Linked Learning and Postsecondary Transitions

Technical Report on the Early Postsecondary Education Outcomes of Linked Learning Students

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Introduction

From 2009 through 2016, SRI Education conducted a comprehensive evaluation of the California Linked Learning District Initiative with funding from The James Irvine Foundation. We used a multimethod research design that included qualitative and quantitative data collection and analysis to examine district-level implementation of Linked Learning systems and assessed student outcomes associated with district participation in the initiative. In 2017, we continued to track the students in the evaluation cohorts as they entered and progressed through postsecondary education.

This technical report provides supporting detail for SRI's research brief *Linked Learning and Postsecondary Transitions: A Report on the Early Postsecondary Education Outcomes of Linked Learning Students* (Caspary & Warner, 2017). In the brief, we present the postsecondary outcomes of certified pathway students—students enrolled in Linked Learning pathways that successfully completed an external review process based on established pathway quality standards—compared with peers with similar demographic characteristics and prior achievement in traditional high school programs. For the postsecondary analysis, we drew on data from three sources: the nine districts that participated in the initiative, the National Student Clearinghouse (NSC), and 14 California community college districts in close proximity to the initiative districts. In this technical report, we provide general background information on the pathways and districts and describe the data sources and demographic, achievement, and outcome variables used in the analysis. We then detail the analysis methods used and provide complete results for certified pathway students overall and by student subgroup. These results are similar to the early postsecondary findings we reported in the evaluation's comprehensive seventh-year report, but are more complete for two reasons. First, the estimates for persistence into a second year of college are based on students in all three evaluation cohorts, whereas the persistence estates in the seventh-year report did not include the final 2015 cohort. Second, for this analysis we obtained postsecondary data for the full sample of pathway and nonpathway students in the evaluation cohorts, not only the subset of these students who graduated from the initiative districts.

Participating Districts

Antioch Unified
Long Beach Unified
Los Angeles Unified
Montebello Unified
Oakland Unified
Pasadena Unified
Porterville Unified
Sacramento City Unified
West Contra Costa Unified

High School Data

The research team received student-level demographic, standardized test performance, and high school program enrollment data for the evaluation from the Institute for Evidence-Based Change (IEBC). We requested 7th- through 12th-grade data for the class of 2013 (students who started 9th grade in the 2009–10 school year) in Antioch, Long Beach, Pasadena, and Porterville and for the classes of 2014 and 2015 (students who began high school in 2010–11 and 2011–12, respectively) in all nine districts. SRI received Los Angeles data directly from the district (not through IEBC) because of district policies prohibiting redisclosure of student-level data.[1]

[1] The sample for Los Angeles was restricted to the high schools that were originally in Local District 4 and ended up in the innovation subdistrict after district reorganization. To align with the high school survey sample which we reported on in the fifth-year evaluation report, the Los Angeles sample also included students from two additional schools—Los Angeles Senior High School and Hollywood High School (Guha et al., 2014).

HIGH SCHOOL AND PATHWAY CLASSIFICATION

Each Linked Learning district provided students with a variety of academic options for school and pathway enrollment, including certified pathways, noncertified pathways, traditional high schools, alternative schools, and charter schools. To describe the academic options, we classified all high school programs in each district into one of the following program types:

- **Certified pathways**—Because pathways develop over time, we considered a student to be enrolled in a certified pathway if the pathway was certified before the end of that student's 10th-grade year. This decision rule means that students in different cohorts who were enrolled in the same pathway may be classified in different pathway types. ConnectEd began to recognize NAF certification for Linked Learning pathways in 2012–13, the year the class of 2015 (our final cohort) was enrolled in the 10th grade and thus the last year during which certification affected the classification of any students in our sample. We classified pathways certified by NAF in 2012–13 as Linked Learning pathways for the 2015 cohort. Exhibit 1 shows the certified pathways in each district in all extant-data analyses.
- **Noncertified pathways**—We considered any program that districts flagged as a pathway without the certified classification to be a noncertified pathway. These programs typically shared some important features with the certified pathways (e.g., small cohort, career theme) but varied in how closely they aligned with or aimed to replicate the full Linked Learning approach. This category included pathways deemed in progress toward certification. These noncertified pathways were not the focus of our evaluation, and we do not report on them here.
- **Alternative and continuation schools**—We classified schools for struggling students (e.g., credit recovery programs) or students with special needs (e.g., special education) into one group. We excluded such alternative and continuation schools from the analytic sample.
- **Nonpathway at wall-to-wall schools**—Several districts have at least one high school where all students should be assigned a pathway designation (these schools are commonly referred to as "wall-to-wall schools") but not all the students in the school had a flag identifying their pathway. We designated any students at these wall-to-wall schools without a pathway flag as "nonpathway at wall-to-wall schools." We excluded these students from the analytic sample.
- **Schools outside district control**—We excluded any schools deemed out of district control (e.g., home school programs, independent charter schools) from all extant-data analyses.[2]

Linked Learning Certification

During the evaluation period, Linked pathways could be certified by ConnectEd or NAF.

