0.200	0.200	0.000	0.999
College graduate	0.204	0.210	0.014	0.763
Graduate school/postgraduate education	0.212	0.215	0.006	0.900
English Language Learner in HS	0.464	0.459	0.010	0.829
Eligible for free or reduced price lunch in high school	0.705	0.701	0.009	0.846
Ever identified as student with disability[b]	0.103	0.100	0.011	0.801
Type of CST Mathematics Test[c]	–	–	–	–
General Math (reference)				
Algebra I or higher	0.664	0.674	0.022	0.651
CST Mathematics Scale Score[c]	348.940	346.190	0.040	0.394
CST English Scale Score[c]	353.960	352.640	0.023	0.623
Interaction of CST Mathematics Test Type and CST Mathematics Scale Score[c]				
General Math (reference)	–	–	–	–
Algebra I or higher	234.570	235.090	0.003	0.950

See notes at end of table.

Table E3: The absolute effect size of covariate means for Linked Learning certified pathway and matched comparison group students after balancing on the propensity score: Academic year 2012–13 grade-12 cohort—Continued

CST Mathematics Proficiency Level	Linked Learning	Comparison Group	Absolute Effect Size[a]	$p>\|t\|$
CST Mathematics Proficiency Level[d]				
Far below basic (reference)	–	–	–	–
Below basic	0.185	0.203	0.043	0.349
Basic	0.282	0.273	0.019	0.686
Proficient	0.473	0.456	0.035	0.467
CST English Proficiency Level[d]				
Far below basic (reference)	–	–	–	–
Below basic	0.100	0.113	0.039	0.380
Basic	0.327	0.311	0.033	0.486
Proficient	0.519	0.514	0.010	0.827
Interaction of CST Mathematics Proficiency Level and CST Mathematics Scale Score[d]				
Far below basic (reference)	–	–	–	–
Below basic	51.847	56.623	0.041	0.366
Basic	91.153	88.275	0.020	0.677
Proficient	191.590	185.180	0.032	0.511
Interaction of CST English Proficiency Level and CST English Scale Score[d]				
Far below basic (reference)	–	–	–	–
Below basic	28.262	31.961	0.040	0.374
Basic	106.470	101.170	0.035	0.464
Proficient	205.630	204.030	0.008	0.867
Percent minority enrollment in school[e]	73.541	73.085	0.035	0.491
Percent school eligible for National School Lunch Program	0.637	0.630	0.047	0.339
Log average number of years of teacher experience in school	2.572	2.561	0.041	0.496
Total school enrollment	2156.600	2021.700	**0.103** ^	0.045
District				
Antioch Unified (reference)	–	–	–	–
Long Beach Unified	0.394	0.393	0.002	0.973
Oakland Unified	0.085	0.116	**0.100** ^	0.032
Pasadena Unified	0.216	0.168	**0.122** ^	0.011
Porterville Unified	0.076	0.076	0.001	0.980
West Contra Costa Unified	0.115	0.128	0.040	0.387

—Not available.
^ Absolute effect size is between .05 and .25 (also shown in bold).
[a] The absolute effect size for continuous variables is equal to the absolute value of the difference in the means between the LLCP students and the matched comparison group students, divided by the pooled standard deviation. For categorical variables, the absolute effect size is the difference in proportions divided by the pooled standard deviation.
[b] A student identified with a disability under the *Individuals With Disabilities Education Act*
[c] CST is the grade-eight California Standards Test.
[d] Proficient and advanced combined.
[e] Minority is defined as students who are black, Hispanic, or Native American.
NOTE: Reference categories are the interaction of males with each race/ethnicity. CST math and English proficiency levels are based on categorization of the grade-eight CST scale scores in these subjects.
SOURCE: Data collected by the Linked Learning District Initiative.

APPENDIX F. FIGURES

Figure F1: Histograms showing the distribution of estimated propensity scores (logits) before and after matching for Linked Learning certified pathway and comparison group students: Academic year 2011 grade-12 cohort

