RIGOROUS TESTS OF STUDENT OUTCOMES IN CTE PROGRAMS OF STUDY:

Final Report

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ABSTRACT

This study was designed to investigate the relationship between participation in federally mandated college and career-preparatory programs—known as programs of study (POS)—and high school achievement outcomes. POS are an organized approach to college and career readiness that offer an aligned sequence of courses spanning secondary and postsecondary education, blending standards-based academic and technical content, allowing students to earn postsecondary credit while in high school, and leading to an industry-recognized credential or certificate at the postsecondary level or an associate or baccalaureate degree.

The sample includes 6,638 students from three urban districts in three different states. This study employed a multi-method, longitudinal, quasi-experimental design. Qualitative measures included adherence to the legislatively mandated components of POS. In the quantitative portion of the study, we employed two different statistical approaches to the data in each district. First, we estimated the effects of enrolling in POS and the number of career and technical education (CTE) credits earned on GPA and graduation using an instrumental variable approach. In addition, we also addressed specific policy questions about completing a POS compared to other high school trajectories through posthoc multiple regression analyses.

The outcomes show that in the first district, enrollment in POS schools caused more students to graduate by increasing the number of CTE credits they earned. In all three districts, earning more CTE credits was associated with graduation, although the results for the other two districts did not support the type of causal inferences we were able to draw from the first district's outcomes. We also found that POS students earned significantly more STEM or AP credits than comparison students, depending on the implementation context. POS students outperformed other students on technical measures at little to no cost to overall academic achievement.

Across all districts, participation in programs associated with accruing college credits in high school (e.g., dual enrollment) was low, as was the incidence of earning an industry-recognized credential, two key elements of POS. We lacked the research funding to examine whether POS led to postsecondary degrees; however, senior exit survey results indicated that similar numbers of intervention and comparison students planned to attend a four-year college full time. This suggests that POS can be offered to high school students with no harm to their college aspirations or preparation. In addition, significantly more POS students indicated that their college studies would be related to their high school program, suggesting that students who enroll in a POS often continue their education in the same program area, and reap the benefits of having begun that preparation while still in high school.

Our primary recommendation is for districts to seek ways to increase the number of CTE credits earned by high school students, because in all three districts, earning more CTE credits was associated with graduation. Other recommendations include re-examining dual enrollment programs so that more students participate, encouraging more people from industry backgrounds to become high school teachers, and improving data collection so that the efficacy of interventions may be better evaluated. All of these recommendations should improve POS, secondary school outcomes, and preparation of our nation's youth for postsecondary education and careers.

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ACE	Architecture, Construction, and Engineering
ACT	American College Testing
AHLA	American Hotel and Lodging Association
ANCOVA	Analysis of Covariance
AP	Advanced Placement
ASCA	American School Counseling Association
ASE	Automotive Service Excellence
ASVAB	Armed Services Vocational Aptitude Battery
BLS	Basic Life Support
CAD	Computer-Aided Design
CADD	Computer-Aided Design and Drafting
CCENT	Cisco Certified Entry Networking Technician
CFI	Comparative Fit Index
CI	Confidence Interval
CMAA	Certified Medical Administrative Assistant
CNA	Certified Nursing Assistant
CPR	Cardiopulmonary Resuscitation
CTE	Career and Technical Education
CTSO	Career and Technical Student Organization
DECA	Distributive Education Clubs of America
ECC	East Community College
EKG	Electrocardiogram
EMT	Emergency Medical Technician
ES	Effect Size
FAA	Federal Aviation Administration
FACS	Family and Consumer Science
FBLA	Future Business Leaders of America
FCCLA	Family, Career and Community Leaders of America
FFA	Future Farmers of America
F/RL	Free and Reduced-Price Lunch
FTE	Full Time Enrollment
GPA	Grade Point Average
GST	General Service Technician
HBCU	Historically Black College and University
HIPAA	Health Insurance Portability and Accountability Act
HOSA	Health Occupations Students of America
HVAC	Heating, Ventilation, and Air Conditioning
IB	International Baccalaureate

ICAR	Inter- Industry Conference on Auto Collision Repair
IEP	Individual Education Plan
IGP	Individual Graduation Plan
IRC	Industry-Recognized Credential
IT	Information Technology
LEP	Limited English Proficient
MAR	Missing at Random
MCAR	Missing Completely at Random
NACEP	National American Board of Certified Energy Practitioners
NAF	National Academy Foundation
NATEF	National Automotive Technicians Education Foundation
NCAC	National Career Academy Coalition
NCCER	National Center for Construction Education and Research
OSHA	Occupational Safety and Health Administration
OVAE	Office of Vocational and Adult Education (now known as OCTAE: Office of Career, Technical, and Adult Education)
PAHRA	Partnership for Air-Conditioning, Heating, Refrigeration Accreditation
PBL	Project-Based Learning
PLTW	Project Lead the Way
POS	Program of Study / Programs of Study
PSAT	Preliminary Scholastic Assessment Test
PSM	Propensity Score Matching
RCT	Randomized Controlled Trial
RMSEA	Root Means Square Error of Approximation
ROTC	Reserve Officer Training Corps
SAS	Statistical Analysis Software
SAT	Scholastic Assessment Test
SCC	South Community College
SEM	Structural Equations Modeling
SES	Socioeconomic Status
STEM	Science, Technology, Engineering, and Mathematics
TLI	Tucker-Lewis Index
USDE	United States Department of Education
VIF	Variance Inflation Factor
WCC	West Community College
WLSMV	Weighted Least Squares with Mean and Variance Adjustment

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Jim Stone: sine qua non, you never let me lose sight of the forest

EXECUTIVE SUMMARY

Introduction

This study was designed to investigate the relationship between participation in federally mandated college and career-preparatory programs—known as programs of study (POS)—and high school achievement outcomes. POS are an organized approach to college and career readiness that offer an aligned sequence of courses spanning secondary and postsecondary education, blending rigorous academic and technical content, allowing students to earn postsecondary credit while in high school, and leading to an industry-recognized credential or certificate at the postsecondary level or an associate or baccalaureate degree.

This study was proposed in the context of the reauthorization of the Carl D. Perkins legislation (2006), which funds CTE nationwide. The reauthorization, known as Perkins IV, increased program accountability in the areas of academic achievement, technical skills achievement, and alignment with postsecondary technical education—in the form of POS. In the Perkins IV legislation, POS have four components. They:

- must incorporate secondary education and postsecondary education elements;
- must include coherent and rigorous content aligned with challenging academic standards and relevant career and technical content in a coordinated, non-duplicative progression of courses that align secondary education with postsecondary education to adequately prepare students to succeed in postsecondary education;
- may include the opportunity for secondary education students to participate in dual or concurrent enrollment programs or other ways to acquire postsecondary education credits; and
- must lead to an industry-recognized credential or certificate at the postsecondary level, or an associate or baccalaureate degree.

The primary research question guiding this study has been, *does participation in the high school portion of a POS correlate with improved student outcomes?* We used common high school outcomes, and we also incorporated a qualitative design to help explain the contexts in which the outcomes were achieved.

In this report, we situate the study within current national educational and economic contexts. As college and career readiness has become the federal focus of public education reform, states and districts have sought to implement programs like POS that address readiness gaps and prepare students for further education and training. Career-focused education that blends standards-based, integrated academics with hands-on, challenging, career-ready skills, enriched by educational partnerships with industry, are designed to help mitigate the effects of poverty and low parental educational attainment and positively influence students' postsecondary aspirations.

Method

This study employed a multi-method, longitudinal, quasi-experimental design to investigate the relationship between POS participation and the high school outcomes described in the Perkins

legislation for assessing the effectiveness of POS. The study consists of three strands employing slightly different research designs and separate analyses, one for each participating district. We employed this tripartite design because (a) the districts operate in very different contexts, with quite different state policy contexts; and (b) due to contextual differences, the means of creating samples differed across sites. Further, one district began participating in the study well after the others, meaning that some data could not be collected there (e.g., classroom observations and interviews for students' first three years of high school).

The sample includes 6,638 students from three urban districts in three different states. Minority students were in the majority in these districts. Student participants included lottery applicants in the two districts that held lotteries for entry into specialized high school programs such as POS, and in the third, we included students enrolled in the POS high school and a district-created propensity score-matched comparison group. Despite the presence of lotteries in two of the three districts, students were not randomly assigned to the POS, so an experimental strand was ruled out.

Our outcome measures are found in district systems data and are of practical interest to schools. The intent of Perkins IV is to improve the achievement of CTE students in relation to state academic standards and to ease their transition to postsecondary education. We operationalized these POS elements into outcomes that capture the skills and content that POS were designed to address. These include:

(a) Academic achievement as measured by cumulative grade point average (GPA), STEM credits earned (i.e., credits in science and in higher math, defined as math above Algebra II), and AP credits earned;
(b) Technical skills achievement, measured by CTE GPA;
(c) Graduation rates, and
(d) Transition measures such as post-high school plans and completion of coursework associated with college credits (i.e., dual enrollment)

Qualitative measures included adherence to the components of POS as laid out by Perkins IV and a policy guidance framework subsequently released by the U.S. Department of Education's Office of Adult and Vocational Education, which oversees Perkins implementation.

In the quantitative portion of the study, we employed two different statistical approaches to the data in each district, in order to answer important policy questions about POS. First, we estimated the effects of enrolling in POS and number of CTE credits earned on GPA and graduation using an instrumental variable approach. In addition to that main analysis, we also addressed specific policy questions about completing a POS compared to other high school trajectories through posthoc multiple regression analyses.

The qualitative portion of the study consisted of data collected on annual site visits, including interviews and classroom observations. Interviews were transcribed and observation forms were completed. These data were coded, which involved marking the instances of concepts or topics relevant to the study as they appeared in the interview or observation data. Codes were entered into a qualitative data analysis software package, the corpus of which could then be queried to

yield reports rich with information on each code from every type of interviewee and observed class. These reports allowed us to group the data into more specific topical and descriptive categories, generating an understanding of POS in these contexts that helped explain the diverse outcomes across districts.

Other data included a senior exit survey administered to elicit student post-high school plans.

Outcomes

Specific outcomes are presented by district, but some findings spanned districts: Across all districts, participation in programs associated with accruing college credits in high school (e.g., dual enrollment) was low. The analytical model indicated a weak fit to the data and suggested that important factors in dual enrollment participation were not being captured. Across the two districts that held a senior exit survey, results revealed very similar post-high school plans for both students who enrolled in POS and the comparison group: the majority of both groups planned to attend a four-year college or university full time, and had already been accepted to the school of their choice. Intervention students were more likely to choose a college major related to their high school program area than were those comparison students who were in a specific program in high school (i.e., performing arts). Finally, for each district, a qualitative analysis of POS implementation is presented, based on the elements of the law mandating POS and the subsequent policy guidance framework.

West District

West District is an urban district that experienced a large population increase prior to the recent economic recession. To respond to this growth, new high schools were built and integrated into the district's school choice program. The impetus behind school choice was to improve student achievement, promote diversity, and create an awareness of career opportunities relative to POS and magnet themes. The school cultures at the three participating POS high schools fostered environments where students could both focus on their chosen POS and excel academically.

We tested an instrumental variable model of the effects of POS enrollment and CTE credit earning on GPA and graduation. Our results indicate that enrollment in POS high schools improved students' probability of graduation by 11.3% and that increased CTE credit earning fully explained this effect. This analysis also showed non-significant effects of POS enrollment and CTE credit earning on overall high school GPA. These findings suggest that enrollment in West's POS schools benefited students in terms of retention, at no cost to their achievement.

In West District, 49.5% of the intervention group completed a POS. We examined policy-relevant questions using multiple regression models to compare POS completers to CTE concentrators (a Perkins-derived designation for students earning a state-determined number of CTE credits in a program area), and to the rest of the sample. We found that compared to the rest of the sample, POS completers were more likely to 1) have a higher overall GPA, 2) have a higher CTE GPA, and 3) earn more STEM credits, but completing a POS did not affect the likelihood of earning AP credits. In the comparison with CTE concentrators, POS completers

were more likely to 1) have a higher overall GPA, and 2) earn more STEM credits, but completing a POS did not affect the likelihood of earning STEM or AP credits.

East District

Like many urban school districts, East District developed multiple magnet and choice programs across grade spans. At the high school level, a number of schools or programs within schools offered a range of magnets available to students. Blue Academy, the wall-to-wall magnet POS high school that participated in this study, served students from all over East District. Although Blue held very high expectations for its students, teachers, students, and administrators described a supportive, caring culture where barriers to success were identified and addressed.

Results from the instrumental variable model at East District were not interpretable because it failed to generate substantial exogenous variation in number of CTE credits earned, so we tested a conventional mediator model. We found that although POS enrollment did not impact CTE credit earning, each additional CTE credit earned corresponded to a 9% improvement in the probability of graduation and a .15 unit improvement in GPA. These results suggest that earning CTE credits benefited all students—both intervention and comparison—in terms of retention and also achievement.

In East District, 50.0% of the intervention group completed a POS. In assessing the effect of completing a POS on high school achievement, we found that POS completers were much more likely than the rest of the sample to have earned more AP credits, but completing a POS at Blue did not affect the likelihood of earning higher GPAs overall or in CTE, or the likelihood of earning STEM credits.

Because there was only one intervention school in East District, we compared POS completer outcomes to those of CTE concentrators in Blue Academy (i.e., Blue POS students who failed to complete their POS but qualified for CTE concentrator status) as opposed to all CTE concentrators in the sample. We did this in order to test whether outcomes were attributable to completing a POS or if they had more to do with Blue Academy as a school—its reputation, culture, and faculty. Compared to Blue concentrators, completing a POS did not affect the likelihood of earning a higher overall or CTE GPA, or of earning more STEM or AP credits, suggesting that Blue Academy as a school may be more responsible for the outcomes as opposed to completing a POS.

South District

South District is located in a state that strongly encouraged high schools to develop career academies as a way to engage students and lead them to high-demand, high-wage careers. This state mandated articulation agreements and dual enrollment opportunities, and included industry-recognized credentials as part of a college-and-career-ready accountability program. Rather than create POS high schools, South District ensured that all students had the opportunity to participate by developing POS in every high school. Some of these POS were accessible through the district's lottery system, and others were available for students attending their zoned high schools. There were no systematic differences between these programs.

Like in East District, the instrumental variable model in South also failed to generate substantial exogenous variation in number of CTE credits earned, precluding us from interpreting the results. We tested a conventional mediator model and found that (1) students who enrolled in POS were 9% more likely to graduate than students who enrolled in other programs, (2) students who enrolled in POS had slightly better GPAs than students enrolled elsewhere, and (3) these effects were attributable to increased earning of CTE credits. These results suggest that enrollment in POS may have benefited students in terms of retention and also achievement.

In South District, 58.0% of the intervention group completed a POS. We assessed the effect of completing a POS on high school achievement, finding that compared to the rest of the sample, South POS completers were significantly less likely to earn more 1) STEM credits or 2) AP credits, but they were more likely to have a higher CTE GPA. The results comparing POS completers with CTE concentrators were similar: POS completers were significantly less likely to earn more 1) STEM credits or 2) AP credits, but they were more likely to have a higher CTE GPA.

Unlike the other two districts participating in this study, no senior exit survey was conducted in South District. However, we were able to collect some industry-recognized credential data from South, which was not available at the other districts. The data were not complete, but among the students known to have sat for a credentialing exam, nearly 94% passed and earned the credential. Over three quarters of those credentials were earned by POS completers.

Telling the Story of POS: Cross-District Synthesis

We integrated the findings from the mixed methods of this study to synthesize what we learned about the impact of POS on student achievement.

Context for the Achievement Outcomes: West District

Regular CTE programs in West District did not offer the same rigor as POS—this is evident in both GPA and STEM credits outcomes. POS completers had significantly, substantively higher GPAs than both comparison groups. That, coupled with the higher graduation rate among intervention students, suggests that POS motivated those students to achieve and finish high school. We posit that in addition to completing more CTE credits, the additional elements of POS helped foster engagement and achievement. Students in POS knew that their programs had a built-in next step at the local community college or university. School cultures at the POS high schools fostered individual and career development, opportunities to lead, positive attitudes about achievement and greater commitment to careers. Students knew that their curriculum was at a higher level than at other schools—that their preparation was college-level in many cases, and that it could lead to advanced status in college.

Context for the Achievement Outcomes: East District

The entire Blue Academy staff promoted college attendance as one of the primary student outcomes they sought. The principal claimed that he pushed students to take AP courses, especially those that were in any way aligned with the POS theme. We did not observe this overriding goal of college attendance at the comparison schools. This may account for the significant and substantively important positive outcome of earning AP credits at Blue compared to the rest of the sample. The rest of the findings were neither significant nor did they generate substantive effect sizes, indicating that POS may be offered in districts like East at no cost to other academic achievement measures.

Context for the Achievement Outcomes: South District

Intervention students in South District had slightly better GPAs and were more likely to graduate than the comparison group, although causal inference remains tentative. CTE concentrators and the rest of the sample earned significantly higher numbers of STEM and AP credits than POS completers did. It is possible that the additional CTE credit and other requirements of POS at South District (e.g., internships, industry credentials) took enough time away from POS completers that they were unable to pursue as many advanced academic courses. We know from the qualitative data that many comparison group students were in college-preparatory programs that required advanced academic course-taking, which could help explain the lack of positive outcomes for POS completers on those measures. South POS completers had significantly higher CTE GPAs than CTE concentrators and the rest of the sample, suggesting that they had focused on their POS area over advanced academic course-taking.

Across Contexts

In sum, the findings from the three districts indicate that taking more CTE credits may boost GPA, the probability of graduation, and some achievement measures, and that these results come at little to no cost to overall academic achievement, based on the posthoc findings.

With respect to dual enrollment, despite the promotion of these credit-based transfer mechanisms within POS, completing a POS was not associated with accruing more college credits. In fact, when there was a significant difference between POS completers and the other groups, as there was in West and East Districts, the difference favored the rest of the sample, not POS completers. The models we ran on college credits accrued were not as well-aligned with the data as the other analyses, so this may have affected the results. We know from the qualitative data that all students, not just POS students, were encouraged to take courses that offered the opportunity to earn college credits. It could be that non-POS students had more time in their schedules. Or, as the qualitative data suggested, POS students in these districts saw themselves as bound for four-year colleges and universities, and the community college credits that were being offered did not seem as useful or desirable to them as other college-preparatory approaches like AP and other advanced course-taking.

In terms of industry-recognized credentials, no usable data were collected in West or East Districts. In South District, the data we obtained were known to be incomplete, but provided a

rough picture of credential earning by POS students. About 16% of our posthoc sample took an exam for an industry credential. Of those students who took an exam and earned an industry credential, three quarters were POS completers.

POS are by definition secondary-postsecondary programs, designed to lead to associate and baccalaureate degrees. Although we lacked research funding to follow these Class of 2012 cohorts immediately into postsecondary education and careers, future research on this sample would provide important information on the postsecondary half of POS. In spite of this limitation, senior exit survey results indicated that similar numbers of intervention and comparison students planned to attend a four-year college full time in both West and East Districts (South did not participate in the senior exit survey). This suggests that POS can be offered to high school students with no harm to their college aspirations or preparation.

Notably, survey data showed that significantly more POS students in both West and East Districts indicated that their college studies would be related to their high school programs. This suggests that students who enroll in a POS may continue their education in the same program area and reap the benefits of beginning that preparation in high school. Qualitative data showed this to be a purposeful goal of POS: Teachers and administrators in both districts spoke of putting students on a fast track to college by (a) getting the foundational and pre-requisite courses out of the way while still in high school, and (b) allowing students to earn industry credentials that would help them work in their fields while continuing their studies.

Recommendations

Our primary recommendation is for districts to seek ways to increase the number of CTE credits earned by high school students. Our findings for West District suggested that enrollment in POS schools caused more students to graduate by increasing the number of CTE credits they earned. In all three districts, earning more CTE credits was associated with graduation. In contexts similar to West District, increasing opportunities for students to enroll in POS could improve graduation rates. In districts where POS enrollment is unlikely to change CTE credit earning, using other means to increase the number of CTE credits earned by secondary students could improve graduation rates.

We conclude that CTE credits need not be presented in a POS sequence to have the desired impact on graduation. However, posthoc analyses showed that in most cases, CTE offered in POS sequences may have had a more beneficial impact on other important student outcomes, more than simply taking CTE courses or completing a CTE concentration. Further, qualitative data showed that most students, teachers, and administrators were positively inclined toward POS. They believed that POS provided students with experiences and opportunities that encouraged engagement and prepared them for their next steps after graduation. Administrators and policymakers should consider designing programs around the elements of POS that make the most sense for their contexts, then work to improve practice, learning, and support systems (e.g., data collection methods) to provide evidence of student outcomes.

Other recommendations include re-examining dual enrollment programs so that more students participate, encouraging more people from industry to become teachers, assigning guidance

counselors by high school program instead of student last name, and improving data collection so that the efficacy of interventions may be better evaluated. All of these recommendations should improve POS, secondary school outcomes, and preparation of our nation's youth for postsecondary education and careers.

This study confirms that although high-quality CTE programs in the form of POS are not easy, cheap, or capable of solving all educational problems, they can be implemented well and yield positive results, as the three districts that participated in this study demonstrated. However, this study remains an incomplete examination of POS because the postsecondary portion was not able to be incorporated here. Future work must include the complete intervention in order to arrive at a comprehensive understanding of the impact of POS on student secondary, postsecondary, and career outcomes.

CHAPTER ONE: Rigorous Tests of Student Outcomes in CTE Programs of Study

Introduction

This study was designed to investigate the relationship between participation in federally mandated college and career-preparatory high school programs—known as programs of study (POS)—and high school achievement outcomes. POS are an organized approach to college and career readiness that offer an aligned sequence of courses spanning secondary and postsecondary education, blending rigorous academic and technical content, allowing students to earn postsecondary credit while in high school, and leading to an industry-recognized credential or certificate at the postsecondary level or an associate or baccalaureate degree.

The primary research question guiding this study has been, does participation in the high school portion of a college and career-preparatory program correlate with improved student outcomes? We use common high school outcomes, and we also incorporated a qualitative design to help explain the contexts in which the outcomes were achieved.

In this report, we first situate the study within current national educational and economic contexts. Next, we describe the legislative components of POS, noting that POS were designed to be secondary-postsecondary programs, not just an improvement on high school career and technical education (CTE) programs. We then review the research base on POS and several of its precursors—tech prep, dual enrollment programs, and career academies—on which POS were in part based. In fact, states and districts often implement POS by building upon these efforts. In the chapters that follow, we present the study's research questions, study design, and methods, and then report the outcomes for each participating district. We use a cross-case analysis to discuss these outcomes, and provide recommendations for policy and practice.

Purpose and Significance of the Study

This study was proposed in the context of the reauthorization of the Carl D. Perkins legislation (2006), which funds CTE nationwide. The reauthorization, known as Perkins IV, modified existing practice by increasing program accountability in the areas of academic achievement, technical skills achievement, and alignment with postsecondary technical education—in the form of POS.

Description of the Intervention

According to the Perkins legislation, there are several components to CTE POS, which:

> (i) must incorporate secondary education and postsecondary education elements;
> (ii) must include coherent and rigorous content aligned with challenging academic standards and relevant career and technical content in a coordinated, nonduplicative progression of courses that align secondary education with postsecondary education to adequately prepare students to succeed in postsecondary education;

(iii) may include the opportunity for secondary education students to participate in dual or concurrent enrollment programs or other ways to acquire postsecondary education credits; and
(iv) must lead to an industry-recognized credential or certificate at the postsecondary level, or an associate or baccalaureate degree (Perkins IV, Section 122[c][1][A]).

Because these were the legal requirements of POS, they were among the criteria we used to select our sites. Other criteria included the districts' ability to support our study design (see *Method*, below). Comparison group students from these districts had CTE programs at the comprehensive high schools they attended, and some students availed themselves of these programs. Others took academic and elective courses that are typical of the range of such courses offered in contemporary American high schools.

POS differ from comparison school CTE programs in the ways enumerated by the legislation. First, POS are characterized by non-duplicative sequencing of secondary and postsecondary curriculum, in order to provide seamless transitions. This course sequence at the high school level is a key characteristic of POS—the comparison schools have CTE programs but sequenced course-taking within those programs is not required. Second, POS need to foster standards-based academic course-taking as well as technically rigorous CTE courses as a way to prepare students for postsecondary education. Not all comparison school CTE programs shared these goals. Third, POS may present opportunities for students to accrue college credits in credit-based transfer programs such as dual enrollment. Finally, POS must lead to a credential, certificate, or degree. Again, CTE programs at the comparison schools did not meet these requirements.

Standard CTE programs might offer several of these elements but in the case of the participating districts in this study, only the POS offer the full set of elements. Two of these districts chose to create high schools dedicated to POS in the form of career academies or magnets; the third district integrated POS into all of its comprehensive high schools. There are other themed high schools in the districts besides the participating schools, including performing arts or International Baccalaureate (IB) high schools, which were usually but not exclusively entered through the same lottery system that selected POS students.

In addition to being a departure from traditional CTE, POS are also different from the typical high school experience for college preparatory students. POS provide the opportunity for college preparatory students accustomed to standard academic courses to be challenged in hands-on, career-based ways. POS can also decrease the financial burden of higher education by allowing students to earn postsecondary credits in high school.

Theory of Change

POS change several aspects of the default high school experience. POS upgrade CTE, a program that has been perennially popular among students but traditionally considered less academically rigorous than college preparatory tracks in high school, and directed towards students not interested in attending college. As laid out in Perkins IV, POS infuse CTE with standards-based academics and seamless postsecondary connections; if implemented as mandated, POS may potentially lead to improved academic achievement, high school completion, and postsecondary

matriculation. The implicit theory of change is that infusing CTE programs with rigorous academics and postsecondary connections will (1) help students see the relevance of the academic subjects they are studying, and (2) attract a broad range of students of all levels of ability and interest, both of which should improve overall student outcomes.

POS in Context: College and Career Readiness and the Underpreparedness Problem

College and career readiness has become the federal focus of public education reform as the conversation around the reauthorization of the Elementary and Secondary Education Act (ESEA) began in 2010. In a statement made to the National Governors Association on February 27, 2012, President Obama stated, "The jobs of the future are increasingly going to be those with more than a high school degree. And I have to make a point here. When I speak about higher education, we're not just talking about a four-year degree. We're talking about somebody going to a community college and getting trained for that manufacturing job that now is requiring somebody walking through the door, handling a million-dollar piece of equipment." Federal education policy reflects a clear goal that every student should graduate from high school ready for college and a career, regardless of their income, race, ethnic or language background, or disability status.

Most states have been actively working to improve college and career readiness both academically (e.g., meeting high standards in traditional academic subjects; see Achieve, Inc., 2010; Allen & Sconing, 2005; Rolfhus, Decker, Brite, & Gregory, 2010; Southern Regional Education Board, 2010) and technically (e.g., rigorous assessments of technical skills; competency in 21st-century or workplace readiness skills; see Institute for a Competitive Workforce, 2008; National Research Council, 2012; Partnership for 21st-Century Skills, 2009; Saunders & Chrisman, 2011; Stone & Lewis, 2012). However, most students remain poorly prepared for either. Striking gaps exist between the knowledge and skills students gain in school and the knowledge and skills expected by colleges and employers.

ACT (2013) recently found that only 26% of high school students taking the ACT exam met college-ready benchmarks in English, reading, mathematics, and science. The Alliance for Excellent Education (AEE, 2008) has estimated that, nationally, about a third of all students entering ninth grade will graduate unprepared for college or an entry-level job, and another third will drop out; those most likely to do poorly are minority and low-income students. Research has shown that dropouts are more likely to be unemployed, collect government assistance, or spend time in prison (AEE, 2009; Natriello, McDill, & Pallas, 1990; Rumberger, 1987, 1995). Dropouts also earn far less than those with a diploma or some higher education (AEE, 2009). National Center for Education Statistics (NCES) data show that those with a baccalaureate degree earn 28% more than those with an associate degree, 53% more than those with a diploma, and a staggering 96% more than high school dropouts (Aud & Hannes, 2010). At the same time, studies by the Center on Education and the Workforce at Georgetown University show that 31% of individuals who acquire postsecondary technical certifications earn more than those with baccalaureate degrees. These data show the importance of continuing education beyond high school (Carnevale, Smith, & Strohl, 2010).

For those students who do graduate and successfully enroll in some form of postsecondary education, most will be identified as in need of remediation. As few as one in five high school graduates are prepared for college-level classes (ACT, 2008). The National Center for Public Policy and Higher Education and the Southern Regional Education Board (NCPPHE & SREB, 2010) have estimated that, despite graduating with allegedly "college-ready" high school transcripts, as many as 60% of all U.S. first-year college students require non-credit bearing remedial courses in English or math (see also Bailey, 2009). Current and former community college students have reported that remedial courses were not offered in ways that helped them succeed; they also felt unprepared to establish career goals or take the steps necessary to achieve them (Public Agenda, 2012). These students believed that being in programs with well-defined pathways and more access to career information would give them a greater chance of achieving their goals.

Many underprepared students fail to complete their programs. According to Symonds, Schwartz, and Ferguson (2011), the on-time completion rate at four-year colleges and universities is 56%, and at two-year or community colleges, 29%. Most students who fail to complete college on time will never finish (NCPPHE & SREB, 2010; Symonds et al., 2011). Whereas more selective four-year universities screen out underprepared students and have less of a readiness gap, in less selective four- and two-year colleges—the most affordable and likely choice of low-income, first-generation college students (Deil-Amen & Tevis, 2010; Bill & Melinda Gates Foundation, 2005; Perna et al., 2008; Venezia & Kirst, 2005)—the readiness gap is enormous. As many as 75% of students at two-year colleges require remediation (NCPPHE & SREB, 2010), and many drop out in frustration and in debt. Even colleges with liberal or open admissions may be out of reach or require considerable remediation in core academic subjects (Deil-Amen & Tevis, 2010).

The academic readiness gap is echoed in the workplace, as employers continue to report that recent high school graduates are unprepared to pursue entry-level jobs or career training programs (Business Roundtable, 2009; Manufacturing Institute & Deloitte Consulting, 2011). The nation's largest employers have warned of a growing skills gap and indicated a "reluctance to hire young people with just a high school degree. . . . Once the recession ends, they could face shortages of qualified workers" (Symonds et al., 2011, p. 4). Yet the U.S. economy remains one in which most jobs require at least some postsecondary education and training (AEE, 2008; Carnevale et al., 2011; Carnevale et al., 2010; Ruppert, 2003).

The high school curriculum is known to play a significant role in college access and success (Adelman, 1999, 2006). In response, states and districts have sought to implement college and career-preparatory programs like POS that address readiness gaps and prepare students for further education and training. Career-focused education that blends rigorous, standards-based, integrated academics with hands-on, challenging, career-ready skills, enriched by educational partnerships with industry, may help mitigate the effects of poverty and low parental educational attainment and positively influence students' postsecondary aspirations. The opportunities POS extend to earn college credit while in high school may also shorten students' time to degree and decrease the financial burden of college attendance.

The Federal Mandate: Career-Focused Programs of Study

Successive reauthorizations of the Carl D. Perkins legislation that funds CTE have addressed how career-focused education should prepare students for both postsecondary education and the workplace. Perkins II (1990) required secondary and postsecondary institutions to form regional consortia and align their curricula through articulation agreements spanning two years of high school and two-year community college programs. These agreements led to programs known as 2+2 programs or tech prep. Perkins II also specified that academic curricula and career-focused education should be integrated in order to foster the learning of advanced academic skills in career-oriented, technically challenging settings. Perkins IV (2006) advanced this line of policy, mandating the connection between career-focused education with academic core subjects and postsecondary preparation through POS. In the Perkins IV legislation, POS have four components. They:

- must incorporate secondary education and postsecondary education elements;
- must include coherent and rigorous content aligned with challenging academic standards and relevant career and technical content in a coordinated, non-duplicative progression of courses that align secondary education with postsecondary education to adequately prepare students to succeed in postsecondary education;
- may include the opportunity for secondary education students to participate in dual or concurrent enrollment programs or other ways to acquire postsecondary education credits; and
- must lead to an industry-recognized credential or certificate at the postsecondary level, or an associate or baccalaureate degree. (Perkins IV, Section 122[c][1][A])

POS change several aspects of the default, business-as-usual high school experience. POS infuse academic rigor, seamless postsecondary connections, and college preparation into career-focused education, which has formerly been perceived as directed toward students not interested in college. For example, many high school health sciences programs have offered preparation for CNA (Certified Nurse Assistant) certification; many students chose these programs in order to find employment upon or even before graduation. Now, high schools offer medical sciences POS that incorporate the CNA certification but also include applied medical courses that are integrated with college-preparatory mathematics and science; internship and training opportunities at local facilities (e.g., hospitals, clinics, nursing homes); community college courses; and additional certifications (e.g., phlebotomist, pharmacy technician). Information about the myriad careers available in medicine is an integral part of these POS. Such programs also encourage community service activities that hone students' skills (e.g., hosting community health fairs, blood pressure screenings). Graduates of such programs may then leverage these skills and credentials in high-demand full- or part-time jobs that can help pay for higher education in preparation for a broad range of potential careers (e.g., nursing, occupational or sports therapy, general practice, surgery, medical research).

Prior to Perkins IV, many states and districts were implementing programs resembling POS, mostly in the form of tech prep articulation agreements between secondary and postsecondary institutions, then primarily community and technical colleges. Perkins IV expanded these agreements to include four-year colleges and universities. Driven by cross-institutional faculty

collaboration, articulation agreements align career-focused programs spanning secondary and postsecondary education in a non-duplicative progression of courses. Two mechanisms for earning postsecondary credit are usually employed. In the first, participating postsecondary institutions accept approved high school courses as the equivalent of certain introductory-level postsecondary courses. In the second, postsecondary institutions extend dual or concurrent enrollment opportunities to students, allowing them to take college courses (at a community college or the high school), often for both secondary and postsecondary credit.

Review of Research on the Precursors of Programs of Study

The business-as-usual high school experience has sometimes been characterized by ability tracking, with its disproportionate effect on low-income and minority students (Oakes, 2005), and unfocused course-taking (Powell, Farrar, & Cohen, 1985). Both lead to disengagement and dropout (Bridgeland, DiIulio, & Morison, 2006; Princiotta & Reyna, 2009; Rumberger & Lim, 2008). In contrast, POS focus education on the adult world, allowing students to explore careers, learn career development skills, earn college credits and credentials, and engage in meaningful work through internships with business partners. POS also help students see the importance of college as a means of achieving career goals.

When POS were mandated in 2006, the National Research Center for Career and Technical Education (NRCCTE) conducted a review of research on their precursors (Lewis & Kosine, 2008). They found that programs resembling and predating POS—like (a) tech prep, (b) dual enrollment, and (c) career academies, described below—often share elements of POS like student cohorting in career-themed course sequences, college-preparatory academics, opportunities to earn college credits and industry-recognized credentials or certificates, and/or work-based learning opportunities such as internships.

Tech Prep

One of the goals of tech prep was to eliminate redundancies across and between high school and community college courses and provide high school students with clear paths to postsecondary education and related careers. By relocating foundational coursework at the high school level, tech prep allowed community colleges to teach the more advanced courses thought to be necessary for highly technical occupations. Research on the effectiveness of tech prep has shown mixed results.

Bragg et al. (2002) conducted a longitudinal study of eight well-established tech prep consortia. They found that tech prep students had a significantly higher two-year college enrollment rate than non-tech prep students in just two of the eight consortia. Across all consortia, students from both groups attended community college in high numbers but most needed to take remedial courses in academic subjects; few from either group had earned a certificate or degree three to four years later.

An early evaluation of tech prep implementation across 10 consortia surveyed state and local administrators, estimating that only 8% of high school students participated in tech prep (Hershey, Silverberg, Owens, & Hulsey, 1998). This study found that parents and students often

balked at strictly defined sequences of courses explicitly intended to prepare students for community college; these course sequences were perceived as eliminating the possibility of attending a four-year college or university. Urquiola et al. (1997) found that, once out of high school, tech prep students did not always take advantage of the program's articulated coursework by proceeding to more advanced courses at the community college level; instead, students often had to retake the articulated courses in college, either because the credit was not automatically recorded on their college transcript, or because students were convinced to retake courses with specific college faculty.

Hershey et al. (1998) described the diverse ways in which tech prep was being implemented around the country. Perkins II allowed broad discretion in meeting the requirements of tech prep in order to allow various models to emerge. However, Hershey et al. found that many tech prep elements (e.g., course articulation between secondary and postsecondary institutions) were being implemented piecemeal and without regard to those other elements that would go into constituting a coherent program for students to consciously choose. Hershey et al. recommended:

Our five-year evaluation suggests that prospects for tech prep to change educational pathways and success of students… will be enhanced if federal and state education agencies renew their emphasis on developing structured, focused programs of study with a strong career theme, meaningful integration between technical and academic curricula, and a close link between high school and postsecondary stages of the program. (p. 130)

Since its inception, participation in tech prep has not been systematically flagged in most national-level education databases. Research on tech prep (with the notable exception of the 2002 Bragg et al. study) has largely involved detailed student-level transcript work or relying on student self-reported data. Stone and Aliaga (2003) examined student high school course-taking from the *National Longitudinal Survey of Youth* (NLSY:97), finding no relationship between tech prep participation and high school GPA.

Dual Enrollment Programs

Dual enrollment refers to credit-based transition programs in which high school students take college-level classes, either in high school or at a local college, and taught by either accredited high school instructors or college faculty. In some dual enrollment programs, students receive only college credit; in others, they receive both high school and college credit. High schools and colleges collaborate to provide dual enrollment opportunities for a number of compelling reasons. First, such programs may instill rigor and purpose in the senior year of high school, a focus of some concern (National Commission on the High School Senior Year, 2001). Second, they may serve to not just demystify the college experience, but also shorten the time needed to finish a degree or certificate, thereby encouraging persistence and completion. Third, dual enrollment may also be used for enrichment or credit retrieval. Fourth, for many budget-strapped districts, dual enrollment programs give students access to courses that are unavailable to them in high school. Finally, colleges see dual enrollment as a valuable recruitment tool.

According to NCES data, 82% of U.S. high schools reported having students enrolled in dual enrollment courses (Thomas, Marken, Gray, & Lewis, 2013). Of these high schools, 93% had

students enrolled in academic dual enrollment courses, and 59% of the schools had students enrolled in CTE dual enrollment courses (Thomas et al., 2013). A total of 1,277,100 high school students took a college-credit course within a dual enrollment program during 2010-11 (Marken, Gray, & Lewis, 2013) for a total of 2,036,700 dually enrolled courses taken. Of these 2 million courses, 70.5% were academic courses, and 29.5% were CTE courses. On the other side of the equation, 53% of U.S. postsecondary institutions permitted high school students to take college courses in 2010-11 (Marken et al., 2013).

Research on CTE student participation in dual enrollment conducted in Florida and New York City (Karp, Calcagno, Hughes, Jeong, & Bailey, 2007) showed that participating students in Florida were more likely to graduate from high school, enroll in a 4-year college or university, enroll full time, and persist to the second year compared to similar students in the same grade cohorts. Florida CTE students who participated in dual enrollment also enjoyed higher GPAs in high school and earned a higher number of credits in college. Dual enrollment CTE students in New York City were found to be more likely than their counterparts to pursue a baccalaureate degree, have a higher GPA in the first semester of college, and have earned more credits three and a half years after enrolling in college (Karp et al., 2007). Using secondary data, An (2013) found that participation in dual enrollment programs improved college degree attainment, particularly for first-generation college students.

A three-year study tracking outcomes of thousands of students in career-focused dual enrollment programs in California found that participants were more likely to graduate from high school, transition to a four-year (versus a two-year) college, persist in postsecondary education, and accumulate more college credits, and were less likely to take remedial or developmental education courses than comparison students (Hughes, Rodriguez, Edwards, & Belfield, 2012).

Career Academies

According to the National Career Academy Coalition (NCAC), career academies are characterized by (a) a small learning community, comprised of a group of students within the larger high school who take classes together for at least two years and are taught by a team of teachers from different disciplines; (b) a college-preparatory curriculum with a career theme that helps students see the relationships among academic subjects and the application of academics to a broad field of work; and (c) partnerships with employers, the community, and local colleges that generate resources to improve student motivation and achievement.[1]

Stern, Wu, Dayton, and Maul (2007) summarized outcomes from multiple research studies of career academies up to and including MDRC's long-term randomized controlled trial (RCT) study of career academies (cf. Kemple & Rock, 1996), the results of which we describe separately and in greater detail below. Stern et al. found that across six large-scale studies using longitudinal data to compare student achievement between academy and non-academy students in the same high schools, academy students outperformed their peers on various measures of high school achievement. For example, career academy students had higher attendance rates (Elliot, Hanser, & Gilroy, 2000; Hayward & Talmadge, 1985; McPartland, Balfanz, Jordan, &

[1] http://www.ncacinc.com/index.php?option=com_content&view=article&id=10&Itemid=21

Legters, 1998; Stern, Dayton, Paik, & Weisberg, 1989), lower attrition rates (Elliot et al., 2000; Reller, 1984; Stern et al., 1989), better grades (Elliot et al., 2000; Hayward & Talmadge, 1985; Maxwell & Rubin, 2000; Stern et al., 1989), and a higher likelihood of completing high school (Hayward & Talmadge, 1985; Maxwell & Rubin, 2000) than their non-academy counterparts.

Some of these studies extended beyond high school into postsecondary education, where results were less consistent but still tended to favor academy students. Reller (1987) found that higher numbers of academy students entered postsecondary education than non-academy students, but a follow-up survey two years after graduation found no significant differences in employment status or wages earned. Stern, Raby, and Dayton (1992) found no consistent differences between academy and non-academy students on measures of postsecondary attendance or wages earned, although academy students tended to be employed more hours per week. Maxwell and Rubin (2000) found more academy students entering postsecondary education than non-academy students: a subsequent study at one university indicated that academy students needed remedial education less often and were more likely to complete baccalaureate degrees (Maxwell, 2001).

Stern et al. (2007) examined academy and non-academy student performance across 26 student cohorts from seven career academies in five high schools in California, with mixed results. For the most part, they found no significant differences between the groups on measures of GPA, credits earned, and suspensions. In some individual cases, academy students achieved better results, and in others, the non-academy students did. Given that by law, at least 50% of these California Partnership Academy students had to meet state definitions of at risk, including low socioeconomic status or low test scores (Dayton, Hester, & Stern, 2011), the parity in results affirmed the use of career academies. Stern et al. found consistent positive outcomes for academy students in attendance. Descriptive data had already demonstrated that fewer academy students left the district for unknown reasons (often a proxy for dropout). Both of these results led the authors to hypothesize that if some students leave school because they are struggling, and academies are better at keeping students in school, then those struggling students who are in academies will stay, bringing down the apparent effectiveness of the academies but in fact improving educational outcomes for at-risk students.

As a result of the growth of career academies nationally, career academy networks have been developed, perhaps most prominently the National Academy Foundation (NAF), which supports schools and districts implementing academies structured around any of NAF's five career themes (i.e., Finance, Hospitality & Tourism, Information Technology, Health Sciences, Engineering). Orr, Bailey, Hughes, Kienzl, and Karp (2007) sought to determine whether the NAF experience was positively associated with student achievement, selecting for study NAF academies that had been in operation for 10 years as a measure of sustained implementation. Orr et al. found that NAF students were more likely to have participated in a paid internship experience in high school and found it worthwhile. They found no significant differences between NAF and non-NAF groups on high school attendance, GPA, or students' belief that they would complete a four-year degree.

Orr et al. (2007) also found an interesting difference between students in the two themed academies that participated in the study: Students in the Academy of Finance were significantly more likely to be planning to attend a four-year college, whereas students in the Academy of

Travel and Tourism were significantly more likely to be planning to work after high school and not attend college. These outcomes may be due to the different career opportunities available to students in these respective industries. For those without a college degree, the finance industry offers limited promotion opportunities and lower potential earnings. However, the tourism industry offers many opportunities to work, and the authors pointed out that it is common practice in tourism for employers to pay for employees' college tuition. This study highlighted the important influence of academy theme on post-high school educational and career plans.

The studies reviewed here show mixed but promising results for students in career academies. However, none of these studies were able to control for all unobserved differences between the groups that might influence the results (e.g., motivation). Many academies require students to apply to participate; career academy students thus may exhibit greater motivation—to join the academies in the first place, or to succeed in their studies—than non-academy students.

The issue of selection bias was best addressed in MDRC's longitudinal RCT study of career academies, which was undertaken to more definitively estimate the impact of career academies on student achievement. Kemple and his colleagues were able to randomly assign eligible applicants to career academy and control conditions at nine sites, thus ensuring that unobserved differences between students were randomly distributed across the two conditions. This study presents the best available evidence of the impact of career academies, having met the What Works Clearinghouse (U.S. Department of Education, 2013a) rigorous evidence standards.

Kemple and Snipes (2000) demonstrated that academies are a promising method of organizing the high school experience and curriculum for all students, but with particular benefits for at-risk students. They showed that among students identified as at the highest risk of dropping out, career academies significantly reduced dropout rates, increased attendance, increased the credits students could earn toward graduation, and increased the likelihood of their applying to college. Among those groups identified as at lower risk of dropping out, the effect of career academies was limited to increasing the likelihood of a student having a dual academic and career-oriented curricular concentration in high school. Such students were equally likely as their low-risk non-academy counterparts to complete the core academic curriculum, but they outperformed their counterparts on completing career-oriented course sequences.

Eight years after study participants graduated from high school, Kemple found no difference between academy and non-academy students with respect to completion of a postsecondary credential. However, career academy students earned an average of 11% percent more annually than their non-academy counterparts (Kemple & Willner, 2008).

National Assessment of CTE

Reauthorizations of Perkins legislation have included an independent assessment of the law's implementation and outcomes; however, there is an inevitable lag between a policy change and the availability of data under the new policy. An interim report of the independent assessment under Perkins IV (U.S. Department of Education, 2013b) described CTE participation as of 2004—two years before the passage of Perkins IV. As noted by the authors, the ability to evaluate Perkins IV is limited by this lag, and therefore the impact estimates in the report

"mainly reflect conditions of CTE that were in place at the start of the 2006 act, not those that unfolded subsequently" (p. viii). In spite of this shortcoming, the interim report noted (1) that students who participate in CTE in high school attend college at the same rates as nonCTE participants, and (2) among students who do not attend college, those who took CTE in high school are more likely to find skilled jobs than those students who did not take any CTE in high school.

Two studies of CTE were included for the assessment, both of which also necessarily included pre-Perkins IV, pre-POS data. Results were mixed: An analysis of Education Longitudinal Study (ELS:2002) data found no relationship between the CTE course-taking of the Class of 2004 and their achievement based on a standardized math assessment (Bozick & Dalton, 2013). Similarly, a study of CTE high school attendance in a large urban school district (Neild, Boccanfuso, & Byrnes, 2013) found no relationship between CTE high school attendance and achievement. However, the Neild study did find a positive relationship between CTE high school attendance and math course-taking and graduation. The interim assessment issued two recommendations of note: first, CTE accountability systems must be improved because current performance data do not include the many students who take CTE classes but do not complete program sequences. Second, research on the effects of CTE needs to disaggregate analyses by program and implementation quality in order to provide useful information to the field.

Prior Research on POS

The NRCCTE embarked on three field-based longitudinal studies of POS as soon as POS were mandated under Perkins IV. These studies probed the impact of POS on various secondary and postsecondary outcomes. They included (a) an exploration of South Carolina's Education and Economic Development Act (EEDA), (b) a three-site study of well-established POS at the postsecondary level, and (c) the current study. Below, we discuss findings from the first two studies.

Hammond et al. (2013) conducted a quasi-experimental, mixed-methods multi-site study of South Carolina's EEDA, a career-focused school reform policy that strongly resembled POS. They found an increase over time in the amount of career planning activities and career-based counseling students received. Although they found a large increase in dual credit course-taking for CTE students, but not for non-CTE students, both groups earned similar numbers of credits. Analyses of state longitudinal data showed that CTE course sequence takers were more likely to plan to enroll at a two-year college after graduation, whereas those not in such sequences were more likely to plan to enroll at a four-year college. Students at low-poverty schools were more likely to report planning to complete a baccalaureate degree or higher, compared to students in moderate- or high-poverty schools. However, between the study's two cohorts, the Class of 2009 and the Class of 2011, an increased percentage of students from both high- and low-poverty schools stated that they planned to complete a baccalaureate or master's degree.

Alfeld and Bhattacharya (2013) examined three well-established postsecondary-level POS, which they defined as tightly linked high school-to-community college career pathway programs. From 2009 to 2012, including the transition out of high school into college or work, a sample of 213 high school juniors and seniors enrolled in POS at the three sites were tracked to examine

their progression through their POS. Although only 30% of students continued in the same POS area in either college or work, POS participation appeared to benefit students. High school transcript analyses showed a positive relationship between POS credits, academic credits, and grades. Further, the majority of students reported that being in a POS made them more motivated to stay in school and better prepared to make choices about college and career. In longitudinal analyses controlling for high school GPA, the number of high school POS courses taken was significantly related to (a) staying in the same career cluster in college and (b) earning a college credential. The number of high school dual credits earned was also significantly negatively related to remedial courses in college and positively related to college GPA, staying in the same cluster, and earning a credential. Having a positive attitude toward the POS in high school was related to the number of credits students earned in the first year of college. Of the 65% of the original sample located in 2012, most were still enrolled in two- or four-year colleges.

The current study takes a mixed-method, longitudinal approach, examining POS student achievement compared to well-matched comparison groups in the same districts. The districts participating in this study serve large numbers of low-income and minority students—populations often targeted for career academy experiences that boost engagement and achievement (Dayton et al., 2011).

Research Questions

Programs of study—which offer seamless high school-to-college connections and standards-based academics linked to an engaging real-world career focus and business and community involvement— may help ensure that our nation meets the goal of leading the world in the proportion of college graduates it produces by 2020, including those with sub-baccalaureate certificates and degrees. This is the intervention we examined for five years in three different state and district contexts. The following are the research questions that flowed from Perkins IV and our review of the literature, and that guided this longitudinal study.

1. To what extent does participation in a POS lead to improved student achievement compared to well-matched comparison groups? Specifically, to what extent does POS increase student:
    a. academic achievement?
    b. technical skills achievement?
    c. high school completion?
    d. completion of coursework leading to college credits?

2. How do POS differ from the traditional high school experience of the comparison group students?

CHAPTER TWO: Method

This study employed a multi-method, longitudinal, quasi-experimental design to investigate the relationship between participation in federally mandated POS and the high school outcomes established in the Perkins legislation for assessing the effectiveness of POS. The study consists of three strands employing slightly different research designs and separate analyses, one for each participating district. We employed this tripartite design because (a) the districts operate in very different contexts, with quite different state policy contexts; (b) due to contextual differences, the means of creating samples differed across sites; and (c) due to differences in available data, the measures we used to arrive at reported outcomes varied. Further, one district (South) began participating in the study well after the others, meaning that some data could not be collected there (e.g., a ninth-grade survey, classroom observations and interviews for students' first three years of high school). In this section, we describe the study's sample, measures, and procedures by district.

Participants

This study began two years after the passage of Perkins IV. At that time, not all districts or education agencies had operational POS functioning at a high enough level to warrant intense study. But because federal legislation is often written based on field-generated innovations and best practices, we knew that there were operational and even successful implementations of CTE programs resembling POS in all regions of the country. In searching for sites, we thus looked for districts in which POS were being well implemented in spirit if not in name. An additional key selection criterion was that districts had to employ a random-assignment lottery to place eligible eighth-grade applicants in high school POS. Our goal in establishing this criterion was to construct a randomized controlled trial (RCT; Shadish, Cook, & Campbell, 2002).

After several months of search and negotiation, we began our study with two districts. The first was **West District**, which held a lottery in the spring of 2008 for eighth-grade applicants seeking admission to its POS high schools in the fall of 2008 (the start of our student cohort's ninth-grade year). The second was **East District**. Although East did not hold a lottery in 2008 due to under-enrollment in its wall-to-wall POS high school, Blue Academy, we decided to include the district in the study in part because of the quality of its programs and in part due to its expressed desire to participate. At the end of the first year of the study (the 2008-2009 academic year), **South District** approached the NRCCTE regarding participation in its portfolio of POS research. Based on South's strong POS implementation and lottery-based admissions system, we added this third district. However, because of the late addition of the district to the study, we were not able to collect qualitative site visit data until the study's fourth year (2011-2012; our cohort's twelfth-grade year); we did collect systems data for our cohort's four full years of high school.

Table 2.1 presents important district characteristics during our cohort's ninth-grade year (2008-2009) compared to national averages in the same year. In addition, Table 2.1 also includes U.S. Census information on the counties served by these districts as indicators of the condition of their local economies. In noting differences between our three districts and national averages, note that the national average includes many rural districts. Our participating districts are located in areas classified as urban by the U.S. Census.

Table 2.1
Selected characteristics of participating school districts and their populations, 2008-2009

Characteristics, 2008-2009	U.S.	West District	East District	South District
District Characteristics				
Minority students (%)	45.0[a]	64.7	66.3	60.0
Free lunch eligible (%)	41.8	42.5	48.7	43.0
Student/teacher ratio	14.9	17.2	14.3	12.9
Per pupil expenditure[b]	$10,955	$7,546	$8,794	$9,296
Population Characteristics				
Total population		1,800,000	800,000	1,200,000
Population density per square mile	81	241	1,744	650
Minority (%)[c]	34.2	48.2	44.7	36.5
All persons living below the poverty line (%)	13.6	11.2	11.7	12.2
Children under 18 living below the poverty line (%)	18.9	15.9	15.6	18.4
Unemployment rate[d]	4.9	5.8	5.7	4.9
Households receiving public assistance (%)	2.4	2.3	1.4	1.1
Median household income	$51,369	$55,767	$55,263	$52,420
Persons age 25 or over with a high school diploma (%)	84.9	83.0	89.2	86.9

Sources. National averages of district characteristics were obtained from the U.S. Department of Education Common Core of Data (CCD) website, http://nces.ed.gov/ccd/. District characteristics data were obtained from district websites or reports and the CCD. Population characteristics were based on U.S. Census data (2000 Census and interim updates from Current Population Reports or the American Community Survey) obtained from the U.S. Census website, http://www.census.gov/.
Note. Some of the figures have been rounded to protect district anonymity.
[a]Sum of number of Native American, Black, Latino, Asian, and multiracial students divided by the total number of students with reported race/ethnicity data.
[b]Per pupil expenditures may not be comparable because districts may vary in their definition of what to include in total expenditure per student.
[c]Calculated by subtracting the percent White (one race only) who are not Latino from 100%.
[d]Unemployment rates reflect pre-recession conditions.

West District, located in a Western state, serves a large urban student population, over 60% of whom self-identify as ethnic minorities, which is much higher than the national average (see Table 2.1). In 2008-2009, the percentage of West's students who were eligible for the federal free or reduced-price lunch program (F/RL) was similar to national eligibility rates. Prior to the 2009 recession, unemployment rates were higher than the national average, as were household median incomes. East District is located in a large city east of the Mississippi River. In 2008-2009, the students who self-identified as ethnic minorities exceeded the national average, as did the percentage of students eligible for F/RL (see Table 2.1). Unemployment rates were higher than the national average, but so were household median incomes. South District serves a geographically large area located in a southern state. In 2008-2009, the percentage of students

who self-identified as minorities was higher than the national average, and the percentage of students who qualified for F/RL was similar to the national percentage (see Table 2.1). Unemployment rates in the South District area were the same as the national average at the time, and household median incomes were slightly higher. In sum, the public schools in these urban districts tended to serve predominantly minority students, many of whom lived in poverty.

Sampling Procedures

Once we selected our three sites, we employed slightly different methods to select study participants in each. In West District, although a lottery was used to assign students to POS, built-in lottery preferences (described below) made a pure RCT impossible to construct. However, we used the district's lottery results to construct intervention and comparison groups. In East District, where no lottery was held, district personnel identified a well-matched comparison group to participate in the study. In South District, we discovered that lottery preferences accounted for over 90% of student assignments to POS and other choice programs; as such, student assignments were not random. We included in our South sample all students who were eligible for and had applied to the school choice lottery, which included POS as well as other choice programs such as International Baccalaureate (IB) and performing arts programs. Our total sample included 6,638 students across the three districts. We assigned students to the intervention or comparison group according to their ninth-grade program enrollment. We describe the procedures used in each district in greater detail below.

West District's Baseline Student Sample

A lottery is held every spring in West District for the district's oversubscribed high school choice options. These include its performing arts high school as well as its five "wall-to-wall POS" high schools, where all students are in a POS. At the time we chose sites, West District was in an expansion phase, and two of these POS high schools had only just opened (Fall 2009). We chose to exclude these two schools in part because they were so new, and in part because the district believed that they needed to get started without the burden of participation in a research study. Thus only three of the five POS high schools comprised the intervention condition.

Like many districts, West employed a number of lottery preferences that served to minimize student travel and maximize student diversity across schools. The district reserved up to 25% of the available seats in any program for sibling preference, up to 25% for geographical preference, and up to 25% for feeder preference. The remainder of the seats available—and those not taken in the three preference lotteries—were utilized in a general lottery. The district could not provide us with information on how many or which students were accepted into the POS high schools as a result of these preferences, except to say that in most cases, reserved seats were not all taken by preference students, thus returning untaken seats into the general lottery. However, due to this lack of information, we could not estimate the existence or extent of bias in the sample and were therefore unable to construct an RCT. All students who were eligible for and participated in the lottery for the three wall-to-wall POS high schools made up the sample.

Identification of the Student Sample for West District

One year after the lottery held in Spring 2008, we received anonymized student records for all applicants to any of the three participating POS high schools. Over 4,000 cases were included in the original dataset. First, we removed non-eligible applicants and duplicate records (these included students who had applied to more than one POS high school). This left 2,466 records. Another 391 cases were removed because they were assigned to the new POS high schools that were not participating in the study. Finally, 24 cases were removed due to coding errors and 47 were removed because although the students had been assigned to one of the three participating POS schools, their programs did not qualify as POS (e.g., cosmetology, which in this district had no postsecondary elements or alignment). This left a baseline sample of 2,004 students, 1,175 of whom were in the intervention group (i.e., enrolled in one of the three POS high schools in ninth grade), and 829 of whom were in the comparison group.