ConnectEd: The California Center for College and Career, established by The James Irvine Foundation in 2006, served as the primary intermediary and technical assistance provider for the demonstration project.

NAF, formerly the National Academy Foundation, provides technical assistance, professional development, and curriculum to a national network of academies in five industry sectors.

[2] Some charter schools (e.g., New Technology High, The Met in Sacramento) were created by district school boards and are considered dependent charter schools. These schools are included in all analyses.

- **Traditional high schools**—We classified all other academic programs as "traditional high school" programs. This group serves as the reference group in the postsecondary analyses.

We assigned students to a particular pathway or school on the basis of their 9th- or 10th-grade enrollment, depending on the lowest grade level served by certified pathways in the district. In Antioch, Los Angeles, Sacramento, and Porterville, pathways began in 9th grade. In Oakland and West Contra Costa, pathways began in 10th grade. Several pathways in Long Beach and Montebello began in 10th grade, and a single pathway began in 10th grade in Pasadena.[3] We assigned students in these districts into their ninth-grade program, with the exception of students who transferred from a traditional high school into a 10th-grade start pathway. Montebello chose not to send any pathways through the certification process and therefore did not contain any certified pathways.

Exhibit 1 lists all certified pathways included in the analyses, by district. The column "First Cohort Certified" lists the first class of students for whom we classified the pathway as certified. We consider this class and all subsequent classes as having attended a certified pathway in all analyses.

Exhibit 1
Certified Pathways Included in Extant-Data Analyses, by District

District	High School (HS)	Certified Pathway	First Cohort Certified
Antioch			
	Dozier-Libbey Medical HS	Health Science and Medical Technology	Class of 2013
	Deer Valley HS	Law and Justice	Class of 2015
	Antioch HS	Engineering and Designing Green Environments (EDGE)	Class of 2015
Long Beach			
	California Academy of Math and Science	Engineering and BioScience	Class of 2013
	Jordan HS	Architecture, Construction, and Engineering Academy (ACE)	Class of 2013
	Jordan HS	Jordan Media and Communications (JMAC)	Class of 2015
	Millikan HS	Community of Musicians, Performers, Artists, and Social Scientists (COMPASS)	Class of 2013
	Millikan HS	PEACE Academy	Class of 2013
Los Angeles			
	Robert F. Kennedy Community Schools Complex	Los Angeles High School for the Arts (LAHSA)	Class of 2014
	Miguel Contreras Learning Complex	Los Angeles School of Global Studies	Class of 2014
	New Media Academy	Hollywood High School	Class of 2015
Oakland			
	Life Academy	Life Academy of Health and Bioscience	Class of 2014
	Media College Preparatory	Media Academy	Class of 2014
	Skyline HS	Education Academy	Class of 2014

[3] In Long Beach during the years these data capture, two high schools enrolled the majority of students in freshman academies, intentionally giving them a year of high school before choosing a pathway. We assigned students from these two high schools who began a pathway in their 10th-grade year on the basis of their 10th-grade pathway.

Exhibit 1
Certified Pathways Included in Extant-Data Analyses, by District (concluded)

District	High School (HS)	Certified Pathway	First Cohort Certified
Pasadena			
	John Muir HS	Arts, Entertainment, and Media[a]	Class of 2013
	John Muir HS	Business and Entrepreneurship	Class of 2013
	John Muir HS	Engineering and Environmental Science	Class of 2015
	Pasadena HS	Creative Arts, Media, and Design	Class of 2013
Porterville			
	Granite Hills HS	Digital Communication and Design	Class of 2015
	Harmony Magnet	Engineering Academy[b]	Class of 2013
	Harmony Magnet	Performing Arts Academy[b]	Class of 2014
	Monache HS	Multimedia Technology Academy	Class of 2014
	Porterville HS	Partnership Academy of Business	Class of 2013
	Porterville HS	Partnership Academy of Health Sciences	Class of 2014
Sacramento			
	A. A. Benjamin Health Professions HS	Health Professions	Class of 2014
	Hiram W. Johnson HS	Business Corporate Academy	Class of 2015
	New Technology HS	School of Design	Class of 2014
	School of Engineering and Sciences	Engineering and Science	Class of 2015
	The Met	Learning Through Internship	Class of 2015
West Contra Costa			
	Richmond HS	Engineering Academy	Class of 2014
	Richmond HS	Law Academy	Class of 2014
	Richmond HS	Multimedia Academy	Class of 2014
	De Anza HS	Health Academy	Class of 2015

[a] Includes students enrolled in the Graphic Communications pathway.

[b] Pathway flags were unavailable for Harmony Magnet for the 2010–11 and 2011–12 school years. The two Linked Learning pathways in this school are modeled jointly in these two school years.

HIGH SCHOOL COVARIATES

In our analysis of early postsecondary education outcomes, we controlled for a variety of student demographic, prior achievement, and cohort variables. Exhibit 2 lists all covariates we included in the models, including descriptions of how we calculated each variable.