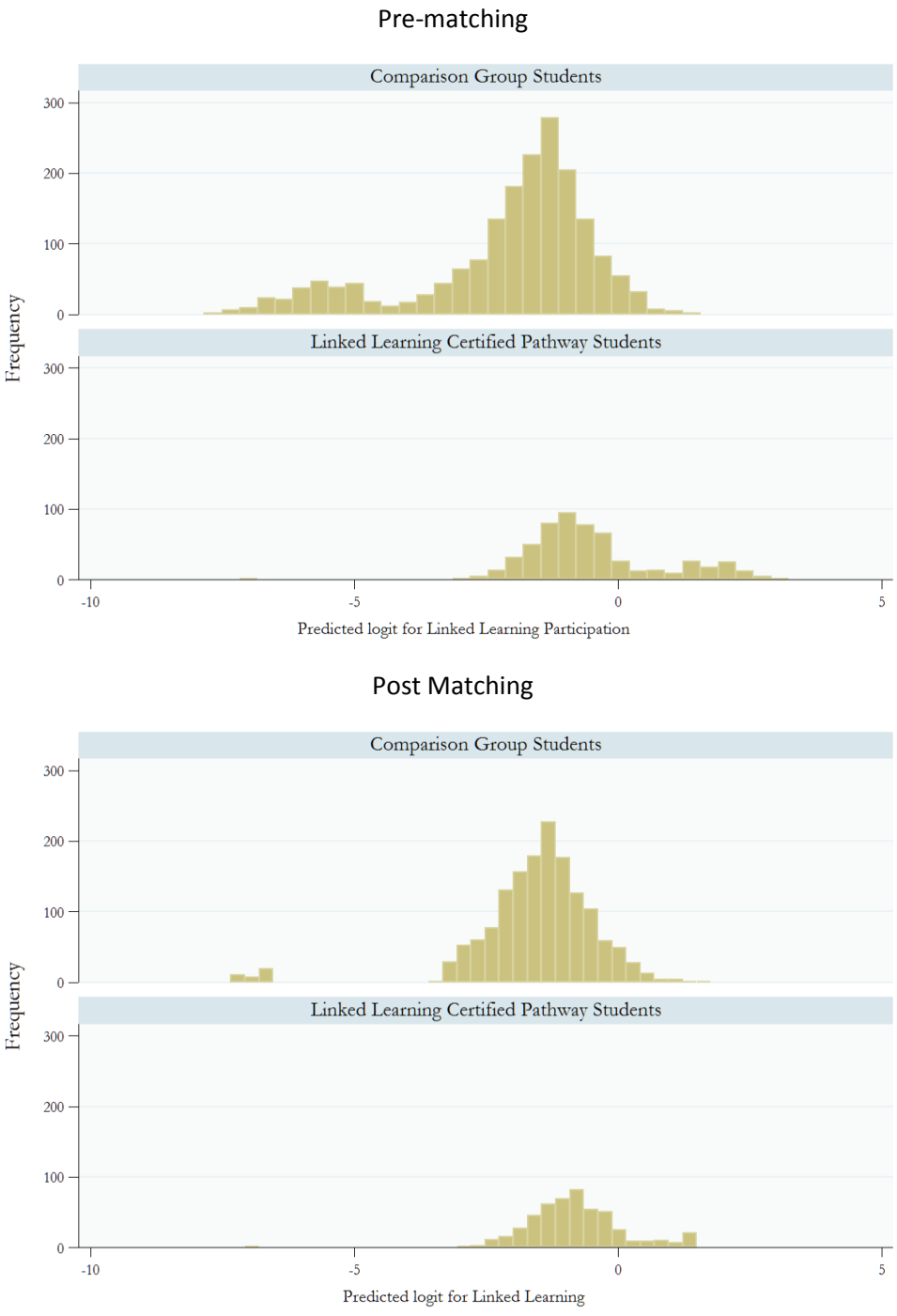
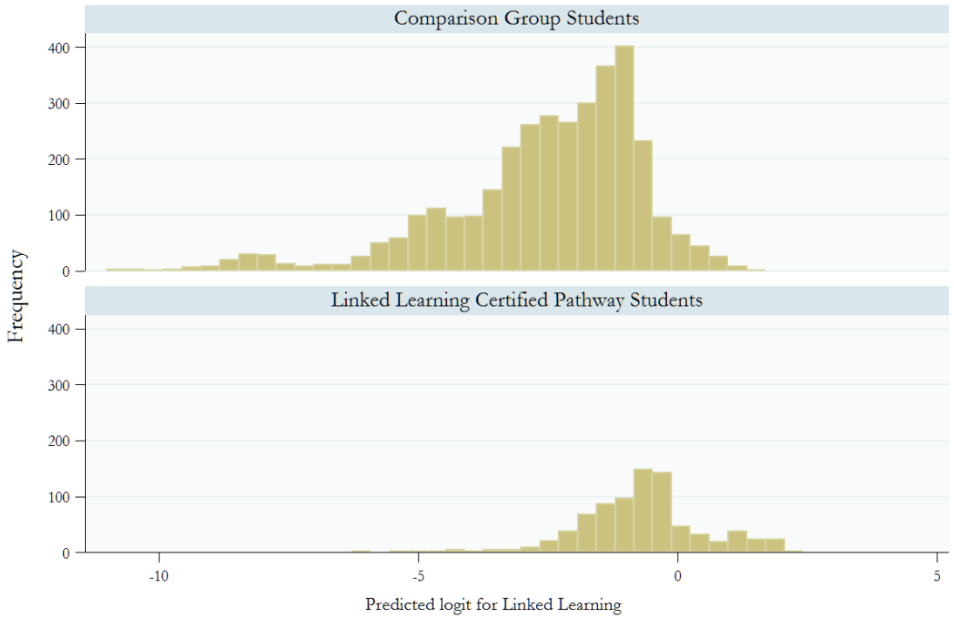