Background Characteristics of the West District Student Sample

We compared student background characteristics of this sample at baseline, the end of 2008. Cross tabulations and chi-square analyses were performed on gender, race/ethnicity, participation in the F/RL program (a proxy for poverty or socioeconomic status [SES]), Limited English Proficiency (LEP) status, and special education status (i.e., the presence of an individualized education program or IEP). School engagement was measured using eighth-grade average daily attendance and the variable *Number of disciplinary occurrences*, which was collapsed into three categories: (1) no occurrences, (2) one to two occurrences, and (3) more than three occurrences. Prior academic achievement was established using results of state exams taken in eighth grade. Independent samples *t*-tests were performed to compare average daily attendance and scaled scores in reading and math.

Table 2.2 shows that there were significantly more males in the intervention group than in the comparison group (49.5% versus 32.3%). At the same time, there were relatively more females than males in each group and in the sample as a whole, meaning that more female than male students applied for these programs. There were also significantly fewer students in the intervention group with an IEP (2.8% versus 5.9%).

Table 2.2
Baseline characteristics of sample, West District

Characteristics	Intervention (N = 1,175) (%)	Comparison (N = 829) (%)	Total (N = 2,004) (%)
Gender			
Male	49.5***	32.3	42.4
Female	50.5	67.7	57.6
Race/Ethnicity			
Black	10.7	8.4	9.8
White	40.9	39.7	40.4
Latino	32.4	35.0	33.5
Asian	15.1	16.0	15.5
Native American	0.8	0.8	0.8
Poverty			
F/RL-eligible	27.4	28.1	27.7
Limited English Proficiency			
Yes	2.2	2.8	2.4
Has Individual Education Plan			
Yes	2.8**	5.9	4.1
School Engagement			
# Disciplinary incidents			
None	76.0	76.4	76.1
One to two	18.0	18.8	18.3
More than three	6.1	4.8	5.5

Note. Comparisons are based on cross tabulations and chi-square analyses. ** $p < .01$, *** $p < .001$.

There were no statistically significant differences in eighth-grade average daily attendance (see Table 2.3) or eighth-grade achievement. The average eighth-grade daily attendance rate for both groups was 97%.

Table 2.3
Baseline attendance and prior achievement of sample, West District

	Intervention		Comparison		Total	
	N	*M* (*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)
Grade 8 attendance	1,093	96.7% (0.03)	811	97.0% (0.03)	1,904	96.9% (0.03)
Grade 8 pre-test math	1,091	368.33 (75.84)	816	369.20 (80.70)	1,907	368.70 (77.93)
Grade 8 pre-test reading	1,091	344.18 (54.14)	816	347.32 (57.58)	1,907	345.52 (55.64)

Note. Independent samples *t*-tests were performed to compare means.

East District's Baseline Student Sample

The intervention group in East District consisted of the students who began ninth grade at the district's one wall-to-wall technology POS high school. Usually, students were selected to attend this high school through a lottery, like the POS high schools in West District. However, the school was expanding its enrollment in the year in which our study began. As a result of this

expansion, there were seats for all eligible applicants, so no lottery was held. In lieu of random assignment, East District personnel ran a cluster analysis on the other high schools in the district, searching for four high schools that were most similar to the intervention school in terms of student demographic variables, mobility, and prior achievement. District personnel then used propensity score matching (PSM) to identify a comparison group from within those four high schools. Propensity scores are the estimated probability that a subject is assigned to an intervention based on various pieces of information (Pasta, 2000). This predicted probability is obtained by conducting a logistic regression that predicts membership in the intervention group utilizing a vector of covariate predictors, in effect mitigating the effects of inherent differences among students in the different study conditions (Foster, 2003; Shadish et al., 2002). Students with similar distributions across the covariates will have similar estimated propensity scores. Thus a student in the intervention group can be matched with a comparison student possessing a similar propensity score, yielding reduced-bias estimates of effects during analysis (Rosenbaum & Rubin, 1985).

Identification of the Student Sample for East District

The comparison group was created by the district research office after the prospect of random assignment was eliminated. A matrix of intervention group variables was selected on which to match students from the comparison schools identified in the cluster analysis:

- Performance on standardized eighth-grade reading and mathematics tests
- Gender
- Race/ethnicity
- LEP status
- Special education classification
- F/RL eligibility (as a proxy for poverty)
- Eighth-grade retention
- Number of violent incidents during the school year in which the student was involved
- Number of nonviolent incidents during the school year in which the student was involved
- Number of unexcused absences
- Number of excused absences
- Number of out-of-school suspensions
- Number of in-school suspensions
- Mobility during eighth grade (the number of school changes)

Once predicted probabilities were obtained, intervention students were matched with comparison students possessing exact probabilities when such were available, and similar probabilities with minimal difference when an exact match was not available. This matching procedure was conducted without replacement, so that a student identified as a comparison student match for a particular intervention student was removed from the potential comparison pool before the next match was conducted. The propensity match procedure was carried out twice to provide two matched comparison students for every intervention student, to take into account attrition over the duration of the study. A comprehensive file was created containing student background information from the eighth-grade year (2007-2008) for all intervention and comparison students.

Background Characteristics of the East District Student Sample

As with the West District sample, cross tabulations and chi-square analyses were performed on gender, race/ethnicity, F/RL participation, LEP status, IEP status, and number of disciplinary incidents. Independent samples *t*-tests were performed to compare eighth-grade average daily attendance and eighth-grade reading and math achievement.

Tables 2.4 and 2.5 show the results of the PSM and the resulting comparisons of the background characteristics of the sample. There are no significant differences between the two East District groups on any of the variables in either table, which confirms that the PSM procedure found appropriate matches for all intervention students. In keeping with overall district demographics, Black students made up the majority in both groups, about two-thirds of the students in both groups were free lunch-eligible, and the proportion of LEP and IEP students was small. Over 75% of all students had no disciplinary incidents while in eighth grade, and there were no statistically significant differences among the groups in this regard.

Table 2.4
Baseline characteristics of sample, East District

Characteristics	Intervention ($N = 376$) (%)	Comparison ($N = 752$) (%)	Total ($N = 1{,}228$) (%)
Gender			
Male	52.1	49.9	50.6
Female	47.9	50.1	49.4
Race/Ethnicity			
Black	71.0	70.5	70.7
White	10.6	11.2	11.0
Latino	10.4	10.6	10.5
Asian	3.7	3.6	3.6
Native American	0.3	0.1	0.2
Other/Multiracial	4.0	4.0	4.0
Poverty			
F/RL-eligible	68.4	66.4	67.0
Limited English Proficiency			
Yes	4.3	4.8	4.6
Has Individual Education Plan			
Yes	2.4	2.3	2.3
School Engagement			
# Disciplinary incidents			
None	76.3	75.9	76.1
One to Two	17.0	17.0	17.0
More than Three	6.6	7.0	6.8

Note. Comparisons are based on cross tabulations and chi-square analyses.

Table 2.5 shows no significant differences on baseline attendance or prior achievement: Both groups had eighth-grade average attendance rates of 98%. Reading and math achievement across both groups was also similar, as measured by scaled scores on East District's end-of-term exams.

Table 2.5
Baseline attendance and prior achievement of sample, East District

	Intervention *M* (*SD*) (*N* = 376)	Comparison *M* (*SD*) (*N* = 752)	Total *M* (*SD*) (*N* = 1,128)
Grade 8 attendance	98% (0.03)	98% (0.03)	98% (0.03)
Grade 8 pre-test math	363.22 (6.96)	362.90 (7.54)	363.00 (7.35)
Grade 8 pre-test reading	359.91 (7.10)	359.69 (7.49)	359.76 (7.36)

Note. Independent samples *T* tests were performed to compare means.

South District's Baseline Student Sample

South's POS took the form of career academies housed in comprehensive high schools across the district; there were no wall-to-wall POS high schools. Some POS were accessible only through the lottery process, whereas others were available for students attending their zoned high schools. Unlike in the other districts, any high school in South District could contain an intervention student, a comparison student, or both at baseline.

Students applied to the lottery for their school(s) of choice during the spring of their eighth-grade year. As in West District, sibling, geographic, and feeder preferences were employed, in addition to a principal's preference that selected up to 20% of all eligible applicants who applied to the school as their first choice. In our analysis of the district's lottery assignments, we concluded that 94.9% of all eligible applicants were assigned to a choice program, either (1) through one of the district's preference mechanisms, or (2) because there were not enough applicants to a given program to conduct a lottery. For this reason, we abandoned the use of an RCT in this district. Instead, we used lottery outcomes to design a quasi-experiment consisting of a sample of students who applied to and were eligible to participate in the district's choice programs.

As West District and South District show, district-run lotteries are designed to provide desirable opportunities to the maximum number of students seeking them. District lotteries are not designed to facilitate researcher-driven RCTs. More is said about this in the *Conclusion*, below.

Identification of the Student Sample for South District

In late 2009, we received anonymized student records for all applicants to South District's choice programs. Over 6,500 cases were included in the original dataset. First, we removed all applicants who were not in ninth grade in 2008-2009, leaving 5,123 records. Another 1,280 cases were removed because they were missing a school name for 2008-2009 assignment, leaving 3,843 records. The lottery records showed that 129 applicants were not eligible for any of their three choices; they were removed as well. Finally, 208 cases were removed because they had no course-taking records to date, which at that time included the ninth and 10th grades. This left a

baseline sample of 3,506 students, 1,985 of whom were in the intervention group (i.e., enrolled in a POS in ninth grade), and 1,521 of whom were in the comparison group.

Background Characteristics of the South District Student Sample

We compared student background characteristics of this sample at baseline. However, eighth grade information on students with an IEP and students eligible for the F/RL program was not available; we used the tenth grade data instead. Cross tabulations and chi-square analyses were performed on these characteristics as in the other districts. Independent samples *t*-tests were performed to compare average daily attendance and scaled scores in reading and math.

Table 2.6 shows that there were significantly more Native American students, students eligible for the free lunch program, LEP students, and students with an IEP in the intervention group than in the comparison group. There were also significantly fewer Asian students in the intervention group at South District.

Table 2.6
Baseline characteristics of sample, South District

Characteristics	Intervention (N = 1,985) (%)	Comparison (N = 1,521) (%)	Total (N = 3,506) (%)
Gender			
Male	48.7	45.8	47.5
Female	51.3	54.2	52.5
Race/Ethnicity			
Black	19.6	18.3	19.1
White	49.9	50.0	49.9
Latino	22.4	20.4	21.5
Asian	3.9***	7.0	5.3
Native American	0.8*	0.2	0.5
Other/Multiracial	3.4	4.0	3.7
Poverty			
Eligible for F/RL	31.7***	25.1	28.9
Limited English Proficiency			
Yes	5.7*	4.1	5.0
Has Individual Education Plan			
Yes	5.5**	3.2	4.5
School Engagement			
# Disciplinary incidents			
None	93.6	92.5	93.1
One to Two	3.0	4.1	3.5
More than Three	3.5	3.4	3.4

Note. Comparisons are based on cross tabulations and chi-square analyses.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

As shown in Table 2.7, the intervention group had significantly lower eighth-grade achievement as measured by state test scores. This could be attributable to the fact that applicants to programs such as IB and focused math and science programs were among those in the comparison group. These differences were controlled for in the outcomes analyses. The average eighth-grade daily attendance rate for both groups was 97.4%.

Table 2.7
Baseline attendance and prior achievement of sample, South District

	Intervention		Comparison		Total	
	N	*M* (*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)
Grade 8 attendance	1,808	97.4% (0.03)	1,287	97.4% (0.03)	3,095	97.4% (0.03)
Grade 8 pre-test math	1,804	328.82 (38.46)***	1,292	344.69 (46.59)	3,096	335.44 (42.76)
Grade 8 pre-test reading	1,804	348.56 (34.03)***	1,292	357.45 (40.74)	3,096	352.27 (37.23)

Note. Independent samples *t*-tests were performed to compare means. *** $p < .001$.

Posthoc Groups for Assessing the Effect of Completing a POS on High School Achievement

For the posthoc analyses in each district, we limited the samples to those students who remained in the district all four years and had no missing data, in order to ensure that all students had the same opportunity to complete a POS. By analyzing student course-taking (see *Appendix A*), we then identified two types of students with respect to their CTE course-taking: (1) POS completers, or those who completed the course sequence of the POS, and (2) CTE concentrators. The latter is a Perkins-derived accountability category denoting a student who has completed a certain number of credits in an occupational area. Each district had a different definition of how many credits were needed to earn a CTE concentration. The number of credits required for a CTE concentration is negotiated between the U. S. Department of Education's Office of Vocational and Adult Education (USDE/OVAE) and each state. CTE concentrators are usually required to earn fewer CTE credits than are POS completers, and those credits do not have to be taken in a specific sequence. The requirement of a specific course sequence for POS completion is one of the ways in which POS differ from CTE concentrations; others are included in the four mandatory elements of POS (see *Measures*).

Sampling Limitations

In East District, a PSM procedure provided a well-matched comparison group for our self-selected intervention students. Limitations in East include those unmeasured characteristics that might influence outcomes, such as the possibility that students who self-selected to participate in a POS might have more motivation to succeed than others. Neither West nor South District randomly assigned students to POS; however, in West, all sample students shared the important trait of being interested and motivated to apply to be in a POS. At South, students also applied to other programs such as IB and performing arts programs. Outcomes from samples like these are only generalizable to students who are interested in being in a POS. Each sample has its strengths and weaknesses; taken together, study conditions reflect the range of districts across the country in which POS are being offered.

Qualitative Samples

To help us understand the process through which POS effect change, this study employed a qualitative component that included (1) stakeholder interviews, (2) classroom observations, and (3) student surveys. We conducted 65 student interviews over the four years of the study (20-25 in each district). Interviewed students were not representative of the entire sample because they were not randomly selected; we chose from among those students whose parents returned a signed informed consent document (see *Procedures*, below), or, at South, were chosen for us by district personnel. We also conducted interviews with teachers, counselors, and administrators at both the intervention and comparison schools and at the local community colleges at West and East Districts. South District's late entry into the study meant that no contacts were made with their local community college. We conducted a total of 95 interviews in West District, 88 interviews in East District, and 44 interviews in South District. Appendix B provides more detail on these interviews.

We observed a range of academic and career-focused courses in all three districts: 62 classroom observations in West, 42 in East, and 21 in South (see Appendix B for more information on our data collection activities). The number of observations varied across districts for two reasons: first, West high schools tended to follow a period schedule, whereas East high schools tended to follow a block schedule. Although the length of the school day was the same in both districts, we found it difficult to schedule two interviews or observations during one course block. In essence, in East District, we had fewer time slots in which to schedule research activities. Second, the delayed entry of South District into the study meant fewer site visits there overall, resulting in less qualitative data collection.

Student surveys were conducted during the students' ninth-grade and twelfth-grade years. In general, student response rates were low. In West District, 43.3% of the sample responded to the ninth-grade survey and 37.5% responded to the twelfth-grade exit survey. In East District, 24.9% of sample students took the ninth-grade survey, and 36.0% took the twelfth-grade exit survey. Surveys were not conducted in South District. The low response rate was in part due to missteps at the district level: In one case, survey invitations were mailed to an older, erroneous sample list; many completed surveys from this mailing had to be discarded because the students were not in our sample. Mishaps like this occur when, in order to protect student privacy, researchers cede control of survey administration to the district. They are virtually an unavoidable hazard in conducting longitudinal research in educational settings.

Measures

Our outcome measures are found in district systems data and are of practical interest to schools. The intent of Perkins IV is to improve the achievement of CTE students in relation to state academic standards and to ease their transition to postsecondary education. But as with many federal education policies, POS requirements were written broadly in order to promote implementation in different state contexts and to encourage innovation. When our study began, the four elements written into the legislation were the sole guidelines for education agencies to follow in implementing POS (cf. Table 2.8).

Table 2.8
The four mandated elements of POS

i	POS must incorporate secondary education and postsecondary education elements.
ii	POS must include coherent and rigorous content aligned with challenging academic standards and relevant career and technical content in a coordinated, nonduplicative progression of courses that align secondary education with postsecondary education to adequately prepare students to succeed in postsecondary education.
iii	POS may include the opportunity for secondary education students to participate in dual or concurrent enrollment programs or other ways to acquire postsecondary education credits.
iv	POS must lead to an industry-recognized credential or certificate at the postsecondary level, or an associate or baccalaureate degree.

Source: Perkins IV, Section 122[c][1][A].

We operationalized these POS elements into outcomes that capture the skills and content that POS were designed to address, according to Perkins IV:

a. Academic achievement: Cumulative grade point average (GPA), STEM credits earned (i.e., credits in science and in higher math, defined as math above Algebra II), and AP credits earned
b. Technical skills achievement: CTE GPA
c. High school completion: Graduation
d. Transition: Post-high school plans and completion of coursework associated with college credits (i.e., dual enrollment)

The first three measures include academic and technical achievement outcomes and high school completion. The data for these measures were collected from the districts. An overall GPA was calculated from students' course grades. On the surface, course grades seem an unreliable measure of achievement because of the variation in grading standards across teachers and schools. However, there is a strong correlation between GPA and college admission test scores as a predictor of college success (Stumpf & Stanley, 2002), and some studies have shown the superiority of GPA over such admissions tests in predicting college graduation (Atkinson & Geiser, 2009). Beyond educational predictive power, some studies also show that GPA predicts salary level and job performance; however, such studies refer to postsecondary GPA (e.g., Roth & Clarke, 1998).

Higher mathematics coursework was selected as part of the STEM (science, technology, engineering, and mathematics) measure for several reasons. Participation and achievement in math are gateway indicators for positive post-high school outcomes such as postsecondary educational attainment and labor market success (National Research Council, 1989; U.S. Department of Education, 1997). In addition, the mathematics course sequence in high school is usually well-defined, making comparisons relatively straightforward. Math is often embedded in CTE coursework, making student achievement in math particularly relevant for POS. Prior research has shown that completing the math sequence is correlated with choosing STEM majors in college (Chen, 2009) as well as with college graduation and employment incomes (National Mathematics Advisory Panel, 2008).

We chose CTE GPA as the technical assessment measure because it is an acceptable measure for Perkins reporting, absent other measures. East had end-of-term assessments in its CTE courses, but comparisons were difficult because Blue Academy and comparison students tended to take different CTE courses and so different exams. South had industry-recognized credentials as their measure of technical assessment for Perkins, but the data we received were incomplete with no way to ascertain the nature of the missing data. Many credential-granting organizations, be they private industries or the state, send credentialing exam results directly to students' homes, not to their high schools, adding to the difficulty of collecting the data. We chose to be consistent across districts by using CTE GPA.

Transition measures capture whether students have made a plan for their next step after high school and begun to accrue college credits as part of that plan. Data for the first transition measure came from a senior exit survey conducted in May 2012, the sample's senior year. Data for the latter transition measure came from systems data collected annually.

Our qualitative research question, posed in its own right and as an explanatory complement to our quantitative outcomes, asks *How do POS differ from the traditional high school experience of the comparison group students?* We delimited this question in order to explore the ways in which the POS experience and the traditional CTE experience differed. This was the most logical difference to explore given the data we collected. We have fewer conclusions to draw about the high school experience of comparison students who took no CTE classes.

Qualitative Measures

In addition to exploring whether participation in a POS leads to improved student outcomes as compared to defined comparison groups, we believe it is useful to probe the ways in which improved outcomes might occur. Our interviews, observations, and student surveys were all designed to provide detailed information on how POS were developed and implemented. We focused on what participants perceived to be the most important differences between the intervention and the comparison schools, as well as the usefulness of their school's programs as preparation for postsecondary education and work. We also used these data sources to further explore the counterfactual experiences of students in the comparison schools in order to ensure that POS were not a part of the comparison group experience.

Qualitative research involves the analytical interpretation of data collected in interviews and observations in order to identify concepts and relationships among concepts, then organizing these into an explanatory scheme (Strauss & Corbin, 1990, 1998). This is done by identifying a set of conceptual codes and marking the instances in which they appear in the data. More detail about the procedures is provided in *Qualitative Analyses* below.

We also developed a plan to analyze implementation fidelity. In the best cases, information on the fidelity of implementation of an intervention can be integrated with outcomes analyses (U.S. Department of Education, 2013c). The elements of Perkins IV are the only elements from which we could outline acceptable ranges of variation for an analysis of implementation fidelity. However, those elements do not lend themselves to "levels of use" (O'Donnell, 2008) or other quantifiable fidelity measures; these four elements of the law function more as a yes/no checklist

(cf. Table 2.8). It became clear that the open, somewhat vague nature of the law's requirements made it next to impossible to operationalize and measure implementation criteria.

As education agencies began to implement POS, USDE/OVAE, in partnership with the National Association of State Directors of Career Technical Education Consortium (NASDCTEc), formulated a policy guidance framework (USDE/OVAE, 2010) to help states and other agencies meet POS requirements. This framework was not available to us at the time of site selection or early fieldwork. The framework's ten voluntary components "support the development and implementation of effective programs of study" (p. 1). They include:

1. **Legislation and Policies:** Federal, state, and local legislation or administrative policies promote POS development and implementation.

2. **Partnerships:** Ongoing relationships among education, business, and other community stakeholders are central to POS design, implementation, and maintenance.

3. **Professional Development:** Sustained, intensive, and focused opportunities for administrators, teachers, and faculty foster POS design, implementation, and maintenance.

4. **Accountability and Evaluation Systems:** Systems and strategies to gather quantitative and qualitative data on both POS components and student outcomes are crucial for ongoing efforts to development and implement POS.

5. **College and Career Readiness Standards:** Content standards that define what students are expected to know and be able to do to enter and advance in college and/or their careers comprise the foundation of a POS.

6. **Course Sequences:** Non-duplicative sequences of secondary and postsecondary courses within a POS ensure that students transition to postsecondary education without duplicating classes or requiring remedial coursework.

7. **Credit Transfer Agreements:** Credit transfer agreements provide opportunities for secondary students to be awarded transcripted postsecondary credit, supported with formal agreements among secondary and postsecondary education systems.

8. **Guidance Counseling and Academic Advisement:** Guidance counseling and academic advisement help students to make informed decisions about which POS to pursue.

9. **Teaching and Learning Strategies:** Innovative and creative instructional approaches enable teachers to integrate academic and technical instruction and students to apply academic and technical learning in their POS coursework.

10. **Technical Skills Assessments:** National, state, and/or local assessments provide ongoing information on the extent to which students are attaining the necessary knowledge and

skills for entry into and advancement in postsecondary education and careers in their chosen POS.[2]

Many of these components are not easily measured: For example, under the framework, legislation and policies supporting POS or professional development for POS teachers were encouraged but not required; nor were details regarding such policies provided. The components are also multifaceted. For example, Teaching and Learning Strategies describes several strategies, one of which is the implementation of career and technical student organizations (CTSOs), which provide engagement and leadership opportunities for students. Because CTSOs incorporate soft skills, they are a recommended teaching and learning strategy for POS students.

Although USDE/OVAE elaborated on and provided policy support related to these suggested components, they were ultimately not enforceable because they were not part of the law. Given this, as well as the difficulties of quantifying them, we concluded that our analysis of implementation fidelity would have to be qualitative. As such, we ensured that we had codes for each suggested component and its subcomponents.

This report responds to the funding agency, USDE/OVAE, by providing a picture of how the intervention and comparison conditions differed in relation to the policies that created and supported POS. By organizing the qualitative portion of this report along these lines, we have also sought to address the issue of implementation fidelity at the intervention high schools.

The overarching goal of our qualitative analyses is to explore how POS differed from the comparison school experience, following USDE/OVAE's ten-component framework and the four elements of POS outlined in the Perkins legislation. Our qualitative analyses may also explain and provide context for each district's quantitative student achievement outcomes.

Qualitative Validity and Reliability

We established the validity of the data in four ways. First, we engaged in member checking (Lincoln & Guba, 1985), or getting feedback from key study participants. This provided them the opportunity to verify the credibility of our account, thus establishing the account as trustworthy and internally valid. We asked the CTE directors from each district to read our accounts of the fidelity of POS implementation in their district. Responses from these stakeholders confirmed that we had captured the contours of the narrative; in fact, no corrections were requested by these study participants.

A second means of establishing validity was to triangulate the data with achievement or other qualitative data so that no claim arose from only one source. Third, we reached saturation in many of the categories we created for analysis. Saturation involves gathering data until no new relevant data are gathered on a category and until the categories are well developed and validated, reflecting the depth and breadth of the category (Josselson & Lieblich, 2003; Strauss

[2] Element #2 and component #6 are identical, as are element #3 and component #7. Therefore instead of reporting on 14 topics, this report only includes 12 topics but covers all of the elements and components of POS as determined by USDE/OVAE.

& Corbin, 1998). And finally, conducting mixed-method research like the present study adds external validity, or generalizability, to the findings.

This study's two co-principal investigators conducted all of the field research, including classroom observations and interviews. We addressed issues pertaining to the reliability of these data by creating detailed data collection protocols, training study team members on the protocol procedures, and developing a formal qualitative database that can, in theory, be accessed and analyzed by others to yield the same results. Details on reliability checks of data collection instruments and data analysis procedures are found in Appendix B.

Research Design

This was a complex, mixed-method, longitudinal study examining POS in three states. We first describe the quantitative approaches that we employed, followed by the qualitative design.

Quantitative Procedures and Analyses

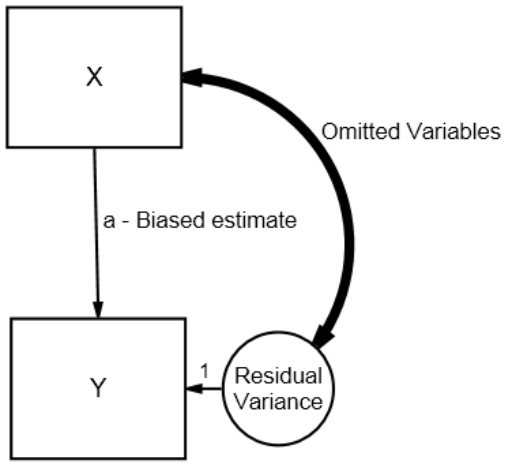
We employed two different statistical approaches to the data in each district, in order to answer important policy questions about POS. First, we estimated the effects of enrolling in POS and number of CTE credits earned on GPA and graduation using an instrumental variable approach. In addition to that main analysis, we also addressed specific policy questions about completing a POS compared to other high school trajectories (i.e., a CTE concentration; see *Sampling Procedures, Posthoc Groups*) through posthoc multiple regression analyses. Each is described in turn.

Instrumental Variables Estimation

We used an instrumental variable approach to estimate the effects of attending POS schools and number of CTE credits earned on GPA and graduation (see Angrist & Krueger, 2001; Antonakis, Bendahan, Jacquart, Lalive, 2010; Greenland, 2000). Omitted variable bias is a common barrier to causal inference in the context of observational and quasi-experimental research. When the causal effect of X on Y is of interest, a parameter estimate may be biased because some or all of the estimated effect is attributable to omitted causes. In the context of structural or simultaneous equations, this problem is known as endogeneity (Antonakis et al., 2010). The most well-known method for avoiding this bias is the randomized experiment, where all omitted variables are randomly distributed across treatment and control groups (e.g., a group that receives X and one that does not). In the context of large samples, this bias can also be eliminated through the use of an instrument for X, which is correlated with X for plausible substantive reasons, but not directly linked to Y. That is, X fully explains the effect between the instrument, Z, and the outcome of interest. In education and psychology, this instrumental variable approach is much less common than randomized experiments.

The central problem stemming from omitted variable bias and non-experimental data is that without an instrument, X's causal effect on Y cannot be isolated from covariance attributable to shared but omitted causes (see Figure 2.1). For example, the covariance depicted in Figure 2.1

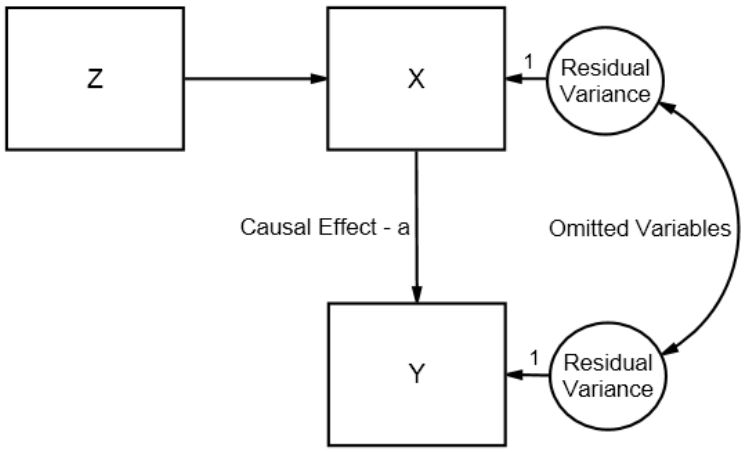
Figure 2.1
Omitted variable bias



Note: Thick line represents an inestimable parameter.

(denoted by a thick line) reflects omitted causes, but gets partitioned into coefficient *a*, creating bias. When an instrument is located, it is possible to partial the covariance of X with Y into consistent estimates of X's effect on Y and also a residual covariance – the covariance between the variance in X not explained by the instrument, Z, and the variances in Y not explained by X. Thus, X's effect on Y can be isolated from covariance due to omitted variables (see Figure 2.2).

Figure 2.2
Instrumental variable approach



Instrumental variable estimates can be understood as well-defined effects for subsets of treated groups (Angrist & Krueger, 2001). Angrist (1990) used Vietnam-era lottery numbers as an instrument to estimate the effect of military service on earnings later in life. In this case, the instrument was needed because not all people were drafted into service. Many people also volunteered for service, meaning it was unlikely that all causes of later earnings were randomly distributed across those who did and did not serve. Many people could have selected into service for reasons that caused their later earnings. In a conventional regression, the covariation of service and earnings due to these shared causes would have been "forced" into the estimated

effect of service on earning, creating bias. In this context, using lottery numbers as an instrument provided an estimate of a well-defined causal effect for a subset of those who enlisted in the military: those who were drafted as a result of the lottery. Thus, using lottery numbers as an instrument for military service facilitated estimation of a Local Average Treatment Effect for draftees, as if they were assigned in a randomized trial (Angrist & Krueger, 2001).

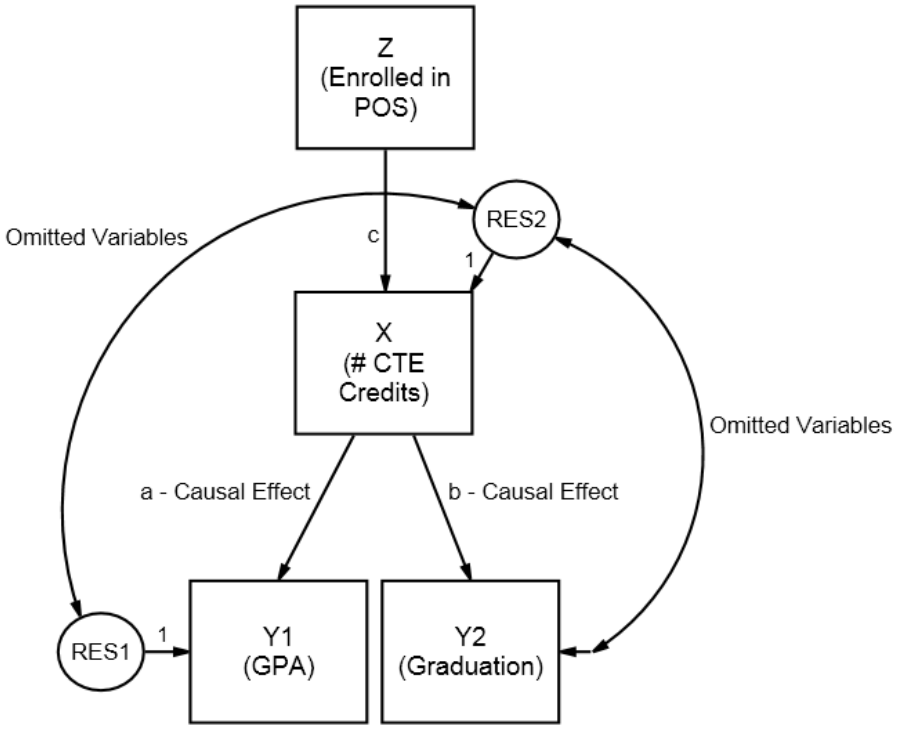
Instrumental variable approaches have also been used to estimate causal effects in the context of treatment non-compliance. In these cases, assignment to a treatment condition is an instrument for a compliance variable such as units of a protocol that were completed or completion of some treatment regimen (Greenland, 2000). Such models can also be conceptualized as mediator models, where compliance translates assignment into the outcome(s). As with the Vietnam-era lottery, here the instrumental variable approach helps researchers estimate a well-defined treatment effect for a subset of those who were assigned to a treatment condition: those who actually adhered to the treatment protocol. The indirect effect of assignment to a treatment on outcomes, through the compliance variable, is the "intent to treat" effect.

In this study, we wanted to estimate the effects of enrollment in POS and number of CTE credits earned on GPA and graduation for students in three school districts. In West District, enrollment in POS could not be understood as stemming from a purely random process. Assignment to POS high schools occurred through a lottery; however, students were able to circumvent this lottery mechanism through preferences already described (see *Sampling Procedures*). Students were also able to select out of POS high schools, which can be seen as an analogue of non-compliance. Thus, it was unlikely that all omitted causes of attending a POS high school (or not) were randomly distributed across POS and non-POS high schools. In addition, omitted variables such as persistence could be expected to impact number of CTE credits earned and also the outcomes of interest.

Modeling enrollment in a POS school as an instrument for number of CTE credits earned allowed us to address these issues, essentially combining features of the Vietnam-era draft and non-compliance scenarios. Use of an instrumental variable enabled us to estimate the effect of enrollment in a POS school for a well-defined subset of students: those whose CTE earning behavior changed as a result of enrollment in a POS school. For the first district, enrollment in POS schools could be expected to change CTE earning behavior because of the great availability of CTE courses at POS schools and because some students attended these schools as a result of a random lottery process. This approach also allowed us to estimate the effects of earning more CTE credits on GPA and graduation because these effects were isolated from residual covariances that captured their association attributable to omitted causes (see Figure 2.3). The substantive rationale for modeling enrollment in a POS school as an instrument for number of CTE credits earned was that number of CTE credits earned could be understood as a mechanism that translated enrollment into GPA and graduation. In other words, earning CTE credits was a mediator that translated enrollment in a POS school into the outcomes of interest.

For East and South Districts, we had reason to suspect that enrollment in POS schools was not a function of a lottery mechanism, even for a subset of students. Therefore, it was possible that enrollment in a POS school did not change student CTE credit earning behavior. At East, we knew that students were generally able to select and enroll in the schools they chose. To address

Figure 2.3
Instrumental variable estimator of the effects of enrollment in POS



this, the district carried out a propensity score match (previously described) to locate a comparison group that corresponded to the students in POS schools. In many school districts, this could have been expected to generate a comparison group of students that were similar to POS students, but earned fewer CTE credits because they were not attending a POS school. If this were the case, enrollment in POS schools could have functioned as an adequate instrument for number of CTE credits earned. However, CTE courses are extensively available at East District and thus the matched students may have been characterized by similar CTE credit earning. This could have stemmed from a combination of individual similarity to their POS matches and also their comparable access to CTE courses.

In South District, the context was similar to East, except no propensity score match was conducted to locate a comparison group. For these two districts, we planned to test whether enrollment in a POS school functioned as a good instrument for number of CTE credits earned, and if it did not, test a conventional mediator model without the residual covariances typical of instrumental variable models (see the double-headed arrow in Figure 2.2). These models would be the same as for West, except they would not estimate the covariance between number of CTE credits earned and the outcomes of interest that was attributable to omitted variables. In essence, these models would look like common longitudinal mediator models, which are routinely tested, but do not support the same strength of causal inference as instrumental variable models because they do not correct for endogeneity (Antonakis et al., 2010).

Structural equations modeling. This study used structural equations modeling (SEM) to estimate the effects of enrollment in POS schools and number of CTE credits earned. Structural

equation modeling, also known as simultaneous equation modeling, is a general term that has been used to describe multi-equation regression models that represent causal effects between variables of interest (Bollen, 1989; Kline, 2010). SEM can be understood as an extension of general linear modeling, analysis of variance, and multiple regression. In SEM, an outcome in one equation may function as a predictor in another and the effects between all variables are estimated simultaneously. SEM often includes latent and observed variables and is often used to correct for measurement error and locate unbiased estimates of the effects between latent variables. Variables in an SEM may influence one another directly, indirectly, and reciprocally.

We used MPlus 7.11, accounted for the clustering of students nested in schools, and selected robust weighted least squares (WLSMV) as the estimator because our graduation outcome was categorical (Muthén, du Toit, & Spisic, 1997). We specified a model that included enrollment in POS as an instrument for number of CTE credits earned. As mentioned, we theorized that number of CTE credits earned was the mechanism or mediator that translated enrollment in POS into the outcomes. To control for relevant background variables, we regressed GPA and graduation on covariates such as age, gender, race/ethnicity, and free lunch status, among others. To evaluate model fit, this study used a variety of commonly used fit indices and their rules of thumb (e.g., Tucker-Lewis index [TLI], comparative fit index [CFI], and root means square error of approximation [RMSEA]; Bollen, 1989; Browne & Cudeck, 1993; Byrne, 2001; Kline, 2010; Hu & Bentler, 1999).

Missing data analyses. We conducted missing data analyses because our data were longitudinal and attrition was a concern. We examined the missing data for each district carefully. Given mean differences for collected information on whether or not missing data were present, we rejected the assumption of missing completely at random (MCAR) and made the more relaxed assumption of missing at random (MAR).

We used multiple imputation to handle the missing data and included auxiliary variables to satisfy the MAR assumption (Enders, 2010). Multiple imputation estimates missing values for variables using complete data from other variables, substitutes predicted values for missing information, and produces an imputed set. This is repeated multiple times and multiple imputed sets result. Analyses are conducted using each imputed set and the results from these analyses are pooled to produce overall results.

Multiple imputation accounts for missing data by restoring the natural variability in the missing data and accounts for uncertainty in their estimation and imputation. This approach allows researchers to preserve important characteristics of the data set as a whole (e.g., variances) and make use of all possible information. Multiple imputation produces unbiased parameter estimates which reflect the uncertainty associated with estimating missing data, is robust to departures from normality assumptions, and provides adequate results in the presence of low sample size or high rates of missingness (Enders, 2010; Little & Rubin, 2002).

Posthoc Multiple Regression Analyses

Posthoc analyses examined the relationships between POS completer status and gains in academic and technical achievement as measured by:

- Overall GPA
- STEM (defined as math above Algebra II and science) credit attainment
- Advanced Placement (AP) credit attainment
- Dual enrollment credit attainment (measured by college credits accrued)
- CTE GPA

We gathered yearly data on these measures over four years, as well as collecting student course-taking records and withdrawal information. To determine the contribution of POS on each outcome, we used an ordinary least squares regression model. Our analytic models used common background characteristics to analyze the POS completion effect on the outcomes of interest. Most of these background characteristics came from eighth-grade baseline data provided by the district research offices, with exceptions for South District as noted above in *Sampling Procedures*. For regressions run on overall GPA, AP credits earned, and college credits accrued, we included the same predictors used in the structural equations models:

- Gender (dummy coded with female as the omitted variable)
- Race/ethnicity (dummy coded with White as the omitted variable)
- Special education (dummy coded with non-special education as the omitted variable)
- Limited English Proficiency (dummy coded with non-LEP as the omitted variable)
- Poverty (school indicator for F/RL eligibility, dummy coded with non-eligibility as the omitted variable).
- Eighth grade achievement (standardized academic tests for math and reading)
- POS effects (dummy coded with the all noncompleters as the omitted variable or CTE concentrators as the omitted variable)

For the regressions run on STEM credits earned, we included all of the above except for reading prior achievement. For the regressions run on CTE GPA, we included all of the above except for math and reading prior achievement. For West district, we also included dummy variables for two of our three schools to account for any school effect:

- Azure (dummy coded with Navy as the omitted variable)
- Sky (dummy coded with Navy as the omitted variable)

We also examined the relationships between POS and postsecondary aspirations and acceptance to a postsecondary institution. Exit surveys given to students in their senior year were the source for data regarding post-high school plans, and, for some students, the alignment of these plans with their high school course of study or POS. We evaluated postsecondary aspiration data with crosstab and chi-square analyses.

All of the analyses in this study used rigorous procedures and standards in the examination of the effect of POS on various high school outcomes (U.S. Department of Education, 2013a). For example, to check for multicollinearity, we included in our regression statistics the Variance Inflation Factor (VIF). To determine the strength of our findings, we included confidence intervals around *b* of 95% confidence. To correct for multiple comparisons, we used the Benjamini-Hochberg method. Effect sizes were computed using Hedges's *g*. We performed

ANCOVAs on each outcome controlling for the same variables that served as predictors in our regressions. We obtained adjusted means and used those means in our effect size calculations.

Limitations. The data for this study did not come from a random sample from the population of U.S. secondary students, thus limiting generalization to districts that resemble those included in this study. In addition, for the posthoc multiple regression analyses, we limited the sample to students who completed four years in the district. This was necessary in order to give all students equal opportunity to complete the POS, but by reducing the sample, some generalizability was lost.

Qualitative Procedures and Analyses

Qualitative methods can assist in the identification of factors that might explain variations in the effects of an intervention. Qualitative analyses complement and help explain the more quantitative outcomes. Most social programs, such as education programs, are multifaceted—some facets function better in some contexts, and other facets thrive in different contexts. It is important to explain why an intervention may work where it seems to work. We conducted interviews with stakeholders such as students, teachers, counselors, principals, and business partners. We observed POS classes, comparison school CTE classes, and academic classes in both intervention and comparison schools. Finally, we conducted student surveys as another means of eliciting the student perspective.

Interviews

Following protocols for research on human subjects and district input, we sought parental permission for students to participate in interviews. In 2009, we paid for a mass mailing to the parents of all sample students in West and East Districts in which we invited their students to participate in the study. These invitations, sent to parents in their homes, were written in Spanish and English and included an informed consent document for parents to sign and return. During the study, we largely interviewed students whose parents signed and returned this form in 2009. Near the end of the study, we decided to target at-risk students for interviews in order to ensure that we were capturing a broad range of student perspectives and experiences. We selected potential interviewees from the dataset based on our definition of at risk (i.e., eligible for F/RL and scoring at or below the 20th percentile on any eighth-grade prior achievement measure) and submitted their dummy ID numbers to the district research office, which provided the schools with the requisite information to send targeted letters to their parents. South District personnel selected the students we interviewed at each school site.

Interviews were audio-recorded and transcribed. Transcripts were classified by type (e.g., CTE teachers, students). Following the case study methods of Yin (2009) and the grounded theory approach of Strauss and Corbin (1990, 1998), the contents of the transcripts were coded and entered into a qualitative data analysis software package called HyperResearch© version 2.8. Coding involved marking the instances of concepts or topics relevant to the study as they appeared in the interview or observation data. We identified 98 conceptual codes based on our site selection process, original site visits, and the elements of the law that we knew we had to identify, and we marked the instances in which they appeared in the data. For instance, one

element in the Perkins legislation requires POS to lead to industry-recognized credentials or a postsecondary degree. Therefore we had a code for these credentials and degrees, and all references to them were coded for later retrieval in query reports. We had to delimit the many possible concepts to a manageable set that could help explain how the POS experience differed from the "default" high school experience at the comparison schools.

These codes were then queried within HyperResearch and yielded reports rich with information on each code from every type of interviewee and observed class. These reports allowed us to group the data into more specific topical and descriptive categories (e.g., specific laws that support or threaten POS), which we could reduce to a series of matrices (Miles & Huberman, 1984) that aided within- and cross-site analyses and helped to identify possible mediating or moderating variables that might help explain the outcomes. The qualitative analysis generated an understanding of POS in these contexts that was derived and analyzed "from the ground up," a hallmark of grounded theory (Strauss & Corbin, 1998). Such an analysis process maximized the triangulation of as many data sources as possible.

Classroom Observations

All of our site visits were planned in advance. We worked with our district contacts and school principals to select the dates of our visits, then obtained school master schedules in order to outline a robust and well-balanced schedule of interviews and observations. All of our interview and classroom observation choices were approved by the principal and/or his or her designee, who also ensured that teachers were willing to be interviewed or observed. The protocols we observed in our classroom observations are detailed in Appendix B and C. All of the completed observation forms were also coded and entered into Hyper Research for later retrieval, thus the searchable qualitative corpus contained both interviews and observations.

Surveys

Two surveys were administered in West and East Districts during the study: a ninth-grade survey and a twelfth-grade exit survey. The ninth-grade survey contained sections on course planning, POS, career planning, classes and schoolwork, plans for the future, beliefs and opinions about school, and background information (e.g., gender, age, race/ethnicity, parents' level of education). The survey was formatted for web-based administration in SurveyMonkey and configured so as to direct intervention and comparison students into appropriate questions based on their responses to key questions (e.g., a comparison student answering "No" to "Do you have or are you in a program of study, career major, academy, or program?" would skip questions on POS and instead be routed to a subsequent section).

Student surveys were administered in a variety of ways in order to work within each district's regulations and capacities. Although in both districts, most intervention students could be found at the POS high schools, we faced challenges in reaching comparison group students, who were distributed across many other high schools in the district. In West District, some schools had perhaps a dozen comparison students, whereas others had up to 100. Similarly, in East District, although we had only four comparison high schools, participating comparison students had to be

identified in each school and invited to take the survey. South District did not participate in the student surveys.

For West's ninth-grade survey, we sent letters to principals in which we asked them to invite participating students to go online and take the district-administered survey using their ID numbers as passwords. Survey results were subsequently matched to the dummy ID system and returned to us. In East District, district CTE office personnel visited the five participating schools and handed out survey invitation postcards to participating students. These postcards provided a survey link and their dummy ID numbers, which they would use as their password to the survey. This process was feasible at East because of its smaller sample size. Both ninth-grade surveys were conducted on SurveyMonkey.

The twelfth-grade exit survey was administered in May 2012, shortly before our sample graduated from high school. This survey contained a section requesting background information in order to match responses to student records, as well as a section on post-high school plans (i.e., education, employment, military). This survey was formatted in SurveyMonkey and configured so as to direct students into appropriate follow-up questions based on their responses to key questions. The twelfth-grade exit survey requested contact information from students over age 18 so that we could contact them after graduation to follow up on their college and career experiences. Because we were requesting confidential identifying information, we worked with a third-party contractor, who acted as a privacy firewall, to receive the surveys and remove and retain the contact information for subsequent follow-up surveys.

Students were invited to participate in the twelfth-grade exit surveys in the same ways as the ninth-grade surveys in each district (in West, through letters to principals asking them to invite participating students; in East, through individualized postcards delivered to participating students by district CTE office personnel). We added an incentive to the twelfth-grade exit survey as a means of obtaining more viable contact information for future follow-ups. In West, because we were beholden to the good will of high school principals to encourage participation, incentives were for the principals: We offered $200 in Walmart gift cards to the ten schools that obtained 80% or higher participation rates in the survey. In fact, 12 high schools beat that response rate, and we held a drawing to select the 10 winning schools. In East, CTE office personnel felt that a student incentive would be more successful. Prominently displayed on students' invitation postcards was a picture of a Kindle Fire, noting that all respondents to the survey would be entered in a drawing for it.

Survey analysis involved crosstabulating the responses by intervention status and performing chi-square analyses to determine the significance of the differences between intervention and comparison group responses. Crosstabs were also run on any baseline differences between survey respondents and nonrespondents as well as differences between intervention respondents and comparison respondents. These results of these sample comparisons are found in Appendix D.

CHAPTER THREE: West District
POS as a tool for improving student achievement and economic development

Abstract

West District is an urban district that experienced a large population increase prior to the recent economic recession. To respond to this growth, new high schools were built and integrated into the district's school choice program. The impetus behind school choice was to improve student achievement, promote diversity, and create an awareness of career opportunities relative to POS and magnet themes.

The school cultures at the three participating POS high schools fostered environments where students could both focus on their chosen POS and excel academically. The unique aspects of those school cultures are described here.

We tested an instrumental variable model of the effects of POS enrollment and CTE credit earning on GPA and graduation. Our results indicate that enrollment in POS high schools improved students' probability of graduation by 11.3% and that increased CTE credit earning fully explained this effect. This analysis also showed non-significant effects of POS enrollment and CTE credit earning on overall high school GPA. These findings suggest that enrollment in West's POS schools benefited students in terms of retention, at no cost to their achievement.

At West District, 49.5% of the intervention group completed a POS. We examined policy-relevant questions using a second statistical approach to compare the POS completers to students who completed a CTE concentration, and to the rest of the sample. Posthoc regression analyses were employed to assess the effect of completing a POS on high school achievement: We found that compared to the rest of the sample, POS completers were more likely to 1) have a higher overall GPA, 2) have a higher CTE GPA, and 3) earn more STEM credits, but completing a POS did not affect the likelihood of earning AP credits. The model for dual enrollment predicted a higher number of college credits accrued by the rest of the sample, but the results indicated a weak fit to the data and suggested that important factors in dual enrollment participation were not captured in the model.

In the comparison with CTE concentrators, POS completers were more likely to 1) have a higher overall GPA, and 2) earn more STEM credits, but completing a POS did not affect the likelihood of earning STEM or AP credits. The model for dual enrollment showed no predictive value, perhaps due again to the weak fit of the data to the model.

The senior exit survey revealed very similar post-high school plans for both students who enrolled in POS and the comparison group: the majority of both groups planned to attend a four-year college or university full time, and had already been accepted to the school of their choice. Intervention students were more likely to continue their high school curricular focus in postsecondary education than were those comparison students who were in a specific program in high school (i.e., performing arts). Intervention students were also more likely to have been accepted into a branch of the military than comparison students.

We then present a qualitative analysis of POS implementation in West District, based on the elements of the law mandating POS and the subsequent policy guidance framework provided by the funding agency (USDE/OVAE, 2010).

Introduction to West District and the Intervention Schools

West District introduced POS as a way to improve human capital and promote economic development. A district administrator attributed the development of these schools of choice to visionary leaders who saw the rapid growth in the district and decided to provide high-quality educational options in all parts of the district. Another administrator described the goal as "elite schools for all children" as opposed to "schools for elite children."

Three of these POS high schools—Navy, Sky, and Azure[3]—participated in this study. Navy had recently been opened before the study began, Sky had a long history of delivering CTE, and Azure had built a reputation of "academic distinction and technological excellence." Each school delivered POS slightly differently: Navy through a project-based curriculum, Sky through more traditional CTE infused with high-level academics, and Azure through an academic-technological focus. These differences reflect practices employed in many high schools implementing POS across the country.

Navy High School

Navy High School was a relatively new, environmentally green, specially designed facility at the beginning of the study: It was the first purpose-built POS high school in the district. In 2008-09, Navy served 1,314 students drawn from its regional service area; although racially and socioeconomically diverse, the school had relatively more female, White, and Asian students and fewer Latino, IEP, LEP, and free-lunch eligible students than the district as a whole. Navy's POS were housed in modular units customized with input from the district's advisory boards for each program area. Modules for each POS consisted of hallways dedicated to the program, with academic teachers housed in the area instead of a separate academic wing.

Navy was designed according to "best practice" tenets of contemporary education, including learning communities, integrated curricula, project-based learning (PBL), and the expectation that students earn postsecondary credits while in high school and subsequently attend college. Although the foundation for each program was career-themed, we heard from several administrators that graduates did not always choose their POS for their later careers. At Navy, this was not considered a failure: Students gained strong academic skills at Navy as well as valuable workplace skills that could help them earn money while they pursued the career of their choice.

POS at Navy

During the study, Navy offered POS in the areas of transportation, biotechnology, construction management, culinary, engineering, hospitality, media, health careers, teacher education, and early childhood education. Senior internships were available for most POS at Navy, but students

[3] All school names are pseudonyms.

were not required to complete one. Career and technical student organizations (CTSOs) were very popular, with dozens of students participating in (and winning) SkillsUSA competitions.

Sky High School

Sky High School broadened its traditional mission as the district's former career center to focus on providing upgraded, intensive academics while maintaining the school's culture of high expectations and 40-year-old reputation for high-quality CTE instruction. In 2009, Sky's physical plant was showing its age—it needed more instructional space, better facilities, a new roof, and a plumbing upgrade. In all other regards, Sky was a high performer and very competitive. Sky's success was the reason the district sought to design and build several new high schools around career and technical POS. By the end of our data collection period, these expansion and renovation plans had come to fruition.

Sky's 2008-09 student body of 1,857, drawn from its regional catchment area, was more female and Latino compared to the rest of the district; there were also fewer LEP and free-lunch eligible students than the rest of the district.

POS at Sky

At Sky, most POS course sequences began in the 10th grade, with the ninth grade dedicated largely to academic coursework and other requirements. Sky offered a range of traditional and technology-focused POS in such areas as 3D animation, architectural engineering, automotive, business, computer networking, culinary, film and video, graphic arts, health, and welding.

Azure Academy

Azure Academy is a magnet high school of eight wall-to-wall academies: business and finance, computer graphic design, computer-assisted drafting and design (CADD), computer science, pre-engineering, information technology, legal studies, and systems technology support. In previous years, these programs served as a high-tech complement to Sky's more traditional CTE programs before the district overhaul. Azure's emphasis was always more college than workforce preparatory. Azure was recognized as a Blue Ribbon School and members of its faculty have received national awards for teaching excellence. As a magnet, Azure drew its 995 students from all over the district in 2008-09. The student body was more male, White, and Asian than the district as a whole; it had fewer Latino, IEP, LEP, and free-lunch eligible students.

POS at Azure

Due to its status as an early adopter and trailblazer for the other POS high schools in the district, Azure was placed in the position of having to "retrofit" its programs when Perkins IV passed in order to measure up to the latest standards and supporting components of POS that were laid out by Perkins IV, the state, and the district. This included better aligning and sequencing their courses into four-course pathways, investigating additional industry certifications, and establishing stronger ties to community and business and industry partners. Azure's challenge both during and after our study period was to take the programs that made it a forerunner of the

district's POS and reinvigorate them as full POS without affecting its reputation as a high-achieving school.

How School Culture and POS Identity Engaged Students

During our visits to the intervention schools, we found that all of the POS met the minimum requirements of Perkins IV, with the exception of cosmetology at Sky, which lacked a postsecondary component. In one way or another, the comparison school CTE programs fell short of POS requirements. Some did not offer any postsecondary or credentialing opportunities, others were not organized into coherent sequences, and we saw no evidence in our observations or examinations of comparison school course guides that academic courses were aligned or cross-referenced to CTE.

Our observations of CTE in West District suggested that the resources and structures supporting CTE were more plentiful in the POS high schools than in the comparison schools. This was not due to district favoritism; schools received finite resources and had to allocate them according to their diverse needs, missions, and student populations. At the POS high schools, this meant strongly supporting CTE; the comprehensive high schools had a wider range of competing demands on their funding. As a result, we saw less emphasis on purposeful, required CTE course sequencing and career preparation at the comparison schools compared to the intervention schools.

We identified other practices at the West District POS high schools that aided in POS development and implementation, such as using innovative teaching techniques that included applying academic learning to career contexts, and developing a sense of identity around POS. Many of these practices, which form a vital part of the POS high schools' cultures, were not evident in our visits to the comparison schools. This does not mean they did not exist there; however, comparison school personnel did not indicate that these practices occurred at their schools. Some of the practices that foster these different school cultures are described below.

Navy: The Cutting Edge

Integrated technology. A recently-built school, Navy featured modern, up-to-date facilities, full online connectivity, and innovative project-based teaching and learning strategies. For example, its culinary and hospitality facilities, including a full-sized banquet hall, industrial kitchens, and demonstration classroom, were described by its chef-instructors as better than the community college's, which uses the school's facilities for evening classes. Classes we observed used digital cameras to record lessons to be broadcast later as podcasts; these were seen as helpful to all students, but especially for those IEP students who needed to review lessons several times for full understanding.

Project-based learning (PBL). PBL was a guiding principle at Navy. PBL combines academic and technical content knowledge and hands-on applications of that knowledge, culminating in an annual multi-day open house of themed projects. During one year of our observations, the theme of this open house was space exploration and Earth conservation. The event featured poster tables, multimedia presentations, technology demonstrations, and mock trials. Transportation

students designed space rovers, biotechnology students cultivated a hydroponics laboratory that simulated various natural environments, and health careers students explored the impacts of space travel on human health and fitness. Some students took on methodologically sophisticated science projects; one student studied the effects on bacteria of a common antibacterial agent found in many personal care products. Such students worked with adult experts outside of the school, and one student had secured herself an internship with a prestigious medical clinic in the area.

Support. Navy's culture nurtured both students and teachers. Notable was its advocacy period, during which students engaged in one-on-one mentoring and advising with a teacher who remained their mentor throughout their four years of high school. Teachers received support on a variety of fronts, including the principal's open-door policy and commitment to supporting curricular innovation and on-going professional development.

Sky: A Tradition of Pride and Success

Familial culture. As one of the older high schools in the district, Sky enjoyed a familial sense of continuity, shared history, and communal values that had been passed on to succeeding cohorts of students. The school's values were communicated to new students through a combination of establishing and reinforcing mechanisms and customs that encouraged students to take pride in the school's appearance and their own accomplishments. Students neatly stacked up their chairs after the end of the lunch period; a welcome luncheon was served to the new freshmen by the senior class; and students and teachers were overtly praised and rewarded for their accomplishments. Sky actively promoted itself as a place of excellence and achievement: It distributed information sheets touting its low dropout rate and high attendance and graduation rates. The school staff we interviewed trumpeted the school's many AP classes, strong pass rates on the state achievement exams, healthy college-going numbers, and reputation for safety.

Hands-on learning. Students engaged in hands-on learning at Sky. One health careers student stated that she was happy at Sky "because usually in regular high school, they don't have any hands on. You're just listening and writing on paper." She described how her health careers POS teachers brought in "biology, chemistry, anatomy all into it to understand the body and functions too. And math– they use it too, for calculations of blood pressure."