Exhibit 2
Data Elements for Postsecondary Education Analyses

Variable	Description
Student Demographics	
Female	Equal to 1 if student was female; equal to 0 if student was male.
Low socioeconomic status	Equal to 1 if student was part of the National School Lunch Program or parents' education level was not higher than high school graduate; equal to 0 if student was not part of the National School Lunch Program and parents' education level was higher than high school graduate and the value was nonmissing.
White	Equal to 1 if student was white, non-Latino; equal to 0 if student was not white and the value was nonmissing.
Latino	Equal to 1 if student was Latino; equal to 0 if student was not Latino and the value was nonmissing.
African American	Equal to 1 if student was African American, non-Latino; equal to 0 if student was not African American and the value was nonmissing.
Asian	Equal to 1 if student was Asian, non-Latino; equal to 0 if student was not Asian and the value was nonmissing.
Other race/ethnicity	Equal to 1 if student was American Indian, Alaska Native, or ethnicity unknown; equal to 0 if student's ethnicity was known and was not American Indian or Alaska Native.
Low prior achievement	Equal to 1 if student scored below basic or far below basic on the English Language Arts (ELA) California Standards Test (CST) before start of pathway or traditional high school program; equal to 0 if student scored basic or higher.
High prior achievement	Equal to 1 if student scored advanced on the English Language Arts (ELA) California Standards Test (CST) before start of pathway or traditional high school program; equal to 0 if student scored proficient or lower.
Gifted and talented	Equal to 1 if student was gifted and talented; equal to 0 if student was not gifted and talented and the value was nonmissing.
Special education	Equal to 1 if student was in special education; equal to 0 if the student was not in special education and the value was nonmissing.
English learner	Equal to 1 if student was classified as an English learner; equal to 0 if student was not classified as an English learner and the value was nonmissing.
Reclassified fluent English proficient	Equal to 1 if student was reclassified as proficient in English; equal to 0 if student was not reclassified as proficient in English and the value was nonmissing.
Initial fluent English proficient	Equal to 1 if student had a home language other than English but was initially classified as proficient in English; equal to 0 if student was not initially classified as proficient in English and the value was nonmissing.
English only	Equal to 1 if student had English as the only home language; equal to 0 if student did not have English as the only home language and the value was nonmissing.

Exhibit 2
Data Elements for Postsecondary Education Analyses (concluded)

Variable	Description
Student Cohort Variables	
Anticipated class of 2013, 2014, or 2015	A student in the 9th grade for the first time in the 2009–10 school year (class of 2013); 2010–11 school year (class of 2014); 2011–12 school year (class of 2015)
Pathway 10th grade start	Equal to 1 if student's pathway or traditional high school program started in 10th grade; equal to 0 if student's pathway or traditional high school program started in 9th grade.
Student Achievement	
ELA CST	ELA CST score taken before start of pathway or traditional high school program.
Timing of ELA CST	Equal to 1 if student had nonmissing value on ELA CST 2 years before start of pathway or traditional high school program and had missing value on ELA CST 1 year before start of pathway or traditional high school program; equal to 0 if student had nonmissing value on ELA CST 1 year before start of pathway or traditional high school program or had missing values on ELA CST 1 and 2 years before start of pathway or traditional high school program.
Math CST	Math CST score taken before start of pathway or traditional high school program.
Timing of Math CST	Equal to 1 if student had nonmissing value on Math CST 2 years before start of pathway or traditional high school program and had missing value on Math CST 1 year before start of pathway or traditional high school program; equal to 0 if student had nonmissing value on Math CST 1 year before start of pathway or traditional high school program or had missing values on Math CST 1 and 2 years before start of pathway or traditional high school program.
Math CST: Grade-Level Math	Equal to 1 if student took the 7th-grade-level Math CST before start of pathway or traditional high school program; equal to 0 if student did not take 7th-grade-level Math CST and the value was nonmissing.
Math CST: General Math	Equal to 1 if student took the 8th- or 9th-grade General Math CST; equal to 0 if student did not take 8th- or 9th-grade General Math CST (if nonmissing).
Math CST: Algebra I	Equal to 1 if student took the Algebra I CST; equal to 0 if student did not take Algebra I CST (if nonmissing).
Math CST: Geometry	Equal to 1 if student took the Geometry CST; equal to 0 if student did not take the Geometry CST (if nonmissing).
Math CST: Algebra II	Equal to 1 if student took the Algebra II CST; equal to 0 if student did not take the Algebra II CST (if nonmissing).
Math CST: Unknown	Equal to 1 if Math CST taken was missing for student; equal to 0 if student's Math CST taken was nonmissing.

Postsecondary Data and Outcomes

In addition to high school data described above, we also received postsecondary enrollment data from the National Student Clearinghouse (NSC), which captures enrollment in approximately 97% of all 2-year and 4-year postsecondary institutions (National Student Clearinghouse, 2017). SRI researchers requested postsecondary enrollment data for all students in the evaluation cohorts and districts, including students who dropped out or left the districts. Submission of the full high school analytic sample to the NSC enabled us to conduct the same intent-to-treat analysis we used to examine high school outcomes. This intent-to-treat approach is less vulnerable to bias from differential attrition than examining high school graduates only. For example, if the least successful pathway students drop out, then analyzing the outcomes of only those students who remain in the pathways will lead to artificially positive results. Analyzing the postsecondary outcomes of all students who began in pathways or traditional high school programs eliminates this potential source of bias, and thus provides greater support for inferring the causal impact of pathway participation on student outcomes than does excluding these students.