Figure F2: Histograms showing the distribution of estimated propensity scores (logits) before and after matching for Linked Learning certified pathway and comparison group students: Academic year 2011 grade-12 cohort

Pre-matching



Post matching

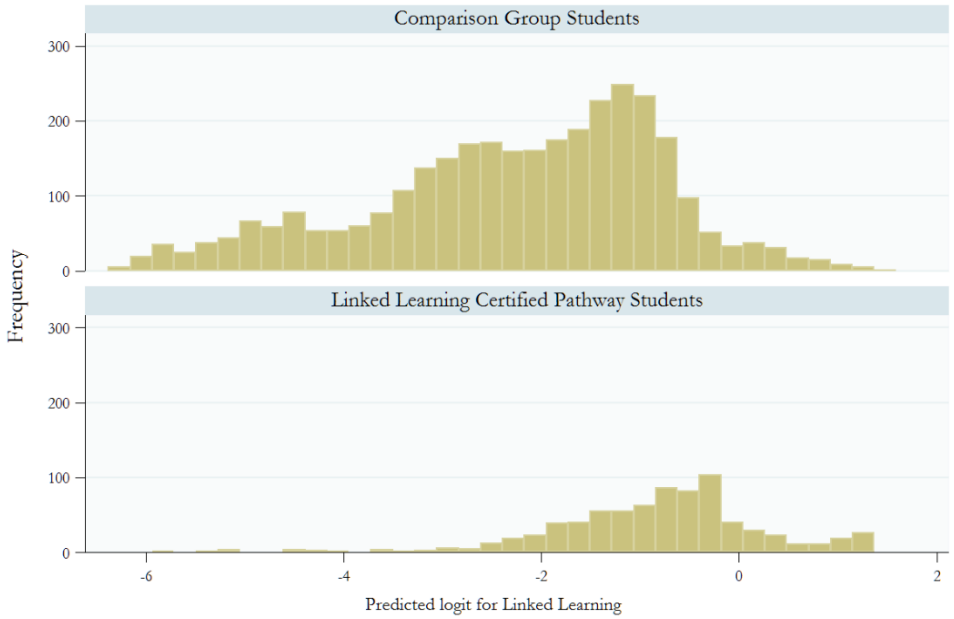
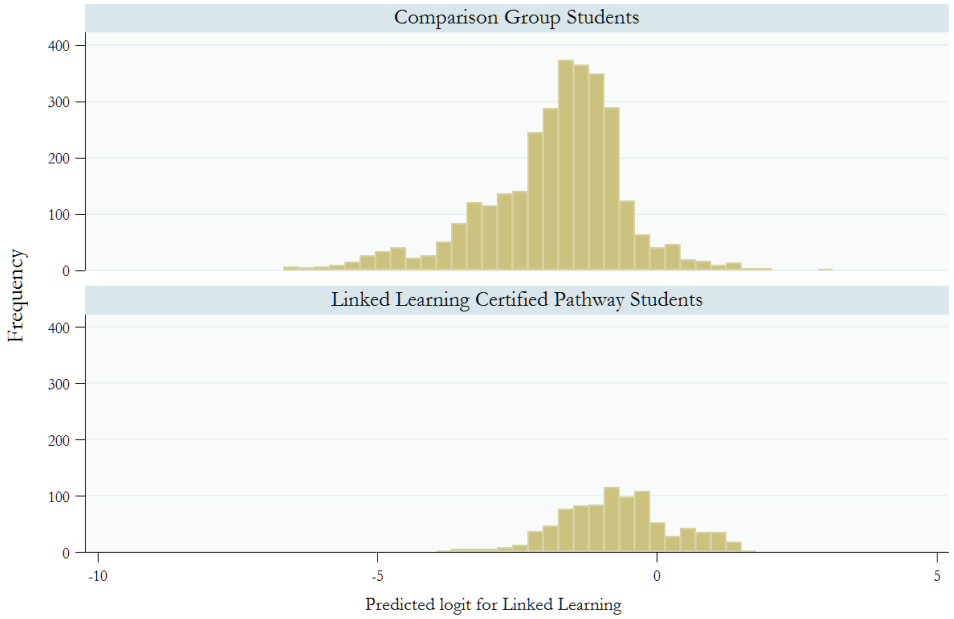
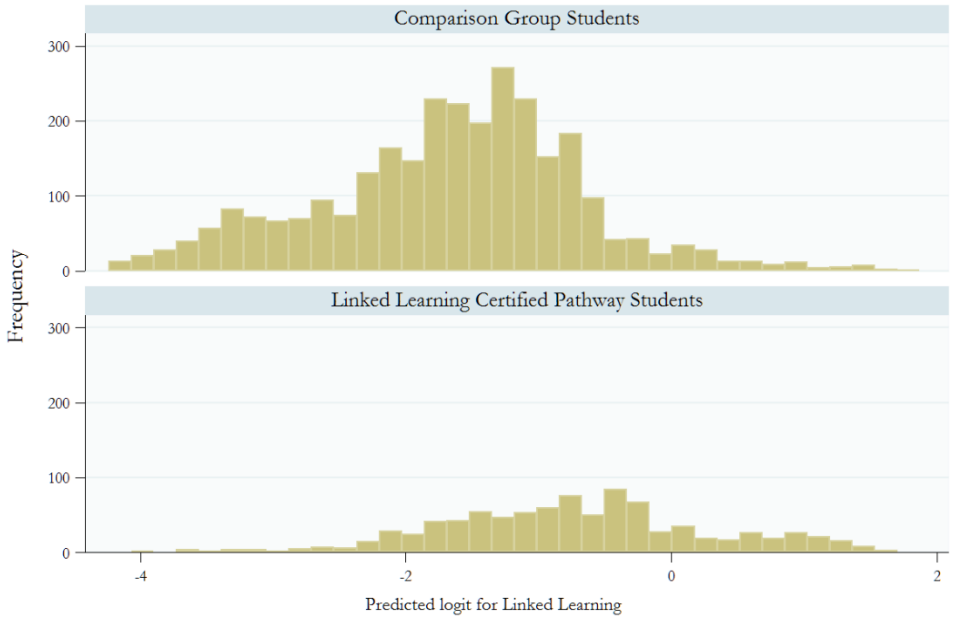