Soft skills and professional standards. A required ninth-grade class at Sky taught soft skills, career exploration, and standards of professional behavior. In this class, students prepared resumes, charted out their four-year graduation plans, and participated in mock interviews with community business partners. During our observations of this class, students were being evaluated on the professionalism of their dress. Sky's Career Center served as a model for the rest of the district: It included a job bank, cooperative education agreements, and computers with access to career interest inventories, college and career information, and industry assessments.

Azure: The Technology Flagship

High achievement. As one of the district's highest achieving schools, Azure had a reputation to maintain. We heard this from district personnel and most interviewees at Azure, including the

students. Azure's focus is academic achievement within career-themed programs. For example, the school hosted popular CTSOs like Future Business Leaders of America (FBLA). A business teacher we interviewed stressed the importance of FBLA in imparting dress, networking, and written and oral communication skills to students in addition to providing opportunities for business-related field trips and leadership development activities. A student described the FBLA-sponsored management and decision-making competitions she took part in that required teamwork to resolve an issue and then to present the resolution to judges. The connection between high academic achievement and careers seemed clear to the teachers we spoke with: "I always tell students, when you get into the workforce, employers want someone who's well rounded." This CTE teacher exhorted her students to excel in both academics and CTE: "Content is the foundation of the [POS] program area. The math, the English, the history. It all works together."

Self-awareness. One Azure counselor reported that the school was full of self-described "nerds." The students we spoke with described their strong focus on schoolwork and goals. One called Azure "a good school for going to college," and another told us that she had applied to Azure because she wanted higher standards. She believed that students back at her zoned high school "don't think about their future as much as they do here."

Instrumental Variable Sample Description

We examined data for 2,004 secondary students; 1,175 enrolled in three POS high schools in ninth grade; 829 attended other schools. Table 3.1 displays descriptive statistics for the West District imputed sample.

Missing Data

We carried out a missing data analysis and observed that the percentage of data missing for the variables ranged from 0.0 to 31.3%, with an average of 7.6%. We rejected the assumption that the data were missing completely at random (MCAR) on the basis of mean differences in eighth-grade standardized test scores between those who were and were not missing GPA data for later years. Thus, we found it necessary to make the more relaxed assumption of missing at random (MAR), used multiple imputation to handle the missing data (Little & Rubin, 2002), and generated five imputed sets using NORM 2.03 (Schafer, 1997).

Instrumental Variable Estimation

We tested our hypothesized model across the imputed data sets and observed that it was over-identified with 13 degrees of freedom and fit the data well (e.g., $\chi^2 = 20.75$, CFI = .99, TLI = .97, and RMSEA of .02). We tested the model using a single imputed set to obtain a χ^2 test and modification indices. We observed a statistically significant global test statistic ($p = .02$), suggesting that the model did not fit the data exactly (see Bollen, 1987, pp. 263 - 269). The observed modification indices and standardized residuals suggested that number of CTE credits earned should be regressed on gender. We added this specification and observed that the resulting model was over-identified with 12 degrees of freedom and fit to the data was excellent (e.g., $\chi^2 = 8.75$, CFI = 1.00, TLI = 1.00, and RMSEA = .00). We tested the model using

Table 3.1
Descriptive statistics for imputed sample, West District

	(*N* = 2,004)	%
Overage		
No	1,937	96.7
Yes	67	3.3
Gender		
Male	847	42.3
Female	1,157	57.7
Race/Ethnicity		
Black	194	9.7
White	804	40.1
Latino	678	33.8
Asian	313	15.6
Other	15	0.7
F/RL eligible	558	27.8
Limited English Proficient (LEP)	50	2.5
Has Individual Education Plan (IEP)	82	4.1
Graduated on time (2012)	1,803	90.0
Attrition	105	5.2
	Mean	*SD*
Discipline incidents	0.51	1.27
Grade 8 pre-test math scale score[a]	369.51	77.02
Grade 8 pre-test reading scale score[a]	345.99	54.88
Grade 8 pre-test science scale score[a]	366.64	64.49
Number of CTE credits earned[a]	5.15	2.71

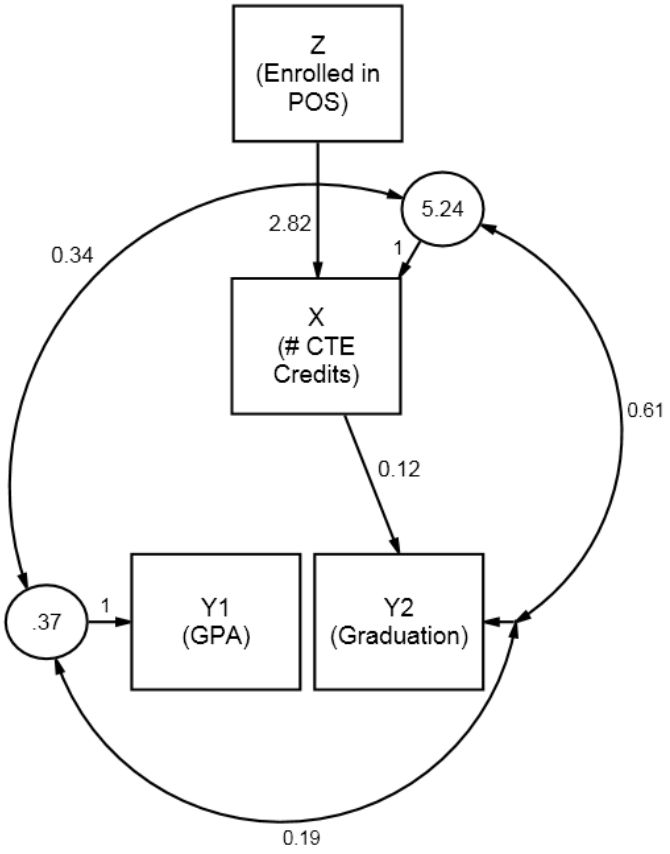
Note. F/RL = free/reduced price lunch program.
[a]Variables were grand mean centered.

a single imputed set and observed a non-significant global test statistic ($p = .46$), suggesting that we should not reject the hypothesis that the model fit the data exactly. This result implies that the instrumental variable model assumptions of nil direct effects of enrollment in POS schools on GPA and graduation were consistent with the data. We also observed that the covariances of number of CTE credits earned with GPA and graduation were *covs* = .34 and .61 (*ps* < .001), respectively. These significant residual covariances suggested that these variables shared variance attributable to omitted variables and that our instrumental variable was necessary to recover consistent estimates (see Antonakis et al., 2010).

For this model, enrollment in a POS high school appeared to increase the number of CTE credits students took by an average of 2.82 credits (see Figure 3.1). Controlling for background variables, the indirect effect of enrollment in POS high schools on GPA was not significant ($p = .959$), while its indirect effect on graduation was $b = .34$ ($p < .001$). The latter effect is a probit coefficient and can be interpreted as indicating that holding the background variables constant, enrolling in a POS high school increased students' probability of graduation by an average of 11.31% (see Figure 3.2). The direct effect of CTE credits on GPA was not significant ($p = .960$),

while its direct effect on graduation was $b = .12$ ($p < .001$). The latter suggests that each additional CTE credit earned by students increased their probability of graduation by 4%. Taken together, these results indicate that (1) students who enrolled in POS high schools were 11.31% more likely to graduate than students who enrolled elsewhere, and (2) this effect is explained by their increased earning of CTE credits.

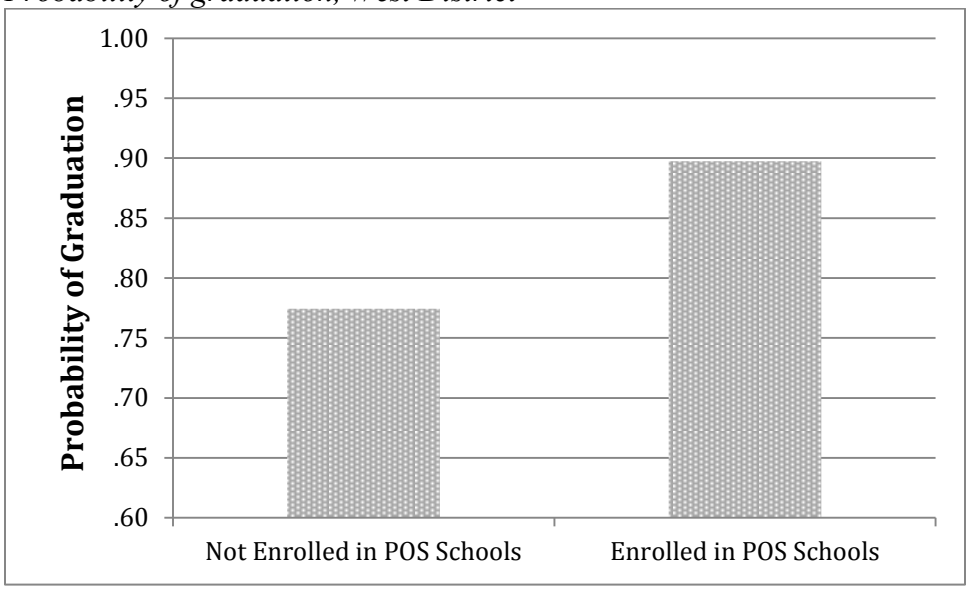
Figure 3.1
Final model for West District



Note: Significant unstandardized estimates are displayed. Covariates are omitted for conceptual clarity.

In addition to the effects described above, several covariates were significant predictors of number of CTE credits earned, GPA, and graduation. Gender (i.e., being male), F/RL, LEP, special education, discipline events, Black, and Latino had significant and small negative effects on GPA, while Asian and Grade 8 science and reading scores had a significant and small positive effect on GPA (all *ps* < .05). Grade 8 math score had a significant and moderate positive effect on GPA ($p < .001$). Age, F/RL, and discipline occurrences had significant and small negative effects on graduation, while Asian and Latino had significant and small positive effects on graduation (*ps* < .05). Finally, gender had a small but significant positive effect on number of CTE credits earned ($p < .001$). Note that each of these effects should be interpreted as the effect of a particular predictor, holding all other predictor variables constant, or within levels of the other modeled predictors. For a complete description of the estimates for West District, see Appendix A.

Figure 3.2
Probability of graduation, West District



Note: Estimated probabilities holding constant age; gender; race/ethnicity; free lunch status; LEP; IEP; Grade 8 science, math, and reading scores (grand mean centered); and discipline incidents.

Assessing the Effect of Completing a POS on High School Achievement

As noted earlier (see *Method*), we employed two statistical approaches to analyze the data. Our second approach employed multiple regression analyses, using a different sample—POS completers, CTE concentrators, and the rest of the sample (All Others). For these analyses, we excluded students who (1) withdrew or were missing course data and (2) were missing baseline achievement data. We were consistent with this even with the CTE GPA analysis (that did not control for baseline achievement) so that the regression sample would match the descriptive statistics to the extent possible. Of course, the sample for the CTE GPA analysis is further reduced to those who actually took a CTE course among the students in the All Others group. Table 3.2 provides descriptive statistics for the posthoc regression sample.

Our analyses found that of the 1,175 intervention students at West, 582 (49.5%) completed a POS. We also identified the number of students who earned credits in the outcome measures outlined in the *Method* chapter. These included measures of academic rigor such as earning STEM credits (i.e., credits in science and higher math courses, which we defined as courses above Algebra II), and AP credits, as well as a transition measure: accruing college credits through dual enrollment. Finally, we included a measure of overall GPA because of its predictive value for college success, and a CTE GPA measure in order to gage technical achievement. All of these measures have high policy relevance: A major impetus behind POS is for CTE students to take more rigorous coursework that leads to postsecondary education. Descriptive results of student course-taking are shown in Table 3.3.

Table 3.2

Descriptive statistics, posthoc sample, West District

	Total (n = 1,368)	POS Completers (n = 545)	All Others (n = 823)	CTE Concentrators (n = 130)	POS Completers Compared to All Others	POS Completers Compared to CTE Concentrators
Characteristics						
Male	41.6	51.0	35.4	44.6		
Black	9.9	10.5	9.6	11.5		
White	38.7	40.9	37.3	38.5		
Latino	34.4	30.8	36.8	40.0		
Asian	16.0	16.7	15.6	8.5		
Other/Multiracial	0.9	1.1	0.7	1.5		
F/RL eligible	27.9	26.4	28.8	34.6		
LEP	2.1	1.1	2.8	1.5	*	
IEP	4.1	2.4	5.2	6.9	**	**
Grade 8 pre-test reading	347.87 (54.66)	348.99 (51.48)	347.13 (56.68)	336.45 (55.26)		
Grade 8 pre-test math	370.80 (76.60)	372.92 (73.65)	369.40 (78.54)	357.89 (87.10)		
Discipline events						
None	76.3	75.8	76.7	68.5		
1-2 events	18.3	17.6	18.7	24.6		
3+ events	5.4	6.6	4.6	7.0		

Note. Excludes students who withdrew or were missing course data. Standard deviations of continuous variables are included in parentheses.

$^{*}p < .05$, $^{**}p < .01$.

Table 3.3

Descriptive outcome statistics, posthoc sample, West District

	Total (n = 1,368)	POS Completers (n = 545)	All Others (n = 823)	CTE Concentrators (n = 130)	POS Completers Compared to All Others	POS Completers Compared to CTE Concentrators
Percent Earning Outcome Credits						
STEM	100.0	100.0	100.0	100.0		
AP	49.2	52.3	47.1	36.9		**
College (accrued)	5.6	0.4	9.1	1.5	***	
CTE	88.7	100.0	81.3	100.0	***	
Outcome Means	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)		
Overall GPA	3.31 (0.61)	3.38 (0.51)	3.27 (0.51)	3.18 (0.60)		**
STEM credits earned	5.20 (2.01)	5.26 (1.77)	5.16 (2.15)	4.60 (1.49)		***
AP credits earned	1.63 (2.37)	1.56 (2.09)	1.67 (2.54)	1.09 (1.94)		*
College credits accrued	1.01 (5.54)	0.07 (1.13)	1.63 (7.02)	0.08 (0.63)	***	
CTE GPA	3.32 (0.64)	3.41 (0.43)	3.24 (0.76)	3.30 (0.61)		*
	n = 1,215		n = 670			

Note. Excludes students who withdrew or were missing course data. STEM credits equals credits in science and higher math courses (i.e., above Algebra II). College credits accrued refers to the potential college credits associated with dual enrollment participation in high school.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Following are the results of our posthoc analyses of high school achievement, controlling for background characteristics (full regression tables are found in Appendix A). Comparing POS completers to the rest of the sample, the results for overall GPA, STEM credits earned, and CTE GPA are positive and statistically significant (see Table 3.4). Of the four statistically significant findings, two (overall GPA, CTE GPA) have effect sizes of 0.25 or larger, making them substantively important as well. In contrast, the college credits accrued (dual enrollment) finding is negatively associated with completing a POS, and contributes relatively little to the variance explained of the difference between completing and not completing a POS in terms of accruing college credits.

Table 3.4
Regression results, POS completers versus all others, West District

	West District POS Completers Versus All Others								
		Adjusted					95% *CI* of *b*		
Outcome	*n*	R^2	*b*	*SE b*	*ß*	*p*	lower	upper	*ES*
Overall GPA	1,368	0.385	.177	.029	.142	.000	.121	.232	0.30
STEM credits earned	1,368	0.268	.276	.102	.067	.007	.075	.477	0.14
AP credits earned	1,368	0.257	-.146	.122	-.030	.232	-.385	.093	-0.07
College credits accrued	1,368	0.021	-1.667	.327	-.147	.000	-2.308	-1.025	-0.30
CTE GPA	1,215	0.085	.155	.038	.121	.000	.082	.229	0.27

Note. All coefficients rounded to two digits. Full regression tables are found in Appendix A. *CI* = Confidence Interval. *ES* = effect size (Hedges's *g*)

Table 3.5 shows the results of the comparison of POS completers and CTE concentrators. The results for overall GPA and STEM credits earned are positive, statistically significant, and both have effect sizes larger than of 0.25, making them substantively important. The dual enrollment finding is not significant; however, the poor fit of the model to the data make the finding questionable.

Looking more specifically at the covariates in the full regression tables (cf. Appendix A), students attending Navy were significantly more likely to have a higher overall GPA than students attending Azure ($p = .000$ for both All Others and CTE concentrator models) or Sky ($p = .000$ for All Others model and $p = .013$ for CTE concentrator model; see Appendix A for all covariates). This suggests a school effect at Navy that could be attributed to aspects of Navy's structure, curriculum, and culture: Navy assigned academic teachers to team with specific POS, and they were co-located in the same building wings for easier collaboration. This collaboration was expected within their problem-based learning curriculum. There were also opportunities to participate in work-based learning experiences at Navy—the operational child care facility onsite, the active culinary and hospitality programs that often hosted community and district events, and internship opportunities. All of these could have engaged students and shown them

how achievement in both academic and technical courses was necessary for the careers they wished to pursue. No other school effect at West was as clear cut as the overall GPA outcomes.

Table 3.5
Regression results, POS completers versus CTE concentrators, West District

	West District POS Completers Versus CTE Concentrators								
		Adjusted					95% *CI* of *b*		
Outcome	*n*	R^2	*b*	*SE b*	*ß*	*p*	lower	upper	*ES*
Overall GPA	675	0.391	.152	.042	.112	.000	.071	.234	0.30
STEM credits earned	675	0.313	.541	.143	.123	.000	.261	.821	0.31
AP credits earned	675	0.332	.178	.168	.034	.290	-.152	.508	0.08
College credits accrued	675	-0.011	-.016	.105	-.006	.875	-.223	.190	-0.02
CTE GPA	675	0.066	.078	.045	.065	.085	-.011	.168	0.19

Note. All coefficients rounded to two digits. Full regression tables are found in Appendix A. *CI* = Confidence Interval. *ES* = effect size (Hedges's *g*)

Senior Exit Survey Findings

A senior exit survey was conducted in May 2012, including all seniors in our original sample (see *Method*). Response rates were not high: The intervention student response rate was 38.8 percent and the comparison student response rate was 39.2 percent—not a significant difference ($p = .858$).

The comparison group's survey respondents were not significantly different from the comparison nonrespondents; among the intervention group students, significantly more female and more LEP students did not take the survey (see *Appendix D*). Appendix D also shows differences between intervention and comparison survey respondents. We found that significantly more males and Black intervention students, and significantly fewer students with an IEP took the survey than in the comparison group. All of these differences should be taken into account when interpreting the survey results.

We found that the students who responded to the survey were very similar in their post-high school plans, regardless of whether they were in the intervention or comparison group (see Table 3.6). Most had been accepted (over three fourths of the sample) and planned to attend a four-year college or university (over 68% of the sample) full time (over 91% of the sample) in Fall 2012. There were no significant differences in their work plans either: most respondents planned to work part time, and those jobs were not related to their high school program. Only a small percentage planned to join the military, but intervention students were more likely to do so than comparison students.

We asked students whether their postsecondary studies would be related to their high school program. Of those students who indicated that they were in a high school program (defined in the survey as "major, program of study, career major, career pathway, career academy, International Baccalaureate, etc."), 60 percent of the intervention students indicated that their post-high school program would related to their high school program. By contrast, less than half (48%) of comparison students indicated that their post-high school studies would relate to their high school program. This suggests that participating in a high school program helped clarify intervention students' post-high school planning.

Table 3.6
Student exit survey responses, West District

Survey Items	Intervention ($N = 456$) (%)	Comparison ($N = 325$) (%)
Do you plan on working immediately after graduation?		
Yes	62.5	61.2
Will you be employed full time?		
Yes	34.0	43.7
Is this job related to your high school program?		
Yes	25.6	8.0
No	67.4	43.2
Not in a program	7.0	48.7
Do you plan to attend a four-year college or university, two-year community college, or trade/ technical school for the Fall 2012 semester?		
Yes	91.7	88.9
Four-year	68.7	72.0
Two-year	27.5	24.2
Trade/technical	3.1	2.8
Other	0.7	1.0
Have you been accepted to this school?		
Yes	81.6	76.8
Will you be a full-time student?		
Yes	91.4	94.1
Will your studies at this school relate to your high school program?		
Yes	56.9	27.0***
No	37.8	28.7*
Not in a program	5.3	44.3***
Have you been accepted into a branch of the military?	3.1	0.9*

Note. Due to missing data, percentages may not add up to 100. Significance levels are based on chi-square analyses comparing intervention and comparison groups.
*$p < .05$. **$p < .01$. ***$p < .001$.

Adherence to the Components of POS

At the beginning of our study, West District's POS, constructed as non-duplicative course sequences aligning secondary and postsecondary content in programs typically requiring three to four years of progressively more challenging coursework, were largely delivered in purpose-built, regionally located POS high schools. Students meeting basic eligibility requirements applied to these choice programs through a district lottery. POS were also offered in magnet programs housed in some of the district's comprehensive high schools. By the end of our data collection activities, West was in the process of developing and implementing POS in all of its comprehensive high schools offering CTE. Block scheduling greatly facilitated POS implementation in the POS high schools; the comprehensives, which did not offer such scheduling, needed more flexibility. Because districts and other local education agencies in this state tended to exert strong local control, West was able to dictate its own policy with respect to the expansion of POS in all of its high schools. To a certain extent, West's CTE programs and intensive POS served as exemplars to the rest of the state. Indeed, during our study, the state began standardizing its CTE programming, in some cases adopting the work completed by West.

Nearly a dozen advisory committees comprised of secondary and postsecondary faculty and business and industry partners designed West's POS to align with postsecondary and industry content and standards. Advisory committees generally met monthly to review and update programs, and committee members were nearly universally praised by study participants as contributing significant expertise and considerable material and financial resources to district POS. Of these partners, West worked particularly closely with West Community College (WCC) to articulate nearly every CTE program offered by the college with similar programs in its high schools. As such, opportunities to earn college credits, through these articulations or a more limited dual enrollment program, were abundant in this district. Overall, but to varying degrees of intensity, West's POS incorporated project-based learning, curriculum integration, CTSO leadership activities, intensive career guidance and exploration, opportunities to participate in work-based learning and earn industry-recognized credentials, industry-quality technology, and embedded soft skills instruction. Administrators, teachers, and counselors reported receiving abundant professional development support from the district; some of this development was offered by WCC. Although technical skills assessments were not in place at the beginning of our study, by 2010, the district was working with the state to align every POS with an industry-recognized credential or third-party assessment, where such were available.

Incorporate and Align Secondary and Postsecondary Education Elements

Working in conjunction with WCC and/or state university faculty, West District developed the POS curricula at its POS high schools to prepare students to pursue further education at WCC or one of the state's four-year universities.[4] Indeed, the secondary POS curriculum development process drew upon state higher education standards so that developers could visualize not only the postsecondary end point of a given POS, but also which components of a program could be offered in high school for college credit. In some programs, the senior-year POS course was deemed the equivalent of a postsecondary course (e.g., an automotive course at WCC, an

[4] If a program did not have a postsecondary component, such as Sky's cosmetology program, we did not consider it a POS for the purposes of this study.

engineering or teacher education course at the state university). Through its articulation agreements with WCC and the state universities, West could offer such courses for college credit, thus eliminating the need for students to take them at the college level.

We were able to observe the process of secondary-to-postsecondary curriculum development and alignment in action at an advisory board meeting for West District's construction programs. Present were construction technology teachers from West high schools, a number of district CTE personnel, a WCC department chair, and several business and industry partners. The goal of the meeting was to ensure that the high school curriculum would continue to align with WCC's construction programs; at that time, WCC was in the process of launching new degree and certificate programs in sustainable construction. This meeting allowed the entire advisory board to not only learn more about these pathways, but also plan how West high schools could develop curricular modules leading to them.

When West District made changes to its own CTE curricula or course titles, such changes had to be approved by WCC in order to maintain curricular alignment. This process sometimes required industry input. As one WCC administrator noted, the business of aligning secondary and postsecondary curricula resembled a "food chain" in which industry—at the top—told postsecondary educators how to structure their programs; postsecondary faculty then worked with the district and secondary-level teachers to redesign their programs to make sure that students met WCC entrance requirements. The same WCC administrator described the relationships between WCC faculty and high school teachers as varying across program areas. Some programs maintained a regular schedule of outreach to their high school counterparts; others developed program leadership meetings or daylong retreats to examine course content, methods, and evaluation processes; still others were more haphazard in the frequency and intentionality of encounters across institutions.

West District POS had other postsecondary components besides their curricula. Some used college textbooks; others featured teachers who also held adjunct teaching positions in the same subject area at WCC. Many high school teachers told us that they pursued additional education and professional development at WCC, where industry partners also said that they went for their training.

Secondary and postsecondary POS also shared facilities. In some cases, high school facilities met industry standards better than those at the college; in others, the reverse was true. To the extent possible, West District and WCC made every effort to share. One notable example was a heating, ventilation, and air conditioning (HVAC) program that suffered from low enrollment at several high schools despite a high demand for workers in the area. The program's advisory board convinced the board of education to consolidate all district training at one site—Fuchsia, a comprehensive high school located next door to a WCC satellite campus that housed a nationally accredited HVAC training center. High school and WCC faculty worked together to write the state standards for the program, which was accredited by the Partnership for Air-Conditioning, Heating, Refrigeration Accreditation (PAHRA). High school students in the program took their regular courses at the high school, then walked across the parking lot to receive their career instruction at the WCC training facility, which served adults at other times of the day. The district's articulation agreement with WCC allowed West students who completed the program

to earn as many as 13 college credits. Students could also take their general education requirements through WCC, making it possible to graduate from high school with a diploma and a completed WCC HVAC certificate. Although Fuchsia's principal strongly supported the program, dwindling enrollment numbers and the retirement of its acclaimed high school instructor in the fourth year of our study ultimately spelled its demise, despite WCC's best efforts to provide an interim instructor and incentives for currently enrolled students to complete their pathways.

A WCC administrator believed that West's heavy investment in POS high schools reflected its desire to incorporate postsecondary education into the high school experience. Because West students enrolled in high school POS voluntarily, such programs were more like college. As he noted, at the POS schools, faculty could "focus on industry requirements, industry outcomes, career focus, that kind of stuff. Makes an entirely different structure there." By contrast, when students were present only because they had to be, which this administrator felt was true at the comprehensive high schools, CTE programs could not coordinate well with postsecondary, "because [the schools'] focus is classroom management or attendance, not career outcomes."

At the state level, administrators recognized the need for representatives of secondary and postsecondary education to collaborate. Postsecondary faculty offered guidance on connecting programs during the state's technical assistance workshops on POS. And a state department of education official reported that his agency was working with the state higher education commission to make sure that POS spanning both systems were a priority in their work and future grantwriting efforts.

Include Academic and CTE Content in a Coordinated, Non-Duplicative Progression of Courses

West worked to design and implement non-duplicative POS course sequences that aligned secondary and postsecondary content in programs requiring as few as two to as many as four years of high school coursework before leading to postsecondary education. Both the state and the district recognized the need to offer flexible POS course sequences, particularly for those comprehensive high schools that followed non-block schedules or offered fewer CTE options. The state's CTE director noted that many rural districts had limited resources, fewer connections with industry, and were sometimes located far from a college campus. As he noted, in such districts, schools could offer the first two levels of an articulated POS sequence, with the third to be taken at the postsecondary level (e.g., Automotive I and II in high school, and Automotive III at a community college). He believed that although three-year sequences were more desirable, two-year sequences (especially in the comprehensives) still held the promise of rigor.

With its more abundant resources and public commitment to building and sustaining the POS high schools, West District designed its aligned course sequences with considerable input from about a dozen advisory boards comprised of secondary, postsecondary, and industry partners. The district's CTE director described this as offering principals a POS "menu" of two- to four-year programs—although the POS we observed all spanned three to four years in length—consisting of entry, mid-level, and terminal (i.e., capstone) courses coupled with industry credentials and ending with state competency certificates. After taking a "painful" look at its

curricula and enrollment numbers, the district eliminated resource-draining singleton courses and programs with low enrollments and streamlined pathways into each of the sector strategy-driven areas. By the fourth year of the study, we saw evidence of the district's effort to roll out aligned sequences in a number of magnet programs at its comprehensive high schools.

One retired district administrator who was instrumental in the early design and implementation of POS told us how they had aligned and sequenced academically and technically rigorous POS that would incorporate postsecondary and industry standards and hands-on, experiential learning and lead to further education and high-skill, high-wage jobs in high-demand areas. District personnel used a "backward assessment" process that began with their goal—students graduating with viable, marketable diplomas, meaningful credentials, and varied skills that would allow them to adapt to a changing job market—and constructed the curriculum backwards from there:

> We tried to start… where we thought students might finish and then go backwards and say… what do we need to put in place to maximize the opportunity for every student? They're not all going to decide at the same point that they want to go on [to college], but we want to make sure that they understand that that's clearly where we want them to go and give them every opportunity to access that… I think it's really made a difference. It really helps kids focus and it gets them excited about taking more rigorous coursework when they can see the application.

The district was aided in this work by WCC, which had committed to offering high school students a quick route into its professional programs. The college employed a full-time coordinator who worked with each of the district's high schools to educate principals, program chairs, teachers, and guidance counselors about available dual credit opportunities. It is worth noting that WCC's investments in creating aligned secondary-postsecondary program sequences did not always lead to successful outcomes for the college. A number of WCC faculty and staff we interviewed reported that students were not always well-prepared to take and pass mid-level courses. Some college faculty also questioned the rigor of some aligned high school programs; in culinary, for example, the department chair spoke of the disconnect between high school programs offering FACS-based (Family and Consumer Sciences) food and nutrition courses and those offering industry-driven cooking and baking courses.

Non-Duplicative Sequences at POS Schools

The hallmark of all of West's POS sequences was the close alignment of program curricula with postsecondary programs, as reflected in the wide availability of college credit from WCC (and in some cases from the local four-year university). There was also a strong, shared expectation that most students would pursue some form of postsecondary education after graduation. Facilitating alignment and sequencing was the purposeful structuring of the district's POS high schools to include block scheduling, project-based learning, curriculum integration, work-based learning, and connections with postsecondary and industry partners. Navy provided many examples of secondary-postsecondary alignment. All of the teachers and program chairs we interviewed were highly articulate regarding the alignment and sequencing of courses in their program areas. POS differed in the depth of their alignment with postsecondary, however. Some programs, like Navy's biotechnology program, were developed in concert with faculty at the local university. In

the case of Navy's teacher education program, the lead teacher developed the curriculum, which included rotations in the school's on-site kindergarten, based on her own postsecondary experiences. She was rebuffed in her efforts to align the program with WCC. The hospitality chair described working with WCC, the local four-year university, and the American Hotel and Lodging Association (AHLA) to design a standards-driven curriculum built around the postsecondary institutions' needs. A transportation teacher noted that his program offered the identical sequence of courses as at WCC—where he used to teach—with the added benefit of more time to delve deeply into the content. Annual course selection guides helped students construct their schedules by laying out clear program strands, course sequences, related electives, and available credit transfer opportunities.

Non-Duplicative Sequences at Comparison Schools

West District provided additional POS opportunities in magnet programs located on comprehensive high school campuses. But there were otherwise few to no POS sequences in evidence at the comprehensive high schools with "regular" CTE. Ruby's magnet coordinator described their EMT/first responder program as the school's only full POS sequence, which she defined as providing opportunities to earn college credit. Although these credit transfer opportunities were considered an easy sell to Ruby students, the coordinator believed that there were not enough college credit-eligible courses being offered. Students in the school's aviation magnet POS took a four-year pathway of aerospace courses that culminated in a senior capstone and an internship at the local university; students were also qualified to test for a private pilot's license. Ruby's principal was aware that his school faced competition from the district's POS high schools; he perceived an advantage, however, in Ruby's ability to offer the kinds of standard high school experiences—including athletics—not offered at the POS high schools.

Student perspectives on their course sequences. Over the course of the study, most interviewed students demonstrated a strong understanding of their POS majors and course sequences and the options available to them at their schools. Students at Sky and Navy, particularly, seemed to benefit from opportunities in ninth grade to experiment with other program areas before fully committing to their POS. Such experimentation took the form of rotations—by semester or nine-week blocks—through different programs. In Navy's culinary and hospitality programs, for example, freshmen spent one semester in each area in order to experience both "front of the house" and "back of the house" activities. One Navy senior said that this experience helped him choose hospitality over culinary; although his ultimate career goal was not hospitality-focused, he believed that the customer service skills he had learned would make him a better future business owner. One Sky student reported that her rotation through culinary did not excite her nearly as much as health science; she was planning to test for her CNA as a junior and specialize in sports medicine as a senior. Overall, most participants acknowledged that once in a program, it was nearly impossible to change POS after 10th grade given the increasing complexity and specialized content knowledge being taught. However, most students we spoke with said that they were not only in their first choice of school, but also in their first choice of program. A number of students said that, because seats were limited in their POS of choice, they were compelled to select a second or third choice. One Navy senior who was unable to get into the school's culinary program had to select between his second choice, transportation, and early childhood education. Happily, transportation presented challenges that this student believed he

simply would not have had at his zoned high school:

> After the first two weeks of being here, … I felt like [it] was challenging me enough to… actually feel like I was progressing in my education… I thought it was just going to be learning about cars and what kind of cars there are and what kind of fuels there are. I didn't know that we were actually going to build our own. So that kind of surprised me in my freshman year when we made our first mechanical mousetrap cars. Instead of using gasoline or solar power, we used [a] mousetrap with a string.

Other students had a less pleasant experience. By Year 4 of the study, budget cuts forced the closure of a number of Sky's programs, including business administration, accounting, and welding. Students in those programs were compelled to choose from a limited number of programs with available seats. A commercial construction instructor noted that some of these students were shunted into his classes against their will, and some self-sabotaged to escape.

Offer the Opportunity, Where Appropriate, for Secondary Students to Acquire Postsecondary Credits

Dual Enrollment

Compared to the robust articulation between institutions, a small dual enrollment program existed between West District and WCC—only about one quarter of West high schools participated because the courses had to be taught at the high schools by West District high school teachers who were certified to teach college-level courses. Not all teachers wanted to or were qualified to teach such courses. In the high schools that did offer dual enrollment, most of the courses taken were general education courses, which were recorded on college transcripts. Some CTE programs operated under this dual enrollment system, including the HVAC program that granted students both a high school diploma and a college certificate at the same time.

Articulation Agreements

Unlike dual enrollment, the articulation agreements between West District and WCC spanned nearly every high school and every CTE program offered by WCC. This state considered articulation agreements to be an integral component of POS, and thus required that all eligible programs be articulated. According to one state official, if a high school CTE program did not meet standards for articulation, "It's incumbent on the high school to get that program up to standards."

Every spring, WCC collected high school student applications for credit from articulated classes, provided students with a WCC student identification number, and added each student to the relevant college course roster. Over the summer, student grades were sent to the college and entered into the system by WCC personnel, even for those students who did not meet the credit-earning threshold of a B. WCC then sent official college transcripts to all students who earned above a B. Throughout this process, all students whose applications were sent to WCC were assigned a WCC student ID number that remained in the system for five years, even if their grades did not qualify them to earn the college credit.

Articulated courses had to be reviewed at least every three years. WCC worked with the West District CTE office, school-level coordinators, and faculty on these reviews. Although most agreements were district-wide, others were school-specific because the resources or facilities to offer a given course or program were only available at one or two high schools.

Amaranth's principal described the close relationship he and his faculty enjoyed with WCC with respect to program articulation: "We work really closely with WCC. We meet with them quarterly. They come out here. We have a full CTE meeting with their liaisons, getting applications, setting goals. Last year I think we had 28 kids [apply for credits], but right now I have 160 applications for this year because we understood what we were doing a little bit better."

A WCC department chair offered his perspective on this close working relationship:

> Our position has always been a solid connection with our feeder units, which are the high schools... Look, some high schools want to go their own way and teach their own stuff and are more fine arts oriented, if you will, and God bless them if that's the direction they want to go in. That's fine. But if they want to embrace a more commercial, career-oriented kind of modality, then we're there for them and we help them any way we can.

The dean of occupational education at WCC said that he and his faculty designed courses to meet industry demands, but could be flexible about methodology when it came to articulating with the district: "I know some colleges and universities will not articulate unless the timeframe is the same or the textbooks are the same. That's not our approach. We look predominantly at the outcomes. We don't mandate textbooks. And frankly, if you get those outcomes in a semester, great. If it takes a year, two years, fine."

Although college credits were automatically transcripted at no charge to students, students still had to apply to receive the credits they earned. According to reports by the WCC articulation coordinator, the majority of credits accrued by West District students were granted. However, we heard from both intervention and comparison teachers and counselors that students sometimes lacked the motivation to fill out the paperwork to receive the credits. These participants felt that some students did not see the value of the credits, not only financially, but also because these students planned to attend out-of-state, top-tier universities, where these community college credits would not transfer.

Lead to an Industry-Recognized Credential or Certificate at the Postsecondary Level, or an Associate or Baccalaureate Degree

West District's goal was for each program of study it offered to lead to a postsecondary degree and opportunities to earn both dual credit and industry-recognized credentials. Although the district, WCC, and business and industry partners strongly supported industry-recognized credentials, one retired district administrator who was instrumental in establishing the district's plan for POS believed that they had only made "hit or miss" progress in implementing them. A district CTE administrator noted that industry-recognized credentials presented particular barriers to implementation, including high costs, which he believed the community had to

embrace, as well as challenging curricula that might not fit a standard school day. During the time of this study, the district did not track credential acquisition, but administrators indicated that this was a future goal.

As a supplement to industry-recognized credentials, the state also provided CTE competency certificates to POS completers at the conclusion of a terminal course; teachers filled these forms out, attesting to students' acquired skills and quality of work. Some study participants questioned whether these certificates truly signaled students' career readiness to employers.

Industry Involvement

West's advisory boards actively supported the implementation of industry-recognized credentials. During a site visit in the second year of our study (see Castellano et al., 2011), we observed a meeting of the district's construction technology advisory board in which members discussed the feasibility of offering an energy auditing certification in response to a recently passed state energy conservation law. Committee members also debated how they might engage OSHA-certified seniors in conducting safety inspections at work sites. Forklift certifications and NCCER national certification were also discussed. As Sky's construction technology teacher, an advisory board member, commented, with these and other credentials in hand— CPR, OSHA, NCCER, forklift operator—his students could graduate and immediately qualify for first- or second-year union membership and well-paying jobs. Construction technology advisory board business partners interviewed in the third year of the study affirmed the high value of industry-approved technical assessments and credentials, making particular mention of the success of the district's vertically aligned HVAC program at Fuchsia, the comprehensive high school located next door to a WCC satellite campus. One of these partners also argued for a new certification in energy conservation (e.g., NACEP; National American Board of Certified Energy Practitioners).

The Local Community College

WCC was a strong supporter of the district's implementation of dual credit and industry-recognized credentials as a means of promoting vertical alignment between high school programs and its own advanced programs, and saw this partnership as a means of providing "stackable credentials" leading to a wide variety of degree options and occupational exit points. As one dean stated, the college believed that industry-approved assessments and credentials—for example, NATEF's ASE-preparatory curriculum—were vitally important to students' workforce preparation. Yet not all of the college's occupational programs—including those aligned with district programs—were aligned with industry certifications, partly because some industries had no national-level certifying body, such as WCC's photography program. Both the dean and photography department chair noted that a college diploma had no signaling power in that industry, whereas a professional portfolio, which did, did not translate into Perkins accountability measures.

Available Credentials

In addition to those already described, West provided a wide variety of industry-recognized credentials in many program areas. Depending on the school (POS or comprehensive), West's

automotive programs were based on NATEF's ASE- and GST-preparatory curricula; ICAR (Inter-Industry Conference on Auto Collision Repair) was also cited at Sky. All district high schools with culinary programs, including the POS high schools, offered the National Restaurant Association Educational Foundation's ProStart curriculum and ServSafe certification. Navy's early childhood education program offered both college credit at WCC and the internship hours needed—provided students acquired their health card and sheriff's card—to sit for an early childhood license at age 18. Navy's hospitality program was certified by AHLA's Educational Institute. Azure's legal studies program qualified students to sit for their paralegal license at 18. In the district's IT programs, the available credentials most often mentioned were C++, CISCO, CompTIA A+, Microsoft, Novell, and Oracle. Health sciences programs offered preparation for the CNA and CPR certification. Students in Navy's medical program could obtain a medical assisting certificate, but its biotechnology program had no industry credential; instead, biotechnology students could earn AP science credits.

Ruby, a comprehensive school, housed several CTE magnets that allowed students to earn both dual credits and certifications. These included an aviation program which offered students the ground school training needed to sit for an FAA certificate (often referred to as a private pilot's license); a PLTW-certified pre-engineering program; and an Emergency Medical Technician (EMT) program in which students prepared for CPR and EMT-Basic certificates. Ruby was investigating the possibility of offering a certified aviation maintenance program as well as certification for its sports medicine track.

Student Perspective

Students interviewed in 10th grade were mostly ignorant regarding the certificates or credentials they could earn in their programs; at this point, these students were still taking core courses. By senior year, students appeared more knowledgeable about industry-recognized credentials. At Sky, one computer networking student commented on the cost of CISCO certification exams; an automotive student noted that his participation in ICAR certification testing cost him nothing, unlike the same program at WCC. A Sky health sciences student said that she did not learn about the CNA until the end of her sophomore year. As an 18-year-old senior, she successfully sat her CNA exam; by that point, she also had earned college credits that would transfer to WCC or the state university and accumulated many hours of clinical hospital experience. She reported that she was careful to play up the earning potential of the CNA when helping the school recruit new students from area middle schools.

State and Local Legislation or Administrative Policies Promote POS Development and Implementation

State Policies

State funding and other resources. This state did not provide legislative funds specifically for CTE. Nor did it provide funding for school construction. Instead, West District floated bonds to construct new schools, including a number of smaller, POS-focused high schools. Given the size of the public expenditure involved, a citizen oversight committee had to approve these construction projects before they went up for school board approval. According to a number of

interviewees, it was not difficult to convince the committee or the general public of the need for the POS high schools. One administrator said that although the district provided a lot of data supporting the initiative, they also benefitted from being "at the right time at the right place… it was good common sense." At the time the POS high schools were conceived, the region was enjoying an economic boom that made gaining public approval easy. Once approved, WCC faculty whose programs aligned with the proposed programs helped design the new facilities.

Although many interviewees praised the idea of POS high schools, some criticisms were voiced. A number of interviewees in the schools and at WCC believed that the district had spent too much money on facilities they did not need or had created too many programs. Others felt that not enough money was available to support all programs. One teacher railed at the low level of public education spending in general, bemoaning the state's position as among the worst-funded in the nation. This teacher also felt that private money from industry was lacking. When trying to secure high-quality, long-lasting equipment for her students, she had to fight "every step of the way, in justification of every piece of that equipment," as administrators tried to talk her into lower quality, lower cost substitutes. Better equipment would last longer because dozens if not hundreds of students needed to use it: "You're training these kids for careers for their life here. This is not just, oh, a little elective where they go in and play. This is something these kids want to leave and go do for a living, you know? You're training a workforce here."

As the economic recession ground on, schools felt the effects of reduced funding. Some CTE programs faced budget cuts or were shuttered. Schools that had not yet opened were reduced in scope. Teachers were laid off. Class sizes in all subject areas increased. The planned adoption of PLTW in some high schools was delayed.

Dedicated staff time for POS development; establish formal procedures for the design, implementation, and continuous improvement of POS. Several statewide POS planning and implementation workshops were held in an effort to bring the comprehensive high schools on board with POS. Four people per school attended these workshops: a curriculum administrator, a counselor, a CTE teacher, and a department chair. Personnel from the community colleges and the state university system also participated, but industry partners did not. After the workshops, each school chose a contact person who was tasked with overseeing POS implementation; these staff members received time and resource support. The state's largest challenge was POS implementation in its more rural districts, where highly skilled teachers, modern equipment, and business partnerships were less available than in its larger cities and counties. One POS high school principal suggested that regional skills centers were an option for such areas.

Provide resources for long-term sustainability of POS. Participants noted that a major challenge to implementing POS was learning the rules and regulations of the different federal and state funding sources that supported them, then learning how to do without those funds when they ran out, either by design or due to the recession.

Although there was no set-aside in the state's education budget for CTE, the district CTE director said that the state supported CTE generously and sought progress and accountability reports on POS implementation. In response, West encouraged POS implementation in its comprehensive high schools. When schools requested funds for new equipment, the CTE

director weighed such purchases against other expenditures that could increase student engagement, sometimes suggesting alternatives such as supporting a CTSO that helped students gain leadership skills.

Other relevant state policies. As in other western states, districts and other local education agencies in this state tended to exert strong local control. The state CTE director believed that a little more top-down authority might help put "more structure in place." During our study, the state was indeed seeking to create a more coherent system by standardizing CTE courses, course names, and sequences. The state also defined a CTE concentrator as a student who completed two credits, one of which was in an exit-level course. West District adopted this definition of CTE concentrators in its comprehensive high schools, but for the POS high schools, many programs spanned the entire four years and earned students four credits; the remaining programs were three-credit programs.

District Policies

Local funding and other resources. As the district's POS high schools and magnet programs began coming online, they received extra support in the form of temporary seed money. By chance, this seed money became available just as regular school budgets were being slashed due to the growing recession. Sky, the POS high school that served as a model for others in the district, was not slated to receive this extra support because it was not a new school. However, the aging Sky had serious physical plant issues, and administrators there convinced the board of education to support the school at the same level as the new POS high schools. Overall, this extra funding shielded the POS high schools from some of the worst effects of the recession. With that said, some programs at the POS high schools faced challenges securing equipment and supplies. One teacher in a new hospitality POS said it took a couple of years for the district to approve certain purchases he wanted to make because it was not used to requests for items like pipe and drape for separating booths at conventions.

Establish formal procedures for the design, implementation, and continuous improvement of POS. West's CTE director introduced the district's plan to expand POS during visits to all of its high schools. He and his team reviewed each school's CTE offerings with the curriculum administrator, the head counselor, and the CTE chair, going over POS requirements to determine if what they were currently offering could become a POS or if some singleton courses could be eliminated. In some cases, the CTE director would say, "We think that this is not a program of study. We recommend you go in this direction." Each school then held staff meetings to share this information. During these meetings, staff members reviewed four-year POS course sequences of CTE and core academic courses and their respective postsecondary articulations. The CTE director said this process was the district's way of encouraging college readiness and preparation in the CTE programs at the comprehensive high schools.

Bringing POS to all of the comprehensive high schools involved significant, continuous curricular upheaval: Courses were revamped and/or renamed, and program sequences came and went. The move to POS became more difficult when the district was forced to cut block scheduling from its budget, which only the POS high schools were able to maintain. Without block scheduling, the comprehensive high schools found it difficult to offer programs at the same

level of intensity. However, over the course of our study, CTE programs at comprehensive schools grew in their capacity to offer POS. Once less well funded than the POS high schools, they benefited as the district sought to implement more components of POS in comprehensive high school settings.

Ensure opportunities for any secondary student to participate in a POS. West designated one POS high school to serve each of its several regions. During the course of our study, regional boundaries were in flux, which meant changing school catchment areas and subsequent shifts in school populations. Although our cohort remained grandfathered at their school of choice, one POS high school counselor lamented that new enrollments were shrinking because students in the school's new catchment area were happy with their zoned high schools. Although the POS high schools were open to students from all over the district, students had to provide their own transportation. As such, the POS high schools competed for enrollments not only with the comprehensives, but also with each other.

Recruiting efforts by the POS high schools and CTE magnets were both shared and individual. The district sponsored school fairs at malls across the region. Recruitment counselors from the POS high schools also visited the middle schools together to let students know about their programs. Individually, each POS high school held open houses for prospective students and parents. Such events were sometimes hosted by the school's culinary and hospitality programs, as at Navy, but all POS were showcased. Participants at one school noted that their CTSOs often took part in local parades, which gave the school additional exposure in the community.

Organizationally, the POS high schools fell under the authority of both the district's magnet office and its CTE office. The former set recruiting schedules and eligibility requirements and ran the district's placement lottery. The CTE office provided curricula, tools and equipment, and funds. Although the POS high schools sometimes perceived a lack of a shared, cohesive philosophy across the two offices, most of the POS high school principals reported receiving a great deal of overall district support for CTE.

As we have described elsewhere in this and previous published reports (e.g., Castellano et al., 2011), the district's lottery admissions process was not entirely random. Eligibility requirements, although not onerous, disqualified some students. West used a two-tiered point system for determining eligibility for what it deemed "standard" or "rigorous" POS. Both types of applications assigned points for attendance, behavior, GPA, and test score results, but eligibility requirements for rigorous POS also included eighth-grade core subject grades. For example, biotechnology and engineering POS had eligibility requirements in math or science because of the work students would be expected to do in those programs. Standard POS had no core subject grade requirements. Eligibility requirements effectively increased the proportion of high-achieving students at the POS high schools, which caused resentment among some comprehensive high school principals and prompted accusations of creaming.

Require secondary students to develop an Individual Graduation or Career Plan. The district required all students to develop a four-year graduation plan in the ninth grade. These plans were completed online and ideally reviewed annually for changes. We found annual reviews occurred more often for the POS students we spoke with than for comparison students.

Some policies did not lend themselves to long-term college and career planning. At the middle school level, in particular, restrictions on the use of postsecondary Perkins funding prevented WCC faculty and staff from sharing information about POS options with middle school students. Because students applied for entry into POS in the eighth grade, this was an opportunity lost.

Provide resources for the long-term sustainability of POS. Funded by public construction bonds, the district's POS high schools were purpose-built to foster POS and curriculum integration by co-locating CTE and core academic teachers in the same area of each building. This closeness fostered teacher collaboration and student cohorting. Elected officials invited to tour these facilities became lifelong supporters when they saw what they made possible, according to a district administrator who had been instrumental in developing them.

Other relevant district policies. Some of the POS high schools implemented policies that put failing students on academic probation. Students who could not achieve a passing grade or overall 2.0 GPA in the subsequent semester were sent back to their zoned high schools.

In the POS high schools, students began their programs in either ninth or 10th grade. In either case, few opportunities existed to transfer into a different program. For those who began their POS in ninth grade, switching programs meant taking the introductory (ninth-grade) class at the same time as the mid-level (10th-grade) class in order to catch up. For those POS that began in the 10th grade, ninth-grade students often took introductory courses in several program areas as a means of sampling their available options, choosing their POS at the end of ninth grade. In these cases, switching programs later was not allowed.

The district's internet policies—specifically its adoption of firewalls, content restrictions, and student privacy-related rules—were cited as a barrier to some programs, including those in broadcasting and journalism. A media teacher reported that her program lost out on opportunities to showcase student work because students were blocked from uploading films to contests.

Ongoing Relationships Among Education, Business, and Other Community Stakeholders Are Central to POS Design, Implementation, and Maintenance

Business and Industry Partnerships

Partnerships with business and industry were vital to the functioning of West's CTE programs and especially to the development and implementation of its POS high schools. The district's advisory boards, comprised of business and industry, postsecondary, secondary, and community partners—were reconstituted prior to the time of our study from some 30 committees to about a dozen. These committees generally met monthly to discuss new and emerging program-related initiatives and to review curricula, standards, articulation agreements, work-based learning opportunities, industry-recognized credentials, and other program-related topics. In every interview in which they were discussed, advisory board members were recognized and valued for their professional and technical expertise and the assets (including material and financial donations) they brought to the district's POS and CTE programs. Advisory board members helped establish the themes around which each of the district's POS high schools were organized

and supported the purposeful design and construction of the buildings themselves. Although the district was ultimately responsible for both curricular and funding decisions related to its programs, as one district CTE administrator noted, the advisory boards used their clout to lobby for and preserve programs that impacted their future business.

A district CTE administrator saw the district's CTE academies as creating public-private partnerships that met educational and economic goals and benefitted students, industry, and the larger community. One such partnership was discussed at the construction technology advisory board meeting that we attended in the second year of the study. At this meeting, an industry partner with a solar energy business presented a proposal to build a solar photovoltaic system in a modular classroom that would be filled with energy-saving devices donated by industry. The classroom would then serve as a facility for private sector training outside of the school day. Advisory board members considered whether the proposed project could be expanded to additional modular classrooms, each powered by an alternative energy system (e.g., geothermal, hydro, wind) that would drive an element of the curriculum.

Overall, industry partners provided not just technical expertise and curricular input but also funds, equipment, work-based learning, advising and mentoring, and jobs for graduates. We noted evidence of this generosity at every school visited, both at the POS high schools and in the regular CTE programs or magnet POS in the comprehensive high schools. However, schools differed in the intensity of their partnerships with industry and the means by which they maintained them.

Business partnerships at POS schools. Sky and Navy employed structures and/or dedicated personnel to make and maintain relationships with businesses, the community, and postsecondary partners. Most notably, Sky's career center, developed by its current director and partly constructed and networked by Sky students, served as a model for other career centers in the district. Calling it "the heartbeat" of the school, the director described how business partners, many of them advisory board members, volunteered their time and expertise for mock interviews that Sky offered to all students. She numbered some 45 business and industry personnel that she could count on to give critiques and career advice to students; some even offered jobs to students who impressed them. For the school's automotive program, for example, the career center regularly hosted an interview event for juniors interested in internships at area car dealerships and shops; service managers came and conducted panel interviews in which they ranked candidates on their professionalism, resumes, and technical skills. Even during the recession, the school's partners continued to post positions on the school's jobs board, offer funds to pay for student scholarships, and volunteer their time: "Anything we ask of them, they're there and assist us… we don't have to beg." The lead instructor of the school's commercial construction program, a member of the construction technology advisory board, described how local businesses and trade associations held the program's graduates in high esteem and were anxious to support the program with curricular input and generous donations of top-of-the-line equipment. This teacher, like many CTE teachers at the POS high schools, came from a business and industry background and maintained strong ties with area construction firms, architects, and unions. Teachers like him drew on their rich work experiences to connect students with other professionals with knowledge and employment opportunities to offer.

Business partnerships at comparison schools. Relationships with industry partners were no less rewarding at the comprehensive high schools, but the mechanisms by which they were created and supported were sometimes less formal than at the POS high schools. A notable exception was Ruby, where teachers in the aviation academy, all retired military pilots, worked with local postsecondary institutions, flight schools, and aviation firms (one of which was owned and run by a Ruby graduate) to offer their students greater rigor and opportunities for hands-on learning. Ruby's medical academy was staffed by teachers who maintained active ties to the EMT, firefighting, and sports medicine communities. In another noteworthy case, Fuchsia's principal was in the process of converting her school's CTE programs into POS-like academies with the help of WCC and area organizations and businesses. One of these businesses, a major apparel retailer known for its positive, customer-focused corporate culture, worked with the school to develop and implement a school-wide "core values" campaign. This school was also home to both a career center that coordinated internships and job shadowing opportunities and an entrepreneurial education program based upon the concept of structuring schoolwork like an office environment. This program counted many business and community partners as active supporters, including banks, the local government, and a Toastmasters club. At other comprehensive high schools, administrators and teachers spoke warmly of the support of area auto dealers, hospitals, restaurants, and hotels, but relationships with these partners were largely managed by individual teachers. An exception was Vermilion's advisory board, managed by its principal, that included representatives from the area's tourism and hospitality industry.

Community Partnerships

Our observations suggested that West's high schools, particularly its POS high schools, were held in high esteem by the community. Sky, in particular, the district's original POS high school, had a long-standing reputation for academic and technical excellence and student achievement. Sky's success and popularity prompted the district to replicate its success with Azure, the area's first technology-focused POS high school, and later with the POS high schools. Community support was part of this process. As one retired district administrator recounted, when the district first conceived of these new schools, it held public meetings at which it solicited input; it also drew on its advisory boards for support. Having been built to support regional economic and workforce development needs, the POS high schools were expected to gain additional public support over time. As a retired administrator said, "I really think that we're going to continue to see such tremendous student success, and because we've had a really broad involvement of the community—both private and public—I think people would be up in arms if we said we weren't going to continue to do what we're doing."

All of West's high schools appeared to offer valuable resources to their communities. At Ruby, the principal related how the school provided informational and enrichment activities to parents and the community (e.g., language programs, computer training, gang prevention forums). Navy employed a full-time business and community partnership coordinator who, in addition to seeking and maintaining partnerships, coordinated special community-wide outreach events that highlighted the school's programs. Navy's culinary and hospitality programs were especially active in catering and hosting such events, like a recent banquet honoring Holocaust survivors that drew on students' work in their history classes. One of the culinary program's chef-instructors commented that in the past year, students had catered at least 10,000 covers by

hosting this and similar events. Such interactions with the community were perceived as valuable ways to teach students how to interact socially with the public and potential future employers.

Postsecondary Partnerships

WCC and the local four-year university were no less instrumental to the successful development and implementation of West's POS high schools. A retired district administrator explained how in the early days of developing POS, the district worked hand-in-hand with the college and the university to ensure that its programs aligned with postsecondary programs not only for the purpose of generating dual credit, but also to meet institutional needs for well-prepared applicants. She told a story in which the dean of engineering at the four-year university, from whom the district had sought input on appropriate courses for students in a construction engineering pathway, acknowledged the value of the skills the POS would offer:

> We went to the dean… and said, "What do we want to make sure we offer our students?" And he said, "Well, you absolutely have to have the rigor, and make sure the kids have access to AP Calculus." And… he went through the courses that he felt were really important. He said, "But you know, it's going to make such a difference to have students who actually will understand and have had experience putting things together… it's not just going to be a mathematical formula for them… They're actually going to have a much better sense that things are going to be able to work together by understanding how things are built." He said, "I wish all of my students had that opportunity." He said it was going to make them far better engineers.

Both the university and WCC supported the district's initiatives because they created seamless pathways to their programs; for WCC in particular, credit transfer opportunities helped boost FTEs and were deemed a sound investment in future enrollments. As such, WCC took many steps to simplify the process of earning dual credit, including waiving the low fee associated with obtaining the credits and automatically transcripting them while students were still in high school. The college also employed a full-time coordinator who kept principals and teachers informed, distributed brochures, and collected paperwork from each of West's high schools.

Over time, WCC's articulated offerings evolved in response to concerns regarding student preparedness and curriculum alignment at some schools. As the articulation coordinator explained, WCC recently signed a new joint policy agreement with the district that would require students to take a full sequence of courses—not random or unconnected classes—in order to qualify for credit. Students could apply as juniors or seniors to receive that credit. Although this change would not affect students in our cohort, it was made to satisfy concerns that high school freshmen and sophomores were not likely to retain enough of what they had learned to justify earning the credit. During our study, the college ended the practice of creating district-wide programmatic articulation agreements. As the dean of the college's engineering technology division explained, the college was now quite selective about the articulation agreements it struck with specific high schools, requiring them to be taught by college-trained high school teachers and to follow college-approved curricula. In return, district high school students who enrolled in these aligned programs and applied for the college credit could graduate with "a leg up" on a college degree—in some cases, enough credits to bypass all or most of the introductory

courses required in a given college program.