Some postsecondary institutions do not allow the NSC to release student records to researchers, and individual students may opt to block release of their records as well.[4] To minimize missing enrollments for students or institutions that block release, we combined the NSC return files received in March 2016 with those received in March 2017 because these blocks vary over time (Goldrick-Rabe & Harris, 2010). Further, we identified the California community college districts in closest proximity to the initiative districts. We obtained data from 14 of these community college districts, including the closest community college district to each initiative district but one.[5] We then supplemented enrollment data from the NSC with community college district data when NSC data were missing for students.

We received NSC data and community college district data from 2013–14, 2014–15, 2015–16, and fall 2016, enabling us to examine postsecondary enrollment and persistence for students in all three evaluation cohorts. We examined both first-year persistence, defined as persistence from fall to spring of the first year, and persistence to a second year, defined as continuous enrollment from fall to spring to the following fall (Exhibit 3). Our analysis of certified pathway students' postsecondary education enrollment and persistence focused on students who enrolled directly in a 2- or 4-year postsecondary institution in the fall of their expected high school completion year, though we also examined enrollment any time in the full academic year following high school completion to check the sensitivity of our results. Further, we examined 4-year college enrollment conditional on any direct college enrollment and unconditionally for the full sample, including students who did not enroll in any college. Because the results of these two analyses were similar, we reported on the conditional 4-year college enrollment outcome in the postsecondary brief for ease of interpretation.

We implemented the following decision rules in creating the postsecondary outcome variables:

- If a student had an NSC enrollment record in a given semester, the NSC record took precedence over a community college enrollment record in that semester.
- For instances where a student had an enrollment record at both a 2-year and a 4-year institution during our defined enrollment period, we designated students as enrolled in the 4-year institution.
- We calculated persistence variables only for students who enrolled in college in the fall directly following high school.

[4] For example, colleges in both the Kern and Peralta Community College Districts, the closest districts to Porterville and Oakland, respectively, block release of student records (National Student Clearinghouse, 2015).

[5] We received data for the following community college districts: Cerritos, Contra Costa, Glendale, Kern, Los Angeles, Long Beach, Mt. San Antonio, Pasadena, Peralta, Rio Hondo, Santa Monica, Sequoias, Solano, and West Hills. We were not able to obtain data from Los Rios Community College District, which is the closest district to Sacramento City Unified.

Exhibit 3
Data Elements for Postsecondary Outcome Analysis

Outcome	Description
Enrollment	
Direct College Enrollment	Equal to 1 if student enrolled in a 2-year or 4-year postsecondary institution in the fall (August 1–December 31) following student's anticipated high school graduation date; equal to 0 if student had no record of enrollment in a 2-year or 4-year postsecondary institution during that time period.
College Enrollment in First Year	Equal to 1 if student enrolled in a 2-year or 4-year postsecondary institution within one year (June 1-May 31) of student's anticipated high school graduation date ; equal to 0 if student had no record of enrollment in a 2-year or 4-year postsecondary institution within that time period.
Unconditional 2-Year College Enrollment	Equal to 1 if student enrolled in a 2-year postsecondary institution in the fall (August 1–December 31) after student's anticipated high school graduation date; equal to 0 if student enrolled in a 4-year postsecondary institution during that semester or if student had no record of enrollment in either a 2-year or 4-year postsecondary institution during that semester. **Calculated for all students in analytic sample.**
Conditional 4-Year College Enrollment	Equal to 1 if student enrolled in a 4-year postsecondary institution in the fall (August 1–December 31) after student's anticipated high school graduation date; equal to 0 if student enrolled in a 2-year postsecondary institution during that semester; missing if student had no record of enrollment in a 2-year or 4-year postsecondary institution during that semester. **Calculated only for students who enrolled in college in the fall directly following high school.**
Unconditional 4-Year College Enrollment	Equal to 1 if student enrolled in a 4-year postsecondary institution in the fall (August 1–December 31) following student's anticipated high school graduation date; equal to 0 if student enrolled in a 2-year postsecondary institution during that semester or if student had no record of enrollment in either a 2-year or 4-year postsecondary institution during that semester. **Calculated for all students in analytic sample.**
Persistence *Calculated only for students who enrolled in college in the fall directly following high school. Persistence does not require enrollment at the same institution.*	
1-year Persistence	Equal to 1 if student initially enrolled in a postsecondary institution in the fall following student's anticipated high school graduation date and also enrolled the following spring (January 1-May 31); equal to 0 if student was initially enrolled but not subsequently enrolled in the following spring semester.
Persistence to Second Year	Equal to 1 if student initially enrolled in a postsecondary institution in the fall following student's anticipated high school graduation date and also enrolled in the following spring and fall semesters; equal to 0 if student was initially enrolled but not subsequently enrolled in the following spring and (second-year) fall semesters.