Figure F3: Histograms showing the distribution of estimated propensity scores (logits) before and after matching for Linked Learning certified pathway and comparison group students: Academic year 2011 grade-12 cohort

Pre-matching



Post matching



APPENDIX G. DESCRIPTIVE STATISTICS FOR OUTCOME MEASURES FOR OVERALL AND MATCHED SAMPLES, BY COHORT

Table G1: Descriptive statistics for outcome measures in the overall and matched analytic samples, by cohort

Outcome measure	Overall Sample				Matched Sample			
	Number of students	Mean	Standard deviation	Percent missing	Number of students	Mean	Standard deviation	Percent missing
AY 2011–12 cohort								
Attendance during academic year[a, b]	2,139	95.0	6.1	8.1	1,916	95.0	5.9	6.5
Ever suspended during academic year	2,139	5.1	22.0	8.1	1,916	5.0	21.7	6.5
High school graduation status[c]	2,681	87.5	33.1	1.4	2,287	89.4	30.8	0.0
Any postsecondary education[d, e]	1,649	69.9	45.9	19.2	1,433	73.4	44.2	15.5
Immediate postsecondary enrollment[e, f]	1,153	81.7	38.7	43.5	1,052	82.1	38.3	38.0
Postsecondary persistence[g]	1,234	62.4	48.5	39.5	1,122	63.0	48.3	33.8
AY 2012–13 cohort								
Attendance rate during academic year[a, h]	1,799	94.9	7.4	16.2	1,444	94.9	7.4	18.0
Ever suspended during academic year[i]	1,799	4.8	21.3	16.2	1,444	4.3	20.3	18.0
High school graduation status[h]	2,565	89.5	30.7	1.4	2,187	89.3	31.0	0.0
a-g grade point average for University of California System (including Long Beach)	3,341	2.69	0.78	30.7	2,669	2.72	0.79	32.7
a-g grade point average for California State University System (including Long Beach)	3,341	2.70	0.78	30.7	2,669	2.73	0.79	32.7
a-g grade point average for University of California System (excluding Long Beach)	2,931	2.69	0.78	16.1	2,283	2.72	0.79	15.8
a-g grade point average for California State University System (excluding Long Beach)	2,931	2.70	0.78	16.1	2,283	2.73	0.79	15.8
University of California System a-g completion status (including Long Beach)	3,312	28.9	45.3	31.3	2,648	30.2	45.9	33.3
California State University System a-g completion status (including Long Beach)	3,312	37.3	48.4	31.3	2,648	38.3	48.6	33.3
University of California System a-g completion status (excluding Long Beach)	2,902	29.2	45.5	16.9	2,262	30.5	46.1	16.6
California State University System a-g completion status (excluding Long Beach)	2,902	37.0	48.3	16.9	2,262	37.7	48.5	16.6
Any postsecondary education (including Oakland Unified)	3,178	69.5	46.1	20.7	2,816	69.6	46.0	18.7
Any postsecondary education (excluding Oakland Unified)	2,815	65.5	47.5	16.1	2,566	66.7	47.1	15.1
Immediate postsecondary enrollment (including Oakland Unified)	2,208	90.4	29.5	44.9	1,961	90.4	29.5	43.4
Immediate postsecondary enrollment (excluding Oakland Unified)	1,845	88.5	32.0	45.0	1,711	89.0	31.4	43.4

See notes at end of table.