College administrators and faculty actively participated on district advisory boards and contributed greatly to the development and revision of state and district CTE curricula. WCC's culinary department chair, for example, described how he worked with both the state and the district to revise curricula, course titles, assessments, and standards for baking and pastry programs. He also described how WCC worked closely with high school culinary programs in order to ensure that the students coming to the college with advanced standing (e.g., articulated credits) would arrive with the preparation and skills needed to succeed in a professional, restaurant-focused course of studies. Although he rated the ongoing curriculum revision process as "fair to good," he voiced concerns regarding inconsistencies across high school culinary programs, especially those led by FACS teachers with no background in the restaurant industry. At WCC, by comparison, all culinary instructors were required to have professional experience.

Postsecondary partnerships at POS schools. At our intervention sites, many of the teachers we interviewed mentioned participating regularly in district- and state-level curriculum development and revision workgroups with postsecondary colleagues, usually from WCC. A number were qualified to teach community college classes. Many teachers also mentioned enjoying warm relationships with postsecondary colleagues to whom they could turn for student mentoring, assistance with projects, and college advising. Nearly all of the POS high school programs allowed students to earn credits at WCC. One that did not was Navy's biotechnology program, which was developed with input from the local four-year university. For this program, AP courses were the only college credits available; the program's director explained that both WCC and the university preferred that students take postsecondary anatomy courses. In another exception, the director of Navy's early childhood education program tried unsuccessfully to articulate her program with WCC. Instead, she designed its curriculum according to the pattern of her own undergraduate studies; when interviewed, she was in the process of negotiating with a state university to accept some courses for credit. Across all POS high schools, teachers were well informed regarding credit transfer opportunities; interviewed students also seemed well informed, especially as upperclassmen, when such opportunities were more likely to be offered. Information was available in lower grades, however: During our ninth-grade site visit, we saw an Azure computer applications teacher present a detailed lesson on the value of dual credit. This teacher, who had just attended an informational workshop offered by WCC, directed her class to the college's website, where she showed them which of their classes aligned with those offered by the college and which could be transferred to in-state universities. She then described how nearly 70 Azure students had taken advantage of the program during the previous year, at a savings of $19,000. Her lesson also included an exploration of how much students could expect to earn after acquiring a degree in some of WCC's career programs.

Postsecondary partnerships at comparison schools. As with business partnerships, connections with postsecondary appeared somewhat stronger and more formalized at Ruby, with its magnet POS, than at other comprehensive high schools, although many teachers at the comparison sites mentioned having colleagues at WCC or participating in professional development and extended learning there. All schools were fully informed about the college credits available through their programs. With the exception of Ruby, where the magnet coordinator worked with POS teachers to align their programs with WCC and other local postsecondary institutions, we interviewed no

comprehensive high school CTE teachers who reported collaborating directly with their postsecondary counterparts or serving as members of any district advisory boards.

Sustained, Intensive, and Focused Professional Development Opportunities for Administrators, Teachers, and Faculty Foster POS Design, Implementation, and Maintenance

Professional Development on POS

Unique among our three study districts, West was the only district in which POS were the focus of a state-level professional development workshop in which district staff, school administrators, guidance counselors, and CTE teachers participated. As noted by the state's CTE director, the state and district worked closely together to coordinate the event, to which four-person teams of school staff came from nearly every high school. Invited schools included regular comprehensive high schools, comprehensives with magnet POS, and the POS high schools, the leading edge of the state's POS initiative. At the meeting, state standards, processes, and timelines for POS implementation were laid out; as the state CTE director reported, the goal was to reach "a common understanding" and determine "next steps… because this is a process, and right now we have decided that the best thing we can do is to be on call." Post-meeting, the state's primary goal was to provide districts with as-needed technical assistance, host twice-annual meetings with secondary and postsecondary CTE administrators, and maintain an accountability system that kept the initiative moving forward.

State and district administrators believed that schools participating in this meeting recognized the value of POS, as one district CTE administrator stated:

> I was in shock at how quickly they accepted it… the counselors and the administrators, I think they just get blinded by "I've got to build a master schedule," and "I've got to do this and avoid conflicts," and whatever. And once they looked at it, they saw it as an easier way to market programs to students and parents; they saw the connectivity to postsecondary opportunities, and I think they saw how much easier it will be to build a master schedule…without having a bunch of unique, orphan courses out there.

Following this meeting, the district sought to deliver school-specific professional development to ensure that principals understood the integrity of the state's POS and would not only maintain and update their curricula, but also preserve their alignment with postsecondary and industry certifications. To accomplish this, district CTE administrators first met directly with principals, then dispatched district CTE coordinators into the comprehensive high schools to work directly with the assistant principals for curriculum, lead guidance counselors, and CTE chairpersons to identify which of their programs, courses, and industry certifications (where available) fit within the state's POS framework. According to another district CTE administrator, the district strove to offer schools a "menu" of POS choices that would allow those schools with different daily schedules, smaller CTE programs, or programs with limited industry certification options the flexibility to structure their POS as two-year versus three- or four-year POS sequences. A related goal was to identify and cut resource-draining "orphans"— site-specific, singleton courses.

The Local Community College

The district was soundly supported in its efforts to promote awareness of POS by WCC, which employed a dedicated articulation coordinator who visited each of the district's high schools to disseminate information to principals, guidance counselors, CTE department chairs, and teachers about how the high schools' programs aligned with WCC programs. This coordinator also collected completed applications from students applying for college credit. Her role also included monitoring whether schools were properly sequencing their courses and advising students regarding the appropriate level of preparation they needed to qualify for college credit. A WCC department chair stressed that the college's participation on advisory boards and its active role in training district teachers and certifying their courses ensured that students would arrive well-prepared to succeed and with enough credits earned during high school to allow them to start taking advanced classes.

General District CTE Professional Development

West scheduled four full-day trainings during the year for all school personnel: two school-focused, and two curriculum-focused (in the case of CTE, professional development was conducted by program area; e.g., automotive, health sciences, culinary). Other scheduled training opportunities included regular department meetings, monthly advisory board meetings with postsecondary and business and industry partners, school-based career center trainings (at those schools with career centers), intensive summer sessions, academy-specific trainings (e.g., PLTW, NAF), and annual statewide conferences (Navy culinary and hospitality students hosted and catered one of these events, which attracted over 500 attendees). All alternatively certified teachers received expert teacher mentoring and intensive professional development support in instructional strategies and classroom management techniques. The district also supported teachers in their pursuit of professional development at local, regional, and national postsecondary institutions, and from nationally recognized industry certification programs (e.g., Adobe, Apple, Microsoft, NATEF). WCC was most often mentioned as a trusted source of professional development. Some teachers noted that they had pursued and paid for continuing education on a variety of topics on their own.

Major topics of professional development mentioned by study participants included project-based learning (most intensely implemented at Navy), curriculum integration, mathematics, ESOL, the use of student assessment data, instructional technology, credit transfer opportunities, and industry certifications.

Project-Based Learning

As we described in Castellano et al. (2011), Navy's POS—and the school campus itself—were built around the concept of contextualized project-based learning in which academic curricula were integrated into CTE program areas. Several times a year, each year, Navy's various small learning communities came together to put on school-wide project-based learning-focused events. Navy's principal said that he hired teachers (especially talented candidates from business and industry) selectively for the right attitudes toward project-based learning and then sought to cultivate their practice of the approach through intensive, continuous professional development,

including a summer institute, regular staff development days, and support from the school's dedicated project-based learning coordinator and staff trainers. Teachers said that they participated in both formal and informal teacher-to-teacher mentoring and cross-unit collaboration. Although district CTE personnel noted that project-based learning was a key focus of professional development in the other POS high schools and at the comprehensive high schools, few participants outside of Navy mentioned participating in such training. Ruby's magnet coordinator said that she had participated in online-only professional development on the approach and was trying with some difficulty to help teachers in her school's programs implement it in their classes.

Professional Development for Guidance Counselors

Like West District teachers, guidance counselors participated in a minimum of four full-day staff development sessions each year, plus supplemental professional development on a variety of topics and opportunities to earn college credit that could be applied to keeping their counseling licenses current. One Navy counselor interviewed in April mentioned having participated in some 18 training events so far that school year. Professional development topics most often mentioned included scheduling, testing, transcript reviews, credit retrieval, college preparation (planning, testing, advising, financial aid, scholarships), school safety, mental health counseling issues, and career advising. Counselors also described participating in trainings or information sessions addressing CTE-related topics like credit transfer opportunities, internships or apprenticeships, postsecondary occupational programs, and local work opportunities.

Systems and Strategies to Gather Quantitative and Qualitative Data on Both POS Components and Student Outcomes Are Crucial for Ongoing Efforts to Develop and Implement POS

State Assessments

In this state, 10th graders took state proficiency exams in reading, math, and science. Those who passed were allowed to graduate, but those who did not were retested. If students did not pass any one of the required exams by the end of twelfth grade, they received a certificate of completion instead of a diploma.

Academic assessments. In addition to the state 10th-grade assessments, West District also administered interim assessments and common semester assessments for core academic classes, but not for CTE or POS classes. The district began using interim assessments during our study in order to provide teachers with data on their current students. Results were provided instantly at the student and question level. Teachers then sat together as departments and analyzed their results to identify the areas in which their students needed additional help. Those teachers with consistently high-scoring students were observed and their strategies adopted by other teachers. The goal of this process was to address student needs early enough in the semester to make a difference in student achievement.

The district also instituted common semester exams for core courses across all schools in order to help students who changed schools stay on track. District personnel said that these exams were a teaching tool, not a high-stakes exam. Students did not perform well on the first administration

of the tests, so the district responded by providing schools with more learning tools to support them, including software that allowed students to re-take courses such Algebra I and Geometry in an online format that offered a personalized curriculum.

Although academic teachers spoke of using authentic assessments like plays, drawings, and Socratic discussions in their classes, most students we talked to said that core course assessments were almost exclusively paper and pencil tests made up of multiple choice or essay questions.

Content Standards Define What Students Are Expected to Know and Be Able to Do to Enter and Advance in College and/or Their Careers

In West District, college and career readiness was most often described as preparing students to graduate on time armed with the academic and technical knowledge and workplace readiness skills needed to pursue higher education without the need for remediation and to successfully enter the job market. Many participants indicated that they wanted their students to graduate fully aware and prepared to take advantage of a broad range of potential educational and career options. Indeed, in speaking of the key transition point from high school graduation into the next level of education, the state's director of CTE noted that they were "going back to defining—organizing, defining, marketing those exit points we're talking about in career and technical education a little better—about having these students prepared, college ready, for that first exit point. The first of… hopefully it will be many, but it may be the first before the workplace."

Overall, three elements were frequently mentioned as supporting college and career readiness: (a) work-based learning opportunities (facilitated by business partners), (b) the availability of credit transfer opportunities and early college experiences, and (c) continuous, well-integrated career guidance and counseling delivered by many school personnel.

Work-Based Learning and Partnerships with Business and Industry

Although enrollment and persistence in some form of college were stressed as key college and career readiness goals, a number of school personnel emphasized the need to prepare students to get a job right after graduation, especially given the poor state of the local economy and rising college costs. Many interviewees believed that early work-based learning experiences (e.g., through internships, clinicals, or school-based enterprises) were key to helping students acquire well-paying jobs that could help them pay for college. A district CTE administrator attested to the major role that the district's business partners played in aligning district curricula with industry standards and providing opportunities for students to participate in work-based learning that could lead to future jobs. Two business partners from the district's construction technology advisory board attested to their commitment to providing students with internships and summer programs.

Dual Credit Earning Opportunities and Exposure to College

Opportunities to earn college credits or take classes at WCC were also stressed. Dandelion's magnet coordinator described college and career readiness as giving students the opportunity to not only thoroughly understand their program area in a way that allowed them to "jump ahead"

of other students without such opportunities, but also to earn college credits that would allow them to bypass introductory college courses. Another magnet coordinator spoke of how her school's magnet programs prepared students to take "the next step," whatever their interests might be:

> What is it you want to do? We look in terms of whatever we can do that best prepares them for when they leave us. You know they talk about being college prepared and we do offer the college credit. But again, not every kid's looking to go to [WCC] … Our mission of sorts is that kids are well rounded and well prepared when they leave here because we do understand there's a lot beyond the academic that helps to form a student.

Career Guidance and Counseling

At a number of West schools, particularly the POS high schools, participants spoke of comprehensive guidance and counseling as key to college and career readiness. Although many tools and mechanisms (e.g., career interest inventories, a state college and career planning website) were described as part of this, a business partner perceived it as a school-wide effort at Navy:

> Coming out of this school, I would say I have no concerns [regarding college and career readiness]. No concerns to either of those points… I would say that in this school, they have teachers, they have the administrators, they have the advisory board. [The community partnership coordinator] and others get in front of the students a lot. So when you talk about counselors… they—the teachers, the administrators, the people that come in—are counselors for these kids.

Guidance Counseling and Academic Advisement Help Students to Make Informed Decisions About Which POS to Pursue

As previously described, West participated in a state-led training on POS that included principals, assistant principals, and guidance counselors from all district high schools. Over the course of the study, the district continued to educate schools about how to work with their teachers, industry partners, and postsecondary partners to develop robust POS. As a result of this training, many study participants, including counselors, agreed that POS offered a terrific way to market CTE to students and parents. Counselors, CTE teachers, and magnet coordinators at the POS high schools and magnet POS all took an active role in recruiting and educating students about the district's POS at middle schools and magnet fairs.

Guidance Counselors' Roles and Responsibilities

Counselors' caseloads and tasks differed somewhat across the POS high schools. At Navy, counselors were assigned to specific program areas and followed the same students for all four years. These counselors were "specialists" in their areas; one counselor visited program teachers to learn more about their curricula and went on field trips so she could see the connections between Navy's programs and their real-world counterparts. Drawing upon their deep program knowledge, Navy's counselors offered recruiting and training at area middle schools so that both

middle school students and their counselors understood Navy's programs. Counselors also reported serving as facilitators of parent-teacher meetings and tracking students' college and scholarship offers.

Although Azure otherwise broke out student caseloads alphabetically, this school was unique in featuring a dedicated ninth-grade counselor who introduced a student-to-student mentoring program to draw freshmen into the academically intense culture of the school. The Azure counselors we interviewed acknowledged that although they were aware of POS, they mostly focused on academic and college-preparatory advising; with the exception of making in-class presentations on career planning, they largely left career guidance to teachers. Compared to the two other POS high schools in the study, however, Azure had the least well-developed or well-informed understanding of POS. This was reflected in criticisms made by one Azure CTE teacher who believed that, lacking an adequate understanding of POS sequences, some of the school's counselors and administrators placed students in classes in which they had no interest or in higher levels of courses than they were competent to take.

At Sky, counselors carried alphabetized caseloads and actively worked with teachers to market the school's programs to area middle schools and the larger community. One guidance counselor noted that although she did not have the same deep knowledge of the school's POS as its teachers, she considered herself well-informed regarding credit transfer opportunities and summer learning options.

By contrast, at Crimson, a comprehensive high school, the counselor we interviewed seemed unfamiliar with her school's CTE programs. Her work mostly involved scheduling, screening potential dual enrollment applications, registering students for classes, and reviewing four-year graduation plans. On these plans, students indicated their postsecondary goals (e.g., attending a two- or four-year institution; working); she then guided them toward coursework that suited their goals. Although she worked with teachers to offer some career guidance, she perceived such guidance as more relevant for "business-oriented" (i.e., CTE) students. The school's one-semester, non-mandatory careers class covered resumes, job applications, and interviewing.

Career Guidance Activities and Personnel

In addition to the core elements of Perkins-defined POS, West's programs of study incorporated many enriched curricular, pedagogical, and extra-curricular elements that demanded considerable time and resources to be implemented well. One of these elements was sustained career guidance, development, and exploration, which many POS teachers incorporated into their classroom teaching. In some schools, dedicated support staff—like academy coordinators or Navy's business and community partnership coordinator—oversaw partnerships, arranged outreach activities, internship placements, and special events, and located resources to support programs. Sky infused career guidance into the curriculum through established structures (its full-service career center) and required courses (its career-focused 21st-century skills course). Both of these mechanisms served to enculturate students and teach them the behaviors and skills they needed to help them advance in college or careers. Schools were also supported by WCC, at which a dedicated coordinator worked with principals and contacts within the POS and CTE programs—lead teachers or academy coordinators, not counselors—to promote dual enrollment

and handle paperwork.

Classroom-Based Career Guidance

Classroom observations revealed that teachers used their professional backgrounds to enrich learning and skill development. As an example, during a senior medical assisting class at Navy in which students practiced taking EKG readings, the teacher—a licensed doctor with a background in emergency medicine—offered students feedback that combined technical knowledge with frank assessments of patients' body types and needs (e.g., weight, gender differences) and how these might affect treatment. In an interview, this teacher reflected on his experiences training medical residents and how Navy's commitment to professionalizing its students influenced his decision to teach there:

> What I'm interested in is creating professionals… what I saw… when I was working in medicine that distressed me was kids [who] got all the way through medical school and now they're residents and they still don't understand what it is to be a professional. They don't understand their responsibilities. They think they're supposed to get a coffee break, and they're surprised when I tell them, "You know what? Being a professional is not about when you get your coffee break. Being a professional is about giving fiduciary responsibility to your patients. You have to treat them first and take care of their issues before your own issues, and if you can't be a fiduciary, you can't be a professional" … I've always kind of been working against that, so I heard [here at Navy] that "OK, we want to create some professionals here and show people how to become professionals"… that's what really interests me.

Many other personnel interviewed at Navy expounded on the school's culture and curriculum of professionalism. The principal believed that Navy students were being given a broad preparation that offered them many options and the skills needed to succeed in any career in a rapidly changing economy. A media teacher said her program allowed students to do television and film work using the same equipment used in industry; the test of their training, she believed, was their demonstrated ability to excel in postsecondary and do any kind of related work.

We also observed expert classroom-based career guidance in the comprehensive high schools, albeit mostly in the magnet POS. During an EMT class in the health sciences magnet at Ruby, the teacher offered a lively, interactive review of the types of equipment and emergency situations encountered by EMTs. Herself an EMT, the teacher discussed the serious ramifications of work-related injury—and the importance of safety standards—to any young person seeking a career in emergency medicine. Framing her remarks in relation to her students' educational and career plans, she asked them to consider what they would do if they were disabled on the job but had no fallback training or education on which to reestablish their careers.

Other Support Personnel

Outside the classroom, career guidance and services were offered by personnel other than counselors and teachers. Navy and Sky allocated staff—at Navy, a business and community partnerships coordinator; at Sky, the director of the school's career center—who established and

maintained school-community partnerships, arranged work-based learning experiences, provided career preparatory activities, and oversaw special events. In the comprehensive high schools with magnet POS, magnet coordinators took on these roles. Ruby's magnet coordinator recalled how she had helped a health sciences magnet POS student clarify her career interests in pharmacology and ROTC, identify specific college programs tailored to her interest, and make sure she was taking the right courses to qualify for admission to those programs. She also helped her teachers work with WCC to align their curricula.

Innovative and Creative Instructional Approaches Enable Teachers to Integrate Academic and Technical Instruction and Students to Apply Academic and Technical Learning in Their POS Coursework

Interdisciplinary Teaching Teams

POS high schools. One of the district's original developers of POS recounted how academic and technical teachers served together on the study committee that created the POS high schools. This committee decided which program areas would drive the district's POS and intentionally designed the physical structure of the district's first new POS high school, Navy, in order to co-locate academic and POS teachers in a given program in the same part of the building.

Wearing hard hats, Navy's future academic department chairs and POS program leaders discussed in these meetings what academic and CTE teacher collaboration would look like even before the school was fully built. Each of Navy's two houses contained four POS program areas, with math, English, science, and social studies teachers assigned to each house. Co-locating academics and CTE made teacher collaboration easier. In interviews, many participants said that it was common for academic teachers to assign research projects that students could tailor to their POS-related interests. Navy's principal said that he expected academic teachers to make their assignments relevant to their house POS; similarly, he expected POS teachers to ensure that academic concepts (e.g., syntax and grammar) were part of their assignments. Students were released early once a week to give teachers an opportunity to collaborate, which the principal believed was key to integrating curricula and developing cross-curricular school-wide project-based learning events. As he noted, Navy's academic curriculum supported the goals of its POS curriculum, not the other way around. By building and defining the school in this way, Navy attracted teachers who were drawn to this approach, which in turn helped perpetuate it.

Other POS high schools did not share Navy's structure. An English teacher at Azure said that their schedule precluded cohorting students around their eight POS. The school's budget-driven move from block scheduling to regular periods meant shorter class times and hence less time to work on projects, cross-curricular or not. Other teachers at Azure also mentioned the lack of time provided to collaborate across subject areas—teachers there did what their curricula required and sometimes had little time or energy for more.

Sky's principal noted that prior to his arrival, POS and academic teachers rarely spoke to each other. To combat this, he invited POS and academic teachers to open houses in which teachers could showcase their work, communicate with each other, and "feel valued." However, an overall lack of regularly scheduled opportunities to collaborate discouraged academic and CTE

curricular integration at Sky. An office technology teacher said that she taught students percentages and how to read a ruler without help from a math teacher. She wanted to work with an English teacher on a publishing project, but saw no opportunity to do so.

Across the POS high schools, common examples of curriculum integration involved integrating math in construction classes, math and physics in robotics classes, and English in law classes. We directly observed no examples of team teaching across disciplines at any POS high school.

Comparison schools. The challenge of integrating academic and technical instruction at the comprehensive high schools was summarized by one automotive teacher. He said that with only two or three automotive students in any given math class, auto-specific math would alienate the rest of the students in the class. Despite this obvious difficulty, some integration of academics and CTE did take place: Amaranth's principal described how his English teachers taught CTE and art teachers how to teach writing in their program areas and helped them with strategies to get students writing every day. The principal served as a substitute for a physics teacher, allowing that teacher a full day to engage in curriculum development with a CAD teacher. On some staff development days, Crimson's academic teachers worked with CTE teachers to incorporate academic goals and objectives into their courses. A strong example of curriculum integration in the comparison schools was a Fuchsia business class that was integrated with English and co-taught by an English teacher—this was the only example of cross-disciplinary team teaching we directly observed in West District.

Student perspective. Students at Navy were aware that teachers worked together to integrate academic and technical instruction. One student said that her academic teachers often asked, "Who's in medical?... Who's in engineering? Because you'll need to know this." No student we spoke with at Azure mentioned such teacher collaboration. At Sky, students reported that POS teachers presented academic material; no students reported experiencing team teaching.

District perspective. In general, West followed a mandated state curriculum and met state-set benchmarks for its courses. Only teachers at Navy appeared to have received intensive training in how to meet those benchmarks using project-based learning techniques that blended academic and technical content knowledge. Professional learning communities within academic departments were being implemented throughout the district during our study. Teachers' responses to this effort were positive, and some principals and teachers saw the value of trying to develop such communities for CTE teachers or across disciplines. This had not become policy by the time we completed our observations.

Contextualized Learning Approaches: Work-Based Learning

Although not a district-wide mandate, work-based learning was integral to many of the CTE programs we observed. District administrators noted that they had abundant business and community support for work-based learning and were in the process of developing new materials to guide these activities, but acknowledged that scheduling remained the biggest obstacle to making it a district-wide initiative outside its POS high schools. In most comprehensive high schools, non-block schedules made it difficult to schedule any kind of work-based learning, but especially off-campus internships or job placements. Staffing was also seen as a challenge, as

CTE teachers, aided by release periods, were largely responsible for coordinating work-based learning. Dedicated support staff were seen as a solution to the problem, as at Navy and Sky, where a business partnerships coordinator and a career center director handled the tasks of identifying, vetting, and training business partners, screening and placing students, and documenting student outcomes. Navy's partnerships coordinator believed that perhaps 10% of the school's students participated in internships, whereas far more performed community service work for credit (a half-credit for 60 hours of volunteering or a full credit for 100 hours).

Despite the recession, support for work-based learning among the district's business partners remained high. For one of Navy's energy industry partners, investing in the district's CTE programs, providing input into district and community college curricula, and committing to offering work-based learning just made good business sense because "you don't want to hire a kid and have to retrain them. You want to be able to help get him the tools, and the best way is I come along and say, 'Listen. This is what the industry is doing right now. This is what's happening in energy. You need to be focusing in these areas.'"

A WCC dean agreed that business and industry made substantial investments in district and college CTE programs, each of which had work-based components. In many instances, due to liability, practicality, or maturity issues, work-based learning primarily took place at the college level. As the dean noted, most CTE programs began in the 11th grade and progressed through college, with different opportunities for work-based learning, internships, or apprenticeships appropriate to each stage.

Work-based learning varied across schools and programs, but included school-based enterprises (e.g., school coffee shops and restaurants, t-shirt and poster design and print shops, student stores), on-campus activities (e.g., providing sideline sports medicine assistance at school athletic events, performing oil changes on faculty cars in the school's in-house auto shop, shooting and broadcasting school news programs, building and selling furniture), and off-campus internships or jobs (e.g., interning for local television and radio stations, hotels, restaurants, businesses, law practices, or construction companies; completing clinicals at hospitals, medical research labs, elementary schools, or daycare centers).

Students in Navy's early childhood and teacher education programs gained experience that would allow them to become teachers' aides after graduating from high school or, drawing upon the district's articulation agreements, pursue additional coursework in preparation for a baccalaureate degree and a teaching license. Cost was a factor: All students had to acquire health cards and be insured prior to placement. Further, because transportation presented a barrier to students pursuing internships at off-site elementary schools, early childhood programs, or non-home daycare facilities, many students opted to do their clinical work in Navy's on-site kindergarten. Clinicals involved lesson planning, converting lesson plans into centers, engaging in hands-on teaching in the school's on-site kindergarten, and revising and improving lessons. The entire process was designed to culminate in the creation of a year's worth of curriculum that students could carry with them to college.

According to the school's biotechnology instructor and project-based learning coordinator, Navy's biotechnology students were eagerly sought-after for internships—not mandatory in this

POS—at regional medical and cancer research centers, where they were able to apply their advanced skills to lab work and field research. We met several students in this program who were working on research projects with microbiology faculty at the local university.

Navy's culinary students were required to complete short internships at major restaurants during the second half of their senior year. As an instructor described it, these internships had to entail a minimum of 10 hours (2 hours per day for 5 days), but many students chose to work additional hours—as many as 4 to 6 a day—because they enjoyed the work. The restaurants' standards had to be stringent. By this instructor's tally, some 95% of the students who sought a job immediately after their internships secured one with their internship employer. Hospitality students similarly went out on internship during the second semester of their senior year; these students also had to pass an AHLA certification test with an 80% or better.

Interviewed students unanimously spoke positively of their internships and work-based learning experiences, describing both on- and off-campus placements as drawing on the skills they learned in the classroom and allowing them to explore career options free of the pressure associated with a real job or college major. As one automotive student commented, an internship at an area dealership gave him a chance to "see how it is in the real world. Not the high school. And actually to see if I'm really interested, you know? If not, I'm just gonna be wasting my time." A health sciences student spoke of how rewarding—personally and professionally—her clinical experience in a hospital's surgery wing was. When a post-operative heart patient suffered a panic attack, this student saw what was happening and rushed for assistance: "I got her help as fast as I could, and afterwards, the feeling was great, having her say, 'You were a really great help.' Just knowing that I was part of that… And it's not so much the money, and I didn't get paid for it. I just love the experience and I love seeing their smile…. I enjoyed being with the patients."

Contextualized Learning Approaches: Project-Based Learning

As district CTE personnel and school personnel at all sites informed us, project-based learning was the focus of a district-wide initiative that began with the POS high schools and was gradually being rolled out to CTE programs and magnet POS at the comprehensive high schools through district-provided professional development and CTE mini-conferences. Our POS high schools—Azure, Sky, and Navy—differed in the intensity and intentionality of their focus on project-based learning. At Azure, only a few teachers described project-based learning as a hallmark of their curricula; a legal studies teacher noted that although he had participated in intensive professional development and built a number of project-based modules into his curriculum, the school was no longer financially supporting implementation of the model. At Sky, a project-based focus was more evident in some CTE POS than in others; this school seemed to place a greater emphasis on work-based learning (e.g., school-based enterprises, internships, or off-campus jobs) and the development of 21st-century skills. At Navy, project-based learning formed the core focus of the school's construction, staffing, curriculum, and school-wide learning and service activities. Teachers in Ruby's magnet POS implemented project-based learning with the support of their principal and magnet coordinator. District CTE personnel acknowledged that, like work-based learning, project-based learning was more challenging to implement in comprehensive high schools without block schedules. However,

support for the initiative, particularly from business partners, was quite strong. One such partner praised the PLTW curriculum, in particular, for blending engineering technology with teamwork-building activities. For this partner, project-based learning offered a means of overcoming misperceptions about CTE, better marketing CTE programs, and recruiting high-quality students. He also saw it as a powerful tool for creating lifelong learners.

Project-based learning at Navy. Navy's principal was instrumental in the design and construction of the school, and under his leadership, project-based learning formed the core focus of its physical plant, programs, staffing, and culture. A number of interviewees noted that familiarity with project-based learning or willingness to embrace it were key factors in the principal's hiring decisions. All teachers participated in four days of professional development each year in addition to intensive summer training sessions. The school also employed certified trainers, one of whom served as the school's project-based learning coordinator. As this coordinator noted, although the school's focus was initially selected by the principal, the initiative was fully supported and driven by teachers. Further, Navy's school-wide project-based learning events, such as its solar car challenge, space exploration day, and world cultures bazaar—were wildly popular with students, parents, and community members. That popularity was borne out by the school's low dropout rate (especially compared to the comprehensive high schools) and high test scores, which the principal attributed to the approach's focus on teaching skills, not teaching to the test:

> If project-based learning was not working, then our scores would tank … we're not teaching to the test, but they see the application of the math, the science, the writing, the reading, and its use throughout all of our classes. So they're learning it but not learning it for the sake of learning it. They understand the importance of it and I think it shows in our scores.

According to the project-based learning coordinator, this approach to learning was all about creating cognitive dissonance that sparks learning—presented with a real-world problem, students seek ways to fix it by synthesizing and applying their knowledge and skills: "Let's apply it. Let's make this real… I think that's the answer specific to this whole school is 'make it real, make them live it.' If you're living it, you get it. If you're regurgitating it, it's gone. [That approach] doesn't make sense. Never has."

The effects of project-based learning were perceived as just as transformative for teachers; as one teacher said: "So we give the problem and the students do research to come up with the solution, and that sounds real simple in theory, but boy, was that a change for me as a teacher. … I had to let them make the mistake and let them see why it didn't work. And that's hard as a teacher – real hard.'"

Curriculum integration was key to the approach. A history teacher explained how his students engaged with history through projects that allowed them to explore topics that related to and drew upon their POS. In a unit on the Civil War, he collaborated with culinary instructors to teach students how to make hardtack, a battlefield dietary staple. Other projects allowed students to learn more about local history. In one such project, students worked with the media program

to record and preserve oral histories from area veterans; the project culminated in an emotional community-wide event hosted and catered by hospitality and culinary students.

Teaching Soft Skills at the POS High Schools

West District only used curricula that incorporated state standards. As such, all CTE courses included a set of employability skill standards, although the state CTE director believed these standards could be better integrated with the other content standards of each course. Below, we describe how the POS high schools each took a different global approach to teaching these skills—which participants variably referred to as employability skills, soft skills, or 21st-century skills. In subsequent sections, we describe how individual soft skills—including team-building, critical thinking, problem-solving, and communication skills—were taught in the classroom or incorporated in CTSO activities at the POS high schools.

At Navy, an on-site daycare center offered a real educational setting in which students learned how to teach, engage young children in learning and play, write and test lesson plans, and develop a year's worth of curriculum that they could show potential employers or use in college. A hospitality teacher noted that the soft skills she emphasized—business writing, customer service, and marketing skills—would be valuable even if students chose not to pursue a career in hospitality. In planning the many public events that took place at Navy, hospitality students prepared guides that described the steps and materials involved in hosting each event; students then compared their guides to those produced in previous years, analyzing differences and describing how their procedures could be improved.

Sky developed a 21st-century skills course for ninth graders that included preparing four-year graduation plans, researching colleges and careers, writing resumes, making presentations, modeling professional dress and grooming habits, and developing a positive work ethic. Beyond this course, Sky students had many opportunities to engage in mock interviews with school business partners, practice filling out job applications, and create and maintain portfolios of their best work to show employers. Students we spoke with expressed gratitude for the internship, clinical, and interviewing opportunities they had and considered themselves better prepared than their peers at their zoned high schools.

At Azure, a counselor started a student mentoring program that taught soft skills to ninth-graders. Older mentors visited ninth-grade computer classes and led students in fun activities focused on decision-making, positive choices, time management, organization, and stress relief. Azure teachers found other ways to teach soft skills. One IT teacher stressed the idea of teaching students how to collaborate with each other to find information instead of simply asking a teacher for help: "We… work together collaboratively, which you're going to do on the job because people are going to know stuff that you don't, and you're going to know stuff they don't, so we need to learn to work cooperatively and collectively." A business teacher invited guest speakers, including local university business students, to talk to her class about networking, being flexible, and understanding other cultures. This teacher emphasized collegial teamwork and competition through a lemonade stand fundraiser in which teacher-created teams of students created business plans and vied with each other to generate the most sales.

Team-building. Over the course of the study, we observed 35 POS classes and 10 academic classes in the POS high schools. In both types of classes, about one-quarter of our observations captured instances of in-class teamwork, defined on our observation form as: "working as teams on projects or activities" and "more than just working in groups to answer questions at the end of the chapter." In academic classes, we saw students working in groups to respond to the literature they read, negotiating their interpretations of the reading as they sought a shared way to produce the assigned product (e.g., a play, a drawing). This kind of teamwork required planning, self-direction, and imagination.

In POS classes, teamwork was more varied: We saw students learning to place EKG leads on their classmates, baking cookies, surveying their school grounds using theodolites, filming scenes that evoked certain moods, and cleaning up the auto shop. In most cases, teachers assigned students to teams, and students seemed to be engaged and on task. In one case of off-task behavior, we were told that the students exhibiting poor teamwork were late—and forced—transfers into the POS and as such lacked the engagement and commitment of their classmates.

A fine example of teamwork took place at Azure, where groups of students in a Robotics class built robots that had to move, pick up a stack of blocks, and load them onto a parallel wooden surface. Each team clustered around a kit of parts, with most students taking an active role in selecting parts, assembling components, or testing their robots. Although this activity tended to promote a great deal of chatter and occasional horseplay, it was hands-on, challenging work, with students using all of their communication skills to negotiate solutions together.

Critical thinking and problem-solving skills. During our observations, we sought to identify whether and how students worked with information, conducted disciplined inquiry, and engaged in higher order thinking skills (see our observation form in Appendix A, cf. questions III1c, IV1, and IV2). The most commonly observed way in which students exhibited critical thinking and problem-solving skills was by applying information. Across all types of courses, we saw many students using the information and knowledge they had acquired in a prior class, whether they were completing worksheets, taking tests, or engaging in hands-on activities.

We observed critical thinking as students engaged in hands-on activities in their POS classes, particularly in their upper-level courses. In introductory courses, concepts were introduced (e.g., how to use software), then students applied their knowledge in an assignment demonstrating their mastery of the concept. Such assignments tended to be closely prescribed. By contrast, in capstone, upper-level classes, teachers stressed longer-term assignments with much wider parameters. For example, a 3D Animation teacher at Sky asked students to create an instructional module that linked academic content from another class of the students' choosing with advanced design principles. One student with an interest in astrophysics created a module about the death of a star; another assembled an interactive CD on the culture, food, geography, and people of Spain. Another designed a 3D animation that demonstrated how a martini glass dropped from various angles and heights would break. These highly sophisticated and attractive projects showed that students were thinking deeply not only about the concepts that interested them, but also how to draw upon their knowledge of 3D animation and design principles to communicate those concepts effectively and memorably.

Teaching soft skills through CTSO activities. CTSOs offered valuable opportunities to teach soft skills, especially teamwork, leadership, and problem-solving. The POS high schools varied in the CTSOs they offered and the extent of their integration with the curriculum. At Navy, some CTSOs were more active than others. Marketing students were required to join DECA because the program used some DECA-developed curricular elements; DECA competitions were an integral part of the program. Azure had fewer CTSO chapters than Navy or Sky, although one teacher leader there received a National Advisor of the Year award from a CTSO, and Azure students placed at state CTSO competitions and competed at nationals.

CTSOs had the strongest presence at Sky, where we saw posters in classrooms and hallways and a very large trophy case devoted to the school's CTSOs in its cafeteria. With broad student participation, Sky had a history of national winners in various CTSOs, according to district personnel. Sky's 21st-century skills course also included the first unit of a work readiness curriculum developed by a CTSO; the rest of the units were presented in various POS courses as a way for students to develop professionally and prepare for competitions. A counselor said that students showed great growth in leadership over their four years at Sky as a result of their CTSO participation and the many opportunities Sky teachers created to exercise their leadership opportunities, self-govern, and "get the job done." The principal commented that he enjoyed seeing students start at Sky as freshmen, running around the halls like "little water bugs;" over the years, they came to impress him with their intellectual gifts, professionalism, and poise.

Sky students also ran the student store, which brought in tens of thousands of dollars that helped fund student travel to CTSO competitions. One teacher said that many of the students who went to these competitions had never before traveled in an airplane; the skills they learned on these trips went far beyond the content of the competitions.

Teaching Soft Skills at the Comprehensive High Schools

In a business class at Fuchsia, students worked with a local Toastmasters chapter to improve their public speaking skills. Second-year students in this two-year sequence then mentored first-year students by helping them format their first speeches and complete time management activities. However, this class was not representative of soft skills instruction we observed at the comprehensive high schools overall. In our observations and interviews, we saw students learning how to complete tasks "the way the boss wanted the job done," get noticed by taking the initiative to do more (e.g., grabbing a broom in an auto shop), plan and prioritize goals, deal with machines safely, get along with others, complete jobs on time, and communicate orally and on paper so that customers understood the work being done (e.g., writing an estimate for HVAC work). The CTE teachers at the comprehensive schools recognized that these lessons were as important as the technical skills being taught.

Team-building. In our observations of 16 CTE classes at the comprehensive high schools (we saw no academic classes), about one-quarter captured instances of teamwork. Students appeared to enjoy the opportunity to work with one another on assignments, whether these were hands-on projects (e.g., taping each other's wrists in a sports medicine class) or group seatwork. Although every instance of teamwork included occasionally off-task or "dead weight" students, such students were in the minority—and often already known to the teacher.

Critical thinking and problem-solving skills. We observed a particularly strong example of problem-solving skills in an advanced 3D Animation class at Dandelion. Students were introduced to an open source 3D animation software program, asked to follow its basic tutorial, and tasked with creating a three-dimensional pyramid. This activity challenged the students, who worked intently for the entire period. Near the end of class, only one student figured out how to successfully complete the assignment by creating three-dimensional blocks and tapering and stacking them into something resembling a stepped pyramid.

Teaching soft skills through CTSO activities. CTSOs were popular across West District. The automotive, CAD, and photography programs at Amaranth and the medical program at Ruby each medaled at state-level competitions in their respective CTSOs. Although most participants we spoke with strongly supported CTSOs as a positive aspect of CTE programs, one CTE teacher felt that CTSOs sidetracked teachers, making them focus on a subset of their students to the detriment of others: "The teacher's gone and there's a sub in the room… I've never been able to justify leaving 200 kids and taking three [students] for three days to someplace else."

National, State, and/or Local Assessments Provide Ongoing Information on the Extent to Which Students Are Attaining the Necessary Knowledge and Skills for Entry Into and Advancement in Postsecondary Education and Careers in Their Chosen POS

When our study began, West's state had not yet developed technical skills assessments, but by the end of 2010, the state CTE director reported that they had begun having discussions regarding their development. The state's goal was to align every program with an industry-recognized credential or similar neutral, third-party assessment that demonstrated that students had mastered the knowledge base. Graphic design and IT teachers interviewed in 2011 stated that assessments were coming to their programs in the following year. Navy culinary teachers helped design their own technical skills assessment, as Navy was a pilot school for these assessments. Perhaps because technical skills assessments were not controlled at the state level, West CTE teachers did not mention examining assessment data either within or across schools, as was the case for West's core academic teachers.

Creating the Standards

Each CTE program area in the state formed a writing committee made up of secondary and postsecondary teachers who created or reviewed the standards, course goals, and assessments for all secondary programs. These standards then went before the state board of education and were presented to all program area faculty for comment. Adherence to the standards was required at the secondary level. CTE program and course standards incorporated related state academic standards because the state's goal was for all teachers, not just academic teachers, to be involved in helping students pass the high-stakes academic exams. We spoke with many teachers in various program areas who had served on these writing committees.

New Programs Coming Online

State mandates required that all new CTE programs be aligned with industry standards. For example, the hospitality teachers at Navy who were responsible for revamping their program first examined its currently available courses. The teachers disassembled and reconfigured the state's standards for the program into lower-level standards that could serve as the focus of the early years of the program and upper-level standards that would allow students to exceed program expectations by their senior year. These decisions drove later decisions on the program's curriculum, books, and student projects.

Navy developed its biotechnology program with the aid of the local university's medical program faculty. Navy's teacher asked the university faculty whether it would be more beneficial to students if her courses approached the topic from a molecular biology perspective or a biomedical engineering perspective. The faculty suggested the latter approach, because biomedical engineering was a field that students could enter after an undergraduate program, whereas molecular biology required postgraduate work.

Assessments and Standards in the Classroom

In CTE and POS classes in West District, rubrics were the method of choice for evaluating assessment results. Teachers received professional development on rubrics and used online tools to create them. A desktop publishing teacher described how she graded her students' work with a rubric of industry-approved standards for layout, alignment, and proximity and repetition of graphic items. A media teacher said she used rubrics to judge whether minimum project requirements were met; she also used a more global assessment: "Can this be aired?" If the answer was no (e.g., the audio was poor quality), students had a chance to improve the project and their grade. Although her projects were often completed in groups, she graded individually so as to avoid rewarding "freeloaders." Many teachers said they used rubrics because they clarified expectations (e.g., teamwork, content, spelling). One automotive teacher said that his rubrics were like a "measuring stick of how well they've learned the standard." He likened the rubric to "a competency certificate that you're using daily."

Authentic assessments. Several POS teachers described using authentic assessments. The culinary program at Sky lent itself to authentic assessment because the school had a restaurant that opened to the public every day. Teachers also told us about building robots that could accomplish specific tasks, refurbishing a classic automobile, designing and building a model airplane, and developing and teaching early childhood lesson plans.

The local community college. The quality of West District's CTE programs varied from school to school. For example, many district culinary programs continued to be taught by FACS teachers who had no restaurant experience in high school classrooms that resembled home kitchens. By contrast, the culinary programs in the POS high schools were aligned with the WCC program's focus on large-scale food production and the culinary arts as a career. Culinary classrooms at the POS high school were designed to mimic the types of facilities available in commercial kitchens. WCC culinary faculty had begun to work with the district to standardize their course offerings across high schools and to assess students' hands-on skills.

A WCC dean said he wanted to institute annual reviews of every career program at every school in the district because his college could not maintain its own credibility if it bestowed credits on students who could not be said to have legitimately earned them. WCC set up workshops for high school faculty during the summer to explain its requirements, but there was no way to enforce these requirements with teachers who did not want to change their programs despite district-level articulation agreements with WCC.

During our study, the state began mandating that postsecondary occupational programs use industry credentials as assessments for their programs wherever possible. For some of its programs, WCC experienced difficulties identifying industry standards or even national associations associated with certain industries (e.g., commercial art and graphic design). One dean noted that in lieu of industry standards, many of his programs had instituted portfolio requirements that allowed open access to introductory courses but required students to provide evidence of quality work in order to enroll in more advanced courses.

CHAPTER FOUR: East District
POS as a method of developing and maintaining a skilled workforce in a new and changing regional economy

Abstract

Like many urban school districts, East District developed multiple magnet and choice programs across grade spans. At the high school level, a number of schools (or programs within schools) offered a range of magnets available to students through a lottery process. Eighth-grade applicants had to demonstrate successful completion of core competency standards in reading, math, and computers to be eligible.

Blue Academy, the wall-to-wall magnet POS high school that participated in this study, served students from all over East District. Although Blue held very high expectations for its students, teachers, students, and administrators described a supportive, caring culture where barriers to success were identified and addressed.

We planned to test an instrumental variable model of the effects of POS enrollment and CTE credit earning on GPA and graduation. However, POS enrollment did not generate substantial exogenous variation in number of CTE credits earned, which precluded us from interpreting the results of the instrumental variable analysis. We tested a conventional mediator model and found that while POS enrollment did not impact CTE credit earning, each additional CTE credit earned corresponded to a 9% improvement in the probability of graduation and a .15 unit improvement in GPA. These results suggest that in East District, earning CTE credits benefited students in POS and comparison schools in terms of retention and also achievement.

At East District, 50.0% of the intervention group completed a POS. We examined policy-relevant questions comparing POS completers to those who completed a CTE concentration, and to the rest of the sample. We found that POS completers earned significantly more AP credits than the rest of the sample, while students in the rest of the sample accrued more college credits than POS completers.

In assessing the effect of completing a POS on high school achievement through posthoc regression analyses, we found that POS completers were more likely than the rest of the sample to have earned more AP credits, but completing a POS at Blue did not affect the likelihood of earning higher GPAs overall or in CTE, or the likelihood of earning STEM credits. The model for dual enrollment predicted a higher number of college credits accrued by the rest of the sample, but the results indicated a weak fit to the data, suggesting that important factors in dual enrollment participation were not captured in the model.

Because there was only one intervention school in East District, we compared POS completer outcomes to those of CTE concentrators at Blue Academy (i.e., Blue POS students who failed to complete their POS but qualified for CTE concentrator status) as opposed to all CTE concentrators in the sample. We did this in order to test whether outcomes were attributable to completing a POS or if they had more to do with Blue Academy as a school—its reputation, culture, faculty, and so on. Compared to the Blue concentrators, completing a POS did not affect

the likelihood of earning a higher overall or CTE GPA, or of earning more STEM or AP credits, suggesting a school effect rather than a POS effect. The model for dual enrollment showed no predictive value to POS completion, but again the fit of the data to the model was weak.

The senior exit survey at East District showed that students who enrolled in Blue Academy and those in the comparison group had very similar post-high school plans: the majority of both groups planned to attend a four-year college or university full time, and had already been accepted to the school of their choice. Intervention students were more likely to choose a college major related to their high school program area than were comparison students who were in a specific program in high school (i.e., performing arts).

We then present a qualitative analysis of POS implementation in East District, based on the elements of the law mandating POS and the subsequent policy guidance framework provided by the funding agency (USDE/OVAE, 2010).

Introduction to East District and Blue Academy

We identified East District and Blue Academy as a potential candidate for inclusion in the study because of its wall-to-wall technology academy structure and strong, well-articulated POS that provided advanced technological training to highly engaged students.

East District's state has historically had control over CTE programs in order to maintain a strong workforce in the state. Changes to the state economy that mirrored national changes (i.e., a loss of manufacturing) led to the retooling of CTE programs and the development of programs with more academic rigor and postsecondary opportunities. East District chose to develop high-tech POS for their magnet POS high school, which they located near downtown in order to attract district students from the immediate suburbs.

Blue Academy

Blue Academy is a state-of-the-art high school featuring nine POS in three academies: engineering, health careers and biotechnology, and information technology (IT). Blue's 1,081 students in 2008-09 reflected the racial and socioeconomic composition of the district; the school was predominantly Black, and a large proportion of its students were F/RL-eligible.

Blue's structure was marked by strong top-down leadership that was diffused across its three academy directors, who undertook such tasks as ensuring that their curriculum was up-to-date and that teachers had the resources they needed. The goal of the principal and his leadership team was to provide firm, fair, and consistent leadership, a core vision for the school, modeling and re-assessment of that vision, trust and collaboration among faculty and staff, and a safe, nurturing, challenging environment for students.

Although national in scope, the recession hit this state particularly hard. The state curtailed the ability of students to earn postsecondary credits and take courses at the local community college. There were cuts in counseling and support positions, causing teachers to have to take on additional responsibilities. Cutbacks also compelled the school to offer more broad-based,

introductory courses that enrolled greater numbers of students, and fewer small, specialized courses serving more limited numbers of students. Changes in the district's busing plan also created changes in the student body.

At the comprehensive high schools that made up our comparison schools, the recession cut elective funding (including CTE) and staffing levels. Programs and entire high schools were closed, causing involuntary student mobility and the interruption of programs. District-wide, students were often placed in CTE courses or other electives not of their own choosing. This led to students with no interest in a CTE program being enrolled and expected to achieve on the states' end-of-term exams. Without motivation, however, achievement suffered. In contrast, Blue's core CTE mission helped preserve programs there, although the elimination of some POS capstone courses hurt our cohort's ability to complete their POS.

POS at Blue. POS at Blue began in the ninth grade with introductory coursework and a mandatory computer class and progressed to more advanced coursework in the remaining three years. The POS offered at Blue included five POS in the Engineering Academy: electronics, pre-engineering, construction, automotive, and architectural technology. The Health Careers and Biotechnology Academy offered two POS, medical and diagnostics and biotechnology. Finally, the IT Academy offered POS in IT and business IT.

How School and POS Culture and Identity Engaged Students

CTE in East District was a well-supported curricular component in the high schools. Instructional technology was in wide use throughout the district, and teachers were clearly trained in its use. However, East District was badly affected by the recession, and many of the elements of POS suffered. Students at both Blue and the comparison schools lost the state funding that waived tuition for them to attend the local community college. Nor could students depend on district help in paying for industry-recognized credentialing exams. Such opportunities—including some mandated elements of POS—continued to exist, but fewer students were able to take advantage of them.

Blue students enjoyed a school environment that was supportive of CTE as a means to attend college, more up-to-date equipment, and many faculty members with recent careers in relevant industries. We also found that Blue students appeared to be held to high expectations within a culture of support, as described below.

By contrast, there was no relationship between CTE course sequences and specific academic requirements at the comparison schools. These schools often had less well-resourced programs that lacked a tangible connection to careers and "the real world." CTE was much more variable in technical and academic rigor at the comparison schools. As in West District, CTE had to compete for funds at the comprehensive high schools. Finally, comparison school students could take CTE courses in one program area and move to another at any time.

Blue Academy: A Culture of Caring and High Expectations

Culture of caring and collaboration. Blue's school culture helped the school maintain its focus on academic and technical achievement. It emphasized caring and collaboration, high expectations, and college and career planning as part of its daily activities. This culture was communicated on multiple fronts using a variety of media, including posters in hallways, mandatory student schedule books, and closed-circuit monitors in each classroom that delivered a constant stream of interesting facts, school news, and inspirational quotes.

The principal introduced a corporate-inspired philosophy about implementing change through personal responsibility and positive interactions with others. Mascots embodying this philosophy were displayed in classrooms, hallways, and offices, and posters featuring its main tenets hung in common spaces. The principal told us that he thought students had bought into it; he saw this reflected in the older students' practice of befriending ninth graders, who, coming to Blue from far-flung corners of the district, were unlikely to know other students. We also observed students in a 10th-grade English course critiquing each other's work. They were required to comment on their partner's writing or the student being assessed would lose points. In this way, students knew their responsibility for one another's learning: the teacher reminded them to respond "out of respect for them."

High expectations. High expectations were visible in the staff's frequent monitoring of student progress and sponsorship of friendly competitions to spur higher achievement. One teacher had students from each of his classes post their self-determined goals (i.e., increase end-of-term test scores by two points) on the wall for others to see, along with graphs of their progress.

College and career planning. College-going was championed at Blue—for example, a banner hung in one classroom read, "Students who are the first in their families to go to college END poverty in their family lines forever. - U.S. Department of Labor." College and career planning was suffused in the classroom, through the curriculum and through many college- and career-oriented assemblies and field trips. At the end of one biotechnology class we observed, the teacher spoke of an upcoming field trip to a biotechnology company in the area. She related a story about a former student who during a tour the previous year caught the attention of company staff; this student interviewed with the company and got a job upon graduation.

Blue's principal stated that his philosophy was not "to graduate them from high school. I want them graduating from college. So I'm pushing – I push a lot more if the AP courses match up with the CTE courses – I need them to participate in the most rigorous courses available to them so that they are going to college better prepared." This principal and East's CTE director spoke of raising the level of expectations, and how students had risen to it. These educators knew that supports had to be in place for that to happen, and they were in place at Blue: teachers were paid to stay after school or on Saturdays to tutor students or prepare them for college entrance exams.

Instrumental Variable Sample Description

The East District portion of the study examined data for 1,128 secondary students; 376 enrolled in Blue Academy, the POS high school, in ninth grade, and 752 attended other schools. Table 4.1 displays descriptive statistics for the East District imputed sample.

Table 4.1
Descriptive statistics for imputed sample, East District

	(*N* = 1,128)	%
Overage		
No	1,113	98.7
Yes	15	1.3
Gender		
Male	571	50.6
Female	557	49.4
Race/Ethnicity		
Black	797	70.7
White	124	11.0
Latino	119	10.5
Asian	41	3.6
Native American	2	0.2
Other	45	4.0
F/RL eligible	756	67.0
Limited English Proficient (LEP)	52	4.6
Has Individual Education Plan (IEP)	26	2.3
Graduated on time (2012)	861	76.3
Attrition	207	18.4
	Mean	*SD*
Discipline incidents	0.54	1.31
Grade 8 pre-test math scale score[a]	363.00	7.35
Grade 8 pre-test reading scale score[a]	359.76	7.36
Grade 8 pre-test science scale score[a]	150.07	7.86
Number of CTE credits earned	5.24	2.01

Note. F/RL = free/reduced price lunch program.
[a]Variables were grand mean centered.

Missing Data

We carried out a missing data analysis for East and observed that the percentage of data missing for the variables ranged from 0.0 to 35.3%, with an average of 2.7%. As with West District, we rejected the assumption of MCAR given mean differences in eighth- grade standardized test scores between those who were and were not missing GPA data for later years. We made the more relaxed assumption of MAR and handled missing data using the same procedure as reported for West District.

Instrumental Variable Estimation

We tested our hypothesized model across the imputed sets and observed that it was over-identified with 13 degrees of freedom and fit the data poorly (e.g., $\chi^2 = 141.26$, CFI = .88, TLI = .58, and RMSEA = .09). We tested the model using a single imputed set to obtain a global test of fit and modification indices. We observed a significant χ^2 test statistic ($p < .001$) and

modification indices and standardized residuals indicating that number of CTE credits earned should be regressed on LEP status, discipline referrals, Latino, Asian, Black, and Grade 8 math score. We added these specifications and observed that the resulting model was over-identified with 8 degrees of freedom and fit to the data was excellent (e.g., $\chi^2 = 14.47$, CFI = .99, TLI = .97, and RMSEA = .03). We tested the re-specified model using a single imputed set and the global test statistic was non-significant ($p = .07$), suggesting we should not reject the hypothesis that model fit the data exactly (see Bollen, 1987, pp. 263 - 269).

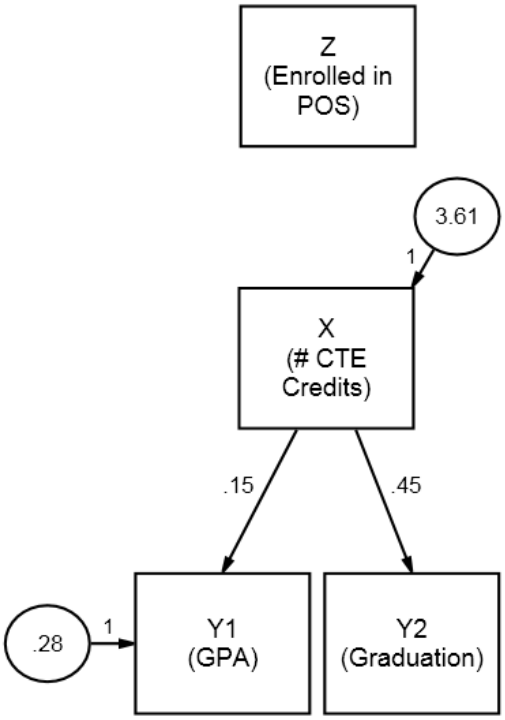
Enrollment in Blue Academy appeared to increase the number of CTE credits students took by an average of .19 credits, explaining less than 1% of the variance in CTE credits earned. Controlling for background variables, the indirect effect of enrolling in Blue on GPA was non-significant, and so was its indirect effect on graduation. The direct effect of enrollment in Blue Academy on number of CTE credits was small but significant (i.e., $b = .19$, $p < .01$, $\beta = .05$). The direct effects of CTE credits on GPA and graduation were non-significant. We noted a non-significant residual covariance between number of CTE credits and GPA. However, the residual association between number of CTE credits and graduation was large and observed at $cov = 2.32$ ($p < .001$). Taken together, these results imply that in this district, enrollment in the POS school was not a good instrument and failed to generate adequate exogenous variation in number of CTE credits earned. Indeed, attendance at Blue Academy only appeared to increase the number of CTE credits earned by .19 and explained a trivial amount of its variance, while in the West District model, enrollment in their POS schools increased the number of credits earned by 2.82 and explained 28% of the variance in credits earned. Because weak instruments tend to produce unstable estimates, we did not interpret the results for this model.

Given the findings above, we tested a conventional mediator model by removing the covariances connecting the graduation and GPA residuals to the number of CTE credits earned residual. This model was over-identified with 9 degrees of freedom and fit the data very well (e.g., $\chi^2 = 13.55$, CFI = .99, TLI = .98, and RMSEA of .02). We tested the model using a single imputed set to obtain a χ^2 test and modification indices. We observed a statistically significant global test statistic ($p = .14$), suggesting that we should did not reject the hypothesis that the model fit the data exactly.