Analytic Sample

We determined the analytic sample for each model based on the number of cases with nonmissing values for all covariates (student demographic, cohort, and achievement data) and outcome variables required for the model. To create the analytic sample, we made the following exclusions:

- Students with missing values for our covariates were excluded. Approximately 17% of students in the final sample were excluded because of missing covariates, mainly missing prior achievement data.[6]
- We excluded students who were not enrolled in one of the nine districts in 9th or 10th grade, depending on the lowest grade level served by pathways in the district.
- We excluded students in alternative or continuation schools because their high school experiences were not comparable to those of students in pathways or traditional high school programs.
- For purposes of model convergence, we excluded a small number of students who, before enrolling in a pathway or traditional high school, took a Math CST exam that 10 or fewer students overall had taken.

In addition, to minimize data errors, we implemented a number of additional cleaning steps:

- We excluded students in wall-to-wall schools with no pathway designation.
- We excluded students in any programs with fewer than 20 students in the analytic sample (after making the exclusions described above) because we deemed these programs too small to estimate an accurate outcome while controlling for all necessary variables. Note that we did not make this exclusion for the subgroup analyses, where we consider analyses to be exploratory, and eliminating pathways with small numbers of subgroup students would have excluded enough pathways to limit the generalizability of some findings to the full initiative.

DESCRIPTIVE STATISTICS

Exhibits 4 through 7 display descriptive statistics for students in certified pathways and traditional high school programs. These tables present the sample sizes, means, and standard deviations (for continuous variables) or percentages (for dichotomous variables) for all students in all districts who were included in the analytic sample for any outcome analysis. The tables show student demographics, student achievement data, and outcome data, respectively. We provide these overall descriptive statistics to allow for an understanding of how the characteristics of students who enrolled in certified pathways might differ from those of students in traditional high school programs. We include background descriptives for students enrolled in noncertified pathways as context (Exhibits 4 through 6) but do not include outcome descriptives for students in noncertified pathways (Exhibit 7) because we do not report results for this group. The sample sizes vary both between and within tables in Exhibits 5 through 7 because of the variation in missing data for prior achievement and outcome variables. The results tables (Exhibits 8 through 14) provide the number of students included in each analysis.

[6] Districts were able to provide middle school data for only those students who attended middle school within the district. This limitation excluded approximately half the students in Porterville, which has several feeder elementary districts.

Exhibit 4
Demographics and Cohort Variables

	Overall	Certified Pathway	Noncertified Pathway	Traditional High School
n	47,538	5,061	20,831	21,646
Female	49.6%	51.5%	50.4%	48.4%
Low SES	78.7%	78.1%	78.3%	79.3%
White	12.4%	14.8%	10.0%	14.2%
Latino	58.5%	60.7%	59.1%	57.4%
African American	14.7%	14.2%	15.0%	14.4%
Asian	13.7%	9.4%	15.4%	13.0%
Other Race/Ethnicity	0.8%	0.9%	0.5%	0.9%
Gifted and Talented	3.3%	2.3%	2.6%	4.2%
Low Prior Achievement	24.5%	20.5%	24.4%	25.7%
Special Education	8.1%	6.3%	7.1%	9.5%
Reclassified Fluent English Proficient	26.8%	27.4%	27.2%	26.2%
Initial Fluent English Proficient	8.0%	8.5%	8.1%	7.7%
English Only	44.4%	45.0%	41.9%	46.7%
English Learner	20.8%	19.1%	22.7%	19.4%
Class of 2013	18.1%	19.0%	21.0%	15.1%
Class of 2014	41.5%	33.8%	40.2%	44.6%
Class of 2015	40.3%	47.2%	38.7%	40.3%
Pathway Starts in 10th Grade	18.6%	23.5%	23.4%	12.9%

Exhibit 5
Prior Achievement Test Descriptive Statistics, by Grade[a]

	Overall	Certified Pathway	Noncertified Pathway	Traditional High School
7th Grade				
ELA CST	326	336	327	325
SD	(55)	(56)	(53)	(56)
Math CST	325	340	325	323
SD	(61)	(61)	(60)	(61)
8th Grade				
ELA CST	348	356	348	346
SD	(61)	(57)	(61)	(61)
Math CST	342	346	348	337
SD	(70)	(69)	(72)	(69)
9th Grade				
ELA CST	332	333	332	333
SD	(59)	(55)	(57)	(65)
Math CST	297	300	298	293
SD	(56)	(58)	(54)	(58)

[a] Sample size differs by cell.

Exhibit 6
Prior Achievement Test Descriptive Statistics, by Type and Period[a]

	Overall	Certified Pathway	Noncertified Pathway	Traditional High School
Prior Math Test Type				
Math CST: Grade-Level Math	4.5%	2.9%	3.2%	6.0%
Math CST: General Math	33.3%	24.2%	32.7%	36.0%
Math CST: Algebra I	52.7%	63.4%	54.2%	48.8%
Math CST: Geometry	8.6%	9.0%	8.8%	8.3%
Math CST: Algebra II	0.9%	0.4%	1.0%	0.9%
Prior Test Period				
Math CST 2 Years Before Pathway Start	4.7%	2.9%	3.3%	6.5%
ELA CST 2 Years Before Pathway Start	4.8%	2.8%	3.4%	6.7%

[a] Sample size differs by cell.