Table G1: Descriptive statistics for outcome measures in the overall and matched analytic samples, by cohort—Continued

Outcome measure	Overall Sample				Matched Sample			
	Number of students	Mean	Standard deviation	Percent missing	Number of students	Mean	Standard deviation	Percent missing
AY 2012–13 cohort								
Attendance rate during academic year[a, h]	2,187	94.8	8.1	0.0	1,841	95.0	7.5	0.0
Ever suspended during academic year[j]	2,187	3.9	19.3	0.0	1,841	3.7	19.0	0.0
High school graduation status[h]	2,616	86.0	34.7	1.1	2,266	87.5	33.1	0.0
a-g grade point average for University of California System (including Long Beach and Oakland)	3,313	2.64	0.82	27.9	2,663	2.70	0.80	28.8
a-g grade point average for California State University System (including Long Beach and Oakland)	3,313	2.65	0.82	27.9	2,663	2.71	0.80	28.8
a-g grade point average for University of California System (excluding Long Beach and Oakland)	2,417	2.64	0.81	10.4	2,038	2.68	0.80	9.1
a-g grade point average for California State University System (excluding Long Beach and Oakland)	2,417	2.65	0.80	10.4	2,038	2.69	0.80	9.1
University of California System a-g completion status (including Long Beach and Oakland)	3,044	29.0	45.4	33.7	2,578	30.5	46.1	31.1
California State University System a-g completion status (including Long Beach and Oakland)	3,044	39.2	48.8	33.7	2,578	41.1	49.2	31.1
University of California System a-g completion status (excluding Long Beach and Oakland)	2,334	28.2	45.0	13.5	1,977	29.5	45.6	11.8
California State University System a-g completion status (excluding Long Beach and Oakland)	2,334	36.9	48.3	13.5	1,977	38.3	48.6	11.8

[a] Ratio of days attended to days enrolled.
[b] Data for Long Beach and Pasadena.
[c] Data for Long Beach, Pasadena, and Porterville.
[d] Any postsecondary enrollment: Identifies students who enrolled at a postsecondary institution after leaving high school based on data from the National Student Clearinghouse
[e] Data for Long Beach and Porterville.
[f] Immediate enrollment: Identifies students who enrolled at a postsecondary institution during the first summer or fall after leaving high school based on data from the National Student Clearinghouse.
[g] One-year persistence: Identifies students who were continuously enrolled at a postsecondary institution for at least one year after leaving high school based on data from the National Student Clearinghouse for Long Beach and Porterville.
[h] Includes data for Antioch, Long Beach, Oakland, Pasadena, Porterville, and West Contra Costa.
[i] Includes data for Long Beach, Oakland, Pasadena, Porterville, and West Contra Costa.
[j] Includes data for Antioch, Long Beach, Pasadena, Porterville, and West Contra Costa.
NOTE: AY means academic year.
SOURCE: Data collected by the Linked Learning District Initiative.

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APPENDIX H. CERTIFICATION CRITERIA FOR LINKED LEARNING PATHWAYS

The Certification Criteria for Linked Learning Pathways is reprinted with permission from:

ConnectEd: The California Center for College and Career. 2011. *Certification Criteria for Linked Learning Pathways*. Berkeley, CA: ConnectEd.

Criteria

1. PATHWAY DESIGN

The pathway is designed with a structure, governance, and program of study that provides all students with opportunities for both postsecondary and career success.

1.1 Design Structure	1.1.1	**Pathway theme:** The pathway represents a broad theme that reflects high expectations for all students and teachers and appeals to and engages students, regardless of their prior academic achievement. The pathway theme expands, rather than narrows, postsecondary options for all students leading to a full range of postsecondary and career opportunities. The theme has been thoughtfully selected based on students' interests as well as other criteria.
	1.1.2	**Student learning outcomes:** The pathway community of practice has established a pathway-specific set of student learning outcomes that describes what students should know and be able to do when they complete the pathway program of study. Pathway student learning outcomes align with student outcomes articulated by the district (e.g., graduate profile) and by the school (e.g., ESLRs).
	1.1.3	**Program of study:** A 3- or 4-year industry-themed pathway serves as the organizational structure for a 4-year high school program of study based on pathway student learning outcomes and aligned with district graduation requirements. By design, the program of study embeds the UC/CSU a-g subject area requirements and ensures that all students, regardless of their prior academic achievement, have access to them. The program of study establishes conditions for linking core academics with technical content at each grade level. Courses are sequenced and coordinated.
	1.1.4	**Student recruitment, selection, and placement:** The pathway's student recruitment and selection process is formalized, ensures that students are aware of all their available options, and guarantees open access to students who make informed decisions based on their current interests and aspirations after high school. Through the recruitment process, counselors, advisors, and other pathway staff communicate that they have high expectations for all students, regardless of their prior academic achievement. Pathway demographics reflect those of the school and district.
	1.1.5	**Cohort scheduling:** Pathway students, regardless of their prior academic achievement, participate as a cohort in the academic and technical courses that are part of the program of study. Cohort scheduling enables flexible use of class time and instructional methodologies that promote multidisciplinary projects.