For this model (see Figure 4.1), enrollment in Blue Academy was not a significant predictor of number of CTE credits earned. The direct effect between CTE credits and GPA was $b = .15$ ($p < .001$, $\beta = .34$), while the direct effect between credits earned and graduation was $b = .45$ ($p < .001$). Taken together, these results indicate that students who enrolled in Blue were not any different than those who enrolled elsewhere in terms of CTE credit earning. However, for the sample as a whole, earning one additional CTE credit was associated with a 9% greater probability of graduation. In addition, the standardized effect between CTE credits earned and GPA was moderate in size ($\beta = .34$), and each additional CTE credit earned corresponded to a .15 unit increase in GPA. Although student CTE credit earning behavior was not changed by enrollment in the POS school at East, the data suggest that earning more CTE credits benefited students. We note that this model did not correct for endogeneity so causal inference must remain tentative.

In addition to the effects described above, several covariates were significant predictors of number of CTE credits earned, GPA, and graduation. Gender (i.e., being male), overage, F/RL, discipline occurrences, and Latino had significant and small negative effects on GPA, while Grade 8 grade science and reading scores had small but significant positive effects on GPA (*ps* < .05). In addition, Grade 8 grade math score had a significant moderate positive effect on GPA (*p* < .001). Gender, F/RL, special education, discipline occurrences, and Grade 8 grade science score had significant and small negative effects on graduation, while Black and Grade 8 grade math score had significant and small positive effects on graduation (*ps* < .05). Finally, LEP and discipline occurrences had significant and small negative effects on number of CTE credits earned, while Latino, Asian, Black, and Grade 8 grade math score had small but significant positive effects on number of CTE credits earned (*ps* < .001). For a complete description of the estimates for East District, see Appendix A.

Figure 4.1
Final model for East District



Note: Significant unstandardized estimates are displayed. Covariates are omitted for conceptual clarity.

Assessing the Effect of Completing a POS on High School Achievement

Our second approach to data analysis employed multiple regression analyses, using a different sample—POS completers, all other students, and CTE concentrators. We excluded students who (1) withdrew or were missing course data and (2) were missing baseline achievement data. We were consistent with this so that the regression sample would match the descriptive statistics to the extent possible. The sample for the CTE GPA analysis is further reduced to those who actually took a CTE course among the student in the All Others group. Table 4.2 provides descriptive statistics for the posthoc regression sample.

Table 4.2

Descriptive statistics, posthoc sample, East District

	Total (n = 907)	POS Completers (n = 187)	All Others (n = 720)	Blue CTE Concentrators (n = 39)	POS Completers Compared to All Others	POS Completers Compared to Blue CTE Concentrators
Characteristics						
Male	49.5	43.9	51.0	74.0		*
Black	71.0	75.9	69.7	66.7		
White	10.6	8.0	11.3	12.8		
Latino	11.1	10.7	11.3	7.7		
Asian	3.9	3.2	4.0	7.7		
Other/Multiracial	3.4	2.1	3.8	5.1		
F/RL eligible	65.8	67.9	65.3	59.0		
LEP	4.2	2.7	4.6	2.6		
IEP	1.1	1.1	2.1	2.6		
Grade 8 pre-test reading	360.19 (7.10)	360.74 (7.16)	360.04 (7.08)	358.31 (6.14)		
Grade 8 pre-test math	363.43 (7.22)	363.83 (7.11)	363.43 (7.22)	362.72 (5.82)		
Discipline events						
None	79.4	79.1	79.4	79.5		
1-2 events	16.5	17.1	16.4	17.9		
3+ events	4.1	3.7	4.1	2.6		

Note. Excludes students who withdrew or were missing course data. Standard deviations of continuous variables are included in parentheses.

* $p < .05$.

Table 4.3

Descriptive outcome statistics, posthoc sample, East District

	Total (n = 907)	POS Completers (n = 187)	All Others (n = 720)	Blue CTE Concentrators (n = 39)	POS Completers Compared to All Others	POS Completers Compared to Blue CTE Concentrators
Percent Earning Outcome Credits						
STEM	99.6	100.0	99.4	100.0		
AP	36.8	55.1	32.1	38.5	***	
College (accrued)	5.2	3.7	5.6	2.6		
CTE	94.3	100.0	92.8	100.0	***	
Outcome Means	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)		
Overall GPA	2.69 (0.74)	2.77 (0.65)	2.67 (0.76)	2.64 (0.63)		
STEM credits earned	5.12 (1.43)	5.29 (1.26)	5.08 (1.47)	5.00 (1.28)		
AP credits earned	1.18 (2.04)	2.08 (2.55)	0.95 (1.81)	1.62 (2.63)	***	
College credits accrued	0.80 (4.53)	0.19 (1.04)	0.97 (5.04)	0.08 (0.48)	***	
CTE GPA	2.76 (0.83)	2.79 (0.68)	2.75 (0.87)	2.65 (0.72)		
	n = 859		n = 672			

Note. Excludes students who withdrew or were missing course data. STEM credits equals credits in science and higher math courses (i.e., above Algebra II). College credits accrued refers to the potential college credits associated with dual enrollment participation in high school.

*** $p < .001$.

We found that of the 376 East intervention students, 188 (50.0%) completed a POS. We then identified the number of students who earned credits in the outcome measures defined in the *Method* chapter (i.e., measures of academic rigor, technical rigor, and transition as outlined there). Descriptive results of student course-taking are shown in Table 4.3.

For the comparison of POS completers and the rest of the sample, the results for AP credits earned were positive, statistically significant, and have an effect size of 0.52, making this the most substantively important finding at East District (cf. Table 4.4). The dual enrollment finding is significant favoring the rest of the sample, but due to the low effect size and poor fit of the model to the data, the finding is questionable.

Table 4.4
Regression results, POS completers versus all others, East District

	East District POS Completers Versus All Others								
		Adjusted					95% *CI* of *b*		
Outcome	*n*	R^2	*b*	*SE b*	*ß*	*p*	lower	upper	*ES*
Overall GPA	907	0.523	.054	.042	.030	.196	-.028	.137	0.07
STEM credits earned	907	0.342	.141	.096	.040	.140	-.046	.329	0.10
AP credits earned	907	0.348	1.067	.136	.212	.000	.801	1.333	0.52
College credits accrued	907	0.023	-.846	.369	-.076	.022	-1.571	-.121	-0.19
CTE GPA	907	0.139	.027	.064	.014	.667	-.098	.153	0.02

Note. All coefficients rounded to two digits. Full regression tables are found in Appendix A. *CI* = Confidence Interval. *ES* = effect size (Hedges's *g*)

Table 4.5 shows the comparison of POS completers and Blue CTE concentrators. There were no statistically significant results; however, for CTE GPA, there is a substantive positive effect size, meaning that although the finding did not reach statistical significance, there is practical significance in the number of CTE credits earned by POS completers compared to CTE concentrators at Blue.

Senior Exit Survey Findings

Sample students at East District were given a senior exit survey in May 2012 (see *Method*). Response rates were not high. Significantly more intervention students took the survey than comparison students (42.0% versus 32.2%, $p = .001$).

The intervention group's survey respondents were not significantly different from the intervention nonrespondents. Among the comparison group students, significantly more Black and Asian comparison students took the survey than not, and significantly fewer White comparison students and LEP comparison students took the survey than not (see *Appendix D*). All of these differences should be taken into account when interpreting the survey results.

Intervention and comparison survey respondents were also compared to each other, and no significant differences were found, as shown in Appendix D.

Table 4.5
Regression results, POS completers versus Blue CTE concentrators, East District

	East District POS Completers Versus Blue CTE Concentrators								
		Adjusted					95% *CI* of *b*		
Outcome	*n*	R^2	*b*	*SE b*	*β*	*p*	lower	upper	*ES*
Overall GPA	226	0.463	-.012	.088	-.007	.887	-.186	.161	-0.05
STEM credits earned	226	0.372	.107	.183	.032	.559	-.254	.469	0.06
AP credits earned	226	0.401	-.109	.366	-.016	.766	-.830	.612	-0.08
College credits accrued	226	0.040	.225	.175	.088	.201	-.120	.569	0.19
CTE GPA	226	0.096	.202	.119	.111	.090	-.032	.437	0.25

Note. All coefficients rounded to two digits. Full regression tables are found in Appendix A. *CI* = Confidence Interval. *ES* = effect size (Hedges's *g*)

Table 4.6 provides information on students' next steps after high school graduation. The students who responded to the survey were very similar in their post-high school plans, regardless of whether they were in the intervention or comparison group: most had been accepted (over 78% of the sample) and planned to attend a four-year college or university (over 71% of the sample) full time (about 97% of the sample) in Fall 2012. There were no significant differences in their work plans either: most respondents planned to work part time, and those jobs were predominantly not related to their high school program. Only a small percentage planned to join the military, but relatively more intervention students reported that as their next step than comparison students.

We asked students whether their postsecondary studies would be related to their high school program. Of those students who indicated that they were in a high school program (defined in the survey as "major, program of study, career major, career pathway, career academy, International Baccalaureate, etc."), 69 percent of the intervention students indicated that their post-high school program would related to their high school program. This is similar to the comparison group percentage who indicated that their post-high school studies would relate to their high school program (64%). One possible reason for the similarity in response could be that one of the comparison schools at East was a performing arts high school. Many of those students would have self-identified as having participated in a program in high school, and many might have also been planning to continue their arts program in college. In either case, the results suggest that participating in an identifiable high school program can help clarify students' post-high school planning.

Table 4.6
Student exit survey responses, East District

Survey Items	Intervention ($N = 152$) (%)	Comparison ($N = 233$) (%)
Do you plan on working immediately after graduation?		
Yes	59.9	51.1
Will you be employed full time?		
Yes	46.2	35.3
Is this job related to your high school program?		
Yes	13.2	9.2
No	71.4	62.2
Not in a program	15.4	28.6
Do you plan to attend a four-year college or university, two-year community college, or trade/ technical school for the Fall 2012 semester?		
Yes	88.8	93.1
Four-year	74.8	71.8
Two-year	21.5	25.5
Trade/technical	1.5	1.4
Other	2.2	1.4
Have you been accepted to this school?		
Yes	79.3	78.2
Will you be a full-time student?		
Yes	97.8	96.8
Will your studies at this school relate to your high school program?		
Yes	63.0	44.4**
No	28.9	25.5
Not in a program	8.1	30.1***
Have you been accepted into a branch of the military?	7.2	4.3

Note. Due to missing data, percentages may not add up to 100. Significance levels are based on chi-square analyses comparing intervention and comparison groups.
*$p < .05$. **$p < .01$. ***$p < .001$.

Adherence to the Components of POS

East District offered vertically aligned POS designed by secondary and postsecondary educators in conjunction with business and industry partners; POS curricula, standards, and assessments were either generated at the state level or locally developed and submitted for state approval. For students in our cohort, East's POS were comprised of four courses in a progressively intensive sequence, culminating in a capstone course and coupled with opportunities to earn articulated college credits. Although East certainly stressed the career aspect of college and career readiness, in part by embedding career development and exploration in all of its CTE courses, college credit-earning, and college preparation in general, were a major press in this district. The district greatly benefited not only from its partnership with a highly regarded local community college, but also from the state's efforts to establish articulation agreements between its secondary

education agencies and its community college and university systems. Although committed to offering students a broad range of college credit-earning opportunities, the recession challenged the district's ability to do so; as such, over the course of our study, it increasingly emphasized lower-cost online coursework. Similarly, although industry-recognized credentials were a fairly low policy priority, the recession limited the district's ability to offer such credentials, or to pay for students to take credentialing exams, in the programs in which they were available.

The recession's impact on East was grave and far-reaching, and greatly affected its ability to implement and sustain many elements of POS. The district endured personnel cuts (teachers, administrators, and support positions), school and program closures and reorganizations, drastic transportation reductions, and the limitations of aging and inadequate technology. Despite such challenges, the district remained committed to supporting its CTE programs with the resources, personnel, and training those personnel needed to offer high-quality educational experiences. Business and industry partners offered material, financial, and personal assistance to help the district achieve this goal, including by providing opportunities for students to participate in work-based learning experiences (i.e., internships) and donating much-needed equipment.

Both core academic course assessments and CTE end-of-term assessments were managed at the state level and administered via a fairly recently adopted online assessment system; CTE assessments were developed by educators with input from industry, or were associated with industry-recognized credentials. A major component of this online system was its integrated data analysis tools, which allowed educators to both track and predict students' performance over time. Many academic and CTE teachers described receiving training to help them adapt to this system; teachers also mentioned collaborating with each other in professional learning communities in which they used systems data to target student deficiencies and improve their instruction. For POS and CTE programs, a major weakness of this system was its lack of a performance-based component.

Interdisciplinary teacher collaboration and curriculum integration were most often observed at Blue, where block scheduling and the school's academy structure made such instructional approaches a more natural fit. We saw fewer examples of either approach at our comparison sites. Project-based learning was not a major district initiative; however, we observed more examples of it at Blue than at the comparison sites. In both Blue's POS and regular CTE programs, workplace readiness skills were infused in classroom instruction and CTSO activities.

Incorporate and Align Secondary and Postsecondary Education Elements

East District is located in a state considered at the forefront of providing standards-based CTE and seamless transitions from secondary to postsecondary education. The state designs and maintains articulation agreements with postsecondary institutions, although local education agencies may also develop their own local agreements. Postsecondary faculty members provide input into secondary CTE curricula, standards, and assessments, usually at the state level.

At the comparison schools, participants reported somewhat limited direct contacts with postsecondary. A digital media teacher at Heliotrope reported that district CTE leadership, rather than teachers, worked with East Community College (ECC) staff in his program area. This

teacher was aware that ECC faculty designed some of the activities he used in his class. He also reported that ECC IT faculty members were working with East District middle and high schools to increase interest in IT careers among girls and minority students.

At Blue Academy, in contrast, an IT teacher described a much closer relationship with ECC. Faculty members from both ECC and the state university system sat on the advisory boards of some of Blue's programs. This teacher also described how the district IT curriculum alignment committee met monthly with the college programming instructor in attendance in order to ensure that all of the high school programming teachers were on pace with their shared syllabus. This committee had begun to meet at ECC. New agenda items included aligning and negotiating program content and appropriate student entry into the postsecondary part of the program.

Prior to our study, ECC developed a strong partnership with Blue Academy that included certifying Blue teachers to teach postsecondary-level courses and giving Blue students opportunities to attend after-school clubs and take courses offered by ECC instructors. One teacher described a defunct program in which Blue students took classes on the ECC campus:

> They could leave Blue and the district would pay for them to go to ECC and take game simulation. We would give the kids a bus pass that couldn't afford one. But they would get on the bus in front of the school, go to ECC, and take their night class, and they were excused from us. And then some of them that work, that was great for them because they could earn a little money, they earned college credit, and they're still in the high school – can you imagine the independence that they felt and you know, the parents are looking at the responsibilities that they have, and the maturity level, you know, they can drive. I mean it was great. Kids loved it.

Post-recession, the grants and funding to support such programs and opportunities disappeared. Although interviewees at ECC lamented the loss of these funds and the opportunities they provided, they had mixed feelings regarding the return on their investment in Blue. Participants believed that despite the college's generous underwriting of the faculty time and resources needed to partner with Blue's programs, Blue faculty were encouraging their students to apply to universities, not the college's highly regarded and highly accessible programs: "Their students over there – they're pushing them towards the four-year schools."

As our data collection efforts in East drew to a close, additional alignments between district and ECC curricula were being cultivated. For example, East was in the process of implementing PLTW programs in high schools all over the district. To better align with this curriculum, ECC proposed to develop a pathway from the district's high school-level pre-engineering programs to related programs in its department of Engineering Technology. The college's plan was to better align its program prerequisites with the end-of-term exams given in PLTW courses. ECC also proposed to cohort any graduates of high school PLTW programs who enrolled at the college. East's CTE department proposed to begin recruiting students for this aligned secondary-to-postsecondary pathway in district middle schools offering PLTW's Gateway to Technology program. The district's expansion of PLTW also sparked deeper conversations with the state university system, which had previously done little recruiting in the district. Indeed, the chair of

the engineering department noted that there were no district graduates in his program at the state university campus located in the heart of East District.

Professional development offered another means through which elements of postsecondary education were incorporated into secondary programs. East District counselors and career coordinators received training from ECC staff on the occupational programs the college offered and the grants and scholarships available to students.

In addition to ECC, the state and district also maintained partnerships with other postsecondary institutions. For example, a state university hosted summer enrichment programs for high school students, including in engineering and architecture, for which students could earn college credits. Another community college located in a different county developed a curriculum used by Blue's biotechnology program; teachers in Blue's program took their students to see lab experiments in this college's facilities. Proprietary schools also worked with the district; in one example, a local trade and technical college offered scholarships to students interested in completing their senior year at the college while simultaneously beginning their postsecondary coursework.

Include Academic and CTE Content in a Coordinated, Non-Duplicative Progression of Courses

East's approach to POS course sequencing and secondary-postsecondary alignment evolved in response to changes to state-mandated graduation requirements. Students in the Class of 2012, our study cohort, began high school when district students had a choice of four graduation options involving varying emphases on college-preparatory and career-preparatory coursework. For CTE students, four courses in a defined sequence, with one upper-level or capstone course, were required to be considered a CTE completer. Students could choose to concentrate in areas linked to about a dozen of the 16 Career Clusters. Early in the study, however, East's approach to course sequences changed to embrace what the district's CTE director and other participants described as a "Clusters model" that de-emphasized more narrowly defined pathways and sought to free students to design their own programs and gain a "broader understanding of careers." Sequences were envisioned as more of a "funnel" than a "pipeline," beginning with a common entry point—broad introductory courses within each cluster—and opening up to a range of higher-level courses. For example, a student might begin a course of study with a Principles of Business course, then go on to take additional courses like Accounting or Computer Applications before completing a final, upper-level class. The district saw this model as a way to streamline course offerings, consolidate advisory committees, better market CTE, and eliminate the burden of maintaining and updating pathways. The recession made these aims more desirable.

Defined four-course sequences remained viable and sustainable at Blue Academy, in magnet programs based at the comprehensive high schools (e.g., Emerald's burgeoning NAF Academy of Engineering offering a PLTW curriculum), and in high schools offering PLTW. Indeed, the district's CTE director considered PLTW to be the district's only true POS outside of Blue.

The Local Community College

ECC department chairs, faculty, and counselors actively participated in the district's efforts to streamline its course sequences. An IT department chair described how the college worked with the district to eliminate restrictive pathways and duplicative programs in order to create:

> One integrated technology degree [that] will have a certain set of core courses, just like we have now. But then they'll have tracks out of it and the students will actually take a diploma [that] will identify their track. And so we'll go back to one program, but multiple tracks, instead of having a lot of separate programs. That will make it much easier for a student to come in—everybody will know what the core has to be—and then you can take these other tracks and if you get into one of those tracks and you decide you don't like it, you can probably use everything you've taken as an elective in some others so that you don't lose the credits… we tried to make it as flexible as possible and yet still let the student specialize.

ECC counselors spoke of their efforts to align curricula and standards with the state and district as creating prescribed pathways in the humanities and social sciences or engineering and mathematics that ran through "13th grade" (e.g., four years of aligned high school coursework plus a first year of community college). College faculty believed that these alignment efforts would help create a pipeline of talented students for their programs.

Non-Duplicative Sequences at Blue Academy

As the state and district moved to implement a looser, clusters-based interpretation of POS, students in our cohort faced challenges in completing their more prescribed course sequences. At the beginning of the study, Blue offered postsecondary-aligned POS linked to a number of industry-recognized credentials, as described later in this report. The recession forced Blue to close some of its programs and eliminate a number of upper-level courses with low enrollments. Such cutbacks, coupled with the district's defunding of early college learning opportunities, compelled some students in our cohort to fill their schedules with courses outside of their prescribed programs. Our transcript analyses, completed after our cohort graduated in May of 2012, revealed that whether due to poor advising or a simple lack of available options, many students in our cohort failed to complete their POS under the old graduation requirements to which they were still subject.

Changes in the administration at Blue also impacted the availability of POS programs and courses. The first principal we interviewed, who left Blue after the study's second year, understood that the POS available at Blue differed from the CTE options at the comprehensive high schools. This principal, who instituted the school's dedicated academy coordinators and counselors, encouraged students to enrich their experiences by taking courses offered in any of the school's other POS once they had completed their own sequences. The school's new principal stated that he valued the way in which the school's academies made learning relevant, integrated academic and technical content, and prepared students to be lifelong learners. However, the new principal also referred to certain programs (including automotive, which he closed) as "dinosaurs" that held no appeal for on-grade level (i.e., higher-achieving) students.

Non-Duplicative Sequences at the Comparison Sites

The availability of non-duplicative CTE sequences at other district high schools varied according to the amount of CTE these schools offered. Some of our comparison sites, like Neon, the district's arts magnet, offered very little CTE and hence no POS sequences that met the Perkins IV definition. Other schools offered a broader range of CTE programs with enough introductory, mid-level, and capstone courses to allow students to complete full sequences. The comprehensives also varied in the extent to which their programs offered industry credentials or certificates or credit transfer opportunities. Among our comparison sites, Emerald's sector-driven clusters in engineering, automotive, health, and marketing stood out. In the last two years of our study, Emerald's CTE and academic teachers were engaged in the process of designing and implementing a sequence of integrated, STEM-focused courses for its new NAF engineering academy offering a PLTW curriculum.

Offer the Opportunity, Where Appropriate, for Secondary Students to Acquire Postsecondary Credits

Dual Enrollment

This state maintained control over much of the alignment between high school and postsecondary education. Dual enrollment and articulation agreements were required statewide, although local education agencies could tailor these agreements. Related to dual enrollment, the state mandated that universities and community colleges offer tuition-free, pre-approved college-level classes to high school students aged 16 or over. Students had to have a 3.0 GPA and pass a college readiness exam (e.g., ACT, SAT, PSAT). Eligible students could earn high school credit and start a college transcript. One principal called dual enrollment "better than taking AP, because you actually have credit on a transcript."

Scheduling conflicts between the district and ECC made it difficult for East students to take ECC classes. Lack of transportation was also a barrier to participation. Due to issues like these, East made online postsecondary course-taking a major component of its dual enrollment offerings. High school juniors and seniors could enroll in selected online college courses that were often offered in structured sessions in their zoned high school's media center. A Blue administrator believed that offering online college courses as regularly scheduled classes, overseen by school personnel, helped students achieve success. Indeed, staff at schools that did not offer structured online classes frequently talked about students struggling with or dropping their online courses.

Although the state had previously approved postsecondary general education and humanities course-taking, the recession forced it to limit its dual enrollment offerings to STEM and CTE courses (e.g., Anatomy and Physiology, Java Programming). Students could not take courses that were also offered at their high school, but all options remained available to students in online courses.

Articulation Agreements

Through both local and statewide articulation agreements, students in approved high school CTE courses, usually at the mid- or capstone level, were eligible to receive tuition-free college credit based on their end-of-term exam performance and course grades. A statewide set of articulation agreements between the state community colleges and the university system allowed students to potentially earn what ECC counselors called a "Triple Crown" of high school, community college, and university transfer credits.

All applicants to ECC were required to show college counselors their high school transcripts at registration, at which time any articulated courses for which they were qualified to receive credits were taken into account. Students could also ask ECC department chairs to review their transcripts, but a number of ECC faculty in the college's engineering and machining programs with whom we spoke reported never having done so.

Students learned about available credit transfer opportunities from ECC representatives who visited district high schools three times a year (in the fall, in the spring, and to register seniors).

Blue personnel appeared well-informed of the credit transfer opportunities available to their students. Blue's IT Academy Coordinator noted that because college faculty wanted to attract top-quality students to their schools, she was also able to negotiate college credit for IT students with industry certifications.

At the comparison schools, some administrators and CTE teachers we interviewed were not as knowledgeable about available credit transfer opportunities. Some did not know whether their students took advantage of these opportunities, or how many did so. Interviewed comparison students did appear aware of these programs and could cite their requirements. By contrast, interviewed Blue students seemed more familiar with AP credits than articulated credits.

Not all students actually obtained the articulated credits they accrued in high school. In some cases, students were required to pass an additional challenge exam and did not do so. In other cases, students enrolled in ECC with the declared intention to transfer to a four-year university, in which case the occupational credits they had accrued—because they would not count toward transfer—were unlikely to be granted. As one administrator noted, some students saw themselves as "four-year students" and did not value the credits: Some ECC occupational credits did not transfer to out-of-state schools or in-state universities. One high school guidance counselor told us that he encouraged his students to take online university courses instead of articulated coursework because of the risk that earned ECC credits would be thrown away.

Lead to an Industry-Recognized Credential or Certificate at the Postsecondary Level, or an Associate or Baccalaureate Degree

Of the three districts participating in the study, East appeared to offer the fewest opportunities for students to earn industry-recognized credentials. A number of East schools featured CTE programs with built-in credential or certificate-earning potential, such as CISCO, NAF, NATEF, NCCER, or PLTW. Such programs were found at Blue, our POS high school, and at Emerald, a

comprehensive high school with a developing NAF engineering academy. Although a number of participants noted that constrained resources hampered their ability to offer industry-recognized credentials, it was also the case that industry credentials were simply not a major district policy focus. Instead, district CTE personnel described the use of NAF academy completer certificates for students who completed such programs. District personnel acknowledged that it was difficult to get people from industry or postsecondary institutions to recognize the value of the NAF academy completer certificates compared to industry-recognized credentials.

District students were also eligible to receive three varieties of state career readiness certificates, derived from ACT's WorkKeys tests, as an indicator of basic work readiness. Both district CTE personnel and ECC counselors cited these certificates as being recognized by business and postsecondary. However, only a few interviewed students seemed aware of the availability of these certificates, or other credentials for that matter.

Available Credentials

Blue's three academies (Engineering, IT, and Medical and Biotechnology) offered a range of POS and a limited number of industry-recognized credentials. In Engineering, these included an automotive POS based on NATEF standards that prepared students to take the ASE examination; an NCCER-accredited construction program; and a PLTW-accredited pre-engineering program. Students in the Engineering academy were encouraged to get their OSHA certification. The IT academy's CISCO program offered the Cisco Certified Entry Networking Technician (CCENT) certification, CompTIA A+, C++, Oracle, and SAS. The Medical and Biotechnology academy was nationally recognized, but offered no formal industry credential; instead, the medical POS prepared students to take the CNA exam at their own expense elsewhere. According to the former head of the academy, the academy's advisory board was working with a local biotechnology center in an attempt to develop a credential for the biotechnology POS that would be recognized upon graduation.

The most-often mentioned industry-recognized credentials available from Blue and at other East District high schools were, in engineering, NCCER, OSHA, and PLTW; in IT, CISCO, CompTIA A+, Microsoft Office, C++, and Oracle; in culinary, the National Restaurant Association's ServSafe certification; in health sciences, the CNA; and in automotive, NATEF. In nearly all cases, participants noted that due to the recession, students bore the cost of taking these exams. Many participants noted that although students benefited from taking the exams, many could not afford them.

Case Study: NATEF Automotive Programs

Over the course of this study, we noted a reduction in the number of automotive programs in the district. By study's end, Blue's automotive POS was shuttered, along with several other district automotive programs, due to their high costs and comparatively low enrollments. Students in these programs were offered the opportunity to switch to another program or attend another school. One such student—a Blue automotive student whom we met in 10th grade—was the only East student we interviewed who not only knew about the future certification for which she was preparing, but also spoke knowledgeably and enthusiastically about graduating, taking the ASE

qualifying exam, and using it to work toward an advanced degree in automotive engineering. In her senior year, after the Blue automotive program closed, this student was compelled to return to her zoned high school, which had no automotive program.

A comparison site automotive teacher expressed his frustration at these closures as well as the pressures on him as an instructor of the demanding NATEF ASE-preparatory curriculum. As he noted, the curriculum was the same whether it was offered at the high school or the community college, with the exception of some curricular additions made by the state (e.g., career guidance, car maintenance) in order to ensure high school graduates' career readiness. Program graduates were prepared to continue their studies at ECC, where their high school courses were accepted for credit, shortening their time to a two-year degree by one semester or more. At least until the recession, high school students could also take automotive courses at ECC. Unlike the less stringent program leading to NATEF's GST credential, the ASE-preparatory curriculum features strict guidelines for learned tasks, skills, and standards. This intensity made it that much more difficult for him to reach disinterested students. Each semester, students were placed in his classes merely because they had empty slots in their schedule—such students usually lacked the motivation to complete the demanding curriculum. A different perspective was taken by the instructor of another comparison school automotive program. This teacher recognized that, although his program aimed to prepare graduates to receive the additional training they needed to become ASE technicians, not all students had the same level of interest. His goal was to help them understand that:

> There's just so many aspects to the automotive industry that they could become interested in… I just want them to be successful and know that there's all kinds of options. Not be so rigid that… I turn anybody that doesn't want to be a technician away, or turn them off… I have to be flexible enough to… recognize some of their talents… even though it may not be automotive technician.

Prior to the fourth year of our study, this teacher's automotive program was shuttered.

State and Local Legislation or Administrative Policies Promote POS Development and Implementation

State Policies

East District's state exerts strong control over educational policy, especially CTE-related policy; as such, many actions taken at the state level impinged both positively and negatively on how the district's POS were developed and sustained.

State funding and other resources. This state provided ongoing funding specifically for CTE as well as extra funding for schools with large populations of students from low socioeconomic status backgrounds. Many schools in East District qualified for this extra funding. Blue's principal told us that although a comprehensive high school would invariably apply such extra funds to its core departments, at Blue, he also used such funding to improve POS classes and purchase needed equipment.

Establish formal procedures for the design, implementation, and continuous improvement of POS. State-generated POS curricula, standards, and assessments were developed with input from secondary and postsecondary faculty members from across the state. We spoke to many East teachers who had participated in state curriculum committees. Industry representatives were also involved in the review of POS curricula, standards, and assessments.

Require secondary students to develop an Individual Graduation or Career Plan. East's state offered several options for earning a diploma, depending upon a student's concentration in college preparatory courses, career preparatory courses, arts programs, ROTC, or some other combination of courses or programs. Based upon these available diploma options, students worked with guidance counselors to choose classes each year, which they tracked on four-year course-taking plans. Parents were required to sign off on students' course selections. This annual process, as well as the four-year plans themselves, appeared to be designed to help counselors schedule students into courses and ensure that they earned the requisite number of credits, rather than to help students plan for future careers. No student we interviewed mentioned using his or her four-year plan at any time other than during course registration periods. Plans also did not record the results of any career interest inventories that students may have taken, or any other activities undertaken in preparation for the transition to college and careers. One counselor noted that although comprehensive plans that followed students from middle school through high school had once been in use, such plans were no longer required. The district's CTE director said that the state did not mandate such highly individualized plans.

Provide resources for long-term sustainability of POS. As part of its college and career readiness initiatives, the state was developing more POS and STEM programs, drawing upon a statewide coalition of secondary and postsecondary faculty and industry partners. Schools with PLTW programs worked together on grants to enrich their programs.

This state allowed teachers to develop and test curricula, with the expectation that such curricula would pass through the state's approval process. To receive state approval, a new curriculum had to include an item bank of test questions and be reviewed by a committee comprised of postsecondary faculty and at least 80% industry representatives. According to one STEM teacher, the state's intensive review requirements not only served to squelch teachers' desire to develop new and different curricula, but also moved so slowly that some newly developed programs ran the risk of being out of date by the time they were approved by the state.

The state worked with postsecondary faculty and industry partners to develop vertically aligned postsecondary curricula for use statewide. State-convened curriculum improvement groups united faculty from every college offering a given program. Post-recession, such groups were not able convene frequently, although some fields, like IT, changed so frequently that the state needed to quickly alter its curricula to keep up.

How to develop POS that could be sustainably and responsively updated over time presented challenges to both the state and the district. One district CTE administrator believed that conceiving of POS as prescribed, on-paper course sequences was outdated. Given the rising popularity of online and dual credit course-taking options, fewer students were remaining in high school for the full four years. In this "new world," she believed the district needed to think more

"futuristically" about its POS; the future included a program consisting of six years of education offered in a five-year period, culminating in both high school and postsecondary credentials. This accelerated five-year plan had been approved by the state for pilot testing.

Other relevant state policies. The state defined a CTE concentrator as a student who completed four credits in a CTE program area, the last of which was credit from a capstone course. However, CTE concentrators did not have to follow a specific course sequence. By contrast, POS completers, as defined at the district level, had to earn at least four credits in focused, progressively more intensive course sequences, culminating in a capstone. Students in Blue's POS academies were expected to take POS-related electives.

District Policies

Local funding and other resources. The recession led to major cuts to teacher and administrator positions during the early years of the study, and even some school closures. Most of these closures were at the elementary and middle school levels, but high schools were also closed; students from closed schools were transferred to other schools. In the case of students attending district magnet programs (e.g., POS, IB, or arts programs), students were offered the option of pursuing their programs at other schools. To ease their transition, high schools receiving large numbers of transferred students quickly moved to implement curricula offered at the closed schools so that students could complete their programs. For example, Heliotrope, one of our comparison sites, de-emphasized its comparatively under-enrolled pre-engineering program in order to adopt programs in early childhood education and marketing that were needed by the many transfer students it received.

The recession meant that CTE programs at all district schools faced cutbacks. Although some programs lost teachers, both the district and the schools themselves made efforts to "protect the classroom" by focusing cuts elsewhere, where possible. One position targeted for cuts was the school-based administrative career coordinator; some schools lost their dedicated coordinator and were compelled to share this position with another school. Schools with limited technology resources resisted the pressure to "double up" students on computers because students needed free access to technology in order to perform well on end-of-term technical assessments.

The recession also affected operations in the district's CTE department. During one especially difficult year, districts were required to return money to the state with little notice; orders of needed materials "that were in delivery en route [were] just cancelled, you know, on the truck." With its budget slashed close to 40%, the district's CTE department concentrated on its core missions: supporting technology, basic supplies, professional development, and CTSOs. Activities deemed less essential were cut, including monthly curriculum alignment committee meetings. Although school administrators sought ways to work around budget cuts—say, by filling an open administrative position with a classroom teacher—district funding formulas precluded many such efforts. Some participants thus complained of "downtown" bureaucratic procedures that required them to "go through ten levels of approval to get anything."

One comparison school CTE teacher was well aware that given the district's constrained budget and restrictive funding formulas, it made more sense to hire one English teacher who could teach

multiple sections, each serving 30 to 35 students, rather than one CTE teacher serving small numbers of students in program-specific upper-level courses. Given such pressures, some expensive-to-maintain programs, like the CNA strand of health sciences, were cut. Other programs, according to one teacher, sought to perform well but keep a low profile: "If we're quiet and do our business, and get good scores, they'll leave us alone. But if you're costing them money…" Overall, a number of teachers in more traditional CTE programs at the comparison sites believed that the recession offered a ready excuse to close their programs and re-allocate funds to more popular initiatives (e.g., STEM, PLTW).

By 2011, as the economy slowly recovered, the district was able to restore some teacher positions and purchase new equipment for some programs.

Ensure opportunities for any secondary student to participate in a POS. Cuts to the district's transportation budget led to a reduction in the number of bus pickups made near students' homes and the creation of a more limited number of regional "shuttle stops." For students enrolled in distant magnet or POS programs, this meant having to secure either private or public transportation to the shuttle stops. Although the district saved money through this new policy, it created considerable upheaval for magnet schools and students. Students who could not obtain transportation were compelled to give up their programs and return to their zoned high schools. As one teacher lamented, "Kids need consistency and structure."

Provide resources for the long-term sustainability of POS. East's long-term goal was to implement POS in all of its comprehensive high schools and to gradually eliminate resource-draining singleton classes in favor of groups of related courses linked to selected Career Clusters, as we described in an earlier section on non-duplicative course sequences. The district's CTE department sought to help principals choose programs that would help them meet broader school goals, weighing a program's popularity against the need to attract and retain students from feeder middle schools with similar magnet programs.

East District supported its high school CTE programs with dedicated school-based personnel, including career coordinators who served as point people for all CTE services and activities. Career coordinators ensured that a school's CTE or POS-related instructional, material, or purchasing needs were met and conducted instructional visits. Instructional coordinators were responsible for administering assessments and reporting outcomes. During the recession, many schools lost one or both of these positions; in some cases, schools shared career coordinators, and teachers picked up some of their duties. As schools lost more CTE teaching positions, however, teachers could not continue to absorb these additional tasks. As such, some coordinator positions were brought back.

The district supported transportation for field trips within the county. At Blue, academy teachers sought to give students opportunities to visit workplaces related to their POS. Given the limited number of biotechnology companies in the area, one of Blue's biotechnology teachers solicited a donation from a previous employer that allowed her to take her students on a field trip to a manufacturer located in a different county.

Other relevant district policies. Students enrolled in any of East's lotterized magnet programs who failed a required magnet course (i.e., a POS course) were given extra academic support for a semester. If they failed to improve by the end of that semester, students could be sent back to their zoned high schools.

Ongoing Relationships Among Education, Business, and Other Community Stakeholders Are Central to POS Design, Implementation, and Maintenance

Business and Industry Partnerships

East's CTE programs and POS were governed by "umbrella" state-level advisory boards (e.g., spanning Career Clusters tied to sector strategies) comprised of postsecondary and industry partners. Industry partners were involved in all levels of curriculum development in order to ensure that CTE curricula met industry standards; the state also required that industry partners review all end-of-term test questions as they were being developed. According to the district's CTE director, business and industry involvement was not only "good PR," but also a valued mechanism for developing a pipeline of skilled workers to replace a graying workforce.

Although the recession forced many business partners to reduce or withdraw some of the material, financial, or personal assistance they provided to the state, the district, and individual schools, many interviewees stated that business partners continued to offer abundant support. Such support included donated equipment, work-based learning opportunities (coordinated centrally by the district), funding to support field trips and other special events, scholarship assistance, and mentoring and volunteer hours. Academy coordinators and career coordinators facilitated the process of building and maintaining relationships with these partners.

Overall, there appeared to be little difference in the types or amount of business and industry support offered to Blue Academy versus our comparison sites, which offered "regular" CTE in comprehensive high school settings. Support also flowed in the other direction, with schools reaching out to businesses and the community to offer help and expertise. At Blue, for example, e-Commerce students worked to create and update websites for small businesses; they also offered marketing plans to businesses featured in the local business newspaper. At Indigo, students in the school's PLTW architectural design program joined with students from other East District ACE (Architecture, Construction, and Engineering) Mentor programs[5] to redesign a derelict shopping mall into a vibrant new mixed-use facility.

Each school also had school-level advisory boards; at Blue, NAF required one board for each of its three academies. At Emerald, participants interviewed in the third year of the study described an upcoming open house event at which they planned to showcase the school's emerging NAF Academy of Engineering to dozens of business and community partners, including nearly three dozen academy advisory board members. These members were described as providing input on the academy's curriculum and work-based learning experiences. The school saw these partners as providing a valuable supplement to the otherwise state-directed CTE curriculum. Emerald was

[5] A national initiative with affiliates in nearly every state, ACE Mentor programs bring schools, students, and industry professionals together for a year's worth of concentrated lessons, teamwork, career exploration, and a hands-on construction project. We found ACE programs in East and South Districts.

also remarkable for its foundation: Funded by generous alumni, the foundation paid for professional development and personal enrichment for faculty and students. Every few years, the school held pledge luncheons, catered by the school's award-winning culinary students, to generate additional donations. Emerald's principal and career center coordinator agreed that finding business and community partners to support the school's programs was never a problem. As the coordinator stated, "We have a warmth in the community and a willingness to jump in."

Student experiences. Although not mandated by any district CTE program or POS, work-based learning experiences in the form of internships were available to students who wanted them. CTE teachers also arranged interactions with business and industry. In one Blue IT class, students worked on a long-term project that involved building a virtual computer system and creating a sales pitch to describe it. The teacher arranged for these presentations to be filmed and reviewed by a Microsoft representative who returned feedback on their technical and marketing know-how.

Community Partnerships

As in our other two districts, East schools not only received valuable support from local service organizations, non-profits, and charities, they also sought to give back to these organizations. Indigo's high-energy principal described doing "something every week" with "homeowners associations, … feeder schools, [and]… various civic groups in the community, whether it's the Y or Kiwanis, Rotary, Optimists, the Masons…and on and on and on… I'm at a lot of sports events. We participate in any community activity we can." This principal also described how highly involved his school's CTSOs—including DECA, FBLA, and FFA—were in giving back to the community.

Postsecondary Partnerships

Because articulation agreements and curriculum alignment were largely negotiated at the state level, there was much less incentive in East District for teachers to seek out or nurture personal relationships with postsecondary partners. However, participants at every site commented on the positive, supportive relationships they enjoyed with the region's highly regarded community college, state universities, centrally located Historically Black College and University (HBCU), and local trade-technical and culinary schools. Postsecondary institutions, especially ECC, sent representatives to the schools to make presentations and assist students with applications, testing, financial aid, and scholarship information; sponsored campus visits for students and parents; hosted informational meetings for high school guidance counselors; and in one special initiative, sent university students to the district's engineering and IT classrooms to give hands-on presentations about the latest technologies.

The local community college. ECC administrators, faculty, and counselors all described efforts to create seamless pathways between the district's programs and its own, thus increasing enrollments. As our data collection efforts in East drew to a close, ECC was in the process of working with the state and district to coordinate a new dual credit program that would offer more prescribed, streamlined pathways to earning college credit. Overall, however, over the course of our study, district support for credit transfer opportunities drastically declined. A highlight of our

first site visit to East was an early college enrollment program that allowed students to take courses on the college campus with district support for books, tuition, and transportation. This program had disappeared by the last year of our study, having been largely replaced by cheaper online coursework.

ECC remained a popular and affordably priced option for many East District graduates. The first principal we interviewed at Blue commented that as many as 80% of his graduates went on to enroll there. However, he and others at Blue also strongly encouraged students to apply to four-year universities. Some ECC faculty who had worked closely with Blue to align their programs and accommodate high school students' schedules said that many of the students who earned credits from their program ended up attending four-year universities on scholarships instead. These faculty members questioned the value of their investment in Blue's programs.

ECC also cultivated relationships with the district and the state university system, as in the case of a college transfer success class that was being piloted with a group of district students who had been denied admission to the state university because of their low academic performance. If these students agreed to attend ECC and successfully completed two semesters of intensive remediation and university-preparatory coursework, they would be guaranteed admission to the state university.

The state university system. When interviewed in 2010, the district's CTE director described efforts to align the district's engineering programs—particularly its PLTW programs and NAF engineering academies—with one of the state universities as still "in its infancy." He believed that state university officials realized how few district students were enrolling at the college compared to students from out of state, and recognized that they could do a better job of marketing and recruiting from within the district's high-quality programs: "I think they're viewing [CTE] in a different light… They're seeing the coursework that we're providing and they didn't know it could lead directly into the university system, and they didn't know the percentage of students who were already college prep … in the district."

Sustained, Intensive, and Focused Professional Development Opportunities for Administrators, Teachers, and Faculty Foster POS Design, Implementation, and Maintenance

East District provided professional development to all school personnel on a wide array of topics related to assessment and accountability, technology use, college and career readiness, state graduation requirements, enriched academics, CTE curricula, POS, school safety, pedagogical strategies and classroom management techniques (e.g., differentiated instruction, literacy interventions, professional learning communities, block scheduling), and counseling issues. The district also provided support for new teachers entering the profession from business and industry. Study participants described professional development as occurring during summer sessions, Saturday workshops, and regularly scheduled in-services throughout the school year. Professional development was available onsite, online, at national conferences or trainings, and at local and regional postsecondary institutions.

Across all four years of our study, many participants reported that a great deal of professional development addressed the district's electronic assessment and accountability systems, which included online test item banks, data reporting and analysis tools, and electronic student education plans (e.g., four-year graduation plans). Administrators, CTE instructional coordinators, career coordinators, academy coordinators, guidance counselors, and teachers all mentioned participating in trainings related to these tools and systems. Most agreed that the district's goal was to help schools use data to improve instruction and increase student achievement. As one principal stated, the district was "trying to minimize the amount of data they're giving us, but help us understand how to use that data." Training related to these systems was most often described as helping teachers understand how to upload items into and use test item banks, analyze system-generated data reports, use those reports to identify deficiencies, and work together to enhance their teaching strategies. A number of interviewees noted that CTE teachers had an advantage in adapting to these new assessment systems because they had been using state- and district-sanctioned CTE test item banks and data tools for many years. Core academic teachers, by contrast, were familiar only with the state's high-stakes tests and had never before been asked to upload their classroom assessments to a centralized system. Despite CTE teachers' perceived advantages in using this system, two coordinators agreed that the pressure to use these assessment systems could be "overwhelming even for seasoned teachers," to say nothing of new, alternatively certified teachers.

Given East's heavy investment in instructional technology, many interviewees noted that they had participated in technology-related professional development, and most said that they were fully supported by their principals and the district in their efforts to incorporate technology in their classrooms. Frequently mentioned were trainings related to Moodle, the district's online teacher community of practice, document-sharing hub, and virtual classroom environment; instant student response systems (i.e., "clickers"); common classroom equipment (e.g., graphing calculators, document cameras, projection systems); and various instructional software packages.

General District CTE Professional Development

East's CTE department provided professional development to all schools offering CTE, whether that CTE was offered in the form of stand-alone classes or programs or fully fledged POS. Participants described these trainings as being delivered by district CTE personnel, school-based CTE instructional coordinators, academy coordinators, personnel from external accrediting agencies (e.g., NAF, PLTW, NATEF), the local community college or universities, and somewhat less frequently, industry partners.

During the course of our study, the district's CTE department engaged in a major effort to explain the structure of the state's sector strategy-aligned career pathways and how these connected to course sequences and graduation requirements within CTE programs and POS. District-trained instructional coordinators and academy coordinators were primarily responsible for helping guidance counselors and CTE teachers understand these requirements so they could communicate them effectively to students and parents.

As noted, a major district initiative during our study was the implementation of the PLTW curriculum in nearly all district high schools. The district's CTE director explained that although

it required substantial investments in intensive teacher training (sometimes out-of-state), materials, and software, PLTW offered the best value in terms of academic rigor, curricular quality, and improved outcomes for all students, not just those enrolled in PLTW, by creating a culture of high expectations in each school. By embracing models like PLTW, the district's philosophy was that it had to "raise the bar for every kid in your school and … move forward from there. That's what we've done here rather than…[seek] the quick fix."

At Emerald, for example, teachers, administrators, guidance counselors, and instructional coordinators were committed to building a NAF-accredited Academy of Engineering featuring the PLTW engineering curriculum. With financial support from the school's foundation, the district, and industry partners, participants reported engaging in both PLTW and NAF trainings. Having started with one cohort of students and a limited number of courses, the school was gradually adding courses and grade levels to its curriculum. Data collection and analysis were identified as very important to this process, as the school was keen to earn distinguished status for its NAF academy.

Abundant occupationally-specific professional development was available from national certifying bodies and regional postsecondary and industry partners. An Indigo automotive teacher described how he participated in 20 hours of NATEF training each year and also received training on changes in automotive technology from General Motors, Chrysler, and ECC. Similarly, a business academy teacher at Blue noted that she had received continuing education support from her program's business partners, including training in how to use computer programming and data analysis software packages like SAS. This training allowed her to develop engaging, hands-on projects for her students. Some highly-skilled teachers also trained their fellow teachers.

Professional Development for Guidance Counselors

Guidance counselors noted that although most school-based professional development was focused on teachers, they were otherwise well-supported with the counseling-specific training needed to maintain their licensures. Trainings were generally reported as focusing on scheduling, testing, college preparation, student safety and mental health issues, and to a lesser extent, career preparation. When asked about POS, guidance counselors at all study schools reported that they had received some degree of professional development from their instructional coordinators, career coordinators, or academy coordinators related to the state's changing graduation requirements, POS, and course sequences. Counselors also noted that both the district and ECC provided them with abundant information related to credit transfer opportunities, admissions tests, financial aid, scholarships, and enrollment processes. All counselors mentioned that ECC and state and regional universities sent representatives to school college fairs and facilitated campus visits.

Professional Development Provided by the Community College

ECC was described by many participants as a major provider of professional development and credentialing for district teachers in both academic and occupational programs. Faculty in one of the college's engineering-related programs described how they helped credential high school

teachers to offer college-approved dual credit courses. These faculty members were intimately involved in the development of aligned, sequenced POS between the district and the college and were strongly motivated to protect the integrity of their programs. As one college faculty member stated, "[our] accreditations rely on a certain level of expertise of our faculty. That's one problem in high schools—there's not many engineers teaching in high schools."

ECC admissions counselors noted that they spent a great deal of time working directly with students, parents, counselors, and teachers at district high schools so that they understood college enrollment and admissions policies, credit transfer options, and the full range of financial aid and program opportunities available. ECC hosted events both in the schools and on its own campus.

Systems and Strategies to Gather Quantitative and Qualitative Data on Both POS Components and Student Outcomes Are Crucial for Ongoing Efforts to Develop and Implement POS

State Assessments

Little to no distinction existed in this state between state assessments and other academic assessments: All were state-run and housed online. The same held true for CTE technical skills assessments, described later in this report. In lieu of offering high-stakes math, English, and science tests in the 10th grade, all assessments in this state were end-of-term assessments administered at the end of every core course. In order to graduate, students had to pass the Algebra I, English, and Biology end-of-term exams; these courses were often but not always taken in the 10th grade.

This state adopted a web-based assessment system as its statewide growth model that allowed users to track students' longitudinal performance data, including their grades and performance on interim and end-of-term assessments, for the length of their residency in the district. Given past performance data, the system could make individual student-level performance projections for a given course and identify which students were at risk of failure, thus allowing teachers to target those students with instructional interventions. The system also measured teachers' effectiveness with high-achieving, mid-level, and low-achieving students. According to one principal, teacher performance data were used to protect, not punish, struggling teachers by helping them identify areas of instructional weakness and, supported by peer mentoring or targeted in-services, adopt new practices to better reach all students.

At least as initially implemented, unlike the CTE assessment system, academic assessment results were not broken down at the individual student or question level; rather, the system offered trend data—student growth and teacher growth over time. However, academic and CTE assessments were similar in drawing upon state-provided test item banks that allowed the state to track achievement on the same items statewide. As noted elsewhere, CTE teachers were already familiar with the use of these test item banks; academic teachers were not. Further, when the state implemented an interim assessment system, CTE programs were able to quickly populate their interim assessment test item banks; no extra support was available to help pay for the extra time academic teachers needed to populate their interim assessment test item banks.

Principals reported that assessment results varied based on the availability and quality of teaching staff. Prior to the hiring of the first principal we met at Blue Academy, the school had a shortage of certified math teachers and instead employed long-term substitutes with limited classroom management skills. Low math test scores reflected these teachers' inexperience. Three years later, after the new principal stabilized hiring and achieved consistency in the math department, scores rose. Similarly, at Neon, non-certified science teachers produced low science scores. Once the school hired a certified science teacher, scores rose.

Principals used other strategies to improve students' test scores, including online remediation. At Indigo, 100 ninth graders who were reading below grade level were given a remedial reading program and online coursework supported by some of the school's best teachers and facilitators. Students then took the English I end-of-term assessment online; 92 of the 100 passed both the course and the exam. According to Indigo's principal, the experience "allowed us to meet kids and develop skill sets depending on where they were." He stressed that although online courses could be a great economic decision, they were not necessarily a great educational decision if resources were not devoted to their successful implementation.

Other Assessments

The state board of education mandated that all juniors take the PSAT and all seniors take either the SAT, ACT, or a WorkKeys technical assessment. Students in the federal free or reduced-price lunch program could take the SAT or ACT at no charge.

As part of its outreach efforts, ECC staff visited all East high schools to encourage students to participate in its early registration program. During these visits, students took ECC's placement exam. If their scores were good, students could keep that administration of the exam; if their scores were not good, students had time to improve and retake the exam.

Content Standards Define What Students Are Expected to Know and Be Able to Do to Enter and Advance in College and/or Their Careers

Participants' definitions and perceptions of college and career readiness varied across East District. College preparation—and a general expectation that all students would strive to attend college—was the most commonly expressed goal. As one Blue pre-engineering teacher bluntly stated: "All of these students are college bound… We have the mentality that these students are going to college and we're preparing them in that fashion."

In addition to urging students to prepare for college and earn college credits, however, teachers and administrators also stressed preparing for careers. As one medical careers teacher put it: "I really want to see all my kids in some sort of career that I can look back and say, 'I remember her. Now she's Dr. Such-and-Such,' or 'She's head over research at this university,' or something like that. So we talk on a daily basis about their future because I have mainly ninth graders."

Another avenue for career preparation was through work-based learning and opportunities to earn industry-recognized credentials and certificates that would have value in the workplace. At

Blue, portfolio preparation was a cross-academy initiative designed to combine POS research and college application planning. Students kept career journals in which they explored different jobs linked to the medical fields and concepts they were studying. They also compiled transcripts, recommendations, SAT scores, community service hours, evidence of extracurricular activities, and other materials that they could readily present to college admissions officers. A computer science teacher described how students with carefully prepared portfolios had been "accepted on the spot" by admissions officers attending an on-campus college fair. School-wide, teachers and administrators sought to create a culture in which students "look prepared… [like] a student that's ready to be a freshman in college."

Definitions of college and career readiness varied at the four comprehensive high schools in our comparison group. Emerald's principal and career center director both emphasized the role of work-based learning, partnerships with local businesses, job readiness workshops, and career guidance and exploration in creating smooth transitions into either college, jobs, or military service. At Indigo, the principal believed that his students needed to graduate with coursework, college credits (both general education and CTE), and skill sets that would dovetail with their career choices and allow them to pursue any form of postsecondary education, whether that was at a two-year or four-year college or a technical school.

At Heliotrope, a self-described college preparatory school, interviewees cited the school's expectation that all students would go to college and frequently referred to college fairs, college advising, scholarships, and the school's partnership with ECC. However, the career coordinator also described her efforts across programs to better educate students about the district's Career Clusters approach and to help "build [their] transferable skills to be able to go into any type of career to be successful."

Interviewees at Neon, East's arts school, saw themselves as readying students to graduate with the same or better preparation for arts-oriented careers as college students. Such preparation included college and career advising tailored to students' arts focus. As the school's drama department chair explained, students were counseled to understand the differences between regular colleges and specialized conservatories; the latter, she noted, did not always offer credits that could be transferred to other institutions. Students were also extensively advised on their college application and audition materials. Although less formal CTE was offered at Neon compared to the district's other high schools, its career coordinator perceived college and career readiness as offering rigorous academics coupled with work-based learning that would enable students to make empowered college and career choices after high school.

Guidance Counseling and Academic Advisement Help Students to Make Informed Decisions About Which POS to Pursue

In East District, state graduation requirements for our cohort mandated an academically rigorous college preparatory curriculum for all students. Students enrolled in the district's POS (as at Blue) or in CTE programs at the comprehensive high schools could earn a career-ready diploma provided they completed a series of sequenced, non-duplicative courses. As with the other two districts participating in this study, East did not necessarily refer to these sequences as "programs of study." As previously described in the non-duplicative sequences section of this report, district

personnel perceived their approach as broader and more flexible, giving students the option to complete their sequences in as little as three years. All CTE curricula included a state-mandated career guidance component delivered by CTE teachers through classroom instruction and career exploratory activities.

At ECC, the admissions counselors we interviewed supported the district's approach, believing that students who followed a POS were more directed, better advised, had better grades, and were generally better students. The college helped ease students' paths from high school to postsecondary by bringing high school guidance counselors to its campus to educate them about its programs and sending admissions counselors to the high schools to provide students and parents with information and early registration support.

Guidance Counselors' Roles and Responsibilities

As in the other two districts participating in the study, East guidance counselors reported spending much of their time engaged in scheduling, course registration, college planning, and administrative tasks. At Blue, for the first three years of the study, guidance counselors were academy-specific and worked with the same group of students across all four years. This allowed counselors to not only develop deep knowledge of their academy's POS, but also personal histories with the students in them. We perceived this system as a school strength. However, prior to the fourth year of our study, the loss of a staff member and the recession led Blue to revert to alphabetic student caseloads. This model prevailed at the district's comprehensive high schools, including at our four comparison schools.

One Blue guidance counselor explained how during pre-registration periods, she reviewed students' transcripts and preselected classes for them based on their POS; during scheduled counseling sessions, students and parents could select different electives or customize students' course selections based on their college and career goals. She conducted credit checks twice yearly, and the district also mandated on-track-to-graduation credit checks in senior year.

Other Support Personnel

At all district schools offering CTE, CTE teachers and programs were supported by career coordinators who delivered career exploration activities, coordinated internships, implemented technical skills assessments, and facilitated student participation in dual enrollment, online coursework, and credit recovery programs. Trained by the district's CTE office, career coordinators also educated guidance counselors and teachers about district CTE initiatives, including POS, technology adoption, and graduation requirements. At Emerald, an instructional coordinator worked with teachers to integrate technology into their curricula. Emerald also had a career center staffed by a full-time director. Other district schools shared a career coordinator with a neighboring school. At Blue, academy coordinators—de facto department chairs—undertook the tasks performed by career coordinators and served as liaisons between the administration and their academy's teaching and counseling staff.

Classroom-Based Career Guidance

Although all of Blue's academies embedded career guidance and career development into their curricula, its Medical and Biotechnology Academy yielded such striking examples that we offer it as a case study. In a senior-level Biomedical Engineering class that we observed, an alumna—now a lower classman at a prestigious in-state university—came to spend the day with her former classmates and share her thoughts regarding the realities of college. This young woman talked about how well Blue students were being prepared for the rigors of college, explaining that many of her fellow university students lacked her knowledge and lab skills. Such visits were a common occurrence, according to the teacher. This particular class featured a number of noteworthy examples of career guidance and skill development, including a reference to a previous module in which the class built and maintained online stock portfolios in an effort to understand biotechnology startups and the obstacles they faced finding funding and turning a profit. Although the main focus of the class was practicing DNA analysis techniques, this reference highlighted how the teacher incorporated the business aspect of biotechnology to her curriculum.

Professionalism was a major component of this academy's curriculum. Students developed portfolios in which they maintained resumes, work samples, community service hours, action plans, recommendation letters, and transcripts that they could use for job or college applications. Students also kept journals in which they explored careers linked to each unit they studied (e.g., if learning about heart disease, a student might prepare an entry on cardiologists). As the academy coordinator noted, these journals exposed students to a wide range of career options within a POS. The goal was for students to understand that career trajectories were not linear, and that different levels of education and training provided access to different kinds of jobs.