Exhibit 7
Outcome Descriptive Statistics

	Overall	Certified Pathway	Traditional High School
Direct College Enrollment	55.3%	59.0%	53.7%
College Enrollment in First Year	60.94%	64.2%	59.4%
Unconditional 2-Year College Enrollment	32.9%	34.6%	32.2%
Conditional 4-Year College Enrollment	40.5%	41.3%	40.0%
Unconditional 4-Year College Enrollment	22.4%	24.4%	21.5%
1-Year Persistence	89.2%	89.5%	89.0%
Persistence to Second Year	78.1%	79.0%	78.6%

Note: These descriptive outcomes are not adjusted for student demographics and prior achievement.

Analysis Methods

We used statistical controls to compare outcomes for certified pathway students with those of students who attended traditional high schools, had similar demographic characteristics and prior achievement, and were enrolled in the same high school district. We could not control for unobserved and unmeasured characteristics of students, however, such as motivation and parental support. Our analyses therefore can neither shed light on nor adjust for ways these unobserved characteristics may differ between pathway and traditional high school students. For this reason, we cannot conclusively determine whether pathway participation improved high school outcomes for students.

We estimated an intent-to-treat effect and classified students as participating in a pathway if they were enrolled in its earliest grade level (in either the 9th or 10th grade); for students in traditional high school programs, their program classification was based on their school enrollment in the same academic year. To estimate the differences between pathway students and similar peers in traditional high schools on all outcome variables, we used a multilevel logistic regression with random effects at the student and pathway levels. We used a vector of indicators for the student's district and cohort to control for fixed effects of each district and cohort. Outcome *Y* for student *i* in pathway *j* is given as

$$Y_{ij} = \beta + (\mathbf{PW_{ij}})\boldsymbol{\pi} + (\boldsymbol{X_{ij}} - \bar{\boldsymbol{X}})\boldsymbol{\zeta} + \alpha_j + \varepsilon_{ij}$$

where:

Y_{ij} = outcome *Y* for student *i* in pathway *j*.

$\mathrm{PW_{ij}}$ = vector of dummies representing pathway classification (certified pathway and noncertified pathway, with traditional high schools omitted as reference).

X_{ij} = vector of covariates, including district and cohort fixed effects and student prior achievement and demographics. Prior achievement variables consisted of the student's Math and ELA CST scores from the year before entering the pathway,[7] a vector of dummies indicating the Math CST exam taken,[8] and an indicator for the pathway beginning in the 10th grade. Demographic variables consisted of a series of indicators for student gender, ethnicity, English language proficiency, special education status, gifted and talented status, and low socioeconomic status. All variables were grand-mean centered.

α_j= pathway random effect.

ε_{ij}= student random effect.

The π coefficients therefore provided the estimate of the difference between pathway students (in each certified and noncertified category) and traditional high school students, controlling for all variables captured by X_{ij}.

Because all covariates were grand-mean centered, our estimates predicted differences for an "average" student in the sample. We predicted models by using Stata 14's *meqrlogit* command. We transformed the estimates into probabilities to present in the brief but also provide untransformed results in these technical report tables. We use the standard $p < .05$ threshold to determine statistical significance throughout this report.

We ran the same models for students in each of the subgroups of interest, subsetting the analytic sample to students in each group. Some of these logistic regression models did not converge for particular subgroups, and so we ran them as linear regressions using Stata 14's *mixed* command.

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[7] We controlled for achievement 1 year before the pathway or high school start, and to minimize the number of students excluded from the analyses, we used achievement 2 years before the pathway or high school start when achievement in the prior year was missing; our models accounted for this difference.

[8] Seven students in the analytic sample who took an unknown math exam, five students who took the Summative High School Math CST exam, three students who took the Integrated Math I exam, and one student who took the Integrated Math II exam were dropped from the analysis because fewer than 10 students took each of these exams types. With so few students taking these four types of exams, they were not representative of the analytic sample and prevented convergence of the maximum-likelihood estimator.

Results for Certified Pathway Students

In this section, we provide estimates for certified pathway students, along with their significance levels, the associated standard errors, and sample sizes at both student and academic program (school or pathway) levels. We also include the difference in predicted likelihood of each outcomes for the average student in the sample in a certified pathway relative to traditional high school (percentage point difference). We provide estimates for certified pathway students overall (Exhibit 8) and then for certified pathway students in each of six subgroups compared with their subgroup peers in traditional high school programs (Exhibits 9 through 14).