	1.1.6	**Staff collaboration:** School and pathway leadership nurtures the development of a pathway community of practice among staff that encourages ongoing teacher development as well as frequent and effective collaboration for program coordination, curricular integration, and specialized attention to individual student needs.
	1.1.7	**Pathway preparation and orientation:** The pathway provides an orientation and other transition services for incoming students and their families, preferably beginning in middle school.
	1.1.8	**Postsecondary articulation:** The pathway ensures opportunities for students to make a seamless transition into postsecondary education and training opportunities through dual enrollment, articulation agreements, and other formal and informal activities.
1.2 Governance	1.2.1	**Advisory board with broad representation:** A demographically diverse advisory board meets regularly to set policies, develop resources, and provide advice on pathway student learning outcomes and the pathway's program of study.

2. ENGAGED LEARNING

In supportive learning communities, students meet technical and academic standards and college entrance requirements through real-world applications, integrated project-/problem-based instruction, authentic assessments, and work-based learning.

2.1 Standards-Aligned Curriculum	2.1.1	**Academic core:** The academic curriculum is rigorous, aligned to state and Common Core Standards, and designed to lead to student proficiency on standardized tests as well as on more authentic assessment measures. All pathway students—regardless of their background, special education or English Language Learner designation/s, or prior academic achievement—have access to UC/CSU approved a-g curriculum.
	2.1.2	**Technical core:** The pathway includes a 3- or 4-year sequence or cluster of rigorous technical coursework that is aligned to state and/or national CTE and industry standards. All pathway students, regardless of their prior achievement, have access to all offered UC/CSU a-g-approved technical core curriculum in the pathway.
2.2 College and Career Readiness	2.2.1	**College readiness:** The pathway prepares students for success—without remediation—in California's community colleges, universities, apprenticeships, and other postsecondary programs.

	2.2.2	**Career readiness:** Technical courses deliver basic and advanced industry-related knowledge and transferable skills. They focus on preparing youth for high-skill, high-wage employment by using authentic applications that bring learning to life.
2.3 Real-World Relevance	2.3.1	**Real-world relevance:** Academic and technical courses deliver rigorous standards-based content through authentic, career-related applications. Pathways alter how core academic and technical subjects are taught, but they do not lower expectations about what is taught.
2.4 Integrated Curriculum	2.4.1	**Multidisciplinary integrated curriculum:** Pathway students participate in multidisciplinary projects that integrate rigorous academic and technical course content.
	2.4.2	**Curricular alignment:** Teachers collaborate within and across disciplines and grade levels to provide students with an outcomes-driven, coordinated, coherent, and relevant curriculum.
2.5 Instruction and Assessment	2.5.1	**Project-/Problem-based approach:** Pathway teachers use inquiry-based instruction to engage students in authentic theme-based experiences that require them to integrate knowledge and apply skills from several disciplines. Research-based instructional practice is evident in pathway classrooms.
	2.5.2	**Authentic assessment:** Pathway teachers individually and collaboratively design and use a variety of formative and summative assessments to gain an accurate understanding of student learning. Assessments include opportunities for students to demonstrate deep content learning and the application of skills through authentic products and performances.
2.6 Work-Based Learning (WBL)	2.6.1	**Coordinated, sequenced, and scaled:** All pathway students participate in and have access to a continuum of high-quality, real-world learning experiences. The sequence culminates in an extended, intensive work-related experience that may occur in a workplace, in the community, at school, and/or when using virtual technology.
	2.6.2	**Connected to coursework:** Each WBL experience is aligned to pathway student learning outcomes; helps students develop transferable, applied workplace skills; and provides opportunities for them to apply academic and technical knowledge and skills learned in the classroom.