Medical and Biotechnology Academy students also had many opportunities to engage in work-based learning, CTSO-sponsored activities, and other forms of career exploration. One senior said that she interned at a local hospital during the previous summer and also spent time shadowing an emergency room nurse. She actively volunteered at four health care-related community organizations and, as a HOSA member, participated in school blood drives. The academy invited health professionals to speak to students and sponsored visits to universities with well-regarded medical programs and field trips to health-related companies. The biotechnology teacher noted that one of these field trips had led to an excellent job for a student.

Career guidance and career exploratory activities were also a part of the curricula at our comparison sites, but in a less concentrated and sometimes less well-resourced way. At Neon, the district's arts school, career guidance was arts-inflected. For example, a senior-level theater class featured advice and feedback regarding how to prepare for college auditions. The teacher spoke at length about how the program sought to professionalize students, working with them on how to dress, obtain head shots, build resumes, conduct mock auditions, and choose agents and managers. Program faculty wanted their students to graduate as well prepared, if not more so, than most college students. The program also sought to arrange internships at local theater companies at which students could perform theater tech and stagehand work, but scheduling issues sometimes made such internships difficult to secure. Overall, work-based learning opportunities were challenging to organize and not overly abundant for Neon students; two

interviewed students suggested that they sought out internships by requesting the support of a CTE teacher, the CTE chair, and the school's career coordinator. Career coordinators at other comparison sites—including Heliotrope and Indigo—agreed that arranging internships was challenging not just because of scheduling issues, but also because the recession had reduced the ranks of their business and community partners. An advanced business studies teacher at Heliotrope drew on her own personal business connections to place her students in internships.

Innovative and Creative Instructional Approaches Enable Teachers to Integrate Academic and Technical Instruction and Students to Apply Academic and Technical Learning in Their POS Coursework

Interdisciplinary Teaching Teams

Blue Academy. At Blue, curriculum integration and teacher collaboration occurred during teachers' planning periods; no additional time was allotted for this activity. In general, core academic teachers shared items that POS teachers could incorporate into their classes to help students meet academic standards. The POS teachers we interviewed said that they largely integrated their curricula themselves.

Although limited in scope by scheduling constraints, interdisciplinary collaborations were appreciated by students and relished by teachers. A medical POS teacher reported working with science colleagues on curricular units like DNA, sharing worksheets and activities across departments; her students were excited about encountering the same topic in different classes. An engineering teacher said he found himself providing less tutoring in math after he mentored the school's three new math teachers in how to integrate their instruction with architectural engineering problems. One of these math teachers commented that his engineering academy students were highly engaged by such lessons.

Blue's biotechnology teacher found many opportunities to collaborate across disciplines, despite the limited planning time available to her. Having first solicited the principal's approval, she co-taught a microbiology class with a science teacher; the science teacher served as the lead teacher, and she led the class's lab component. The biotechnology teacher also sought to align her program with the school's earth and environmental science classes; if the school could find the resources to construct a greenhouse, she envisioned her biotechnology students genetically manipulating the plants that Blue's earth and environmental science class students would grow in the greenhouse. This teacher also believed that the school should foster data sharing across, not just within, academic and technical departments; she asked the principal to allow POS and academic departments (e.g., biotechnology and science, or computer programming and math) to work together to analyze their student performance data, identify areas of curricular weakness, and spend the summer developing lesson plans and other activities to address those weaknesses. This teacher strongly believed that the more each department understood the other's curriculum, the better they could sequence their instruction and target individual student learning needs.

We observed only one example of interdisciplinary team teaching at Blue: a math teacher and an engineering teacher co-teaching a pilot PLTW course. In this example, however, the math

teacher remained largely silent. Team teaching appeared to be a relatively new phenomenon at Blue, with teachers' roles still unclear.

Comparison schools. Curriculum integration and interdisciplinary teacher collaboration were less evident at the comprehensive high schools we visited. One comparison site CTE administrator said that despite a national push to align academics and CTE, this state "never did buy into it wholly, as in, 'Let's sit down at the table with the academic teachers to integrate what we do.' If it's a drafting teacher and students need geometry skills, he teaches those skills, but it's not aligned in any way with what that geometry teacher would be doing."

Overall, CTE teachers were responsible for teaching the academic skills embedded in their CTE curricula, not the other way around. These embedded academic skills were an implied component of the state's technical skills assessments. For example, although there were no explicit geometry questions in a drafting assessment, students had to know geometry concepts in order to answer questions about drafting.

Statewide, as academic testing expanded and became more high stakes, academic teachers became even less available to help other teachers integrate academics into their curricula. This affected all disciplines, not just CTE. As a theater teacher at Neon, the arts school, put it, "I feel that everybody is so stressed about teaching what they're going to be tested on in their own curriculum, it's really hard for them to move beyond that sometimes." Further, given that common planning time in most schools was dedicated to single departments, there was little time for academic teachers to collaborate across disciplines.

We observed some examples of curriculum integration in the comparison high schools, but most involved no teacher teaming. A math teacher at Indigo used examples from science and medicine to teach the concept of volume in her Algebra II class; this led to a discussion of professions in which calculating volume would be an essential job function. Heliotrope's advanced business teacher heavily infused her class with reading, writing, and communication skills. Overall, the teachers we spoke with saw curriculum integration as a means of capitalizing on student interest and teaching academic skills almost by stealth. As Indigo's automotive teacher said:

> The perception has always been that automotive, construction, horticulture… is not academic, but it is. My kids come to Indigo, [and] some of them stay the whole four years, and what motivates them to come is my class. Or if they're interested in horticulture, then what motivates them to come is horticulture… It's not that we don't teach academics, because we do. We just don't advertise…. [Students] get [academics] pushed down their throats, and you have to get in the back door with them. I mean, yes, we have to do it, and we do it. But the main reason we do it is so the car will run.

During our study, Emerald was developing a NAF Academy of Engineering featuring the PLTW engineering curriculum. As part of the process, an interdisciplinary team of academic and technical teachers met weekly to collaborate, frequently observed each other teach, and were scheduled to receive training on curriculum integration over the summer. We observed one of their weekly meetings, at which a math teacher commented that he signed on to the academy because of the district's adoption of the Common Core State Standards. He believed that the

PLTW curriculum not only met the standards, but was also "fun and interactive" and helped students "to take what they know and apply it to a real world situation." The teachers we met were enthusiastic about working, learning, and teaching together; their palpable excitement highlighted the comparative dearth of such opportunities elsewhere in the district. Overall, we found that schools were not averse to teacher collaboration or integrated curricula; rather, budget and scheduling constraints made it difficult to change institutional cultures to support such collaboration. By contrast, the launch of Emerald's NAF academy involved significant schedule changes; an assistant principal for scheduling was a key member of its planning team.

District perspective. Despite the difficulties involved, district personnel recognized the importance of implementing common planning time and changing school cultures to foster curriculum integration and cross-disciplinary teacher collaboration. They also acknowledged the limits of their ability to effect such changes beyond encouraging principals to recognize and communicate the value of such activities.

Contextualized Learning Approaches: Work-Based Learning

Budget and transportation issues limited the extent to which East students could participate in work-based learning opportunities, particularly off-campus; despite these issues, however, work-based learning in various forms remained popular and well-supported by district and school administrators, teachers, parents, and students. Many study participants described internships and participation in school-based enterprises or other on-campus hands-on learning experiences as an excellent way for students to explore careers, learn valuable skills, and prepare for both college and the job market. As Emerald's principal noted: "It's a great way to get them into an area… [and] not all kids are college-bound. However, if they get into an environment that will teach them the skills to pay for their college, too, that's another benefit for the … internship program."

Work-based learning was facilitated by the state's recently revised graduation requirements, which freed space in students' schedules for additional course-taking or off-campus work. At the district level, three district coordinators were responsible for maintaining relationships with area employers, creating protocols for employer and student conduct, and monitoring internships. Although internships associated with particular programs that required them—allied health, for example—often took place as group outings, students could also request and identify their own internship sites, provided they secured their own transportation. Regarding group internships, students in a medical pathway might travel as a group to an area hospital to visit various departments, supervised by their teacher and identified hospital personnel. Students who completed internship requirements, including completing assignments and making journal entries regarding their experiences in a web-based system, received a half-credit on their transcripts.

Work-based learning took many forms, including school-based enterprises, participation in business and community-sponsored in-school activities, and internships and job shadowing experiences at area businesses. Students in the culinary pathway at Emerald were required to work in all capacities in the school's on-site restaurant, bakery, and catering business and to complete mandatory after-school service hours at school functions. Many culinary students also sought and received external job placements in community restaurants. At Indigo, students in the school's design and drafting program were invited to participate in a competition to design a new

mixed-use facility at the site of an abandoned mall. Neon's career coordinator noted that although it was sometimes a challenge to educate his arts-focused students regarding the availability of internships and CTE credits for their work, he had several students currently in the internship pipeline, including one student whose internship with an area fashion designer had turned into steady employment for over a year. During one site visit, advanced business studies students at Heliotrope were preparing portfolios related to their career interests that the teacher was using to identify internship sites, which included a community organization focused on developing entrepreneurs, a photography studio, and a clothing store for a student interested in fashion merchandising. In Blue's IT program, work-based learning took the form of community service: Students repaired discarded laptops for donation to community organizations and also built their own towers using donated parts.

Contextualized Learning Approaches: Project-Based Learning

Project-based learning did not appear to be a district-wide, cross-curricular mandate; however, all East seniors undertook self-selected long-term graduation projects related to their studies and documented those projects in a portfolio or binder. Although formally overseen by English teachers, graduation projects were often related to students' career interests. This was especially the case at Blue and in high schools with career-related magnets or CTE programs.

As a pedagogical strategy, project-based learning was most widely and consistently supported and implemented at Blue, where the school's academy structure and block scheduling made it a natural fit across CTE and core academic classes, although we also observed examples of project-based learning at our comparison sites. At Blue, an IT teacher described how her students partnered with a professional sports team to perform analyses of game data; area businesses also donated equipment that allowed her students to design and build computers. In the school's PLTW biomedical engineering POS, students explored genetic differences in DNA labs to isolate strawberry DNA and solved mysteries in long-term forensics units in which they engaged in blood-typing, fingerprinting, and crime scene analyses. During one site visit to Emerald, we observed a common planning period for teachers in the school's developing NAF engineering academy. These teachers were engaged in planning a multi-phase, multi-year green roof design and building project with curriculum connections to science and mathematics. At Neon, project-based learning generally assumed an arts focus; we saw students staging theater productions, planning jewelry and fashion shows, and generating small business plans.

Teaching Soft Skills at Blue Academy

Soft skills—also described as workplace readiness skills or 21st-Century skills—were infused in Blue's POS curricula. Blue's medical POS employed patient care scenarios that allowed students to role-play the kinds of skills they would need in the workplace (e.g., handling a patient who refuses his or her medication). Medical teachers also brought guest speakers into their classrooms, including professors from local colleges and universities who talked to students about medical careers and the importance of time management in the medical profession. According to one teacher, the latter discussion represented a real learning experience for some students. This teacher also impressed upon students the connection between their behavior in the classroom or the workplace and future references or recommendation letters.

Blue's PLTW engineering program was tied to several after-school clubs that offered students hands-on learning and mentoring experiences. Some of these activities specifically targeted girls and minority students; one such example was a district-wide "Girls in Engineering" event featuring engineering challenges, a business etiquette workshop, and exhibits set up by local college and university engineering departments.

Team-building. Over the course of our classroom observations (13 POS, 3 academic) at Blue, we observed a range of activities involving student teamwork. In an English class, groups competed with each other to look up and use verbs in written sentences. We saw six examples of teamwork in POS classes, including students negotiating correct answers in a test-preparatory Jeopardy game, assembling a computer network cable, and dusting and lifting fingerprints. In a few of these observations, off-task behaviors went unaddressed; however, most students were highly engaged and cooperative. Senior medical academy classes offered some of the best examples of student teamwork: In their labs, students collegially conferred with and taught each other. Good teamwork and appropriate classroom behaviors were taught in this POS. In one 10th-grade medical science class, the teacher tolerated few disruptions: When students grew loud during their Jeopardy game, she announced that they would go back to using study guides "if you can't handle it."

Critical thinking and problem-solving skills. Blue's drafting classes offered many opportunities to hone critical thinking skills. During one of our observations, students were challenged to think in three dimensions as they imagined how a complicated object could be projected in space from several different angles. Students had to determine whether an object contained hidden angles or shapes, then used their drafting skills to represent that object in just two dimensions on paper.

Teaching soft skills through CTSOs. Blue's biotechnology teacher said that she taught soft skills through lab write-ups and CTSO activities like leadership seminars. CTSO competitions related to biotechnology and the forensic sciences were team-based: Students' combined individual scores on knowledge tests comprised a first round of competition; in the second round, teams competed to complete lab work or crime scene evaluations. Blue students placed nationally in these competitions. Students enjoyed such CTSO activities because they allowed them to socialize with students with similar interests from across the state and the nation. The biotechnology teacher valued CTSOs because of their power to engage students in learning and practicing their skills after school. When struggling students came to her for help, she encouraged them to participate in CTSO meetings, at which she could pair them with stronger students. Although CTSOs offered excellent extracurricular learning opportunities, they were not free: One student we interviewed wanted to join her academy's CTSO, but knew her mother's strained finances could not bear the cost.

Teaching Soft Skills at the Comparison High Schools

Heliotrope's advanced business studies teacher included many skill-building activities in her fast-paced 75-minute class. In preparation for the SAT, students contributed words to a classroom word wall and completed a vocabulary-driven "ticket out the door" at the end of class. Students reflected on and discussed an inspirational quote from Apple founder Steve Jobs; took

notes on a short presentation on creating outlines; and spent time working independently on research reports. Two students delivered presentations on business etiquette in different foreign countries; at the conclusion of their presentations, their fellow students filled out feedback forms rating their performance. Selections from these forms read out by teacher showed students to be supportive and professional in their compliments and suggestions for improvement.

PLTW, offered at high schools district-wide, offered many opportunities to teach both hard and soft skills. At Heliotrope, an assistant principal commented on how the program increased students' critical thinking and problem-solving skills by requiring them to "think and process." Our observations showed PLTW being implemented with varying degrees of skills and intensity; although one teacher offered largely rote instruction through a PowerPoint and handouts, other teachers mixed their instruction with other curricular materials and facilitated student collaboration and problem-solving in lively group projects, like a marble-sorter construction activity we observed at Emerald. During this activity, which was sometimes uproarious, we saw students explaining to their classmates the connection between physics principles and the machines they were assembling.

Emerald's principal said his school tried to teach soft skills in many different venues. One was its ROTC program, which offered an elective open to the whole school in which students learned sound reasoning and problem-solving skills. The school rewarded students who demonstrated character and went "above and beyond the call of duty" with special t-shirts; students wore them with pride and, according to the principal, "really [pushed] hard to try to win" one.

Team-building. We looked for evidence of teamwork during our classroom observations at the comparison sites. We saw no teamwork in the three academic classes we observed. Out of 19 CTE class observations, less than one third captured examples of teamwork. The least successful was a highly unruly senior technical modeling class in which group work led to confusion, chatter, and bickering. The teacher appeared unable to channel students' energy into productive pursuits, exclaiming, "You guys need to learn to work together." Most examples of teamwork were positive, however; we saw students collaborating or leading their classmates to bleed brakes, prune shrubs, and prepare meals. A culinary class at Emerald generated particularly positive examples of students working together to solve unexpected problems. For instance, a team of boys making Oreo-based truffles for a buffet dinner ran into difficulties with the texture and consistency of their filling, and debated how best to scoop it into balls and then coat it in chocolate. They were able to use a melon baller to make the truffles, then popped their tray into the freezer to render the balls firm enough to be coated in chocolate. Students in this class also sought out tasks if they were idle: While the balls of filling were in the freezer, a student from this team volunteered to take care of the sweetened and unsweetened tea for the dinner.

Critical thinking and problem-solving skills. At Neon, the district's arts school, an apparel teacher described how in learning how to conceptualize and depict a three-dimensional objects onto two dimensions (i.e., paper patterns for clothing), her students were learning the "same higher-level thinking skills that an engineer is getting." This teacher also prompted students to think seriously and sensitively about topics that would affect them or their families in their future lives. In one class we observed, her students discussed ways in which the clothing they made could be adapted to disabled or elderly clients; they also researched the costs and benefits of

cloth versus disposable diapers, then discussed their findings and opinions with each other. In these discussions, the teacher urged her students to reflect critically on their personal beliefs.

Teaching soft skills through CTSOs. During the worst years of the recession, the district cut back in many areas, but continued its support of CTSOs at all of its high schools. Scheduling constraints and transportation issues sometimes made it difficult for students to participate. Indigo administrators noted that their four-by-four block schedule, in which students took a full-year course in one semester, made recruitment tough. Students were not motivated to join or remain in a CTSO if they were not enrolled in a related class. Despite their scheduling challenges, Indigo's CTSOs related to its marketing, business, construction, health sciences, family and consumer sciences, and horticulture programs were popular and well-supported. In particular, Indigo's principal described the school's FFA chapter as "vibrant" and "civic-minded." Indigo's horticulture teacher said that most of his students participated in FFA and gladly gave of their Saturdays and summers to plan for and attend competitions. When new students learned that their teacher came to school on the weekend to catch up on landscaping work or work with students on their FFA projects, they began to show up on weekends, too. Soon, these students were also helping beautify the school and engaging in FFA projects.

Emerald offered CTSOs related to its health sciences, culinary, family and consumer sciences, and PLTW programs. Its culinary program was so popular and so successful at FCCLA competitions that many more students sought to participate than could be accommodated. The culinary program won several state competitions as well as national silver and gold medals. Articles and photos of past winners covered a "Wall of Fame" in the school's café, and many students held state leadership positions. Upper-level culinary students completed FCCLA projects as part of the curriculum, including self-awareness exercises.

The local community college. Interviews with ECC administrators, faculty, and counselors revealed mixed perceptions regarding the college and career readiness of East District graduates. One instructor believed that, overall, East students would benefit from more "real-world experiences" and "real-world type projects [like those] we would do in our applied science programs," especially those activities that taught teamwork, research, and critical thinking skills. These skills were seen as helping East graduates avoid the "cultural shock" that some experienced in the much less prescribed world of higher education.

National, State, and/or Local Assessments Provide Ongoing Information on the Extent to Which Students Are Attaining the Necessary Knowledge and Skills for Entry Into and Advancement in Postsecondary Education and Careers in Their Chosen POS

Technical Skills Assessments

As with core academic course assessments, CTE and POS end-of-term assessments were managed at the state level and administered via an online system. Most exams were developed by educators with input from industry, but some were industry-developed (e.g., A+, Cisco, Oracle). Other certification exams that served as end-of-course exams included the CNA for health sciences and the NCCER for construction.

Blue's principal believed that, compared to his peers at the comprehensive high schools, his job was more difficult because his CTE assessment scores had to be as high as his core academic scores, in part to justify the additional resources needed to support his facility. This principal also used test score results to allocate resources.

As previously noted, during our study, the state moved its CTE assessments to an online platform that quickly delivered student performance data to teachers. Broken out by student demographics and by classroom, these data allowed teachers to identify and address learning gaps at the question level. Teachers within programs could analyze why students missed certain questions and adjust their curriculum to target these gaps. Teachers worked in professional learning communities to compare outcomes; those identified as more effective at teaching certain skills mentored their peers in pedagogies and practices that better taught those skills.

At some schools, the shift to an online testing platform was hampered by outdated technology and/or insufficient numbers of computers. Other issues hindered teachers' ability to use the system. CTE teachers told us that there were limits to the numbers of test items that would populate on tests they wanted to give. They were also not able to score their own tests; instead, they were given to a school testing coordinator. Further, the test item bank from which end-of-term exam questions were drawn was only accessible on the day the exam was given. If a new course did not yet have an end-of-term exam, districts and schools were required to develop one with industry input.

Teachers found ways to use the system to their students' benefit. A career coordinator at one comprehensive high school reported that teachers discovered that if they created interim assessments from the item bank, their students performed better on end-of-term exams because the questions were similar. In most cases, teachers pulled their own interim test questions from the system's test item banks; at Heliotrope, however, CTE teachers from the same program area were working to create common interim assessments. During weekly after-school meetings, Heliotrope teachers analyzed student performance outcomes by pooling the results from their shared interim assessments and identifying questions that caused problems across classes. Teachers then collaborated on strategies to improve instruction in those curricular areas. In some cases, teachers repeated instructional units until their students achieved mastery; in others, teachers who were more successful at teaching certain content would share their teaching strategies or offer tutoring to small groups of struggling students from other teachers' classrooms. Heliotrope teachers also designed common warm-up activities.

Not all interviewees reported such positive experiences with or perceptions of the online system. Some teachers told us they feared that their students' scores were too accessible to department chairs, career coordinators, principals, and district and state CTE administrators. Administrators not only had access to reports on students' interim and end-of-term assessments, they also saw the growth attributed to the individual teacher.

Creating the Standards

Industry representatives were highly involved in aligning curricula and assessments with industry standards. To secure state approval for new curricula or assessments, districts and

schools had to prove that their review board included postsecondary partners and at least 80% industry representatives. One teacher believed that this requirement placed onerous demands on program advisory boards, especially those with several new courses to review.

As previously described, the state required CTE teachers to teach the academic skills embedded in their programs. Although state assessments did not explicitly test such academic skills, many test items could not be answered without mastery of these skills. The same was true for technical standards, which were laid out as task lists of competencies to master: In order to earn a CTE competency certificate, students had to master both academic and technical standards.

Authentic Assessments

Because the state's technical skills assessment system was housed online, tests had to be delivered in an easy-to-administer, easy-to-score format. As such, all technical skills assessments were multiple choice and contained no applied assessments or demonstrations of proficiency. Many teachers and administrators expressed unhappiness with these assessments and what they perceived as an over-emphasis on rote memorization and written assignments. To counteract this, one CTE teacher told us that he made class labs count for a larger part of students' grades.

One principal believed that multiple-choice tests lacked authenticity and needed to be supplemented with CTE- or POS-specific capstone projects emphasizing real-world applications of academic and technical skills. As an example, he envisioned a horticulture student being asked to develop a complete prospectus for a landscaping job that would involve math, science, writing, and literacy skills. The student would design the project, select its raw materials, cost it out, and write a "nice proposal" for a prospective customer.

Assessments were most authentic at Neon, where it was not surprising to see dance performances or student monologues supplementing the state's multiple choice end-of-term exams.

East's CTE director acknowledged that although the current technical skills assessment system did not include a performance component, future iterations of these assessments might be able to include one. For the time being, CTE and POS teachers were expected to assess student performance in an ongoing, formative way.

CHAPTER FIVE: South District
POS as a means of answering the call of business and industry for better prepared students

Abstract

South District is located in a state that strongly encouraged high schools to develop career academies as a way to engage students and lead them to high-demand, high-wage careers. Through this and other policy measures, such as mandating articulation agreements and dual enrollment opportunities, and including industry-recognized credentials as part of college-and-career-ready accountability program, various parts of the state, including South District, were in essence implemented POS earlier than other parts of the country.

Rather than create POS high schools, South District ensured that all students had the opportunity to participate by developing POS in every high school. Some of these POS were accessible through the district's lottery system, and others were available for students attending their zoned high schools. There were no systematic differences between these programs.

We planned to test an instrumental variable model of the effects of POS enrollment and CTE credit earning on GPA and graduation. However, similar to East District, POS enrollment in South did not generate substantial exogenous variation in number of CTE credits earned, which precluded us from interpreting the results of the instrumental variable analysis. We tested a conventional mediator model and found that students who enrolled in POS were 9% more likely to graduate and had slightly but significantly better GPAs than students who enrolled elsewhere. Both of these effects were attributable to increased earning of CTE credits. These results suggest that enrollment in POS may have benefited students in terms of retention and also achievement.

We examined policy-relevant questions comparing the subsample of students who completed a POS to those who completed a CTE concentration, and the rest of the sample who did neither. At South District, 58.0% of the intervention group completed a POS. We found that more students in the rest of the sample earned AP credits and accrued college credits than their comparison groups, perhaps a function of the types of programs that constitute the other choice programs in South District (i.e., strong college preparatory programs such as International Baccalaureate).

In order to assess the effect of completing a POS on high school achievement, we performed posthoc regression analyses on POS-relevant achievement measures for POS completers compared to the rest of the sample and compared to CTE concentrators. We found that compared to the rest of the sample, South POS completers were significantly less likely to earn more 1) STEM credits or 2) AP credits, but they were more likely to have a higher CTE GPA. The model for dual enrollment indicated a weak fit to the data and suggested that important factors in dual enrollment participation were not captured.

The results comparing POS completers with CTE concentrators were similar: POS completers were significantly less likely to earn more 1) STEM credits or 2) AP credits, but they were more likely to have a higher CTE GPA. Again, the model for dual enrollment indicated a weak fit to the data and suggested that important factors in dual enrollment participation were not captured.

Unlike the other two districts participating in this study, no senior exit survey was conducted at South District. However, we were able to collect some industry-recognized credential data from South, which was not available at the other districts. The data were not complete, but among the students known to have sat for a credentialing exam, nearly 94% passed and earned the credential. Over three quarters of those credentials were earned by POS completers.

The chapter concludes with a qualitative analysis of POS implementation in South District, based on the elements of the law mandating POS and the subsequent policy guidance framework provided by the funding agency (USDE/OVAE, 2010).

Introduction to South District and the Intervention POS

South District is a geographically large district with urban, suburban, and agricultural regions. South has been recognized for being in the vanguard of education reform, data-driven decision-making, and implementing career academies[6]. Although there were no wall-to-wall POS high schools in this district, there were instead career academies located in most comprehensive high schools. Many career academies were accessed through South's school choice program, in which students applied to a lottery to attend POS, performing arts, International Baccalaureate (IB), and military ROTC programs.

In the early 2000s, the district saw substantial growth in student enrollment, and the county passed a temporary sales tax increase to support school construction and renovation. Six high school campuses were augmented with state-of-the-art career academy facilities as a result of this revenue.

South District's state has an active legislature with respect to education. The state encouraged the development of career academies. The mandate fit South District's goals of improving achievement, promoting diversity, and providing a specialized curriculum to engage students. At the same time, the business community was calling for better-prepared students, and district leadership believed that in addition to making education more rigorous and relevant, POS in the form of career academies promised to further their goal of having students graduate, as one teacher put it, "with a diploma and something else" (i.e., college credits, an industry-recognized credential).

High Schools

Unlike West and East District, POS were not limited to specific POS high schools; most of the high schools in South District contained career academies. In fact, in addition to the lotterized POS that were part of the district's choice program, many high schools also offered career academies for their zoned students as well. Although the curriculum was not exactly the same between lotterized and zoned high school POS, those differences were not systematic, and in fact, lotterized POS across high schools also differed in scope and sequence.

[6] All career academies do not necessarily meet POS requirements but the career academies of South District did. We will use the terms interchangeably with South.

Due to the late entry of South District into the study, we were only able to conduct one site visit and thus did not visit many high schools. Although we tried to visit a wide range of schools, we were not allowed to visit schools that were in danger of not meeting their yearly academic progress goals. The schools we did visit had for the most part energetic POS teachers, often hailing from industry, who worked well with the community in terms of student internship opportunities.

How POS Culture and Identity Engaged Students

Rather than discuss school culture in a district with no wall-to-wall POS high schools in which a "POS school culture" might emerge, we comment upon how the individual POS foster their own culture and a sense of identity within the comprehensive high schools. The main means by which the POS engaged students was naturally through the curriculum content, because students had selected their POS.

Although more prevalent in the past than during the time of our study, student cohorting was another way that the POS fostered a sense of identity among its students. Before new state mandates made cohorting difficult to impossible, most POS in South District kept their POS students together for academic courses. During the study period, some high schools cohorted POS students into science, English, and social studies classes, others limited cohorting to English and social studies only, and other schools had eliminated cohorting altogether. Math was not cohorted due to the wide range of levels of math into which students were placed. At one school we visited, the principal lamented the loss of cohorting, recalling the "family atmosphere" of students travelling together from class to class. In the large high schools of South District, having a "family" to travel with was one way of developing unique cultures and identities for each POS. Cohort teachers reported meeting together to better monitor student progress.

Another means of developing student identity around a POS was through CTSOs, which were very popular among students across the high schools we visited. CTSOs provided students opportunities to develop leadership skills both through competitions and also through community service. FBLA students at one high school had adopted a kindergarten class at a local elementary school and they enjoyed it at least as much as the youngsters did. Health careers students in HOSA put on health fairs for the community, helping to check blood pressures and glucose levels.

Finally, POS identity developed around program pride, whether in CTSO awards or general pride of purpose. In one classroom we visited, students wore T shirts declaring their membership in that "Triple A Magnet" POS. Every possible space on the walls of the class contained student-made posters, including along the top of the walls, just below the ceiling. Some contained the student's name as the most prominent element, and then what they liked: basketball, FBLA, senior year, SAT, and colleges they wanted to attend. Bulletin boards were decorated with photographs of students at competitions.

Instrumental Variable Sample Description

The South District portion of the study examined data for 3,506 secondary students, 1,985 of whom enrolled in a POS, while 1,521 were not. Table 5.1 displays descriptive statistics for the South District imputed sample.

Table 5.1
Descriptive statistics for imputed sample, South District

	(*N* = 3,506)	%
Gender		
Male	1,664	47.5
Female	1,842	52.5
Race/Ethnicity		
Black	668	19.1
White	1751	49.9
Latino	754	21.5
Asian	185	5.3
Native American	19	.5
Other	129	3.7
F/RL eligible	1,012	28.9
Limited English Proficient (LEP)	176	5.0
Has Individual Education Plan (IEP)	158	4.5
Number of Days Suspended		
No days	3,264	93.1
1 or 2 days	122	3.5
3 to 10 days	113	3.2
More than 10 days	7	.2
Graduated on time (2012)	3,296	94.0
	Mean	*SD*
Grade 8 pre-test math scale score[a]	354.77	36.86
Grade 8 pre-test reading scale score[a]	338.30	42.22
Grade 8 pre-test science scale score[a]	345.84	57.88
Number of CTE credits earned	4.84	1.57

Note. F/RL = free/reduced price lunch program. Due to incomplete withdrawal data, we could not determine an attrition rate (cf. Appendix A).
[a]Variable was grand mean centered.

Missing Data

We carried out a missing data analysis for South District and observed that the percentage of data missing for the variables ranged from 0.0 to 46.4%, with an average of 7.4%. We rejected the assumption of MCAR given mean differences in eighth-grade standardized test scores between those who were and were not missing GPA data for later years. We made the more relaxed assumption of MAR and handled missing data using the same procedure as reported for the two other districts.

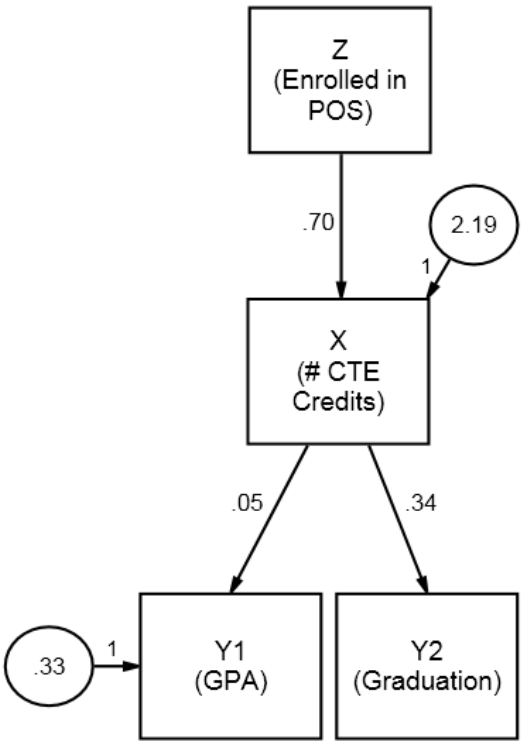
Instrumental Variable Estimation

We tested our hypothesized model across the imputed data sets and observed that it was over-identified with 9 degrees of freedom and fit the data marginally well (e.g., $\chi^2 = 65.38$, CFI = .93, TLI = .74, and RMSEA of .04). We tested the model using a single imputed set to obtain a χ^2 test and modification indices. We observed a statistically significant global test statistic ($p < .001$), suggesting that the model did not fit the data exactly (see Bollen, 1987, pp. 263 - 269). We observed modification indices and standardized residuals suggested that number of CTE credits earned should be regressed on free lunch status, reading score, and Black. We added these specifications and observed that the resulting model was over-identified with 9 degrees of freedom and fit to the data was generally good (e.g., $\chi^2 = 22.33$, CFI = .98, TLI = .91, and RMSEA = .02). However, we tested the model using a single imputed set and observed a significant global test statistic ($p = .007$), suggesting that we should reject the hypothesis that the model fit the data exactly.

With residual covariances in place, enrollment in a POS did not appear to have a significant effect on the number of CTE credits students took. As with East District, this result implied that enrollment in South District POS was not a good instrument for number of CTE credits earned. Thus, we did not interpret the results of this model. Instead, we tested a conventional mediator model with no residual covariances. This model was over-identified with 11 degrees of freedom and fit to the data was excellent (e.g., $\chi^2 = 12.44$, CFI = 1.00, TLI = .99, and RMSEA of .01). We tested the model using a single imputed set to obtain a χ^2 test and modification indices. We observed a statistically non-significant global test statistic ($p = .33$), suggesting that we should not reject the hypothesis that the model fit the data exactly (see Bollen, 1987, pp. 263 - 269). In addition, modification indices and standardized residuals did not indicate that any areas of substantial strain existed for the model.

For this model, enrollment in POS predicted an average of only .70 more CTE credits earned and the model explained just 14% of the variance in credits earned (see Figure 5.1). Controlling for background variables, the indirect effect between enrollment in POS and GPA was $b = .04$ ($p = .005$, $\beta = .02$), while the indirect effect between enrollment and graduation was $b = .24$ ($p = .001$). The latter effect is a probit coefficient and can be interpreted as indicating that holding the background variables constant, students in POS were 9% more likely to graduate on average. The direct effect between CTE credits and GPA was $b = .05$ ($p < .001$, $\beta = .10$), while the direct effect between credits earned and graduation was $b = .34$ ($p < .001$). The latter suggests that each additional CTE credit earned by students was associated with a 4% increase in the probability of graduation. In addition, each additional CTE credit earned was associated with a .05 unit increase in GPA. Taken together, these results indicate that (1) students who enrolled in POS were 9% more likely to graduate than students who enrolled in other programs, (2) students who enrolled in POS had slightly better GPAs than students who were not enrolled in POS, and (3) these effects may be attributable to increased earning of CTE credits. However, we note that this model did not correct for endogeneity so causal inference must remain tentative.

Figure 5.1
Final model for South District



Note: Significant unstandardized estimates are displayed. Covariates are omitted for conceptual clarity.

In addition to the effects described above, several covariates were significant predictors of number of CTE credits earned, GPA, and graduation. Gender (i.e., being male), F/RL, and discipline occurrences had significant and small negative effects on GPA, while LEP, Reading Score, and Science Score had significant and small positive effects on GPA (*ps* < .001). In addition, Math Score had a significant moderate and positive effect on GPA (*ps* < .001). F/RL and discipline occurrences had significant and small negative effects on graduation, while Black had a significant and small positive effect on graduation (*ps* < .001). In addition, Reading Score and Math Score had significant and moderate positive effects on graduation ($p < .001$). Finally, F/RL and Black had small but significant positive effects on number of CTE credits earned, while Reading Score had a small but significant negative effect on number of CTE credits earned ($p < .001$). For a complete description of the estimates for South District, see Appendix A.

Assessing the Effect of Completing a POS on High School Achievement

As with the other participating districts, we employed two approaches to data analysis at South District. Here we present multiple regression analyses, using a different sample—POS completers, all other students, and CTE concentrators. All of the regressions excluded students who (1) withdrew or were missing course data and (2) were missing baseline achievement data. We were consistent with this even with the CTE GPA analysis (that does not control for baseline achievement) so that the regression sample would match the descriptive statistics to the extent possible. The sample for the CTE GPA analysis is further reduced to those who actually took a

Table 5.2

Descriptive statistics, posthoc sample, South District

	Total (n = 2,488)	POS Completers (n = 956)	All Others (n = 1,532)	CTE Concentrators (n = 396)	POS Completers Compared to All Others	POS Completers Compared to CTE Concentrators
Characteristics						
Male	46.3	49.0	44.6	47.0		
Black	20.1	19.7	20.3	23.2		
White	46.4	46.5	46.3	48.0		
Latino	22.8	25.3	21.3	20.5	*	
Asian	6.2	3.9	7.7	6.3	***	
Other/Multiracial	4.5	4.6	4.4	2.0		*
F/RL eligible	30.7	34.4	28.4	35.9	**	
LEP	5.7	6.6	5.2	6.8		
IEP	4.7	5.4	4.2	5.8		
Grade 8 pre-test reading	337.09 (43.45)	327.44 (36.88)	343.11 (46.08)	333.32 (41.11)	***	*
Grade 8 pre-test math	354.20 (37.60)	348.47 (32.84)	357.78 (39.88)	350.40 (35.26)	***	
Discipline events						
None	93.7	93.7	93.7	94.9		
1-2 events	3.3	2.8	3.5	2.8		
3+ events	3.0	3.5	2.7	2.3		

Note. Excludes students who withdrew or were missing course data. Standard deviations of continuous variables are included in parentheses.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Table 5.3

Descriptive outcome statistics, posthoc sample, South District

	Total (n = 2,488)	POS Completers (n = 956)	All Others (n = 1,532)	CTE Concentrators (n = 396)	POS Completers Compared to All Others	POS Completers Compared to CTE Concentrators
Percent Earning Outcome Credits						
STEM	100.0	100.0	99.9	100.0		
AP	72.5	63.9	77.9	70.7	***	*
College (accrued)	4.2	3.3	4.7	3.3		
CTE	100.0	100.0	73.7	100.0	***	
Outcomes	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)		
Overall GPA	3.30 (0.70)	3.21 (0.59)	3.35 (0.76)	3.22 (0.68)	***	
STEM credits earned	5.32 (1.83)	4.94 (1.48)	5.57 (1.98)	5.19 (1.66)	***	**
AP credits earned	3.20 (3.15)	2.27 (2.66)	3.78 (3.29)	3.15 (3.11)	***	***
College credits accrued	0.06 (0.34)	0.04 (0.23)	0.08 (0.40)	0.06 (0.34)	**	
CTE GPA	3.42 (0.65)	3.49 (0.48)	3.36 (0.76)	3.41 (0.60)	***	*
	n = 2,085		n = 1,129			

Note. Excludes students who withdrew or were missing course data. STEM credits equals credits in science and higher math courses (i.e., above Algebra II). College credits accrued refers to the potential college credits associated with dual enrollment participation in high school.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

CTE course among the student in the All Others group. Table 5.2 provides descriptive statistics for the posthoc regression sample.

We found that of the 1,985 South intervention students, 1,152 (58.0%) completed a POS. We then identified the number of students who earned credits in the outcome measures defined in the *Method* chapter (i.e., measures of academic rigor, technical rigor, and transition as outlined there). Descriptive results of student course-taking are shown in Table 5.3.

The following are South District's results of posthoc analyses of high school achievement, controlling for background characteristics (full regression tables in Appendix A). Comparing POS completers to the rest of the sample, the results for STEM credits earned and AP credits earned are significant favoring the rest of the sample. The effect size for AP credits earned make it a substantive finding as well (-0.27, cf. Table 5.4). The results for CTE GPA are positive for POS completers and statistically significant; however, the poor fit of the model to both the CTE GPA and college credits data make the findings questionable.

Table 5.4
Regression results, POS completers versus all others, South District

	South District POS Completers Versus All Others								
		Adjusted					95% *CI* of *b*		
Outcome	*n*	R^2	*b*	*SE b*	*ß*	*p*	lower	upper	*ES*
Overall GPA	2,488	0.464	.022	.022	.015	.306	-.020	.064	0.03
STEM credits earned	2,488	0.372	-.329	.061	-.088	.000	-.448	-.210	-0.19
AP credits earned	2,488	0.457	-.220	.095	-.035	.000	-.988	-.605	-0.27
College credits accrued	2,488	0.040	-.015	.014	-.021	.292	-.043	.013	-0.06
CTE GPA	2,085	0.092	.131	.027	.101	.000	.078	.185	0.20

Note. All coefficients rounded to two digits. Full regression tables are found in Appendix A. *CI* = Confidence Interval. *ES* = effect size (Hedges's *g*)

Table 5.5 shows the comparison of POS completers and CTE concentrators. The results for STEM credits earned and AP credits earned are negative and statistically significant (i.e., favoring CTE concentrators), and the results for CTE GPA are positive and statistically significant, but none of these results achieved substantively important effect sizes. The adjusted R^2 for college credits accrued and CTE GPA shows a poor fit of the model to the data, make the findings questionable.

Unlike at the other participating districts, no senior exit survey was conducted at South.

Table 5.5
Regression results, POS completers versus CTE concentrators, South District

	South District POS Completers Versus CTE Concentrators								
		Adjusted					95% *CI* of *b*		
Outcome	*n*	R^2	*b*	*SE b*	*ß*	*p*	lower	upper	*ES*
Overall GPA	1352	0.376	.042	.029	.031	.155	-.016	.099	0.07
STEM credits earned	1352	0.305	-.188	.077	-.055	.015	-.339	-.036	-0.14
AP credits earned	1352	0.388	-.608	.133	-.098	.000	-.869	-.346	-0.23
College credits accrued	1352	0.052	-.008	.016	-.013	.619	-.039	.023	-0.04
CTE GPA	1352	0.053	.073	.030	.064	.016	.013	.132	0.14

Note. All coefficients rounded to two digits. Full regression tables are found in Appendix A. *CI* = Confidence Interval. *ES* = effect size (Hedges's *g*)

Industry-Recognized Credentials

Industry-recognized credentials and state licensure are two ways that potential employees have of signaling their work readiness (Bartlett, 2002). Some licensures, such as the CNA (Certified Nursing Assistant) or cosmetology licenses, have been offered in high schools for years. In addition, more certifications are being offered at the high school level, including at our three districts. However, reliable data on this measure has been as difficult to obtain at the high school level (Castellano, Stone, & Stringfield, 2006) as it has been nationally (Ewert & Kominski, 2014). Our districts were no exception: We were unable to collect any data on student credentials at West or East. At South, we received some data on the students who took exams in order to earn an industry-recognized credential. These data were not collected in ways similar to other district data, and they appeared to be incomplete, although district personnel could not elaborate on the ways in which they might be. But we report on partial results in order to illustrate student participation.

According to South District records, of the 2,488 students in our posthoc analytic sample, 390 or 15.7% took an exam to earn an industry-recognized credential. Of these students who sat for a credentialing exam, 366 (93.8%) passed and earned the credential. Over 75% of those credentials were earned by POS completers. The most popular credentials earned were Certified EKG Aide, Certified Medical Administrative Assistant (CMAA), and Autodesk Certified Associate.

Adherence to the Components of POS

South District's POS—structured as career academies in all high schools with little perceivable difference between lotterized ("choice") and non-lotterized programs—placed a heavy emphasis on offering vertically aligned, progressively more intensive POS course sequences and rigorous college-preparatory academics combined with work-based learning, clinical experiences, dual enrollment and other postsecondary credit-earning options, online career exploration tools,

abundant college and career guidance, and industry-recognized credentials. Perhaps due to the mandated career academy opportunities in their high schools, most participants held college readiness and career readiness in largely equal esteem, defining these concepts in terms of state and district policy guidelines.

Although located in a state that exerted considerable control over educational policy, including CTE curricula and standards, South District administrators still enjoyed some flexibility in developing, implementing, customizing, and marketing their POS and career academies in conjunction with their postsecondary and business and industry partners. State and district policies both helped and hampered this work, and as in the other districts participating in the study, the economic recession frequently hindered the ability of schools and specific programs to offer the full range of experiences and resources required in robust POS. Despite their limited budgets, however, the schools we visited reported receiving unstinting support—material, financial, and personal—from their postsecondary, business, and community partners. Support also flowed in the other direction, as schools made significant investments in the communities they served, offering not just their facilities but also the professional and personal skills of their students and faculty.

Participants almost unanimously agreed that South District supported student services and quality instruction in both academic and POS classrooms with frequent professional development. Participants were less sanguine regarding the amount of support—time, resources, and facilities—they received to implement both the state's online high-stakes tests and the exams associated with industry-recognized credentials, which this state treated as its technical skills assessments. Finite resources also constrained but did not dampen schools' efforts to engage in cross-curricular instruction and project-based learning; we saw evidence of both at all visited sites. Students in South's career academies learned soft skills through classroom instruction, internship and job shadowing experiences, and voluntary participation in CTSOs.

Incorporate and Align Secondary and Postsecondary Education Elements

South District personnel led the process of collaborating with South Community College (SCC) administrators to develop opportunities for students to earn postsecondary credits while in high school. Faculty from both the district and the college gave final consent to the specific alignment of CTE curricula. In addition to credit transfer opportunities, the district and SCC partnered to offer an early admission option through which high school seniors could take their senior year courses at SCC instead of at their high school. Students had to enroll for a full-time course load, but courses were tuition-free.

Professional development offered another avenue through which to blend postsecondary with secondary education. Large counselor turnover generated a constant need to provide professional development about available credit transfer opportunities to both high school and postsecondary counselors. Because the credits were not all automatically transcripted, counselors needed to identify potential credit opportunities and remind students to apply for them when necessary.

Include Academic and CTE Content in a Coordinated, Non-Duplicative Progression of Courses

South's aligned, non-duplicative course sequences consisted of at least three courses. The district described these sequences as roadmaps illustrating how academy programs included valuable industry-recognized credentials, work-based learning experiences, and credit transfer options. Nearly all academy sequences were enhanced by block scheduling, advisory board input and participation, and leadership and enrichment activities offered by related CTSOs. All sequences were vertically aligned with feeder middle schools, SCC, and other postsecondary institutions.

Course sequences in both lotterized and non-lotterized POS were designed to lead to further education (often two- or four-year degrees) and well-paying jobs in high-demand areas. Some differences were evident in the entrance requirements for these POS, with some popular lotterized programs (e.g., medical) setting higher standards (e.g., achievement, attendance) for admission. At Scarlet, administrators dealt with space, class size, and hiring issues by treating their popular non-lotterized academies like their choice academies, requiring an application for admission. Outside the academy framework, "create-your-own" CTE course sequences were also possible. For those students who were unsuccessful in the lottery or unable to meet admissions standards for Plum's automotive program, for example, administrators designed a "non-academy" pathway. For those students dissatisfied with their programs, change was possible only if open seats were available in another program. No changes could be made after the 10th grade. However, students in lotterized academies could choose to return to their zoned high schools.

Plum's academy coordinator reported that sequences were refined during year-end curriculum writing sessions in which teachers examined existing sequences and identified courses outside of CTE that would enrich and support the academy curriculum. In the criminal justice program, for example, "we… encourage [students] to take electives like psychology and sociology if their school offers it. If they're looking for a science elective and their school offers forensics, we tell them to take those kinds of courses because although [they] are not CTE-related, they are subject areas that would help support someone looking to going into a criminal justice field."

Student Perspectives on Their Course Sequences

Students interviewed during our senior-year site visit were well-informed regarding the structure and benefits of their POS course sequences, noting the increasing rigor and challenge of their programs, the industry-recognized credentials and dual credits they earned, and the work-based learning and CTSO activities available to them. Students also understood the lotterized versus non-lotterized nature of South's academies. One senior engaged in the specialized pharmacy technician program at Bronze described how she gained access to her non-lotterized medical academy after first gaining admission to the school—one of the district's most competitive and well-regarded college-preparatory high schools—through its extremely popular lotterized STEM academy. Bronze's medical academy was open to twelfth graders only after they completed a sequence of health science prerequisites. This type of "academy within an academy" structure was also present at Lavender, where two seniors in the drafting and design academy said that participation in a specialized house restoration project (a partnership between the school, a non-profit, and a local architectural design firm) was predicated on completion of two years of

drafting or engineering courses. One of these students called the project "a pseudo academy" that entailed enrollment in a "very specialized class [in which] we're learning specific industry construction techniques." The other affirmed that it was only for experienced juniors and seniors, because it required a more "mature state of mind."

Students appeared to understand and appreciate the role of the academies as a place to explore and imagine different careers for themselves. A medical careers student said that his experience in the career academy had been "really good because I've learned that it's really hard, especially when it comes to choosing what you actually want to do, because there's so much to choose from [in the field of medicine]." He went on to say that being in a POS helped him and his peers decide if they really wanted to pursue medicine or not.

A number of business academy students we met at Periwinkle said that they had college and career plans that lay outside their program areas but saw the application of their business studies to their future goals. One student indicated that the business academy had been her first choice of program; although she was interested in majoring in psychology and becoming a practicing psychologist, she believed that business skills could enhance her success in this field.

Offer the Opportunity, Where Appropriate, for Secondary Students to Acquire Postsecondary Credits

Dual Enrollment

Free tuition and books were provided to high school students who dually enrolled in a specific list of postsecondary classes, whether they went to a community college or university. Nominal fees were associated with attending the state university. Although most students took dual enrollment courses on the SCC campus, South District teachers could be certified to teach these courses on the high school campus as part of their regular load. Some students preferred this to going to the college for the class.

To be eligible, high school students had to pass all parts of a placement exam and otherwise show college readiness by having a 3.0 GPA (2.0 for CTE certificate dual enrollment courses). Students had to maintain a 3.0 GPA at the high school and at least a 2.0 on the college transcript. High schools had to give the same weight to college-level dual enrollment courses as AP courses when GPAs were calculated. This policy began to attract high-achieving students pursuing high GPAs who might not previously have been interested in SCC courses.

The state created faculty committees to establish the equivalency of courses based on content, and the subsequent list of courses that high schools accepted as meeting their requirements applied to all high schools statewide. However, the schedule for CTE courses at SCC made it difficult for high school students to take them: Most were offered in 7-hour blocks, either in the daytime or at night. South District personnel decided that general education courses would be the most helpful to their students because they would allow them to graduate high school having completed one year of college general education requirements. Students were free to take courses not on the dual enrollment course list, but they did not enjoy the same free tuition, fees, or books.

Student participation in dual enrollment was one of the measures by which high schools were rated in the state's school rating system. This created incentives to increase participation. One high school transported all eligible dual enrollment applicants to SCC to take the placement exam. At another school, students had a difficult time passing all parts of the placement exam. Staff there considered doubling up ninth-grade mathematics courses so that students would be ready sooner for the placement exam.

In general, we found South District students were quite sophisticated in their knowledge of how to acquire college credits and which institutions would accept them. Many students appeared to have participated in dual enrollment starting in 10th grade and were graduating with multiple college credits, some even having earned an associate degree as well. Students told us that dual enrollment was heavily promoted. One high school estimated that 20% of its seniors took dual enrollment courses. This was on the high end; participation was not so high at other schools. Students learned about dual enrollment through the guidance department, which one counselor called "dual enrollment central." Counselors disseminated information about the program by visiting classes with PowerPoint presentations and holding meetings with eligible students.

Articulation Agreements

Articulation agreements were created at the district level, with input from the schools' academy coordinators. Curriculum review committees made up of high school and postsecondary faculty reviewed assessments, textbooks, and projects and decided what could take the place of a college course. Every CTE program had at least one articulation agreement.

Agreements were designed so that high school students who completed designated coursework and passed either an industry certification exam or a proficiency test would not have to take the related introductory course in college. However, the articulated credits were not immediately transcripted. Students had to enroll at SCC in a related program within two years in order to start the process of obtaining their credits. As the agreements developed, some postsecondary programs opted to administer challenge exams to students from lower-rated high schools as a means of ensuring that students knew the content. This led to a new policy in which all students applying for the college credit had to take challenge exams if a given program required them of anyone. Other requirements included presenting a portfolio or proof of having earned an industry certification.

Given the way these two credit transfer programs were structured, South District students were encouraged to take advantage of both immediate and escrowed credits. One high school counselor described how she sold these opportunities: "Especially for our kids who are in the academies, it would make sense for them to get a concurrent [dual enrollment] credit now for something they're learning in the academy. So we encourage those kids to go ahead and get your 'gen eds' [general education requirements] out of the way through the dual enrollment, and then at the end you can also be able to pick up additional credits through the articulated process."

Lead to an Industry-Recognized Credential or Certificate at the Postsecondary Level, or an Associate or Baccalaureate Degree

Of the three districts participating in the study, none put greater emphasis on industry-recognized credentials than South, which benefitted from the force of a fairly recent state law requiring districts with workforce development agencies in their area to develop career academy programs that allowed students to earn college credits and industry-recognized credentials and prepared them for well-paying, high-demand jobs. Although industry credentials were primarily targeted at POS participants, students taking a general course of study at a comprehensive high school could take a sequence of related courses and qualify to sit for a credential. The state made this initiative stick by supporting districts with resources, professional development and training, and an accountability component. During our study, student participation rates in courses offering industry-recognized credentials were scored in the school grading system, but participants told us that student success rather than mere participation would eventually be measured. As such, students' failure to earn the certifications could negatively impact the school.

South furthered state policy by redoubling its efforts with industry and postsecondary partners and by fully funding the cost of students' certification exams—the only district to do so in the state. The district CTE administrator responsible for securing the state's industry certification agreements for its medical and health science programs noted that both the state and the district recognized the value of industry-recognized credentials in attracting and retaining high-quality students. Industry credentials also offered value as sources of longitudinal achievement data: Some licenses and certificates, particularly in medicine, could be tracked into students' postsecondary and career trajectories.

In addition to signaling work readiness, industry-recognized credentials and related CTE program completer certificates were also associated with financial benefits. Plum's academy coordinator stressed how these credentials were a powerful marketing tool for recruiting new students; in her outreach efforts to area middle schools, she talked to students about how "kids are graduating and walking right into jobs. Whether it's something that they want to do full-time or not…we talk to them about how you're [going to] have certifications and experiences, and while you're in college, you can be using those to earn money in the field that you want to be in." Given their vertical alignment with articulated college programs, many industry-recognized credentials were recognized for credit at colleges and universities.

Accountability

Interviewed principals frequently emphasized the importance of industry-recognized credentials to the district's school grading system. Periwinkle's principal outlined its components, which included graduation rates for academy versus non-academy students, state high-stakes test scores, college readiness indicators (SAT, ACT, state postsecondary readiness test scores), career readiness indicators (industry-recognized credentials, CTE completer certificates), and student participation in "AP, IB, and industry certification courses." As Scarlet's principal claimed, "the more certifications [students] get, the better it is for us." Whereas a school's grade used to be determined largely by academic test scores (e.g., reading, writing, math, science), industry credentials were playing a larger role. Scarlet's principal foresaw a shift in how these credentials

would be weighted in school grades, with more points awarded for passing tests than participating in courses. Although generally positive about this "critical piece of success of a school," he saw the emphasis on industry-recognized credentials as creating certain dilemmas, particularly for CTE teachers. Once urged to assist academic teachers in reinforcing math, science, and literacy, CTE teachers were now being pulled in a different direction without a reciprocal expectation of support from their academic colleagues.

Perceived Problems and Benefits

Other problems associated with implementing industry-recognized credentials included the need to vertically align with both middle school and postsecondary curricula, program capacity issues, funding and scheduling constraints, problems securing computer labs or the latest versions of software needed to pass exams, and network or hardware glitches. Although the district used its bargaining power to secure the lowest costs for exams and sought site licenses whenever possible, costs for students to take tests remained quite high—more than $1 million district-wide. As a result, for some especially expensive exams, testing costs were only covered once per student. Further, a few participants believed that some credentialing exams were too difficult, most often citing as examples the ASE certification exam and the test for Final Cut Pro, the video-editing software. Others questioned whether certain credentials—all selected by the state—were relevant or appropriate to their academies. Plum's academy coordinator relayed how her school's criminal justice teachers initially "cringed" over the largely secretarial credential available in their program. Jade's principal feared that some credentials represented "a disconnect" with students' real needs. In the case of his school's medical academy, he was compelled to add a class to support the CMAA credential, which he felt was too low-level: "My kids are more interested in pursuing careers being doctors, nurses, [and] pharmacists."

Overall, most participants believed the opportunities offered by industry-recognized credentials outweighed their drawbacks. Lavender's academy coordinator cited the example of a medical academy student who graduated with 40 college credits, his CNA, CMAA, and EKG Technician certificates, and a state financial aid award. As she said, "That's what our focus is, not one or the other, not college or career, but both… that's what I always tell our students: 'I'm here to open your options up, not to limit them. I want you to have [whichever] college you want to go to, not the ones that would accept you.'" A guidance counselor at Lavender saw POS as a means of breaking the cycle of poverty in this at-risk neighborhood. Many of her students' parents had little formal education, and some undocumented families actively feared the occasional presence of police outside the school. Although she was pleased that both students and parents recognized the value of students' experiences at Lavender, she noted that for those without documentation, participation in many credentialing exams and access to state financial aid and scholarship funds was impossible. A district CTE administrator confirmed that certain exams, particularly the CNA, required a Social Security number.

Student Experiences

The impact of South's investment in industry-recognized credentials was nowhere more evident than in students' comments about their POS experiences. At Plum, one automotive student had not only passed the difficult ASE exam, but was actively planning for the additional

postsecondary coursework and field experience he needed to become a master technician and be able to confidently say, "I have a patch that says, 'I know what I'm doing.'" Another Plum student had already acquired his Allied Health, CPR, EKG Technician, HIPAA (Health Insurance Portability and Accountability Act), and lifeguard training certificates; he was also planning to sit for his phlebotomy certificate as soon as he turned 18. At Periwinkle, a student in the First Responder program successfully passed eight AP classes, obtained her CMAA and CPR certificates, and was waiting to hear about her admission to a pre-med program at a major state university. One Scarlet construction academy student showed us the OSHA card he carried in his wallet; another Scarlet student made a clear connection between his certification in Final Cut Pro and the baccalaureate degree he wanted to pursue in film and television.