ALL STUDENTS

Our analysis focused on students who enrolled directly in a 2- or 4-year postsecondary institution in the fall of their expected high school completion year, but to check the sensitivity of our results we also examined enrollment any time in the full academic year following high school completion. The results of this sensitivity check are consistent with the results for direct college enrollment: there were no significant effects of Linked Learning participation on either direct enrollment or enrollment any time in the full academic year following high school completion. Further, we examined 4-year college enrollment for the entire analytic sample (including students who did not enroll in college) as well as for only those students who directly enrolled in college following high school. Examining 4-year college enrollment in these two ways yielded similar, non-significant results.

Exhibit 8
Binary Outcomes for Certified Pathway Students

	Point Estimate[a]	Standard Error	Percentage Point Difference[b]	Student *n*	School and Pathway *n*
Direct College Enrollment	0.10	0.08	2.35	47,538	183
1-Year College Enrollment	0.07	0.08	1.72	47,538	183
Unconditional 2-Year College Enrollment	0.11	0.09	2.42	47,538	183
Conditional 4-Year College Enrollment	0.08	0.13	1.96	26,292	183
Unconditional 4-Year College Enrollment	0.07	0.11	0.95	47,538	183
1-Year Persistence	0.06	0.10	0.49	26,292	183
Persistence to Second Year	0.04	0.09	0.72	26,292	183

*~p < .10; *p < .05; **p < .01; ***p < .001*

[a] Point estimates are presented in logits to allow for comparison with standard errors of these estimates.

[b] Percentage point difference between certified pathway and traditional high school for the average student in the sample.

STUDENT SUBGROUPS

In addition to the overall analyses, we analyzed outcomes separately for students with low prior achievement, students with high prior achievement, English learners, African Americans, Latinos, and females. For these analyses, we limited the sample to those students in each subgroup of interest. Results can therefore be interpreted as outcomes for subgroup students in certified pathways relative to outcomes for similar students of the same subgroup who attended traditional high schools. Four models did not converge as logistic regressions, and so we present the linear regression coefficients: conditional 4-year enrollment and both persistence variables for students with low prior achievement, and persistence to a second year for English learners.

As with the certified pathway estimates for all students, the results of our sensitivity checks indicate that the findings persist given different outcome definitions. For example, certified pathway students with low prior achievement were 5.7 percentage points more likely to enroll directly in college the fall following high school than similar peers in traditional high school programs, and 5.5 percentage points more likely to enroll any time in the first year following high school. Further, examining both unconditional and conditional 4-year college enrollment yielded estimates with the same direction and statistical significance though different magnitudes. Certified pathway students with low prior achievement were 1.3 percentage points more likely to enroll in a 4-year college than similar peers in traditional high school programs. Considering just those students who enrolled in college, certified pathway students with low prior achievement were 4.2 percentage points more likely to enroll in a 4-year college than their traditional high school peers.

The results suggest that the observed positive effect of certified pathway participation on overall college-going rates for students with low prior achievement is driven by this increased enrollment in 4-year institutions: we found no evidence for an increase in 2-year college going based on our analysis of enrollment at a 2-year institution for students with low prior achievement, unconditional on any college enrollment. In the postsecondary brief, we reported on the conditional 4-year college enrollment outcome to disentangle 4-year enrollment from the overall increase in direct college enrollment for the subgroup, and for consistency with the seventh-year evaluation report, which previewed these early postsecondary findings for high school graduates only (Warner et al., 2016). Estimating 4-year college enrollment for the smaller sample of college-going students is unlikely to exacerbate any positive selection bias associated with these 4-year college-going estimates given that the results suggest that Linked Learning increases college access for students with low prior achievement, broadening the pool of certified pathway students on which we based these estimates.

African-American students, the other subgroup with significant results, were no more likely than their traditional high school peers to enroll in college but were more likely to enroll in a 4-year college. African American pathway students were 3.7 percentage points more likely to enroll in a 4-year college than their traditional high school peers and, considering only students who enrolled directly in college, were 11.6 percentage points more likely to enroll in a 4-year institution. As with the low prior achievement subgroup, we report on the 4-year college enrollment for African American students conditional on any college enrollment in the postsecondary brief. Given the null overall college-going effect for African American students, estimating 4-year college enrollment for the smaller sample of college-going students is unlikely to exacerbate any positive selection bias associated with these 4-year college-going estimates; the greater magnitude of the conditional estimate is driven by the smaller pool of students in both conditions.

Exhibit 9
Binary Outcomes for Certified Pathway Students with Low Prior Achievement

	Point Estimate[a]	Standard Error	Percentage Point Difference[b]	Student *n*	School and Pathway *n*
Direct College Enrollment	0.26*	0.11	5.69	11,667	179
1-Year College Enrollment	0.23*	0.10	5.45	11,667	179
Unconditional 2-Year College Enrollment	0.17	0.10	3.38	11,667	179
Conditional 4-Year College Enrollment	0.04*[c]	0.02	4.27	3,757	175
Unconditional 4-Year College Enrollment	0.43*	0.19	1.33	11,667	179
1-Year Persistence	0.02[c]	0.02	2.05	3,757	175
Persistence to Second Year	0.01[c]	0.03	1.04	3,757	175

*~p < .10; *p < .05; **p < .01; ***p < .001*
[a] Point estimates are presented in logits to allow for comparison with standard errors of these estimates.
[b] Percentage point difference between certified pathway and traditional high school for the average student in the sample.
[c] Linear regression coefficient.