2.7 Personalization and Support Services	2.7.1	**Culture of high expectations and support:** All pathway staff individually hold and collectively maintain a culture of high expectations and support for all students. Pathway staff develop and sustain personalized relationships with all students and foster strong connections between students and their peers. The pathway has processes in place for teachers, counselors, advisors, other pathway staff, and partners to quickly identify and address students' academic, personal, and social support needs.
	2.7.2	**Student motivation and engagement:** Individually and collectively, pathway teachers consciously and consistently work to connect learning (both in and out of the school setting) with students' interests in order to increase their motivation and engagement. All pathway students have regular opportunities to set goals, make decisions, and reflect on learning.
	2.7.3	**Differentiated instruction:** All pathway teachers routinely design instruction that reflects the diversity of student interests, strengths, and ways of learning. They design learning activities to challenge all pathway students and use a variety of methods to teach and assess learning.
	2.7.4	**Academic interventions:** The pathway community of practice works together to quickly identify students who are in need of additional support and/or remediation and uses a variety of timely interventions to ensure that all pathway students achieve pathway learning outcomes. These can include a variety of proactive interventions and acceleration strategies to meet individual student needs.
	2.7.5	**Guidance and counseling:** The pathway has a designated counselor and/or a system of guidance and advisement. The counselor and/or advisors know pathway students well and are familiar with the unique characteristics of the pathway program, thus enabling them to support the success of all pathway students.
	2.7.6	**College and career planning:** Each pathway student has a multi-year college and career success plan that is informed by a range of college and career planning activities, extends through high school, and guides decisions about postsecondary education, training, and career pursuits.

3. SYSTEM SUPPORT

District policies and practices provide leadership, support, and resources to establish and sustain quality pathways.

3.1 District Policies	3.1.1	**Pathway equity, access, and choice:** District, school, and pathway policies and procedures support pathway development, implementation, and sustainability. Policies and procedures allow students to select pathway options based on their current interests and future aspirations; ensure equity in the placement of students in pathways; and ensure that lack of transportation does not exclude students from participating in the pathway of their choice.
	3.1.2	**Recruitment and hiring practices:** District, school, and pathway policies and practices support the recruitment, selection, and retention of pathway teachers who possess the unique skills to support the pathway approach and reflect the demographics of the pathway, school, and district. District policies recognize the need for stability among pathway staff in order to support ongoing pathway improvement, fidelity, and sustainability.
	3.1.3	**Accountability and autonomy:** The district has achieved a healthy balance between pathway autonomy and accountability that values both as necessary to improve student learning outcomes. District policies and practices hold the pathway accountable for improving student outcomes and give the school and pathway the autonomy to determine how best to attain these outcomes.
3.2 Leadership	3.2.1	**Support from school board and superintendent:** The district board of education and superintendent are strong proponents of the pathway approach, publicly endorse it, offer active support, and align resources and procedures to promote the quality and sustainability of pathways.
	3.2.2	**Support from site leadership:** The high school principal and other administrators publicly advocate for the pathway and are actively involved in its funding, facilities, staffing, scheduling, partner recruitment, and other forms of support. Site leaders demonstrate a firm understanding of, vision for, and commitment to pathways and their potential to improve student learning outcomes.
3.3 Professional Development	3.3.1	**Teacher professional development:** Site and district administrators and/or the pathway community of practice provide or coordinate ongoing training for pathway teachers.

3.4 Qualified Staff	3.4.1	**Skilled teachers:** A pathway's success rests on high-quality teaching and collaboration among an interdisciplinary team of academic and technical teachers. Site principals and district leaders hire, assign, and provide ongoing professional growth opportunities for pathway teachers who are willing, skilled, and highly qualified.
	3.4.2	**Pathway leadership:** District and site administrators support the selection and further development of pathway leaders who inspire and guide the pathway community of practice in improving pathway quality and student success. Release time is provided for this role.
3.5 Partnerships	3.5.1	**Active employer and community partnerships:** The pathway has strong partnerships with local employers, community groups, and individuals. Both through the advisory board and other interactions, there is evidence of a healthy partnership between the pathway/high school and its host community.

4. DATA AND IMPACT

A systemic and systematic evaluation process documents the pathway's impact on high school achievement and postsecondary success and drives the pathway's continuous improvement plans.

4.1 Student Data	4.1.1	**Data collection:** The pathway and/or district regularly collect and accurately report pathway students' demographic and performance data.
	4.1.2	**Use of data:** The pathway community of practice regularly analyzes individual student as well as disaggregated and aggregate pathway data and compares data on student performance across the school, district, and state. Pathway staff use data regularly to inform instructional practice and curricular decisions, improve pathway student learning outcomes, make programmatic decisions, and support students' academic success.
4.2 Pathway Evaluation	4.2.1	**Evidence of impact:** Data analysis shows that the pathway retains participating students, demonstrates improvement in student performance, and eliminates opportunity and achievement gaps.