A student in the Bronze medical academy's pharmacy technician program asserted that she was prouder of her internships and earned certificates—which included Allied Health, Basic Life Support (BLS), EKG Technician, HIPAA, and Pharmacy Technician—than her AP credits. Inspired by a relative who had passed away after a battle with cancer, this HOSA member believed her certifications would help her pay for medical school and later become a cancer researcher. Her HIPAA certification had already helped her secure summer work in a law office.

One senior sports medicine student at Lavender spoke of the hands-on, supportive quality of her program and how she had been able to earn 13 college credits, work toward her CMAA, EKG, and personal trainer certificates, and help real patients at the same time:

> The medical program has definitely put me a thousand steps ahead of everybody. I mean, it's definitely a great opportunity… I wouldn't trade anything that I've done in medical for anything because… it placed me on a pedestal that a lot of students going into the medical field haven't had, you know? They may have graduated high school, but I can say I graduated high school with my CNA and my EKG and I worked towards my personal trainer. Even if I haven't gotten it, I still have the background behind it. I think it's a really strong support system, especially applying for college.

State and Local Legislation or Administrative Policies Promote POS Development and Implementation

State Policies

State funding and other resources. This state provided ongoing funding specifically for CTE. Whereas the state funded six periods a day for high schools, South District chose to fund a seventh period in order to make it easier for students to participate in POS. Thus students who needed to double up on core classes still had room in their schedules for their academy courses.

Establish formal procedures for the design, implementation, and continuous improvement of POS. This state exerted more control over education policy than did any of its districts or other local education agencies. The state approved all courses and assigned them a common course number. This helped students who moved within the state to pick up their studies where they left off. Although curricula were state-provided, they could be personalized according to area workforce needs, said one counselor. For example, some criminal justice programs focused on

corrections because there were prisons located nearby, whereas other programs addressed law enforcement.

Ensure opportunities for any secondary student to participate in a POS. State legislation encouraged the development of POS as career academies, and every district had to offer at least one career academy. Most districts had more, and South had several POS in each high school.

Require secondary students to develop an Individual Graduation or Career Plan. State law required students to make yearly updates to their individual graduation plans (IGPs), which began in eighth grade. The state's online system functioned primarily as an electronic high school planner, with modules offering college and career information and optional career interest inventories. One counselor said that although they lacked the time to meet individually with students to do those activities, they led some in classroom settings and urged students to explore the website on their own. The students we spoke with were largely unfamiliar with IGPs.

Provide resources for the long-term sustainability of POS. The state funded K-12 education, which included support for POS. However, more than one person complained to us about "unfunded mandates"—new initiatives launched without the resources to support them.

Other relevant state policies. This state passed a class size reduction law mandating that all core academic courses at the high school level contain no more than 25 students. This change reverberated through every high school's offerings, and some electives, such as classes attached to student internships, had to be dropped. For example, whereas a biology class could have no more than 25 students, no such limits existed for a marine biology class—an elective. At one school we visited, a marine biology class had 45 students. The pressure to reduce class sizes affected the availability of other resources. Some IT students we interviewed complained that there were not enough computers in their academy classes because non-academy students were being placed in their classes because they had no size limit. One academy coordinator said that the law had also ended common teacher planning time and student cohorting. One culinary teacher said that she had so many students in her class that she could no longer participate in local and regional CTSO competitions. Schools were compelled to delay implementing new academies because moving academic teachers around complicated the entire schedule. Districts were fined if they did not meet the class size reduction law's requirements.

As noted, the state mandated that career academy programs lead to industry-recognized credentials; it also maintained a database of approved certification exams. The state purchased site licenses for some of these exams, which included practice tests. Some participants noted that serious consequences were attached to failing the exams. One teacher said that if his students did not pass their credentialing exams, his program could be dropped. Although there were no negative impacts to students' grades if they did not pass their credentialing exams, the number of students taking industry-recognized credentials did form part of a school's grade.

Another noteworthy state policy involved online course-taking and exams. The state moved its high-stakes testing system to an electronic platform. As a result, computer or IT students were displaced from their classes so that other students could use school computers to take their state tests. Participants noted that newer high schools tended to have the newest computers, leading to

potential inequities if older facilities had technical troubles during testing. To address this, the district established some schools as district-wide testing centers. A counselor we spoke with said that she and other counselors were "tremendously involved" in online course-taking because they registered students for courses, communicated with online instructors if students were in danger of failing, and monitored the completion of courses affecting graduation. She laughed at the memory of being told that online courses "won't be any work for you." She noted that counselors serving the state's online high school earned a higher salary than their school-based peers, although she acknowledged that the online counselors carried caseloads in the thousands.

District Policies

Local funding and other resources. South District's POS received a high level of support from the schools that housed them, including the use of facilities, professional development for teachers, equipment, and funding—all of which came from state K-12 education funding. However, POS enjoyed other sources of support. Several years ago, district officials asked the county to levy a half-cent sales tax earmarked for school construction and improvement. The measure passed, and resulting funds led to the construction of many new high schools with state-of-the-art equipment for POS. Some of that equipment was provided by local businesses; for example, at Periwinkle, an area television station donated an on-air news desk and editing studio.

In all schools, POS faced cutbacks during the recession's worst years, and some people we spoke with feared the demise of the entire academy concept at the state level. As a cost-saving measure, the district considered eliminating academy coordinator positions. A drafting and design teacher said that his program might have to forego the use of the most current CADD software because they lacked the funds to upgrade the hardware needed to support it. More than one participant told us that their aging operating systems were incompatible not only with instructional software, but also with administrative software. Problems beyond those of funding affected schools' use of technology: Students complained that they could not take their credentialing exams online because the district's firewall prevented them from doing so. This same firewall forced teachers to download materials at home because they were unable to access them in class.

Establish formal procedures for the design, implementation, and continuous improvement of POS. Although the state provided a common curriculum framework, POS were created at the local level by local secondary and postsecondary faculty who worked to create articulated, vertically aligned sequences of academic and CTE courses. Many schools built common teacher planning time into their schedules; many also cohorted students through both their POS and core academic courses. However, the state's class size reduction law affected schools' ability to maintain these structures. Some schools used district-sponsored professional development days to preserve time for teacher teams to work together. The law also led to larger CTE classes than were considered safe by the state's own regulations, said some CTE teachers.

Overall, despite policy and resource limitations, determined school administrators found ways to support the career academy concept and POS in general. Periwinkle's principal, who opened several high schools and created many career academies during his tenure, believed that well-designed POS required a combination of excellent teaching, continuous marketing and community outreach, and the resources to make it all work:

> Well the first thing is—and again it goes back to my big three—you have to get teachers on board that are passionate about what they do and have knowledge of the industry or the curriculum that they're teaching. Not just the book aspect of it but actually being out there in the real world. So staff is crucial. Number two is, you have to go out and recruit. You have to get your name out there, you have to sell your program, you have to get students who want to be involved in the program. The big thing is you don't want to put kids in there just to fill up the class—that's like the killer. And then number three is, you have to have the facility. And our district has been instrumental in putting programs in schools and giving them the facilities and equipment to be second to none. You've been through our school, you see what we have. It's top-notch stuff.

Ensure opportunities for any secondary student to participate in a POS. Whether a POS was lotterized or non-lotterized was determined by the district, with some school input. Many POS changed their status during the four years of our study. As a number of participants explained, choice versus non-lotterized status and the purity of the lottery depended as much on politics and parental pressure as popularity. An academy coordinator at Periwinkle said that although all lottery and choice decisions were ultimately made at the district level, schools had some latitude in seeking "weighted" admissions for particular programs. For example, in the case of a program with low or no enrollments of minority students, the school could make a case that such students be given admissions priority. Schools could also seek to change the status of a POS. Jade's principal said that they had successfully shifted two POS to non-lotterized status because they were already operating at "110% capacity" and preferred to fill seats with students zoned for that high school. Changes like these to any one high school had ripple effects across the district: As students moved from one school to another, so did teachers and funding.

As Periwinkle's principal noted, recruitment was key to creating vital POS. Schools used a number of strategies to spark student interest in their programs, including district-sponsored high school showcases. Plum's academy coordinator noted that industry-recognized credentials were a big selling point at their middle school recruiting events, to which the school sent high-achieving, personable students who could talk knowledgably about their college and career options. The district also conducted home visits to students from non-English speaking households to ensure proportional representation.

Eligibility requirements for entry into the POS lottery were not onerous because the district's goal was to encourage student participation. Some programs required a 2.5 GPA, but most only requested three favorable teacher recommendations. Some programs—like medical, veterinary, and computer science—required a 3.0 GPA, but had recently dropped Algebra I as an eligibility requirement. This move upset some teachers who felt it lowered standards. District personnel, however, noted that not enough middle schools offered Algebra in eighth grade. The district's lottery included a preference for students who participated in a middle school magnet; some teachers believed that such feeder preferences limited opportunities for students with genuine motivation and interest.

Provide resources for the long-term sustainability of POS. Although the superintendent and school board strongly supported POS, district CTE personnel recognized that new principals

needed to be educated and brought on board with POS and the career academy model. A district CTE coordinator said that she spent time visiting schools and principals and sharing the benefits of POS, especially their power to retain and recruit quality students: "We do a lot of educating."

One principal with a long history in the district spoke to us about her experiences as the principal of a high school without academies. At the time, she not only felt limited in the resources and opportunities she could offer students, but also in the quality of the student population she could attract. She started a POS at that school before leaving to accept a different principalship.

Other relevant district policies. Students enrolled in lotterized POS who failed a POS course were given a chance to improve their grades during a probationary period in which they received extra resources and support. If they failed to improve, they could be sent back to their zoned high schools.

Ongoing Relationships Among Education, Business, and Other Community Stakeholders Are Central to POS Design, Implementation, and Maintenance

Business and Industry Partnerships

South District's commitment to offering industry-recognized credentials and work-based learning opportunities to students in its POS was greatly aided through the support—material, financial, and personal—of area business and industry. At every school we visited, participants described the many businesses that contributed equipment, money, time, and expertise to enriching their career-focused programs. Some businesses, both large and small, were able to offer both current and future employment and scholarship support. For example, the district's pharmacy technician program, available in some of its medical academies, was sponsored by a major national pharmacy chain; the chain provided materials and funding for the high school curriculum, sites for clinical placements, college scholarships, and guaranteed pharmacist jobs for successful graduates.

Scarlet was one of two South high schools offering architectural design and construction programs that participated in the ACE Mentor Program, which brought schools, students, and industry professionals together for a year's worth of concentrated lessons, teamwork, career exploration, and a hands-on construction project. One of the instructors in charge of the ACE program noted that at least 90 to 100 business partners actively supported the program through mentoring, advising, and donations. Both he and Scarlet's principal believed that this support was a valuable way for businesses to invest in their future. During our site visit, at least a half-dozen of these partners—all enthusiastic—turned up to view the progress being made on the Habitat for Humanity house being built by Scarlet students in the school's large and well-appointed construction lab. Beyond hands-on experience, the principal reported that students were graduating with OSHA cards, industry certifications, and job offers from area businesses that knew and valued the quality of their training and work.

Schools also benefitted from the support of advisory boards. At Periwinkle, the principal noted that there were rarely fewer than 40 or 45 business and community partners present at their monthly meetings, including representatives from the hotel and tourism industry, television and

film, sports, and local restaurateurs. These partners, he said, had not only contributed materially to the school's POS, but also offered job shadowing and internship sites to Periwinkle students.

Depending on the curricular or financial support being provided, the responsibility for managing business and industry relationships was shared among district personnel, administrators, academy coordinators, and teachers. In the case of the district's medical academies, for example, the district coordinator described the process—repeated at two-year intervals—through which he worked with district lawyers to negotiate clinical experiences and internship placements for qualified students at over 100 sites. Placements were then facilitated by school-level academy coordinators and teachers for all students who sought them. All of the medical academy students we interviewed commented on the many and varied opportunities they had to work or job shadow in hospitals, walk-in clinics, nursing homes, sports medicine facilities, and other sites. At Plum, one local hospital not only served as a popular site for clinicals, it also underwrote a portion of the cost of equipping the school's medical lab. Further, instructors in the medical academies were often experienced practitioners—we met doctors, nurses, and a former athletic trainer for an NFL team—who were able to draw on their extensive networks to bring students in regular contact with medical and public safety professionals, including doctors, nurses, EMTs, lifeguards, firefighters, HIV/AIDS experts, sports medicine providers, and recent graduates who had pursued medical studies. Although we focus here on medicine, we observed similar partnerships and opportunities across the broad range of career academies we visited in South.

Community Partnerships

Many interviewees at the schools we visited attested to the strong relationships between their schools and the local community. Geographically quite large, South served a highly diverse student population; many students were low income and came from a broad variety of cultural and language backgrounds. A number of participants commented on the district's high numbers of undocumented students and parents and the great need to build trust between the school and the community by serving that community. Principals, counselors, teachers, and students all described participating in special events and extracurricular and co-curricular activities benefitting various local organizations, schools, groups, and families. At Plum, the school itself was a community hub. The school rented out its auditorium for events and hosted weekend church services; it also served as the site of an annual car show, health fairs, and regular sporting events: "If you come here at night, there's tons of cars here. There's always something going on… The community uses the school a lot," commented one guidance counselor. At Lavender, one of the school's language facilitators hosted a local radio program targeting a large migrant community; the host used the show to describe school opportunities.

As noted, supported by mentors from the local business community, architecture and construction students at Scarlet were engaged in building a Habitat for Humanity house for an area war veteran and his family. Beyond their expertise, area businesses also donated materials and equipment for the house. At Lavender, students were working to redesign, restore, and convert a local historic property. Interviewees at several schools mentioned an initiative through which IT students refurbished and tested older computers to be donated to disadvantaged students and other community members; this initiative was supported by a local low-cost internet service that helped make online access affordable for low-income families. During our site visit

at Periwinkle, business students, many of them DECA members, had just returned from a Christmas party at a local elementary school; the students had adopted this school, purchased presents for all of its kindergarten students, and hosted a party complete with a student Santa and elves. One student ensured television coverage of the event by writing a press release and securing a film crew from a local news station.

Postsecondary Partnerships

In South District, articulation agreements with community colleges and state universities were coordinated largely at the state and district levels. Unlike West, where many of the CTE teachers we interviewed participated in advisory boards, fewer South educators reported working directly with postsecondary partners to align or develop curricula. However, we noted evidence of active involvement with local postsecondary partners at every school we visited. Teachers, guidance counselors, and students all spoke of abundant opportunities to participate in dual enrollment, including spending full days at SCC or a regional state university. Some teachers were university-credentialed to offer dual enrollment courses at the high school. Every site noted the active presence and participation of local and regional postsecondary institutions in college fairs, scholarship and financial aid workshops, admissions counseling, and other college awareness activities. Postsecondary partners participated on advisory boards.

Sustained, Intensive, and Focused Professional Development Opportunities for Administrators, Teachers, and Faculty Foster POS Design, Implementation, and Maintenance

Professional development was provided to all South school personnel (i.e., teachers, academy coordinators, guidance counselors, administrators) in a variety of formats and in a number of locations, including in school, online, and offsite at local postsecondary institutions. Some was delivered during a half-dozen dedicated full-day in-services distributed throughout the school year. At the high school level, additional professional development took place during once-monthly morning in-services; on these days, students arrived two hours late. District staff, invited experts, administrators, and occasionally other teachers were most often mentioned as delivering professional development. Much of the content of these trainings was district-driven and focused on state or district policy; college and career readiness initiatives; best practices in instruction, assessment, and classroom management; and hands-on analyses of assessment data from the state's high-stakes tests. Principals were also given some latitude to deliver school-specific professional development on a range of subjects, including in support of POS.

Career Academy-Focused Professional Development

Training for career academy coordinators and teachers in South District was largely arranged by the district's career academy specialists and targeted to the specific needs of each academy's curriculum, assessments, technology, and certifications. Some of these trainings featured National Career Academy Coalition (NCAC) guidance on standards of practice. Schools with NAF academies participated in NAF trainings, including intensive summer institutes. Coordinator meetings occurred monthly and included some professional development, covering such topics as legislative updates, dual enrollment opportunities, industry certifications, CTE

completer certificates, and new graduation requirements. One new career academy coordinator reported that although she went through no formal preparation for her role, she had been mentored by a former coordinator and was learning a great deal from the district's monthly meetings. One coordinator shared that she was participating in a six-week series of seminars on the effects of poverty; she learned about it through the district's online professional development portal. The same coordinator mentioned that her POS teachers received professional development on fostering literacy and writing skills in the CTE classroom.

In addition to regular in-services, POS teachers noted that they were able to participate in academy-related teacher externships and technology- or certification-specific trainings (e.g., Adobe, CISCO). Teachers themselves offered formal and informal professional development. One school principal noted that the success of his biotechnology program was due to one teacher's gifts as a trainer: "When we were able to hire her, she was probably the best science teacher in our district and the one most ready to tackle a biotech program, and then she's been able to train two other teachers to come along with it."

Professional Development for Guidance Counselors

Guidance counselors reported that because of constrained staffing conditions at their schools, they spent much of their time scheduling courses and coordinating testing activities. As such, they reported that much of their professional development was focused on the state's high-stakes testing system, electronic IGPs, and preparing for college entrance exams. As one guidance counselor noted:

> Most of our professional development these days seems to be related to [the state's high-stakes test.] So all of us [participate]. All of us in every school and I don't care what your job is. If you are a cafeteria manager. If you are a secretary. If you are… a high school guidance counselor, a career choice coordinator: We are all involved in professional development related to [the high-stakes test].

Another interviewee affirmed this focus on testing, acknowledging that, "a lot of the professional development, especially at the school site, is geared towards the teachers more so than counselors." However, guidance counselors also mentioned participating in development focused on getting students college-ready and, to a lesser extent, career-ready. Interviewees spoke of trainings related to the state's scholarship program, the state's college-and-career planning website (underutilized by students, according to one interviewee), and college exploration activities (e.g., campus visits, college fairs). One guidance counselor reported that she was currently participating in college prep training offered by admissions counselors at a local university; this training was being paid for by the university and accepted for in-service credit.

Counselors reported that professional development less often addressed counseling services for students with personal or family issues. One guidance counselor said she wished the district offered more support related to student mental health and substance abuse problems. Overall, South District guidance counselors reported that in addition to district- or school-provided professional development, they were free to pursue any training that supported school mandates; in many cases, supplemental funds were available to support such independent training.

Systems and Strategies to Gather Quantitative and Qualitative Data on Both POS Components and Student Outcomes Are Crucial for Ongoing Efforts to Develop and Implement POS

State Assessments

During our study, the state was moving from high-stakes tests taken in the 10th grade to end-of-term assessments. Some subject areas were piloting these end-of-term tests, thus creating an extra-long "testing season." One counselor told us that testing lasted two months straight, including state tests, AP tests, and end-of-term tests. This change in testing did not affect our cohort, however, as our students had already taken their high-stakes exams. The state tests also went online during our study. New schools and those with updated computers were better resourced to manage the increase in demand created by the online tests. But because all students needed to take exams, students who needed to use the computers in their regular classes were displaced during testing periods. Insufficient numbers of computers were a statewide issue.

A principal said that one way to increase his test scores was to dis-enroll chronically absent students—those not seen for months—prior to the administration of the state tests.

South District fostered teacher professional learning communities in which teachers from the same subject area met to create common assessments, examine results, and determine the best practices that were used to obtain those results.

Content Standards Define What Students Are Expected to Know and Be Able to Do to Enter and Advance in College and/or Their Careers

Of the three districts participating in the study, South was the only district in which participants offered clear-cut definitions of college and career readiness derived from state and district requirements—in this case, math and reading test scores for college readiness, and CTE or POS completer status and acquisition of an industry certification for career readiness. As a counselor at Jade noted, such rules were apt to change from year to year, causing confusion when registering students for dual enrollment, counseling them regarding their eligibility for state scholarships, or reviewing graduation requirements.

Most participants, particularly at the unabashedly college-preparatory Bronze, said that college readiness was a state and district mandate. Other participants, like Scarlet's principal, esteemed job readiness as a goal of equal worth, stressing that the school's focus was to graduate students with the diplomas, skills, and certifications needed to get a well-paying job, whether they attended college at the same time or not. As a counselor at Lavender noted, many students "will go on to the state college… I do appreciate dual enrollment and its ability to get their feet on that campus during high school and see that it's not a scary place, and to save a little money." As she explained, the state college offered programs and training that allowed students to "have a better lifestyle for themselves and their family." The academy coordinator at Plum agreed:

> We prepare them to leave here and go on to whatever the next step of [their lives are] and we do push college. I know it's not the perfect thing for everyone, but education is the

> key, whether it be college or whatever it is. You've got to be trained in something to be able to go out there and make more money and have the better job and be the person that's going to be hired… That's what we believe.

Guidance Counseling and Academic Advisement Help Students to Make Informed Decisions About Which POS to Pursue

Communicating the range of college and career preparatory opportunities available to students and parents required the joint participation, knowledge, and experience of guidance counselors, academy coordinators, and highly skilled CTE teachers with strong industry backgrounds.

Students' electronic IGPs provided a structure around which many guidance and career counseling activities took place. These plans outlined all of the possible permutations of courses available within students' pathways, as well as available dual credit and online courses, options for postsecondary study, and career choices.

Of course, students choose POS and other high school programs for reasons beyond career preparation, and school staff recognized this. Two principals we interviewed noted that some students needed a "hook" in order to keep coming to school. For some it was athletics, for others it was band or art; and for others, it was POS. Periwinkle's principal put it this way: "You have to find something these kids enjoy coming to school for. You know they're not coming here to enjoy calculus and they're not coming here to enjoy chemistry. But if you can tie it to medicine, which is something they have a desire for, they're going to excel, and that's the important part of having these type of programs." Scarlet's principal concurred:

> Every one of those students that goes through the construction program for the most part really buys into it. They enjoy the program, and then the same thing for the other programs - for the IT or for the biotech – they enjoy it. It doesn't mean that every single one of them are going into a biotech career when they are done, but they are focused students and it gives them something that they enjoy coming to school for, and that's the number one reason for any of these programs is to have that hook that makes them want to come.

Guidance Counselors' Roles and Responsibilities

Schools differed in how they distributed counselors' student caseloads—some dedicated counselors to specific POS, whereas others employed school-wide alphabetical caseloads. In the latter case, schools used academy coordinators as liaisons between CTE programs and the guidance department. Bronze took a different approach. There, deans (essentially assistant principals) served as counselors, handling scheduling, course registration, and testing; a dedicated college counselor offered college preparatory services like application reviews and scholarship and financial aid assistance.

Counselors' responsibilities looked the same regardless of the structure (academy-specific or alphabetic) of their heavy caseloads. Counselors oversaw school scheduling, conducted annual IGP updates, registered students for courses, performed graduation credit checks and transcript

analyses (including to determine whether students could qualify as POS completers), disseminated college and financial aid information, coordinated campus visits and college fairs, offered sessions on credit transfer opportunities, and administered state high-stakes tests and AP exams. In some schools, guidance counselors were responsible for overseeing virtual high school and/or online coursework and credit recovery programs; in others, academy coordinators undertook this task. Counselors also reported spending some time managing students' social and emotional problems, although a counselor at Periwinkle believed that counselors needed more support regarding student mental health and substance abuse issues. Most counselors reported that they did limited career guidance and advising; most promoted the use of the state's careers website and administered interest inventories and assessments like the ASVAB. Career guidance was largely the purview of academy coordinators and teachers.

Academy Coordinators and Other Support Personnel

At Scarlet, the academy coordinator said that in order to be college and career ready, her students had to graduate with something other than just a diploma—they should leave school with the knowledge, credentials, workplace skills, and college credits required to thrive in a range of postsecondary and occupational settings. For that to happen, students needed to engage in enriched classroom instruction, participate in work-based learning and credit transfer opportunities, and receive excellent career guidance and counseling. Academy coordinators were the drivers of many of these activities.

Depending on the school, academy coordinators had multiple responsibilities, including, but not limited to, facilitating the district's lotterized academy application process, serving as liaisons between the school's academies and the administration, collecting academy accountability data, overseeing middle school outreach and recruiting, administering industry-recognized credential exams, registering students for dual enrollment, soliciting guest speakers, coordinating special events, scheduling work-based learning opportunities, and maintaining relationships with business and community partners. Plum's academy coordinator described herself as part teacher, part counselor, although she carried a reduced caseload of IEP students compared to the regular guidance counselors' caseloads of general population students.

Career Guidance and Career Exploration

Career guidance and career exploration were embedded in academy curricula and co-curricular activities for all of South's career academies. The goal of this career guidance was to help students understand the full range of college and career options available to them. Academy teachers, many of whom came from business and industry, enriched their classrooms with hands-on learning experiences that brought students into contact with business and community partners while they engaged in work-based learning and earned industry-recognized credentials. The supervisor of South's medical academies said that the district had invested heavily in establishing legal agreements with area hospitals, clinics, nursing homes, and other facilities in order to make such hands-on training possible.

The district's medical and health science academies offered an excellent case study of the types of career guidance and exploration available to students through in- and out-of-class experiences,

including in-class clinical practice, internships, off-campus clinical placements, and CTSO competitions. At Lavender, we observed a health science class taught by a registered nurse in which students practiced nursing skills in preparation for the CNA exam. Lavender was an approved CNA testing site, and this classroom included a fully equipped medical bay featuring hospital gurneys, medical dummies, feeding stations, and supplies. The teacher explained how her students divided their time between the classroom and the lab, then applied and practiced their skills in a series of clinical placements at area nursing homes and medical facilities. Students kept journals in which they logged their clinical experiences. The teacher explained how these journals not only taught students how to write proper case notes, but also encouraged them to engage in critical self-reflection—a valuable skill in the high-stress world of healthcare.

The students we interviewed spoke enthusiastically of their clinical experiences and saw them as sources of skill development and career exploration. A medical academy student at Plum mentioned rotations in the histology and hematology labs at a local hospital, a nursing home placement, and an EMT ride-along. These field experiences, combined with his teachers' advice, input from visiting guests, and HOSA leadership activities, led him to identify pathology as a potential career. A Lavender medical academy student made a similar statement, noting that her internships had helped her gain skills and an understanding of what she wanted to do after graduation. Coupled with the valuable industry-recognized credentials she had earned, these experiences would allow her to get jobs that would help her pay her way through medical school at the in-state university to which she had applied.

Teachers also found creative and challenging ways to blend career guidance into their instruction. At Periwinkle, the medical law and ethics teacher—a former nurse and expert witness—explained how her students explored real-world legal issues facing doctors and medical professionals by thoroughly researching local court cases and conducting in-class trials. This teacher sought to prepare students not only for the rigors of medical training but also for the ramifications of their career choices. In a long-term project, her students researched potential careers and reported on associated colleges or training programs, curricula, study requirements, tuition and financial aid, and lifestyle costs (cost of living vs. earnings).

Many of the students we interviewed spoke in glowing terms of the influence, expertise, and "amazing help" offered by their CTE teachers, describing them as role models and even friends. A Periwinkle medical academy student said that her teachers—"real doctors and nurses"—had helped her understand the opportunities available to her in health care and had been instrumental in helping her narrow her college applications to the programs and schools that would best suit her interests. A Lavender sports medicine student believed that familial relationships and strong bonds between teachers and students—nurtured through co-curriculars like HOSA and after-school athletic events—had supported her through her challenging program.

The cohort model followed by many POS may have fostered the familial environment this student and others described. Medical and health sciences POS students at Bronze, Periwinkle, and Lavender all cited other students as a valuable source of understanding, motivation, and support. A Periwinkle student said that the culture of her academy encouraged student-to-student mentoring; upperclassmen were expected to guide, teach, and support lowerclassmen through the challenging early years of her program, which she likened to medical school in their intensity.

Graduates of these programs often returned and gave advice to current students, telling them to learn the subjects now in high school, and they would have an easier time in college than many of the others that these POS graduates watched struggle.

Students also received career guidance and support from outside experts. A Lavender sports medicine student commented that guests frequently visited her health sciences POS to talk about their careers; such guests included an HIV/AIDS prevention expert, a professional lifeguard, hospital personnel, EMTs, firefighters, and sports medicine doctors. This student believed that these contacts were helping her make more informed college and career decisions. Although not all POS shared as comprehensive a career guidance and exploration approach as the medical and health sciences POS, all district POS attempted to provide similar career guidance experiences.

Innovative and Creative Instructional Approaches Enable Teachers to Integrate Academic and Technical Instruction and Students to Apply Academic and Technical Learning in Their POS Coursework

Interdisciplinary Teaching Teams

South District embraced the idea of rigor and relevance in the high school curriculum and saw POS as a means of achieving both. Most POS cohorted their students, with English, science, and social studies teachers dedicated to each program. Program teachers planned POS-specific cross-curricular instruction during their only common planning time, the high schools' half-dozen regularly scheduled morning in-services. Few high schools could institute any other common planning time. The state's class size reduction law for core academic classes made cohorting and common planning time much more challenging to maintain for those schools that could offer them. For example, under the law, if a school wanted to cohort all 30 of its construction POS students in the same English class, only 25 could actually be in the class; the remaining five would be separated from their cohort.

We heard of geometry teachers working with construction teachers, history and English teachers working with a media program, and a culinary teacher working with a drama teacher to create a murder mystery dinner theater event. A medical POS teacher said that he "camouflaged" the state academic standards in his program; he also brought in academic teachers to help teach embedded concepts. Administrators who reviewed his program told us they were unable to tell "who was the medical and who was the English teacher."

During our classroom observations, we did see academic classes tailored to a cohort of POS students, as was the case with a medical POS chemistry class at Plum. However, we observed more instances of POS teachers incorporating academic subjects into their classes, including an auto body class that reviewed optimum paint/air ratios and air pressure readings for the various paint guns they used, as well as culinary students taking a quiz that looked more like a science quiz ("Which of the following is used to measure humidity levels in dry-storage areas?"). We saw no teacher teaming in our observations at South District.

Student perspective. The students we interviewed provided many examples of how academic concepts were taught in their POS classes. One medical careers student said, "Oh, all the time. I

mean medical, it's from math, science, a lot of reading, a lot of history—the history behind medical, you know, how medicine came to where it is. The math, always adding numbers and how many cc's of this and just adding, in kilograms, in grams, in weight and measurements. Science, just basic body science, you know."

Students also recognized when their academic teachers made connections between their subject area and the world of work:

> All of my teachers-, they're like life lessons in their lesson plans kind of. Like my math teacher, she'll just kind of go off on how you can use what we're learning in class in the real world. And also my chemistry teacher, he'll do the same thing. You know, when he's working in the labs, how he was applying it, and it kind of helps me to see how you can actually use the stuff we're learning, cause sometimes it doesn't make sense to me. It's like, when are we ever going to have to use this? But then they're like, "This is when you're going to use this." and it also depends on what career you're going into but this is just good general knowledge and it helps me see what I want to do.

Students noted differences in the concerns of their academic and POS teachers, as described by a student in the medical careers program: "I know our medical teachers, they're always asking what colleges did I apply to, you know, am I getting my stuff done like scholarships and things like that. Usually regular teachers, they won't really get on you, like 'what are you doing to go to college?' and stuff like that. I think that's one of the reasons it's good to be in a career academy, because the teachers, since their focus is only on you, they'll actually try to understand what you're going to do in the future and try to help you out."

Contextualized Learning Approaches: Work-Based Learning

South District's commitment to providing work-based learning opportunities to every CTE student was apparent at every school we visited. Although it took time, significant resources, and industry cooperation to secure and maintain internship and clinical sites, district and school personnel saw work-based learning as a means of preparing students for life after high school, whether students chose immediate employment, enrollment in a college or technical school, or a mixture of both. As Scarlet's principal said, their goal was to show students what was possible, potentially saving them both time and money:

> What we're doing is giving them alternate paths that they may be interested in and giving them a taste of it… letting them see what it's like to work on a car all the time or to build a house. To let them know if they're gonna like it or not, before they get out of here, so that they don't have to leave high school with a diploma and no direction, and then… go sample jobs for several years until they decide what they want to do.

Work-based learning allowed students to explore and apply what they had learned in theory and by so doing, to not only identify their career goals, but also tap into their personal passions. As an automotive student at Plum said, "My ultimate goal is to own my own body shop. [When] I first came in, I didn't want to do body work, but I came in and I started getting around it and I

just kind of fell in love with it… it was the hands-on—it's… a rush when something rolls out. It's like, 'I did that.'"

Work-based learning in South District frequently took the form of off-campus internships and clinical placements, but also included school-based enterprises and other on-campus activities. Teachers and students described a broad and interesting range of internships, including an environmental studies student conducting site surveys for an engineering company, broadcasting students taking summer jobs with a local Clear Channel affiliate, culinary students earning hours toward their certification by working for local restaurants, and drafting students designing improvements to a community skate park.

As we have described elsewhere, no program placed a greater emphasis on work-based learning than South's medical and health science programs, which required students to complete internships. The district's coordinator for these programs maintained some 100 active contracts with various area medical facilities, including hospitals, clinics, physical and sports therapy providers, labs, nursing homes, ophthalmology clinics, morgues, and pharmacies, among others. Lavender CNA students practiced their skills by bathing and feeding residents and changing beds at area nursing homes, then reflecting on those experiences in field journals. A Plum health sciences student who was indecisive about his future career relished the fact that his program offered many internship and job shadowing opportunities that had allowed him to explore the real world of pathology, histology, and emergency medicine.

Some schools featured school-based enterprises that went beyond simulating real workplaces by offering actual services to the public, as was the case for Lavender's early child development program, which housed an on-campus preschool. One of Lavender's school counselors had a grandchild enrolled in the preschool, which received over 500 applications for 20 available slots. Students gained 480 hours of work experience in preparation for certification. As the counselor noted, both the program and the preschool allowed students to explore the full range of career options in the field.

Where off-campus internships or school-based enterprises were not available, programs sought to provide robust in-school work-based learning and community service experiences. Although she had also participated in formal internships, a Lavender sports medicine student completed more than 2,000 hours of sideline sports medicine at school events. Lavender IT students repaired and rebuilt computers for needy families and earned community service credits at the same time. Plum medical academy students hosted community health fairs at which they took blood pressure readings and earned scholarship money for each blood donation attendees gave.

Contextualized Learning Approaches: Project-Based Learning

Although project-based learning did not appear to be a mandated district initiative, we saw evidence of implementation of this approach at each of the schools we visited. The depth and intensity of project-based learning varied by program, but frequently included examples of curriculum integration—as with culinary students making ratatouille, cream puffs, and baguettes in conjunction with a history unit on the French Revolution, or a public service announcement

film project that was tied in to students' English classes. When available, common planning periods, or even informal teacher planning at lunch, greatly facilitated project-based learning.

Some of the best examples allowed students to solve real-world problems in their communities and also drew upon the strengths and contributions of schools' community and business partners. As noted, Scarlet's construction technology and design and drafting students worked with area business partners—including professionals associated with the school's ACE Mentoring chapter—to design and build a Habitat for Humanity home. The district negotiated an extended contract with Habitat for Humanity that would allow students to complete construction of the home over a longer period of time than other Habitat homes and also purchased insurance to cover student workers. Community members and business partners donated their time and expertise, building materials, and the land on which the house was to stand.

Similarly, juniors and seniors in Lavender's design, engineering, and construction programs undertook the redesign, rehabilitation, and reconstruction of a historic neighborhood property known as Lavender House. This example of project-based learning was not without its problems—the program's instructor commented on the high cost of construction permits, the difficulty of making changes to a landmark property, and constraints on what students could accomplish at the site given the school's schedule. However, two seniors talked about how the project not only allowed them to earn community service hours and apply their "book knowledge" of design and drafting to a real building, but also revealed their work styles and career preferences. One student talked about how much he loved both the mechanical world and the hands-on aspect of construction; Lavender House allowed him to plan, build, and experience all aspects of the process. The other student said that although he enjoyed seeing his designs translated from concept to reality, he discovered that he preferred designing and supervising to hands-on construction work. However, he recognized the value of practical experience: As he said, the program gave him "a lot of book knowledge… But the thing is, if … we're designing something and then we come to figure out that later on it doesn't fit properly in the actual plan, that could cause a lot of conflicts… so it's good that we have that [experience] also."

Teaching Soft Skills

All high schools in South District had two types of POS: those accessed through the lottery and those for students in their zoned high schools. The latter often did not begin until sophomore or junior year, although some prerequisites (e.g., biology for medical POS) were needed prior to joining the POS. At Lavender, the construction POS was for local students only. The teacher required that introductory level courses be taken prior to joining the program; during these introductory courses, he decided whether students were trustworthy enough to join it. Maturity was more important to this teacher than initial capability.

South District students received important soft skills instruction during internships, which were strongly encouraged but not required in most POS. Internships usually offered highly structured opportunities for employers to teach soft skills. Employers evaluated students' performance and eligibility for high school credit on assignments requiring information-seeking and networking, among other activities. Many students identified their own internship locations; one student interned at his father's workplace, where he developed an inventory spreadsheet for the company

warehouse using "first-in, first-out" principles. Such experiences helped students develop the teamwork and problem-solving skills employers desired.

Team-building. Over the course of our site visit to South District, we observed fifteen POS classes and three academic classes. Although we saw no examples of teamwork in the academic classes, POS classes offered many examples, some more challenging than others. Students worked together to organize and file patient identification records according to a terminal digit numerical filing system, baked pumpkin bread, taped each other's ankles, and edited film footage together. In a construction class, students worked in crews identified by different-colored hard hats. Each crew had a supervisor and a quality control person, among other roles. Role assignments changed over time, giving students experience working in different contexts. For example, students acting as team supervisors had to identify and train their own replacements. Students assigned the task of quality control could stop the work at any time if they saw something go amiss. In one such instance that we observed, quality control flagged a problem with the frame of Scarlet's Habitat House; students paused, considered the issue, and negotiated a solution by prying out a number of nails and starting over.

Critical thinking and problem-solving skills. Classroom observations offered many examples of students applying previously learned information to the solution of problems; in some classes, students synthesized information from a variety of sources. In a biotechnology class, for example, students completed a lab assignment on the effects of chemical buffers (e.g., alkaline compounds) on acidic solutions, then moved to the classroom's computers to visually represent their results in Excel tables and graphs. The assignment required students to apply, synthesize, test, and communicate both their biotechnology knowledge and their computer skills.

A Law and Medical Ethics class featuring preparations for a mock trial provided a good example of students thinking critically and generating meaning to arrive at a "real" outcome. Students synthesized legal and medical knowledge as they developed prosecution and defense strategies in a murder case. We watched students work together and with their teacher to compose questions and opening statements, understand mitigating circumstances, present evidence, and understand such concepts as blood alcohol content, rates of metabolization, and the effects of head injuries. Students also practiced typical academic skills like effective composition and communication. Although this was not a real case, students appeared earnest in their efforts to apply their medical knowledge to upholding the law. This teacher sometimes used real closed cases in her class.

Teaching soft skills through CTSO activities. CTSOs were popular and well supported in South District. However, staff at some schools told us that competitions were so demanding that some teachers could not make the time commitment needed to support them. One district administrator said: "I support [CTSO participation] but I won't stop talking to teachers if they decide not to do it. Their plate is very full." One principal said that because many POS classes increased in size after the passage of the state's class size reduction law, many teachers found it difficult or impossible to continue to sponsor CTSOs.

We met a number of students in CTSO leadership roles; these seniors were among the most directed, purposeful students we interviewed. One student, an FBLA president, said he initially joined only to boost his resume, but found the experience to be much more than he imagined. He

was one of several CTSO leaders we spoke with who were taking AP and dual enrollment classes, earning industry-recognized certifications, and accepting early admissions offers from the colleges of their choice.

One Bronze student joined the school's medical academy after learning about and joining the school's chapter of HOSA, the health sciences CTSO. HOSA participation sparked her interest in a medical career. She became her chapter's president and a regional officer and participated in many leadership activities. She also told us she was considering a state leadership role. She was in charge of planning regional competitions and a health fair at Bronze; a dozen high schools and hundreds of students planned to attend. Like many students we spoke with, this student initially had not planned to become an officer, but became more involved in leadership roles as she participated in more regional and state competitions and helped her peers stage successful events.

Every school we visited boasted of their students' success in regional, state, and national CTSO competitions. A medical POS student we interviewed described one such competition in which students received a list of possible medical-related activities they could be asked to do and what they would have to do to compete: "You have to literally to be your own leader and carry yourself through whatever they throw at you." In addition to teaching soft skills through competitions, CTSOs fostered mastery of these skills through hands-on community events like blood drives and health fairs.

National, State, and/or Local Assessments Provide Ongoing Information on the Extent to Which Students Are Attaining the Necessary Knowledge and Skills for Entry Into and Advancement in Postsecondary Education and Careers in Their Chosen POS

Technical Skills Assessments

This state used industry-recognized credentials as their technical skills assessments and provided a list of approved credentials for most program areas. For those programs lacking an industry credential, districts could choose their own certifications. South District assumed the costs of these credentialing exams for students. Some credential exam scores were not reported back to the schools; students received their scores individually. In order to secure these scores for school reporting purposes, the district added a cover page to them that required student and counselor signatures. To improve student outcomes on more difficult credentialing exams, South District cultivated middle school pre-academies that started students sooner on the path to preparing for these exams.

Some program areas, like IT, had a certification at the end of every class: One student we spoke with was certified in Word, Excel, PowerPoint, Final Cut Pro, and Photoshop. Other programs, like automotive, had only one certification as a culminating exam. Some credentialing exams could be taken more than once; others, due to their cost or other restrictions, could not.

Initially, the state's goal was to introduce these certifications to students without the expectation of high pass rates. They incentivized schools to offer industry-recognized credentials by awarding them points toward their school grade for student participation in courses with such credentials. Many study participants reported that principals were eager to have a credential in

every program in order to boost their school grades. Industry-recognized credentials thus increasingly played a greater role in the school grading system. One counselor told us that although this push created pressure for students to succeed, she appreciated the fact that CTE was being recognized as a significant part of school accountability: "If our school is going to be successful, our CTE classes need to be successful."

Passing an industry credential exam represented meeting one element of the district's definition of career readiness. Consequences for not passing varied. In some cases, we were told that failing an exam did not affect a student's classroom grade; in other cases, it did. Failing an exam did not affect graduation status. Participants did say that failing to pass the credentialing exam affected students' prospects. A counselor said that industry credentials—and the well-paying jobs they could help students secure immediately after graduation—were a big selling point when recruiting middle school students. Both students and school personnel acknowledged that credentials held value as a means of earning money to help pay for college, even if students did not plan to pursue careers in the same area. For example, although South's medical programs were not strictly pre-med, many students in those programs planned to become doctors. The certifications they earned in their programs provided them with jobs, experiences, and exposure to different medical fields and potential careers much earlier than students who did not participate in such programs.

Assessments and Standards in the Classroom

Unlike students in West or East District, South District automotive students were encouraged to take and pass the ASE certification exam. Preparing for this difficult credentialing exam required more classroom hours than most high schools were able to provide, but given the state's use of industry-recognized credentials as technical skills assessments, as well as the district's heavy focus on them, South students were able to accumulate the coursework hours needed to take this exam. Students still needed to acquire work experience hours in order to receive the ASE certification and a patch for their work uniforms. One proud student who successfully passed his ASE exam said this patch would announce that "I know what I'm doing."

As noted, many industry exams were taken online, which caused problems for schools with inadequate numbers of computers or outdated equipment and software. Participants mentioned dropped internet connections and lost work; teachers said they were unable to give their students administrator passwords so they could practice for exams that would allow them to become system administrators. Although this specific issue was legal, many technical issues were attributable to budget cuts. A focus group of IT students told us that in one instance, they could not take practice exams until the school's site license was renewed. Once it was, the new software conflicted with the school's old hardware, which had not been updated due a lack of funds. Having practiced on the old software, students were shocked to discover during the timed final exam that the new software used different function keys. They also complained of having to take some exams at a regional testing center, the unfamiliar setting of which added to their stress. Students were quite aware of the stakes involved: "The main focus of the academy is for the testing… because that's how we're measured."

CHAPTER SIX: Telling the Story of POS
Cross-District Synthesis

In this chapter we integrate outcomes from this mixed-methods study to synthesize what we know about the impact of POS on student achievement. Results from all three districts are presented here and integrated with qualitative outcomes for the four mandated elements of POS.

Cross-District Outcomes Synthesis

As noted in *Method*, we operationalized the four mandated elements of Perkins IV into measures that capture the skills and content that POS were designed to address. Most of the academic and technical achievement expectations of POS are found in the second element of the law; transition outcomes are found in the last two elements. We did not quantify the first element (i.e., the extent of secondary and postsecondary alignment). Instead, qualitative data were used to synthesize all findings in that regard. We present the four elements again in Table 6.1.

Table 6.1
The four mandated elements of POS

i	POS must incorporate secondary education and postsecondary education elements.
ii	POS must include coherent and rigorous content aligned with challenging academic standards and relevant career and technical content in a coordinated, nonduplicative progression of courses that align secondary education with postsecondary education to adequately prepare students to succeed in postsecondary education.
iii	POS may include the opportunity for secondary education students to participate in dual or concurrent enrollment programs or other ways to acquire postsecondary education credits.
iv	POS must lead to an industry-recognized credential or certificate at the postsecondary level, or an associate or baccalaureate degree.

Source: Perkins IV, Section 122[c][1][A].

Incorporate and Align Secondary and Postsecondary Education Elements

In all three participating districts, POS incorporated elements of secondary and postsecondary education, primarily in the form of credit transfer agreements, which we describe below in *Postsecondary Credits*. In this section, we discuss other ways in which the districts aligned secondary education with their postsecondary partners.

CTE curricula in all three districts were state-approved and vertically aligned from secondary to postsecondary education. Postsecondary faculty members participated in high school CTE curriculum development in order to ensure that students would be able to transition from one system to the other without duplicating courses or content. Across districts, what differentiated POS from regular CTE programs was that students participating in POS took courses in structured, progressive sequences culminating in a capstone course and they benefited from the other elements of POS, such as intensive course experiences, integrated academic and career curricula, the expectation that students would attend college, and sustained career development and guidance. In contrast, regular CTE students could take any combination of CTE courses offered at their high school, within or across programs, with or without a sequence or a

culminating capstone course. Regular CTE did not necessarily offer college credit or lead seamlessly to articulated, college-level programs.

Alignment between secondary and postsecondary education appeared to be most advanced in **West District**, where in addition to curricula aligned with postsecondary programs, many West POS also aligned textbooks, faculty, and facilities across institutions. In **East District**, a similar level of close alignment once existed between the programs offered by the district's postsecondary partner, ECC, and those at Blue Academy. The recession weakened these ties. Creating aligned POS came at a cost to postsecondary partners. Community college administrators in both West and East were concerned about the return on their investment of the faculty time, facilities, and other resources needed to sustain these partnerships.

In both East District and **South District**, interviewees said that curricular alignment largely occurred at the state and district levels as opposed to the school level. From our interviews, it appeared that faculty had more opportunities to interact across institutional levels in West District than in East. We did not interview teachers during our one site visit to South District and thus know less about cross-institutional collaboration there. Student outcomes related to these alignments are discussed in *Postsecondary Credits*, below.

Include Academic and CTE Content in a Coordinated, Non-Duplicative Progression of Courses

In general, all three districts developed aligned, non-duplicative course sequences in conjunction with postsecondary partners, predominantly but not exclusively at the local community college. Sequences included introductory, mid-level, and advanced or capstone courses and opportunities for students to earn college credits, as established by state- or district-negotiated articulation agreements. Districts varied in how they created, implemented, and maintained these sequences.

Working with significant input from its secondary, postsecondary, and industry partners, **West District** took a backward-mapping approach to designing and implementing non-duplicative course sequences by beginning with where it wanted students to end up, then creating pathways to get them there. Based on the contexts and needs of specific schools and programs, West offered sequences that could be completed in three to four years of high school coursework before leading to college programs. West's sequences were designed to offer opportunities to earn college credit and industry-recognized credentials, where appropriate.

As our study began, program requirements for POS completion in **East District** mandated that students follow tightly-defined four-course sequences. Later changes made to the state's high school graduation requirements compelled East to alter its approach to creating course sequences. Although the new graduation requirements did not affect our cohort, the ongoing recession did force many schools, including Blue Academy, to close programs and cut upper-level courses with low enrollments. Such closures and cuts had a negative impact on students in our cohort, many of whom had to take classes outside their tightly defined sequences. As a result, many students in our cohort failed to qualify as POS completers.

POS sequences in **South District's** career academies were comprised of four progressive courses; these sequences were also vertically aligned with feeder middle school programs, SCC, and other in-state postsecondary institutions. The district envisioned these sequences as "roadmaps" that included industry-recognized credentials, work-based learning experiences, and opportunities to earn college credits.

Academic and Technical Achievement Outcomes

Most of the quantitative outcomes in the study fit under this POS element. These outcomes consist of the two measures from the instrumental variable analysis (graduation and overall GPA) and four measures from the posthoc analyses (overall GPA, STEM credits earned, AP credits earned, and CTE GPA).

Graduation. The results of this study suggest that (1) **West District** students who enrolled in POS schools were about 11% more likely to graduate than students enrolled elsewhere and (2) this benefit was attributable to their increased earning of CTE credits. Our study of West District suggests that earning CTE credits translated enrollment at a POS school into graduation. That is, earning CTE credits mediated the effect of enrollment on this outcome.

Students in **East District** who earned more CTE credits were also more likely to graduate. However, the results for East did not support the type of causal inferences we were able to draw from the West District data. This was because enrollment at the POS school did not perform well as an instrument for estimating the effects of earning CTE credits. Enrollment in the POS school only increased the number of CTE credits earned by an average of .20, or by less than one additional CTE course. Thus, the instrument generated very little exogenous variation in number of CTE credits. Several characteristics of East District may explain why enrollment at Blue was not a good instrument. First, East had strong CTE offerings district-wide, and many students participated. Second, POS completers and CTE concentrators were both required to earn four CTE credits. This perhaps contributed to the failure of enrollment at Blue to contribute to earning more CTE credits. Finally, the recession and the resulting reductions in capstone courses that occurred at Blue meant that some students failed to complete their POS, further diminishing the difference between POS students and other CTE students in the district.

At **South District**, enrollment in POS did not generate sufficient variation in the number of CTE credits earned and thus was not a good instrument. At South, students could enroll in POS at their zoned high schools without going through a lottery, so many students in the comparison group also earned similar numbers of CTE credits. Intervention students who enrolled in South District POS were about 9% more likely to graduate than students who enrolled elsewhere. In addition, earning more CTE credits was associated with a greater probability of graduation. However, the causal inference at South must remain tentative due to the poor performance of the instrument.

In sum, enrolling in a POS in ninth grade and taking the additional CTE credits associated with that enrollment significantly improved the likelihood of graduation in West District. In East and South, such strong causal claims cannot be made; however, earning increased numbers of CTE credits was associated with graduating in these two districts and enrollment in POS was

associated with improved likelihood of graduation in South. This is consistent with prior work showing that CTE is a positive contributor to students' chances of graduating from high school (Aliaga, Kotamraju, & Stone, 2014; Plank, 2002; Plank, DeLuca, & Estacion, 2005; Stone & Aliaga, 2003).

Overall GPA. The instrumental variable analysis in **West District** showed no difference between the intervention and comparison groups on overall GPA, but the posthoc analysis of POS completers showed that they had a higher GPA than either the CTE concentrators or the rest of the sample. The strong effect sizes indicate that completing a POS at West had substantive positive effects on a student's GPA. In addition, we observed a school effect there, with students attending Navy being significantly more likely to have a higher overall GPA than students attending Azure or Sky. This could be attributable to Navy's structure, curriculum, and culture, which may have engaged students and shown them how achievement in both academic and technical courses was necessary for the careers they wished to pursue.

Intervention students in **East District** who earned more CTE credits were more likely to have higher GPAs. But as with our graduation analysis, the results for East did not support the type of causal inferences we were able to draw from the West District data, due to the poor performance of enrollment at the POS school as an instrument for estimating the effects of earning CTE credits. We found no differences between the East posthoc groups in overall GPA, meaning that students were able to complete POS at no negative cost to overall grades.

Our findings for **South District** were similar to those for East: Enrollment in POS did not generate significant variation in the number of CTE credits earned and thus was not a good instrument. Intervention students who enrolled in South District POS were more likely to have slightly higher GPAs than students who enrolled elsewhere. In addition, earning more CTE credits was associated with a greater probability of earning a slightly higher GPA. However, as with the graduation outcome, the causal inference on GPA at South must remain tentative.

AP and STEM credits earned. Completing a POS made no difference on earning AP credits in **West District**. Because West's sample consisted of all students who applied to the three POS high schools, this result suggests that this sample of students would have earned similar numbers of AP credits regardless of the POS intervention.

However, STEM credit earning in West District shows differences among our posthoc groups. Perhaps due to the high-tech POS at the three intervention schools, students took POS-relevant math and science courses, leading to their earning more STEM credits than the rest of the sample or the CTE concentrators. The substantive effect size on the latter finding indicates that there was a difference between completing a POS and completing a CTE concentration at the comparison schools. One difference we observed was that in West District, some concentrations only required two credits. Such concentrations, such as Foods or Graphic Design, seemed less likely to foster extra math or science course-taking than the analogous four-credit POS sequences (i.e. Culinary Arts or Architecture), many of which followed a different scope and sequence despite similar program names. Other differences between POS and CTE concentrations in West District included college preparatory academics at the POS high schools, business partnerships, and alignment with postsecondary programs.

In **East District**, Blue Academy personnel held the expectation that all Blue students would attend college. We did not observe this to be the case at the comparison schools, so the higher AP credits earned by Blue POS completers compared to the rest of the sample is not surprising. The effect size of this outcome, the highest in the study, indicates that completing a POS at Blue may have had substantive positive effects on earning AP credits. However, when we examined CTE concentrators at Blue, we noted that the POS completers' advantage in AP course-taking disappeared. We posit that this outcome might be a result of a school effect—Blue Academy—as opposed to a POS effect. In other words, the result is likely a function of the expectations and culture at Blue, not of completing a POS. In addition to school culture, another factor influencing course-taking in East District may have been the severe budget cuts that resulted from the recession: Many capstone courses at Blue were cut in favor of higher-enrollment courses. This led to two consequences related to advanced academic course-taking: First, many students were unable to complete their POS, making them involuntary CTE concentrators instead who did not otherwise differ from the POS completers except in the opportunity to complete their POS. Second, given the paucity of capstone courses available, students had more room in their schedules to take more AP courses. All of these possibilities may have contributed to these outcomes at East.

Completing a POS in **South District** made it significantly less likely that students would earn either STEM or AP credits, compared to both CTE concentrators and the rest of the South sample. Because the rest of the sample consisted of students who applied to other district choice programs, it seems clear that students choosing strong college preparatory programs like IB, pre-law, or STEM would be more likely to earn more credits in AP or STEM coursework.

CTE GPA. Completing a POS appeared to have a significant positive effect on CTE GPA for completers in **West** and **South Districts**, compared to the rest of the students in our respective samples, with substantive positive effects in West District and moderate effects in South District. In **East District**, there were no significant differences in CTE GPA among POS completers, Blue CTE concentrators, or the rest of the sample, although there was a large effect size for the comparison with Blue concentrators, indicating that completing a POS in East District may have had substantive positive effects on a student's CTE GPA, even though it was not statistically different from the concentrator GPA.

This was not a self-explanatory outcome. One can imagine that taking more CTE, and taking increasingly more difficult CTE courses, as POS completers did, could have meant earning a lower CTE GPA than other students. But where there were differences between groups, they always favored the POS completers, with healthy effect sizes. CTE GPA was our technical assessment measure, so we conclude that completing a POS improved results on assessments of student technical knowledge and abilities.

Context for the Achievement Outcomes: West District

Regular CTE programs in West District did not offer the same rigor as POS—this is evident in both GPA and STEM credits outcomes. POS completers had significantly, substantively higher GPAs than both comparison groups. That, coupled with the higher graduation rate among

intervention students, suggests that POS motivated those students to achieve and finish high school. We posit that in addition to completing more CTE credits, the additional elements of POS helped foster engagement and achievement. Students in POS knew that their programs had a built-in next step at the local community college or university. School cultures at the POS high schools fostered individual and career development, opportunities to lead, positive attitudes about achievement and greater commitment to careers. Students knew that their curriculum was at a higher level than at other schools—that in many cases, their preparation was college-level and could lead to advanced status in college.

Students at Navy, who had a higher overall GPA than that of the POS students at either Azure or Sky, benefited from conditions there. First, students benefited from interdisciplinary teacher collaboration, fostered by grouping programs in houses so that academic teachers shared the same physical space as POS teachers. Navy students also benefited from the school's project-based learning curriculum, which included school-wide as well as classroom-based projects. Navy students enjoyed authentic work-based learning experiences and school-based enterprises on their campus such as an operational child care facility and active culinary and hospitality programs that often hosted community and district events.

Context for the Achievement Outcomes: East District

The entire Blue Academy staff promoted college attendance as one of the primary student outcomes they sought. The principal claimed that he pushed students to take AP courses, especially those that were in any way aligned with the POS theme. We did not observe this overriding goal of college attendance at the comparison schools. This may account for the significant and substantively important positive outcome of earning AP credits at Blue compared to the rest of the sample. The rest of the findings were neither significant nor did they generate substantive effect sizes, indicating that POS may be successfully offered in districts like East at no cost to other academic achievement measures.

Context for the Achievement Outcomes: South District

The outcomes observed in South District were not like those in West and East Districts, possibly due to sample selection. Our sample came from a lottery sample, but it was not a random sample of students from the district. Nor were the lottery results a random assignment of applicants to programs. As noted, nearly 95% of students were accepted into one of their three choices (89% were accepted into their first choice program). There were not enough students in the sample to perform a PSM as was done at East, leaving a comparison group comprised of students who were accepted to other choice programs such as IB, STEM, or performing arts. These were not necessarily students who had applied to be in a POS, nor were they matched to the intervention students—they were a sample of convenience in the sense that South District could not provide an alternate sample. Unlike the other two districts that had few significant differences at baseline, the sample at South showed significant differences at the onset of the study in poverty and prior achievement. Despite controlling for these and other variables in the subsequent analyses, baseline differences suggest that there might be other unobserved differences between these groups that could have led to the outcomes.

We attempted to account for school effects through (1) the clustering of students in schools in the instrumental variable portion of the analysis, and (2) a dummy variable in West and a single intervention school in East for the posthoc analyses. However, at South, intervention students were in a large number of high schools, sometimes in the same school that non-lotterized POS students and general comparison students attended. This could have confounded the results.