Exhibit 10
Binary Outcomes for Certified Pathway Students with High Prior Achievement

	Point Estimate[a]	Standard Error	Percentage Point Difference[b]	Student *n*	School and Pathway *n*
Direct College Enrollment	-0.04	0.12	-0.74	9,566	180
1-Year College Enrollment	-0.08	0.12	-1.21	9,566	180
Unconditional 2-Year College Enrollment	-0.05	0.15	-0.92	9,566	180
Conditional 4-Year College Enrollment	0.10	0.18	2.23	7,458	178
Unconditional 4-Year College Enrollment	0.01	0.14	0.25	9,566	180
1-Year Persistence	-0.08	0.20	-0.42	7,458	178
Persistence to Second Year	-0.07	0.17	-0.68	7,458	178

*~p < .10; *p < .05; **p < .01; ***p < .001*
[a] Point estimates are presented in logits to allow for comparison with standard errors of these estimates.
[b] Percentage point difference between certified pathway and traditional high school for the average student in the sample.

Exhibit 11
Binary Outcomes for Certified Pathway English Learners

	Point Estimate[a]	Standard Error	Percentage Point Difference[b]	Student *n*	School and Pathway *n*
Direct College Enrollment	-0.53	0.11	-1.23	9,894	179
1-Year College Enrollment	-0.09	0.11	-2.32	9,894	179
Unconditional 2-Year College Enrollment	-0.05	0.11	-1.13	9,894	179
Conditional 4-Year College Enrollment	0.25	0.20	3.60	3,740	169
Unconditional 4-Year College Enrollment	0.17	0.19	0.77	9,894	179
1-Year Persistence	0.20	0.20	2.27	3,740	169
Persistence to Second Year	0.03[c]	0.03	3.03	3,740	169

*~p < .10; *p < .05; **p < .01; ***p < .001*
[a] Point estimates are presented in logits to allow for comparison with standard errors of these estimates.
[b] Percentage point difference between certified pathway and traditional high school for the average student in the sample.
[c] Linear regression coefficient.

Exhibit 12
Binary Outcomes for Certified Pathway African American Students

	Point Estimate[a]	Standard Error	Percentage Point Difference[b]	Student *n*	School and Pathway *n*
Direct College Enrollment	-0.04	0.11	-1.11	6,970	163
1-Year College Enrollment	-0.05	0.11	-1.15	6,970	163
Unconditional 2-Year College Enrollment	-0.15	0.11	-3.25	6,970	163
Conditional 4-Year College Enrollment	0.52**	0.17	11.62	3,707	152
Unconditional 4-Year College Enrollment	0.34*	0.16	3.79	6,970	163
1-Year Persistence	0.02	0.19	0.24	3,707	152
Persistence to Second Year	0.12	0.16	2.38	3,707	152

*~p < .10; *p < .05; **p < .01; ***p < .001*
[a] Point estimates are presented in logits to allow for comparison with standard errors of these estimates.
[b] Percentage point difference between certified pathway and traditional high school for the average student in the sample.

Exhibit 13
Binary Outcomes for Certified Pathway Latino Students

	Point Estimate[a]	Standard Error	Percentage Point Difference[b]	Student *n*	School and Pathway *n*
Direct College Enrollment	0.14	0.09	3.40	27,807	183
1-Year College Enrollment	0.12	0.09	2.84	27,807	183
Unconditional 2-Year College Enrollment	0.13	0.10	2.87	27,807	183
Conditional 4-Year College Enrollment	0.05	0.15	1.14	14,157	180
Unconditional 4-Year College Enrollment	0.09	0.13	0.93	27,807	183
1-Year Persistence	0.11	0.11	1.01	14,157	180
Persistence to Second Year	0.06	0.10	1.05	14,157	180

*~p < .10; *p < .05; **p < .01; ***p < .001*
[a] Point estimates are presented in logits to allow for comparison with standard errors of these estimates.
[b] Percentage point difference between certified pathway and traditional high school for the average student in the sample.

Exhibit 14
Binary Outcomes for Certified Pathway Female Students

	Point Estimate[a]	Standard Error	Percentage Point Difference[b]	Student *n*	School and Pathway *n*
Direct College Enrollment	0.12	0.08	2.82	23,564	183
1-Year College Enrollment	0.12	0.08	2.61	23,564	183
Unconditional 2-Year College Enrollment	0.13	0.10	2.84	23,564	183
Conditional 4-Year College Enrollment	0.10	0.14	2.38	14,327	183
Unconditional 4-Year College Enrollment	0.07	0.12	1.13	23,564	183
1-Year Persistence	0.01	0.12	0.10	14,327	183
Persistence to Second Year	-0.001	0.11	-0.02	14,327	183

*~p < .10; *p < .05; **p < .01; ***p < .001*
[a] Point estimates are presented in logits to allow for comparison with standard errors of these estimates.
[b] Percentage point difference between certified pathway and traditional high school for the average student in the sample.

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