4.2.2	**Periodic review and improvement plan:** Pathway staff and the advisory board regularly review data and other indicators to assess students' progress toward achieving the pathway's learning outcomes. These periodic reviews result in the development of an improvement plan and action items that are based on the pathway's data and the recommendations contained in its certification Final Report (if one already exists) and reflect the pathway's underlying mission and goals.
4.2.3	**Postsecondary tracking:** Pathway staff conduct a formal follow-up of students for multiple years after high school graduation and use these data to develop a plan for continuous improvement of the pathway and student learning outcomes. There is some mechanism in place to track a significant and representative sample of pathway students in order to determine their enrollment and success in postsecondary education and careers.

APPENDIX I. DEFINITIONS OF STATISTICAL TERMS USED

Term	Definition
Average treatment effect on the treated (ATT)	A treatment, or policy, effect averaged across the population[1]
Balance	An indication that treatment and comparison groups are statistically similar across the variables used to calculate propensity scores[2]
Bias	The deviation of the average value from the true population value. Bias refers to systematic errors that affect any sample taken under a specific design with the same constant error.[3]
Caliper	A threshold or tolerance on the maximum propensity score distance[2]
Covariate	An independent variable, or a variable that is used to explain the variation in the outcome variable[1]
Dummy variable	Independent variables which take the value of either 0 or 1 Just as a "dummy" is a stand-in for a real person, in quantitative analysis, a dummy variable is a numeric stand-in for a qualitative fact or a logical proposition.[4]
Effect size	The standardized magnitude of the effect or the departure from the null hypothesis. For example, the effect size may be the amount of change over time, or the difference between two population means, divided by the appropriate population standard deviation. Multiple measures of effect size can be used (e.g., standardized differences between means, correlations, and proportions).[3]
Estimate	Estimates result from the process of providing a numerical value for a population parameter on the basis of information collected from a survey and/or other sources.[3]

Term	Definition
Linear model	A statistical model where the relationship between the dependent variable and each independent variable is constant[1]
Log odds	The probability of a binary outcome, also see *logit*[1]
Logistic regression	A statistical model that predicts the outcome of a binary dependent variable or outcome based on linear independent variables[1]
Logit	The log of the odds of an event happening to the odds of it not happening[1]
Marginal effect	The effect on the dependent variable that results from changing an independent variable by a small amount[1]
Matching algorithm	The process used to match treatment cases to one or more comparison group cases in a propensity score matching study[5]
Mean	The sum all the data values divided by the number of data values[6]
Normalized weights	In general, weights are relative values associated with each sample unit that are intended to correct for unequal probabilities of selection for each unit due to sample design. Normalized weights are adjusted such that the sum of the weights is equal to the number of cases in the sample.[3]
Observational data	Data that have not been obtained through a controlled experiment[1]
Ordinary least squares (OLS) regression	A method for estimating the parameters of a multiple linear regression model. The ordinary least squares estimates are obtained by minimizing the sum of squared residuals[1]
Propensity score	A score that describes probability of participation in or receiving a specific treatment[7]
Quasi–experimental study	An empirical study that compares treatment and comparison groups but lacks the critical element of random assignment[8]

Term	Definition
Random error	Random error is generally different each time a measurement is made, and behaves like a number drawn with replacement from a box of numbered tickets whose average is zero.[9]
Randomized controlled trial (RCT)	A research design in which groups are created through a process that is random. Carried out correctly, random assignment results in groups that are similar on average in both observable and unobservable characteristics, and any differences in outcomes between the groups are due to the intervention alone.[10]
Standard deviation	A measure of variation across observations in a sample. A low standard deviation indicates that the observations in the sample tend to be very close to the mean. A high standard deviation indicates that the observations in the sample tend to be spread out over a large range of values. The standard deviation is the square root of the variance.[10]
Standard error	The standard deviation of the sampling distribution; [3] also refers to the average amount of measurement error for an estimate[1]
Statistical adjustment	Including baseline measures in a statistical model at the level of the unit of analysis. A number of different techniques can satisfy the statistical adjustment requirement specified by the What Works Clearinghouse (2014), including regression adjustment, analysis of covariance (ANCOVA), and hierarchical linear modeling. Randomized controlled trials with high attrition and quasi-experimental designs require statistical adjustment to control for differences in baseline characteristics if the effect size of the difference in baseline characteristics is between 0.05 and 0.25 standard deviations.[10]
Statistical significance	The likelihood that a finding based on sample data is due to chance rather than a real difference in the population from which the sample was drawn. When the probability that a finding is due to random chance is less than 5 percent (or some other percentage), the finding is often considered to be *statistically significant.*[10]
Systematic error	An error that affects all the measurements similarly[9]

Term	Definition
t test	A statistical significance test used to test hypotheses about one or two means when the population standard deviation is unknown[11]
t value	A numeric criterion to determine whether the results of a *t* test are due to chance or not[11]
Variance	The average value of the squared difference between the value of a variable for each member of a sample or a population and the average value or mean for all members of the sample or the population. The variance is equal to the square of the standard deviation.[10]

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