CTE concentrators in South District tended to outperform POS completers on several measures, although effect sizes were not large. Because both concentrators and the rest of the sample earned significantly higher numbers of STEM and AP credits than did POS completers, it is possible that the additional CTE credit and other requirements of POS at South District (e.g., internships, industry credentials) took enough time away from POS completers that they were unable to pursue as many advanced academic courses. South POS completers had significantly higher CTE GPAs than CTE concentrators and the rest of the sample, suggesting that they had focused on their POS areas over advanced academic course-taking.

The STEM and AP outcomes suggest that South's comparison group included many high achievers. We know from the qualitative data that there were many college preparatory programs in the comparison group. AP credits should be the most comparable measure across districts, because they have a common curriculum and exams, regardless of where classes are taught. The results reviewed in each chapter show that South District comparison students took almost twice as many AP credits as any other group in the study, in any district. This reflects the advanced academic standing of this comparison group and helps explain the lack of positive outcomes for POS completers.

The preceding may explain the outcomes between POS completers and everyone else, but CTE concentrators also outperformed POS completers on some measures. One explanation for this came from district research office personnel, who had experienced difficulties trying to identify appropriate comparison groups in their own research on the district's career academies because so many South high school students were in POS. In our sample, CTE concentrators were students who were in IB, STEM, or performing arts programs who also completed a CTE concentration. We saw this with course data (see *Identifying POS Completers, Appendix A*).

In sum, findings from the three districts indicate that taking more CTE credits may boost GPA, the probability of graduation, and some achievement measures. Further, based on the posthoc findings, these results come at little to no cost to overall academic achievement.

Offer the Opportunity, Where Appropriate, for Secondary Students to Acquire Postsecondary Credits

All three of the participating districts had credit transfer agreements in place with local postsecondary institutions; some were developed by the state, and others were developed locally by secondary and postsecondary faculty and administrators. **West District** and **South District** offered opportunities to earn general education and humanities credits through their dual enrollment programs. By contrast, **East District** offered STEM and CTE courses through its dual enrollment program. All three districts provided opportunities to earn postsecondary CTE credits through articulation agreements between high school and community college programs. Under

these agreements, high school courses could take the place of some introductory college courses. East District and ECC were more advanced in the use of online courses as a course delivery mechanism than the other districts in the study.

In addition to these structured programs, community colleges also allowed high school students to enroll independently in their programs upon meeting age and placement requirements. In West District and East District, students could apply to their high schools to get their community college credits approved for high school credit. All three districts offered PLTW programs that included supplementary end-of-term assessments that could earn students college credit at PLTW-affiliated colleges and universities.

Many students we spoke with were aware of the credit transfer opportunities at their schools, but not all of them were availing themselves of the opportunity to accrue college credits. We interviewed students in both West District and South District who told us that they had decided not to risk their GPAs or their college prospects on such demanding opportunities, which also included AP courses. Budget cuts to East District's dual credit programs may also have affected participation rates there. East students who were motivated to earn postsecondary credits in high school seemed to value AP credits over the articulated credits with ECC.

In no case did these credit transfer opportunities automatically bestow postsecondary credit, although WCC did create student transcripts while West District students were still in high school. However, the only way for West students to actually obtain their transcripted credits was to enroll at WCC. If they attended another postsecondary institution, their WCC credits were not available. In East District and South District, students sometimes had to take exams or otherwise demonstrate competency in addition to enrolling at the community college in order to obtain their accrued credits.

Postsecondary Credits Outcomes

States, districts, and education agencies have invested much time and effort encouraging high school students to earn college credits while still in high school. The results of these efforts were obvious in the students we met who planned to graduate from high school just a handful of college credits shy of an associate degree. Students like these were not the norm, however. As shown in the descriptive outcomes statistics tables for each district (cf. Tables 3.3, 4.3, and 5.3), the percentage of students who took advantage of these opportunities and actually accrued college credits was quite low, averaging about 5% across all groups and districts.

Despite the promotion of these credit-based transfer mechanisms within POS, completing a POS was not associated with accruing more college credits. In fact, when there was a significant difference between POS completers and the other groups, as there was in West and East Districts, the difference favored the rest of the sample, not POS completers. The models we ran on college credits accrued were not as well-aligned with the data as the other analyses, so this may have affected the results. We know from the qualitative data that all students, not just POS students, were encouraged to take courses that offered the opportunity to earn college credits. It could be that non-POS students had more time in their schedules. Or, as the qualitative data have shown, POS students in these districts saw themselves as bound for four-year colleges and

universities, and the community college credits that were being offered did not seem as useful or desirable to them as other college-preparatory approaches like AP and other advanced course-taking.

Policymakers should note that many of the dual credits available to high school students come from local community colleges. In our districts, a great deal of energy was expended during the POS design and implementation process in bringing secondary and postsecondary faculty together to align their programs. But if POS are designed to align with and lead to postsecondary programs, and if they are designed to include standards-based coursework associated with a college-preparatory high school program, then it should come as no surprise that POS students will be less interested in community college credits that will not transfer to four-year universities and will be more interested in earning AP credits. Indeed, descriptive statistics in each district show that the percentage of students earning AP credits is much higher than the percentage of students accruing college credits through credit-based transfer programs like dual enrollment (cf. Tables 3.3, 4.3, and 5.3).

West District. Dual enrollment was a small program in West District: Few students participated because not many high schools had teachers who were college-certified to teach the classes. College credits accrued through community college articulation agreements attracted more students, but POS students appeared to be more interested in four-year colleges and universities, often out of state, which made those credits non-transferable.

East District. One comparison school principal asserted that dual enrollment was preferable to earning AP credits because dual enrollment allowed students to receive credit on a real college transcript. However, sample students appeared to value AP credits more (cf. Table 4.3). East District students were also limited in the types of courses they could take—limitations that were imposed by the state for budget reasons. A strong press for four-year college attendance may also have led to the low numbers of college credits accrued in East District.

South District. Although dual enrollment participation in all districts was disappointing, participation in South District was the lowest, with low numbers of college credits accrued in all posthoc groups. Compared to some groups in the other two districts, South students simply were not taking advantage of the opportunity to accrue college credits. This may have been because the state increased the placement exam requirements for dual enrollment. South District encouraged students to take academic college courses rather than occupational courses because the local community college tended to schedule occupational courses as day-long blocks that were difficult for high school students to take. Articulation agreements existed, but articulated credits were not immediately available. Outcomes from this cohort did not match the positive rhetoric we heard about participation in these programs.

Lead to an Industry-Recognized Credential or Certificate at the Postsecondary Level, or an Associate or Baccalaureate Degree

Adults participating in this study valued industry-recognized credentials and certificates as a means of aligning secondary and postsecondary curricula, affirming the quality of their CTE programs, and providing students with stackable credentials leading to a broad range of

educational and career options. In addition to signaling students' work readiness to potential employers, industry-recognized credentials were perceived as offering significant financial benefits. Students with certificates in hand could use them to get well-paying jobs to help pay for college. Schools also saw these credentials as a valuable recruiting tool. Despite these benefits, it was not always possible to offer industry-recognized credentials in POS, particularly in those cases in which a POS program area lacked alignment with a national industry accrediting body. Other barriers to offering credentials included the high costs of implementation, teacher training, and student testing; curricular alignment issues between high school and postsecondary programs; stringent technology and equipment requirements; scheduling constraints; liability and eligibility issues; and the perceived difficulty of certain exams.

With the support of WCC and business and industry partners, **West District** sought to make industry-recognized credentials available in all of its POS for which a national-level, industry-approved accrediting agency existed. As both district and WCC participants acknowledged, however, not all programs aligned with national certifications; the district also lacked a mechanism for tracking the acquisition of credentials.

A number of **East District** high schools, including Blue, featured programs with credential or certificate-earning potential. However, industry-recognized credentials were not a major focus of district policy, and many participants cited their high costs as a barrier to their implementation in this economically hard-hit region.

Industry-recognized credentials were most robustly implemented and supported in **South District**. The state required all districts to create career academies that would allow all enrolled students to earn college credits and industry credentials. The state backed this policy with ample resources, professional development, and an accountability component that made completion of credentials a component of schools' grades. South further committed to credential completion by fully funding the cost of students' certification exams. Unfortunately, data collection lagged behind policy implementation, and valid, reliable numbers on the credentials that students earned were not available for this study.

Industry-Recognized Credential, Certificate, or Degree Outcomes

Depending on how the sentence in the legislation is parsed, this component of Perkins IV requires POS to lead to either a credential, certificate, associate degree, or a baccalaureate degree. Most of these credentials are earned at the postsecondary level. As noted, however, industry credentials have also become common in high schools and are even appearing in middle school programs. Collecting data on industry-recognized credentials is difficult. School counselors told us that many credentialing exams are proprietary. Students wishing to take the exams often must register on their own, not through the district, and exam results are frequently sent to students' homes, not to schools. This made collecting student achievement data difficult.

No usable industry-recognized credential data were collected in **West** or **East District**; in **South District**, the data we obtained were known to be incomplete, but provided a rough picture of credential-earning by POS students. About 16% of our posthoc sample took an exam for an industry credential. This was despite the state's incorporation of industry credentials into school

accountability as well as the district's push to fund the cost of the exams. Of those who took an exam and earned an industry credential, three quarters were POS completers.

POS are also designed to lead to associate and baccalaureate degrees. Although we lacked the research funding to follow our cohorts into postsecondary education and careers, future research on this sample would provide important information on the second, postsecondary half of POS. In spite of this limitation, senior exit survey results suggested that similar numbers of intervention and comparison students planned to attend a four-year college full time in both West and East Districts (South did not participate in the senior exit survey). This suggests that POS can be offered to high school students with no harm to their college aspirations or preparation.

Notably, senior survey data showed that significantly more POS students in both West and East Districts indicated that their college studies would be related to their high school programs. This suggests that students who enroll in a POS may continue their education in the same program area and reap the benefits of beginning that preparation in high school. Qualitative data showed this to be a purposeful goal of POS: Teachers and administrators in both districts spoke of putting students on a fast track to college by (a) getting the foundational and pre-requisite courses out of the way while still in high school, and (b) allowing students to earn industry credentials that would help them work in their fields while continuing their studies.

Limitations and Future Directions

This study's generalizability is limited in several ways. First, data did not come from a random sampling of the population of U.S. secondary students. Any generalization to districts that do not closely resemble those studied should be tentative. This limitation also extends to our posthoc analyses. Second, enrollment in a POS did not function well as an instrument for number of CTE credits earned in East and South Districts. Thus causal inference must remain tentative regarding the effects of earning CTE credits in these districts. One of the challenges of instrumental variable modeling is that good instruments can be difficult to find. Future research should examine school district contexts to determine whether enrollment in POS schools can provide greater access to CTE credits.

In spite of these limitations, this study provides evidence that under certain conditions, enrolling in POS schools may increase student graduation rates. The results provide impetus for exploring methods to increase the number of CTE credits that students take. Identifying the characteristics of districts that use enrollment in POS schools as a means of increasing the number of CTE credits earned could help administrators improve graduation rates. It may be that enrollment in POS schools must be accompanied by context-sensitive procedures (i.e., district-sensitive procedures) that enable students to respond by taking more CTE credits. Alternatively, some districts may not be good candidates for intervention via enrollment in POS.

Discussion

POS are complex, multi-faceted programs. The four mandated elements of Perkins IV allowed us to make numerous statistical comparisons of some of these facets. For instance, our quantitative findings indicated that POS may increase the prevalence of graduation by increasing the number

of CTE credits students earn. Other facets could not be quantified, but our qualitative data suggested they had an impact on students: Our interviews with POS seniors across these districts revealed their impressive interpersonal skills, leadership abilities, and ease in describing their life goals.

The posthoc proximal outcomes presented in this report are mixed. In general, POS had no negative effects on high school achievement for POS students in West or East District, and only one substantively negative outcome in South District (AP credits earned), a district in which POS students were compared to IB and STEM students—the best match available to us. The preponderance of positive proximal outcomes argues for examining the more distal outcomes that are part of POS, including postsecondary enrollment, persistence, and completion, as well as employment information like wages. The federal government has made a major investment in POS, but paid little attention to secondary POS students' post-high school trajectories.

The outcomes reported here are based on credits and grades earned in high school: advanced academic credits and CTE credits. Earning CTE credits in and of itself does not make a POS. Students received much more than grades and high school credits by participating in POS. As described in this report, students received career information and preparation, hands-on, challenging coursework developed with industry input and aligned with state academic standards and postsecondary programs, and leadership and internship experiences that helped them develop into mature, thoughtful people with plans for next steps after high school. We did not see this to the same extent in our interviews with comparison school students. Qualitative findings showed that, whether or not they earned similar numbers of credits in the various categories we examined, POS students were taking advantage of other, less measurable aspects of POS, like the sense of identity and support provided by POS, the close relationships between teachers and students, and the strong career preparation that put them ahead of students with a more traditional high school experience.

We concluded that most students enjoyed participating in POS, and chose their POS based on interest, if not zeal. They also seemed to recognize that their choices were not "forever," but instead offered opportunities to decide whether a particular career was right for them or not. "You really learn what you want to do," said one POS student. We met many students who were committed to their POS theme and who were changing their lives based on that POS. POS allowed them to see who they could potentially become and how to get there.

POS differ from the traditional high school experience in several ways. By grouping together students with like interests, POS help students feel a sense of belonging in a program or school dedicated to those interests. This stands in stark contrast to the often chaotic, disengaging atmosphere in many comprehensive high schools (Bridgeland et al., 2006; Powell et al., 1985). Given the POS application and selection process, students also may feel validated or at least fortunate to have been selected. POS allow students to pursue their interests in depth.

As a curriculum, POS are not unique in these differences. Districts have developed other choice and magnet programs precisely because they provide different experiences that engage students. But POS do differ from other choice options in their career focus. POS help students get a head start on college and career, provide them with real work experiences like internships, and allow

young people to imagine and plan for their futures. A POS may be the only place in which some low-income and minority students are held to the expectation that they will go to college; this may help them overcome obstacles that may exist in other aspects of their lives.

Some elements of POS were evident in the best examples of CTE programs at comprehensive high schools. In West District, Amaranth's culinary and auto programs had healthy CTSO participation, and student leadership was fostered there. Similarly, in East District, Emerald's culinary program was a regular champion in regional and state FCCLA competitions. However, we also observed that other elements of POS were not offered in regular CTE programs. Compared to POS teachers, comprehensive high school teachers had fewer relationships with community college or university faculty and businesspeople.

POS completers have intensive course experiences that integrate academic and technical knowledge and skills within hands-on projects that focus on solving real problems both in the classroom and at work sites. Work-based learning experiences like job shadowing and internships are continually reinforced with ongoing career exploration and development activities like resume preparation, job searches, portfolio presentations, and mock interviews. POS students also receive college and career guidance from a range of caring adults including their counselors and their POS teachers. Many of their POS teachers come from industry backgrounds and thus have a more intimate knowledge of the field.

Senior exit survey results showed that POS offer a clear pathway to college. There were no differences between POS and non-POS respondents regarding their desire to attend college. Further, more students indicated that they wanted to attend a four-year college or university than a two-year institution.

Our interview data showed that many POS students were engaged in their studies and knew what their next steps would be after high school. Students were purposeful about their schooling because they had a transition plan. Interviews with comparison school students did not show this to the same extent. Did POS attract high-achieving, purposeful students, or did they develop them? The answer to both questions may be yes: Although we talked to students whose participation in their POS was the fulfillment of a lifelong dream, we also spoke to students who chose their POS only to explore a career or supplement other interests. Both kinds of students were leaving high school with a strong sense of what they would do next.

POS also affected teachers and school staff. In particular, POS changed school schedules, involved extracurricular activities, required ongoing professional development, and offered opportunities to forge partnerships with local businesses and postsecondary institutions. We saw veteran teachers excited about new technologies for the classroom, adopting new roles, and growing in their own careers.

Although achievement outcomes did not show a consistent *advantage* to POS participation, they also did not show a *disadvantage* to participation. Programs of study are a worthwhile high school choice option that offer valuable knowledge and experiences. However, the final measure of the value of POS will only be known after high school (cf. Kemple & Willner, 2008). What kinds of college majors do POS students choose compared to other students? Do they complete

their degree or certificate programs faster than non-POS students? What careers do they enter, and what are their salaries compared to non-POS students? Does their coherent trajectory toward a career have other beneficial effects in terms of family formation, mental health, or other measures of young adulthood? Answers to these questions will determine the value of POS, but they were beyond the scope of this study.

CHAPTER SEVEN: Recommendations

Recommendations emanating from the results of this study are multi-faceted. The sections below offer recommendations at the district, school, and policy levels.

District-Level Recommendations

Our primary recommendation is for districts to seek ways to increase the number of CTE credits earned by high school students. Our findings for West District suggested that enrollment in POS schools caused more students to graduate by increasing the number of CTE credits they earned. In all three districts, earning more CTE credits was associated with graduation. In contexts similar to West District, increasing opportunities for students to enroll in POS could improve graduation rates. In districts where POS enrollment is unlikely to change CTE credit earning, using other means to increase the number of CTE credits earned by secondary students could improve graduation rates.

We conclude that CTE credits need not be presented in a POS sequence to have the desired impact on graduation. However, posthoc analyses showed that in most cases, CTE offered in POS sequences may have had a more beneficial impact on other important student outcomes, more than simply taking CTE courses or completing a CTE concentration. Further, qualitative data showed that most students, teachers, and administrators were positively inclined toward POS. They believed that POS provided students with experiences and opportunities that encouraged engagement and prepared them for their next steps after graduation. Administrators and policymakers should consider designing programs around the elements of POS that make the most sense for their contexts, then work to improve practice, learning, and support systems (e.g., data collection methods) to provide evidence of student outcomes.

In South District, the rest of the sample outperformed POS completers on some advanced academic course-taking measures. These findings are likely attributable to non-ignorable background characteristics that contributed to student self-selection into advanced courses. The apparent lesson here is that if a district or state wants to encourage more STEM and AP course-taking, then they should do so, but not necessarily through the mechanism of POS. We found that POS may encourage students to take more advanced academic courses, as with STEM credits in West District and AP credits in East District, but South District students in STEM and IB programs were more likely to complete more advanced academic coursework than students in POS. The goal of POS should be to implement POS well, which may stimulate advanced academic course-taking and career preparation. POS students should not be expected to take more advanced academics than students who choose advanced academic programs like IB.

Study outcomes suggest that dual enrollment and articulated programs with postsecondary institutions need to be re-examined. Across districts, participation in these credit-based transfer programs was very low. Although this may have arisen from state or district actions that limited participation, like eligibility requirements, credit-in-escrow policies, or a lack of resources for tuition or fees, we observed that community college credits appeared to have little value to students. Students who are interested in accruing college credits while in high school appear to aspire to attend four-year colleges or universities. There is a hierarchy in higher education, and

the students in this study, to the extent that they aspired to attend college, were choosing higher-status four-year institutions over community colleges. States should consider developing better marketing campaigns to educate university-bound students about the value of dual credit in community college transfer pathways. For students interested in less than a baccalaureate degree, states should consider redesigning credit-based transfer programs around modularized, career-focused certification, credential, and associate degree programs.

Qualitative study findings also suggest that states and districts should recruit more high-quality teacher candidates from business and industry backgrounds. This will require changes to teachers' work conditions. Business and industry teachers may need to be paid a salary more commensurate with professionals in the fields from which they came. Alternatively certified business and industry teachers also need pre-service and in-service professional development and support in order to plan standards-based instruction, use research-based instructional strategies, assess students to promote learning, and effectively manage their classrooms. All teachers need to be provided the same respect that other professionals have in their workplaces.

West District administrators shared lessons learned that could help other districts implement POS. One official who helped plan the district's POS high schools believed that POS could be well implemented in comprehensive high schools as long as they included the right teacher, a project-based curriculum, and the industry-standard technology and equipment needed in many POS. This administrator believed that the teacher and creative process fostered by project-based learning were the most important elements of successful POS. He also recommended that program standards be developed at the inception of a POS: "Not just equipment standards, not just textbook standards, not just professional development, but everything you need to deliver that program: the student certifications, the cost of student assessments, the consumable supplies, the tools, every piece."

POS may be more expensive than regular high school or CTE programs because the project-based, hands-on learning approaches that they emphasize require more equipment, more professional development, and more instructional time. Without state and district support, POS cannot be implemented fully. State or local bonds and taxes are some of the strategies that study districts used to build proper facilities for and fund POS.

Data, Data, Data

The future of POS could be endangered by a lack of student achievement data on POS-specific outcomes (i.e., industry-recognized credentials earned). POS need a broader set of outcome measures because there is much more to POS than traditional academic achievement. Therefore there is a great need to better identify POS courses, their related academic courses, and other POS elements that are not currently flagged in student information systems, so that these variables are available for analysis.

Researchers cannot be confident of their results and recommendations if they are not confident in the data. In our study, we used data obtained from district research offices, the data they themselves use. In many cases, we found gaps in these data, suggesting that neither we nor the district knew the full picture. In general, we attempted to preserve sample characteristics (e.g.,

variances) by using modern approaches to missing data handling. However, if POS are to be evaluated, student information systems need to catch up with POS and require the collection of the requisite data in order to be able to tell the story of POS and better evaluate its efficacy.

In both West and East Districts, systems data did not include fields that would allow us, or others interested in POS, to track specific POS outcomes. For example, neither district included a variable that identified students who had enrolled in or completed a POS. Nor did either district include a variable identifying students who earned an industry-recognized credential. South District included these two data fields in their system, but the reliability of these data was suspect and led to the underestimated outcomes described elsewhere in this report.

Even if we could be completely confident in the validity of the data as provided, we still faced what we began to call the "snapshot" effect. Many of the variables we received only reflected students' status at a fixed point in time, the date on which a clerk entered attendance or withdrawal data into district records. These conditions could have changed the very next day. In urban districts with high student mobility rates, "reality" is much more fluid than such snapshots can capture. District information systems need to be modernized so that school-level changes (e.g., a student dropping a program or returning after an extended absence) can be quickly and frequently updated at the district level.

Future research on POS or any education intervention rests on reliable data collection from schools, districts, and states. Technology exists to track progress and outcomes more efficiently than is presently the case. Misplaced fears have limited the collection of individual student data, even when those data are not personally identifiable, and this can hinder efforts to evaluate programs and make wise policy decisions.

School-Level Recommendations

Schools need not create their own POS; they may also choose to adopt a rigorous, research-based national curriculum like PLTW or a NAF academy. However, schools should beware of the temptation to implement a "POS in a box," in which the curriculum, course sequences, assessments, and teacher professional development are all provided. POS, like all education interventions, must be allowed to develop a local flavor. For POS, this means insuring that business and industry are involved in developing, approving, and supporting programs through advisory board participation, supporting internships, and facilitating CTSOs. Like any change effort, people become involved and gain ownership when reforms are co-constructed, meaning that schools can adapt and modify the intervention to fit their unique context and mission (Datnow, Hubbard, & Mehan, 2002).

Wherever possible, students should be cohorted in their academic and CTE classes. Cohorting helps develop a shared identity and creates a familial experience that encourages bonding, the mentoring of younger students, and engagement in all curricular areas. Short-term economic decisions to eliminate electives or place non-POS students in classes intended for POS students compromise the goal of cohorting and the sense of shared identity that POS foster.

For many high schools, alumni may offer a powerful and untapped resource. Many alumni desire to maintain a connection with their alma mater and enjoy serving on advisory boards and mentoring current students. At one comparison high school, alumni began a foundation with seed money that now continues to grow through an annual fund drive. That foundation pays for teacher professional development, special projects, and student trips to CTSO competitions. We also observed young alumni visiting schools to share their experiences with their former classmates. Perhaps even more so than teachers with industry backgrounds, young alumni with contemporary and compelling stories about how their high school experiences prepared them for success in college and work may help to motivate students to aspire to achieve the same.

POS offer new roles for both teachers and counselors, including business partner liaisons, academy coordinators, and internship coordinators. We observed that teachers and counselors did not have to have CTE backgrounds to perform these duties effectively: Acquired familiarity with the programs and the desire to participate appeared more important.

Study findings suggest that counselors for POS students should be assigned by academy or career pathway area, not by student last name. When counselors are assigned by academy or pathway, they become specialists in the subject matter taught in that academy or pathway, in part by participating in externships to learn about related careers. Better informed counselors are better able to serve students: They have a better understanding of the appropriate postsecondary institutions for students to attend because they have a better sense of what students are working to achieve. The counselors we observed who were more knowledgeable about the POS in which their students were participating tended to be those who were assigned to academies or pathways rather than to a caseload of students with disparate goals whose only similarity was a last name starting with the same letter of the alphabet.

We found that POS students often received more career guidance and counseling from their POS teachers, who often came from industry backgrounds, than from their school counselors. We note two limitations to locating career guidance in the classroom as a CTE teacher responsibility. First, doing so assumes that non-CTE students do not need career guidance. Second, the practice ignores the fact that not every student enrolled in a POS is planning to pursue a career in that area; such students may need career guidance of a different or more general type. Career guidance and counseling should be a school-wide, distributed responsibility that takes place in every classroom as well as in extracurricular, co-curricular, and work-based learning contexts.

Middle schools, especially middle school counselors, also have a role to play. In districts with lotteries or school choice programs, students must choose POS or other programs while they are in eighth grade. Middle school students need intensive guidance counseling as well as career development and exploratory experiences in order to understand their choices and the processes involved in applying for high school programs. It is also vitally important that middle school students arrive prepared for more rigorous coursework. As such, middle schools need to offer appropriate advisement as to the courses students need to be ready for high school.

Study outcomes show that CTE engages students and gives them a reason to stay in school. Analyses show that CTE, including POS participation and completion of an intensive course sequence, can contribute to the likelihood of graduation. Given this finding, it may be

counterproductive to take away CTE and "double up" low-achieving students on academic classes, as is current practice in some districts. Some of the schools participating in this study created block schedules that allowed struggling students to double up on their academic classes without harming their ability to take electives like CTE.

Other Policy Recommendations

As plans and blueprints are drawn for the future of Perkins and CTE in the United States, we urge policymakers and educators to remember that CTE credit-earning is a positive path to high school graduation. Completing a strong CTE course sequence does not hinder college aspirations or attendance; indeed, for some students, it awakens such goals. Further, other elements of POS provide a framework that supports college-going, including standards-based academics, seamless transitions to postsecondary programs, college and career development and exploration, and opportunities to earn industry-recognized credentials and participate in work-based learning.

Seemingly unrelated state education policies can in fact affect POS: For example, a state policy requiring class size reductions in one category of courses (i.e., core academic courses) will increase class sizes in other categories of courses. In South District, a class size mandate prevented most schools from cohorting their POS students in academic and POS courses. State legislatures need to consider the ramifications of policies before enacting them. Many school-level participants told us that they were compelled to follow policies even when they seemed whimsical, politically driven, or made in ignorance of the realities of contemporary education.

It would be difficult for any district to implement all elements of POS well. The districts in this study emphasized different POS elements according to their unique abilities, state accountability contexts, and cultures. West District focused on advisory committee input, strong articulations with higher education, and the comparatively easy accrual of college credits. South District focused on industry-recognized credentials and work-based learning experiences, namely student internships. More than the other two districts, East District's efforts to ensure that students were being prepared to go to college were dampened by the harsh effects of the recession. Local contexts are a key driver in how education interventions are implemented and the outcomes that are achieved. We therefore recommend that any further research on POS employ a mixed-method design like ours as a means of interpreting those outcomes.

Final Comment

The Perkins IV interim assessment report asserted that it is "feasible to provide a sound academic and additional technical education at the secondary level" (U.S. Department of Education, 2013b, p. xxv). This study confirms that although high-quality CTE programs in the form of POS are not easy, cheap, or capable of solving all educational problems, they can be implemented well and yield positive results, as the three districts that participated in this study demonstrated. However, this study remains an incomplete examination of POS because the postsecondary portion was not able to be incorporated here. Future work must include the complete intervention in order to arrive at a comprehensive understanding of the impact of POS on student secondary, postsecondary, and workplace outcomes.

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APPENDIX A: Quantitative Technical Appendix

This appendix provides more detail and supplemental tables to support the outcomes in the main body of the report.

Instrumental Variable Estimation

The following tables display the regression results and significant predictors for the GPA and graduation instrumental variable analyses for each district. They provide information on the unstandardized and standardized regression coefficients as well as the covariances and correlations used in the body of the report.

Table A1
Unstandardized and standardized regression coefficients, West District

Regression Coefficients			*b*	*SE*	*p*	β
GPA	←	Age	-.024	.026	.356	-.019
GPA	←	Gender	-.145	.029	.000*	-.108
GPA	←	F/RL eligible	-.139	.032	.000*	-.094
GPA	←	LEP	-.203	.079	.010*	-.048
GPA	←	Special Ed IEP	-.458	.077	.000*	-.137
GPA	←	Discipline occurrences	-.091	.012	.000*	-.174
GPA	←	Asian	.161	.042	.000*	.088
GPA	←	Native American	-.180	.262	.492	-.023
GPA	←	Black	-.198	.054	.000*	-.088
GPA	←	Latino	-.247	.034	.000*	-.176
GPA	←	Grade 8 pre-test math scale score	.003	.000	.000*	.213
GPA	←	Grade 8 pre-test science scale score	.003	.000	.000*	.060
GPA	←	Grade 8 pre-test reading scale score	.001	.000	.035*	.040
GPA	←	# CTE credits earned	-.001	.010	.959	-.002
Graduation	←	Age	-.252	.076	.001*	-.128
Graduation	←	Gender	-.047	.084	.574	-.022
Graduation	←	F/RL eligible	-.189	.088	.031*	-.081
Graduation	←	LEP	-.222	.235	.344	-.033
Graduation	←	Special Ed IEP	-.173	.176	.327	-.033
Graduation	←	Discipline occurrences	-.085	.028	.002*	-.174
Graduation	←	Asian	.272	.119	.022*	-.104
Graduation	←	Native American	.568	.617	.358	.095
Graduation	←	Black	.190	.141	.176	.047
Graduation	←	Latino	.326	.095	.001*	.054
Graduation	←	Grade 8 pre-test math scale score	.001	.001	.162	.087
Graduation	←	Grade 8 pre-test science scale score	.002	.001	.080	.106
Graduation	←	Grade 8 pre-test reading scale score	-.001	.001	.480	-.052
Graduation	←	# CTE credits earned	.121	.028	.000*	.314
# CTE Credits	←	POS school	2.817	.124	.000*	.514
# CTE Credits	←	Gender	.378	.107	.000*	.069
Indirect Effects						
GPA	←	POS school	.028	.021	.257	.021
Graduation	←	POS school	.354	.082	.000*	.166
Covariances and Correlations			*cov*	*SE*	*p*	*r*
# CTE Credits	↔	GPA	.338	.062	.000*	.242
# CTE Credits	↔	Graduation	.607	.161	.000*	.265
GPA	↔	Graduation	.191	.021	.000*	.313

*Denotes statistically significant at $p < .05$.

Table A2

Unstandardized and standardized regression coefficients, East District

Regression Coefficients			*b*	*SE*	*p*	β
GPA	←	Gender	-.352	.027	.000*	-.201
GPA	←	Over age	-.487	.145	.001*	-.064
GPA	←	F/RL eligible	-.136	.027	.000*	-.073
GPA	←	LEP	.083	.081	.309	.020
GPA	←	Special Ed IEP	-.112	.113	.322	-.019
GPA	←	Discipline occurrences	-.093	.005	.000*	-.139
GPA	←	Asian	.255	.135	.058	.055
GPA	←	Native American	.500	.623	.422	.024
GPA	←	Black	.028	.069	.414	.015
GPA	←	Latino	-.135	.060	.024*	-.047
GPA	←	Grade 8 pre-test math scale score	.045	.004	.000*	.378
GPA	←	Grade 8 pre-test reading scale score	.013	.004	.001*	.106
GPA	←	Grade 8 pre-test science scale score	.009	.004	.018*	.076
GPA	←	# CTE credits earned	.147	.009	.000*	.337
Graduation	←	Gender	-.182	.062	.003*	-.082
Graduation	←	Over age	-.604	.599	.314	-.062
Graduation	←	F/RL eligible	-.165	.082	.044*	-.070
Graduation	←	LEP	-.129	.262	.622	-.024
Graduation	←	Special Ed IEP	-.241	.054	.000*	-.033
Graduation	←	Discipline occurrences	-.078	.037	.035*	-.092
Graduation	←	Asian	.390	.217	.072	.066
Graduation	←	Native American	-.006	1.425	.997	.000
Graduation	←	Black	.265	.116	.022*	.109
Graduation	←	Latino	.177	.282	.530	.049
Graduation	←	Grade 8 pre-test math scale score	.013	.004	.001*	.083
Graduation	←	Grade 8 pre-test reading scale score	.004	.004	.382	.026
Graduation	←	Grade 8 pre-test science scale score	-.007	.003	.044	-.046
Graduation	←	# CTE credits earned	.450	.013	.000*	.812
# CTE Credits	←	POS school	.004	.044	.921	.001
# CTE Credits	←	LEP	-.866	.192	.000*	-.091
# CTE Credits	←	Discipline occurrences	-.251	.024	.000*	-.164
# CTE Credits	←	Latino	.992	.105	.000*	.152
# CTE Credits	←	Asian	.663	.189	.000*	.062
# CTE Credits	←	Black	.364	.088	.000*	.083
# CTE Credits	←	Grade 8 pre-test math scale score	.058	.008	.000*	.213
Indirect Effects						
GPA	←	POS school	.001	.006	.921	.000
Graduation	←	POS school	.002	.020	.921	.001

Covariances and Correlations			*cov*	*SE*	*p*	*r*
GPA	↔	Graduation	.195	.014	.000*	.367

*Denotes statistically significant at $p < .05$.

Table A3

Unstandardized standardized regression coefficients, South District

Regression Coefficients			*b*	*SE*	*p*	β
GPA	←	Gender	-.268	.024	.000*	-.169
GPA	←	F/RL eligible	-.138	.034	.000*	-.079
GPA	←	LEP	.443	.060	.000*	.122
GPA	←	Special Ed IEP	.065	.065	.318	.017
GPA	←	Discipline occurrences	-.179	.028	.000*	-.139
GPA	←	Asian	.096	.076	.204	.027
GPA	←	Native American	-.017	.161	.915	-.002
GPA	←	Black	.030	.035	.377	.015
GPA	←	Latino	-.051	.030	.093	-.026
GPA	←	Grade 8 pre-test math scale score	.009	.001	.000*	.411
GPA	←	Grade 8 pre-test reading scale score	.003	.001	.000*	.207
GPA	←	Grade 8 pre-test science scale score	.001	.000	.000*	.108
GPA	←	# CTE credits earned	.052	.009	.000*	.105
Graduation	←	Gender	-.142	.075	.060*	-.060
Graduation	←	F/RL eligible	-.329	.083	.000*	-.127
Graduation	←	LEP	.040	.115	.729	.007
Graduation	←	Special Ed IEP	.152	.187	.416	.027
Graduation	←	Discipline occurrences	-.205	.053	.000*	-.072
Graduation	←	Asian	.407	.268	.129	.066
Graduation	←	Native American	.372	.629	.555	.000
Graduation	←	Black	.334	.094	.000*	.109
Graduation	←	Latino	.064	.120	.596	.049
Graduation	←	Grade 8 pre-test math scale score	.011	.002	.000*	.336
Graduation	←	Grade 8 pre-test reading scale score	.004	.004	.382	.302
Graduation	←	Grade 8 pre-test science scale score	.000	.001	.991	-.001
Graduation	←	# CTE credits earned	.345	.022	.001*	.470
# CTE Credits	←	POS	.700	.215	.000*	.217
# CTE Credits	←	F/RL eligible	.424	.089	.000*	.120
# CTE Credits	←	Grade 8 pre-test reading scale score	-.007	.001	.000*	-.177
# CTE Credits	←	Black	.260	.024	.002*	.576
Indirect Effects						
GPA	←	POS	.036	.013	.004*	.023
Graduation	←	POS	.242	.076	.001*	.102

Covariances and Correlations			*cov*	*SE*	*p*	*r*
GPA	↔	Graduation	.328	.017	.000*	.367

*Denotes statistically significant at $p < .05$.

Assessing the Effect of Completing a POS on High School Achievement: Posthoc Multiple Regression Analysis

Decision Rules for Exclusion from the Posthoc Multiple Regression Sample

For the posthoc analyses, we excluded cases rather than use the imputed sample because we needed to limit the analyses to students who were known to have been there all 4 years taking classes, in order to ensure that all students had the same opportunity to complete a POS.

West District

We used district-provided withdrawal codes and dates to determine which students withdrew from the district during each school year. To be considered a withdrawal, a student must have been coded as withdrawn for that year and also be missing valid course data for that year. We were told that the withdrawal code field was not fully reliable, so we investigated further. We coded students as withdrawn if they attended fewer than the 180 possible days attended and were missing course data for spring of that year or had courses listed for that spring but all the grades were F. District policy states that students who are excessively absent receive failing grades, so we assumed that receiving all Fs indicated that the student had been excessively absent before withdrawing from the district. If we found that a student had a withdrawal code, suggesting that the student had left and possible days attended were less than a full year, but there was valid course data for that year and the following year, the student was not coded as withdrawn. If a student had a withdrawal code of withdrawn and had full data for that year, but was missing data in the fall of the following year, the withdrawal code was attached to the following year. Students were kept in the analysis only if they had been in the district all four years. There were cases where the district could not locate transcript data. Therefore, if a student had remained in the district all four years but was missing course data, that student was excluded from the posthoc multiple regression analyses. Lastly, we excluded students who were missing baseline math and reading achievement data as those variables served as predictors for our posthoc multiple regressions.

East District

We used district-provided withdrawal codes and dates to determine which students withdrew from the district during each school year. To be considered a withdrawal, a student must have been coded as withdrawn for that year and also be missing valid course data for that year. As with West District, we were informed that the withdrawal code field at East District was not fully reliable, causing us to investigate further. We coded students as withdrawn if they attended fewer than the 180 possible days attended and they were missing course data for spring of that year or had courses listed for that spring but all the grades were F. Like West, East District policy includes excessive absenteeism as grounds for course failure, so in those cases where a student received all Fs, we assumed that the student had been excessively absent before withdrawing from the district. If a student had a withdrawal code suggesting that the student had left and possible days attended were less than a full year, but there was valid course data for that year and the following year, the student was not coded as withdrawn. If a student had a withdrawal code of withdrawn and had full data for that year but was missing data in the fall of the following

year, the withdrawal code was attached to the following year. Students were kept in the analysis only if they had been in the district all four years. There were two exceptions to this rule: (1) a student who had completed the credit requirements for graduation and spent the fourth year abroad, and (2) two students who had earned enough credits to graduate at the end of 11th grade. Those three students remained in the analyses.

South District

First, we only included students from our district data who were eligible for at least one of the POS applied for. We could not determine annual withdrawal information as South district did not send yearly withdrawal data. Therefore, we had to use course data to determine who should be excluded from the posthoc analyses. Because semester information was not given to us, we could only determine what year a course was taken, not which semester as in the other participating districts. If a student was missing one year of data, that student was excluded. If the data indicated that a student had graduated, but we had fewer than the required number of credits for graduation in our data, that student was excluded under the assumption that we were missing data. If a student did not graduate and attended all four years but our data showed fewer credits attempted than the graduation requirements, we excluded that student under the assumption that we were missing data for that student. Of those who were not missing course data, to remain in our analyses, students had to have complete data for 0809 school name and 0809 grade level to ensure that these students were our cohort of interest. Lastly, we had to exclude those who were missing baseline math and reading achievement data as those variables served as predictors for our posthoc multiple regressions.

Identifying POS Completers

Like many districts, neither West nor East District had fields in their systems data to identify students who completed a POS. West and South Districts had fields for ninth grade assignment to a POS, and for East District, starting ninth grade at Blue Academy was equivalent to assignment for ninth grade, but student mobility in and out of POS and POS high schools made those fields inadequate for determining which students completed a POS or a CTE concentration. A field indicating participation in a career academy was provided by South District, but it was incomplete and ultimately not used. Instead, we looked to empirical student course-taking and district-provided data on required course sequences or courses to assign students to the categories of POS completer or CTE concentrator, respectively.

West District

Files were created for students who attended each of the three POS high schools as well as the other POS and magnet high schools where students could earn a POS (see *Sampling Procedures*). We used the district's POS course sequence sheets as well as high school course catalogs to identify which courses were required for each POS. The district CTE office provided a list of exit courses which we used to identify which capstone courses were required for each POS. In the multiple records data, each course in a POS was dummy coded for that POS. We also examined student course-taking to identify additional courses used to complete a POS that were not on the course sequence sheets. We used the list of exit courses to determine the exit

course for each POS or CTE concentration. Then a "respective credits earned" variable was created for each course. The sum of credits earned per POS was aggregated to determine if the required number of credits per POS was met.

Similar steps were followed to determine if a student completed a CTE concentration: The district required two credits in a program area to complete a CTE concentration in that area, with one of those credits being from an exit level course. Having identified the necessary courses for each POS, we examined each course record, and for those intervention students who did not meet the course requirements for completing a POS, we identified the POS they had attempted. We did so by examining their course sequences in the multiple records format. If the course-taking did not definitively indicate which POS was attempted, we looked to the POS to which the student was originally assigned. With these data, we were able to identify the following three groups: (1) POS Completers, defined as students who completed a POS; (2) All Others, defined as all those who did not complete a POS; and (3) CTE Concentrators, defined as those who did not complete a POS but did complete a CTE concentration. The CTE Concentrators are a subgroup of All Others.

East District

We identified the required courses for each of the POS offered at Blue Academy. For classifying the engineering and medical POS (see *Chapter 4*), we utilized the course sequence sheets for each POS as well as the Class of 2012 course registration planning sheet used by counselors to place students in appropriate capstone courses. For the IT academy (see *Chapter 4*), we were not provided with course sequence sheets; therefore, we examined the IT courses taken to see if there were discernible course-taking patterns. We identified two such patterns that were either business oriented (focus on programming) or tech oriented (focus on engineering technology). Some of the POS course sequences in all three academies were changed during the study, such as an engineering program that adopted PLTW during our cohort's years in high school. In other cases, budget limitations prevented all capstone courses from being offered. Our contextual knowledge of these events helped us interpret the course-taking patterns we encountered in the data.

There were instances in which the constellation of courses could result in more than one POS if one or more courses could count toward more than one POS, but we only assigned more than one POS if the student took enough courses such that no course counted toward both POS ("double dipping"). If we could not assign more than one POS, we noted when the courses were taken and assigned the POS to the first course taken in that sequence, according to the year or even the semester within the year.

To determine whether a student completed a CTE concentration, we started with a district-provided document that identified which courses counted toward which CTE program area. Because we had courses in the data that were not listed on this document, we spoke with the district's CTE coordinator, who helped us identify for which concentration a course counted and whether it was a capstone course. Four credits were needed to complete a concentration, one of which had to be a capstone course. Having identified the necessary courses for each POS, we examined each course record and for those intervention students who did not meet the course

requirements for completing a POS, we identified the POS they had attempted. We did so by examining their course-taking in the multiple records format. With these data, we were able to identify the following three groups: (1) POS Completers, defined as students who completed a POS; (2) All Others, defined as all those who did not complete a POS; and (3) CTE Concentrators, defined as those who did not complete a POS but did complete a CTE concentration. The CTE Concentrators are a subgroup of All Others. For the analyses in Chapter 4, we used a smaller subgroup still: we only included CTE Concentrators from Blue Academy (i.e., students who did not complete a POS) in order to explore the school effect at East District.

South District

To assign POS completion at South, we started with the course sequence sheets provided by the district. We also looked at course-taking data as well as school catalogs and websites to determine sequences that were not listed on the course sequence sheets. The district required that students earn 4 credits for most POS, except in cases where one of the required courses was only .5 credits (e.g., EKG Aide). For the fourth class, the district allowed an internship, OJT (on the job training with a classroom component), or an independent study course to serve as the capstone requirement if it was related to the POS. Syntax was written to identify all POS completers.

CTE concentration was determined in two ways. First, we looked at those who did not complete the requirements for the POS but took enough credits in that POS to complete a CTE concentration. To earn a CTE concentration within a POS sequence, students earned 3 credits except in the case of EKG aide where they earned 2.5 credits because one of the required courses was only 0.5 credits. We also identified students who completed a CTE concentration in a non-POS course sequence (i.e., visual technology, graphic design). These were CTE programs, but the district did not have POS in these areas. In studying the transcript data, we saw course-taking sequences that met the 3-credit requirement for a CTE concentration. These courses were related but not in a required POS sequence. If a POS was completed, the POS attempted was the same as what was completed. If not, we looked at course-taking (i.e., what was taken and when) and the POS to which the student was assigned. We disallowed double dipping: If the same course had to be used to meet the requirements for completing a POS and a CTE concentration, the POS completion remained and the concentration was coded to 0. With these data, we were able to identify the following three groups: (1) POS completers defined as those who completed a POS; (2) All Others, defined as those who did not complete a POS; and (3) CTE Concentrators, defined as those who did not complete a POS but did complete a CTE concentration. The CTE Concentrators are a subgroup of All Others. It is important to remember that the All Others group includes students from IB and other advanced academic programs—clearly these students were completing CTE concentrations as well as their chosen programs.

Full Regression Tables

West District. Following are the full regression tables, upon which the outcomes displayed in Tables 3.4 and 3.5 of Chapter 3 are based. We present the tables for POS completers versus all others and then for POS completers versus CTE concentrators.

Table A4

Linear regression predicting weighted overall GPA, POS completers versus all others, West District

	Overall GPA					
	n = 1,368					
	Adjusted R^2 = 0.385				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	1.387	.102		.000	1.187	1.587
POS_all_others (1=POS Completer)	.177	.029	.142	.000	.121	.232
Azure	-.276	.054	-.116	.000	-.381	-.171
Sky	-.145	.039	-.086	.000	-.222	-.068
Male	-.169	.028	-.137	.000	-.223	-.114
Asian	.087	.039	.052	.027	.010	.163
Black	-.091	.047	-.045	.053	-.183	.001
Latino	-.075	.033	-.059	.025	-.141	-.010
Other	-.100	.140	-.015	.474	-.375	.174
F/RL eligible	-.031	.031	-.023	.327	-.092	.031
Special Education	.005	.071	.002	.947	-.134	.143
LEP	.257	.095	.061	.007	.071	.443
Grade 8 pre-test math	.003	.000	.378	.000	.003	.004
Grade 8 pre-test reading	.003	.000	.225	.000	.002	.003

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A5

Linear regression predicting STEM credits earned, POS completers versus all others, West District

	STEM Credits					
	n = 1,368					
	Adjusted R^2 = 0.268				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	.899	.287		.002	.336	1.462
POS_all_others (1=POS Completer)	.276	.102	.067	.007	.075	.477
Azure	-.219	.192	-.028	.255	-.597	.158
Sky	-1.006	.141	-.181	.000	-1.283	-.730
Male	-.037	.097	-.009	.702	-.227	.153
Asian	.601	.140	.110	.000	.326	.876
Black	-.033	.168	-.005	.843	-.364	.297
Latino	.103	.120	.024	.390	-.132	.339
Other	-.785	.503	-.036	.119	-1.772	.202
F/RL eligible	-.125	.112	-.028	.266	-.345	.095
Special Education	.224	.253	.022	.375	-.272	.720
LEP	.613	.340	.044	.071	-.053	1.279
Grade 8 pre-test math	.012	.001	.439	.000	.010	.013

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A6

Linear regression predicting AP credits earned, POS completers versus all others, West District

	AP Credits					
	n = 1,368					
	Adjusted R^2 = 0.257				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-4.745	.436		.000	-5.600	-3.891
POS_all_others (1=POS Completer)	-.146	.122	-.030	.232	-.385	.093
Azure	.752	.229	.081	.001	.303	1.201
Sky	-.516	.168	-.079	.002	-.846	-.187
Male	.026	.118	.005	.828	-.206	.258
Asian	.967	.167	.150	.000	.640	1.295
Black	.089	.200	.011	.657	-.304	.482
Latino	.256	.143	.051	.074	-.025	.536
Other	-.277	.599	-.011	.644	-1.452	.898
F/RL eligible	-.155	.134	-.029	.245	-.417	.107
Special Education	.548	.302	.046	.070	-.045	1.142
LEP	.596	.405	.036	.142	-.199	1.391
Grade 8 pre-test math	.009	.001	.294	.000	.007	.011
Grade 8 pre-test reading	.008	.001	.188	.000	.005	.011

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A7

Linear regression predicting college credits accrued, POS completers versus all others, West District

	College Credits Accrued					
	n = 1,368					
	Adjusted R^2 = 0.021				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	2.493	1.169		.033	.199	4.787
POS_all_others (1=POS Completer)	-1.667	.327	-.147	.000	-2.308	-1.025
Azure	.836	.614	.039	.174	-.369	2.041
Sky	.411	.451	.027	.362	-.473	1.295
Male	-.837	.318	-.074	.009	-1.460	-.214
Asian	.283	.448	.019	.528	-.596	1.161
Black	.118	.538	.006	.827	-.938	1.173
Latino	-.541	.384	-.046	.159	-1.293	.212
Other	-.925	1.607	-.016	.565	-4.077	2.227
F/RL eligible	-.056	.358	-.005	.876	-.759	.647
Special Education	-.919	.811	-.033	.258	-2.510	.673
LEP	-.791	1.088	-.021	.467	-2.925	1.343
Grade 8 pre-test math	-.001	.003	-.013	.754	-.007	.005
Grade 8 pre-test reading	.000	.004	-.001	.972	-.008	.008

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A8

Linear regression predicting CTE GPA, POS completers versus all others, West District

	CTE GPA					
	n = 1,215					
	Adjusted R^2 = 0.085				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	3.429	.036		.000	3.358	3.500
POS_all_others (1=POS Completer)	.155	.038	.121	.000	.082	.229
Azure	.013	.068	.006	.848	-.121	.147
Sky	-.036	.050	-.021	.478	-.134	.063
Male	-.095	.036	-.074	.009	-.166	-.024
Asian	.015	.054	.009	.776	-.090	.121
Black	-.229	.063	-.108	.000	-.352	-.106
Latino	-.207	.045	-.154	.000	-.296	-.118
Other	-.430	.187	-.064	.021	-.797	-.064
F/RL eligible	-.041	.042	-.029	.332	-.124	.042
Special Education	-.527	.091	-.166	.000	-.705	-.349
LEP	-.089	.124	-.021	.472	-.332	.154

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A9

Linear regression predicting weighted overall GPA, POS completers versus CTE concentrators, West District

	Overall GPA					
	n = 675					
	Adjusted R^2 = 0.391				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	1.516	.133		.000	1.255	1.777
POS_CTE_Conc (1=POS Completer)	.152	.042	.112	.000	.071	.234
Azure	-.245	.052	-.153	.000	-.346	-.143
Sky	-.104	.042	-.084	.013	-.185	-.022
Male	-.182	.034	-.169	.000	-.248	-.115
Asian	.048	.051	.032	.344	-.052	.149
Black	-.135	.057	-.077	.018	-.246	-.023
Latino	-.042	.043	-.036	.337	-.126	.043
Other	-.102	.152	-.020	.503	-.400	.197
F/RL eligible	-.015	.040	-.012	.710	-.094	.064
Special Education	.083	.099	.027	.402	-.111	.276
LEP	.448	.156	.090	.004	.142	.754
Grade 8 pre-test math	.003	.000	.389	.000	.002	.003
Grade 8 pre-test reading	.002	.000	.241	.000	.002	.003

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A10

Linear regression predicting STEM credits earned, POS completers versus CTE concentrators, West District

	STEM Credits					
	n = 675					
	Adjusted R^2 = 0.313				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	1.461	.356		.000	.762	2.161
POS_CTE_Conc (1=POS Completer)	.541	.143	.123	.000	.261	.821
Azure	.042	.178	.008	.813	-.307	.391
Sky	-1.027	.143	-.257	.000	-1.307	-.747
Male	-.178	.113	-.051	.116	-.401	.044
Asian	.633	.175	.131	.000	.289	.978
Black	-.069	.195	-.012	.726	-.452	.315
Latino	.297	.148	.080	.046	.006	.588
Other	-1.032	.521	-.064	.048	-2.056	-.008
F/RL eligible	-.053	.138	-.014	.702	-.323	.217
Special Education	.664	.337	.068	.049	.003	1.325
LEP	.975	.534	.061	.068	-.073	2.024
Grade 8 pre-test math	.009	.001	.404	.000	.007	.011

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A11

Linear regression predicting AP credits earned, POS completers versus CTE concentrators, West District

	AP Credits					
	n = 675					
	Adjusted R^2 = 0.332				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-4.912	.536		.000	-5.964	-3.860
POS_CTE_Conc (1=POS Completer)	.178	.168	.034	.290	-.152	.508
Azure	1.080	.209	.175	.000	.670	1.490
Sky	-.399	.168	-.084	.018	-.728	-.069
Male	-.191	.136	-.046	.162	-.458	.077
Asian	.859	.206	.149	.000	.454	1.263
Black	.324	.230	.048	.159	-.127	.775
Latino	.394	.174	.089	.024	.052	.736
Other	-.586	.613	-.031	.339	-1.789	.617
F/RL eligible	-.121	.162	-.026	.454	-.439	.197
Special Education	1.011	.398	.087	.011	.230	1.791
LEP	.846	.629	.044	.179	-.389	2.080
Grade 8 pre-test math	.007	.001	.244	.000	.004	.009
Grade 8 pre-test reading	.010	.002	.260	.000	.007	.014

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A12

Linear regression predicting college credits accrued, POS completers versus CTE concentrators, West District

	College Credits Accrued					
	n = 675					
	Adjusted R^2 = -0.011				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	.572	.335		.088	-.086	1.230
POS_CTE_Conc (1=POS Completer)	-.016	.105	-.006	.875	-.223	.190
Azure	.123	.131	.039	.345	-.133	.380
Sky	-.063	.105	-.026	.548	-.269	.143
Male	-.091	.085	-.044	.283	-.259	.076
Asian	.058	.129	.020	.655	-.195	.311
Black	-.094	.144	-.028	.514	-.376	.188
Latino	-.056	.109	-.025	.608	-.270	.158
Other	-.093	.383	-.010	.809	-.845	.660
F/RL eligible	-.022	.101	-.010	.825	-.221	.176
Special Education	-.132	.249	-.022	.596	-.620	.356
LEP	-.090	.393	-.009	.820	-.862	.683
Grade 8 pre-test math	8.220E-006	.001	.001	.992	-.002	.002
Grade 8 pre-test reading	-.001	.001	-.060	.290	-.003	.001

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A13

Linear regression predicting CTE GPA, POS completers versus CTE concentrators, West District

	CTE GPA					
	n = 675					
	Adjusted R^2 = 0.066				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	3.441	.050		.000	3.343	3.540
POS_CTE_Conc (1=POS Completer)	.078	.045	.065	.085	-.011	.168
Azure	.048	.056	.034	.394	-.062	.157
Sky	-.012	.044	-.011	.796	-.099	.076
Male	-.042	.036	-.044	.239	-.112	.028
Asian	.046	.055	.035	.404	-.062	.154
Black	-.209	.062	-.136	.001	-.330	-.088
Latino	-.182	.047	-.180	.000	-.274	-.089
Other	-.108	.166	-.025	.516	-.433	.218
F/RL eligible	-.039	.044	-.037	.377	-.125	.047
Special Education	-.310	.101	-.116	.002	-.509	-.111
LEP	.107	.166	.025	.518	-.218	.433

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

East District. Following are the full regression tables, upon which the outcomes displayed in Tables 4.4 and 4.5 of Chapter 4 are based. We present the tables for POS completers versus all others and then for POS completers versus Blue CTE concentrators.

Table A14

Linear regression predicting weighted overall GPA, POS completers versus all others, East District

	Overall GPA					
	n = 907					
	Adjusted R^2 = 0.523				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-23.362	1.096		.000	-25.513	-21.210
POS_all_others (1=POS Completer)	.054	.042	.030	.196	-.028	.137
Male	-.345	.034	-.234	.000	-.413	-.278
Asian	.237	.104	.062	.023	.033	.440
Black	-.045	.062	-.027	.476	-.167	.078
Latino	-.065	.081	-.028	.423	-.223	.094
Other	-.012	.107	-.003	.909	-.222	.198
F/RL eligible	-.132	.039	-.085	.001	-.208	-.057
Special Education	-.180	.127	-.033	.157	-.428	.069
LEP	.166	.097	.045	.089	-.025	.357
Grade 8 pre-test math	.053	.003	.518	.000	.047	.060
Grade 8 pre-test reading	.019	.003	.187	.000	.013	.026

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A15

Linear regression predicting STEM credits earned, POS completers versus all others, East District

	STEM Credits					
	n = 907					
	Adjusted R^2 = 0.342				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-35.838	2.186		.000	-40.128	-31.548
POS_all_others (1=POS Completer)	.141	.096	.040	.140	-.046	.329
Male	-.390	.078	-.137	.000	-.543	-.237
Asian	.636	.233	.086	.006	.179	1.093
Black	.265	.138	.084	.055	-.005	.536
Latino	.000	.182	.000	.999	-.358	.358
Other	.270	.243	.034	.265	-.206	.747
F/RL eligible	-.163	.088	-.054	.063	-.335	.009
Special Education	-.504	.288	-.048	.080	-1.069	.060
LEP	.304	.217	.043	.163	-.123	.731
Grade 8 pre-test math	.113	.006	.568	.000	.101	.124

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A16

Linear regression predicting AP credits earned, POS completers versus all others, East District

	AP Credits					
	n = 907					
	Adjusted R^2 = 0.348				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-50.770	3.535		.000	-57.707	-43.833
POS_all_others (1=POS Completer)	1.067	.136	.212	.000	.801	1.333
Male	-.487	.111	-.120	.000	-.705	-.269
Asian	.720	.334	.068	.032	.064	1.375
Black	-.552	.201	-.123	.006	-.947	-.158
Latino	-.413	.260	-.064	.113	-.925	.098
Other	-.347	.345	-.031	.315	-1.023	.330
F/RL eligible	-.339	.125	-.079	.007	-.583	-.094
Special Education	.184	.409	.012	.652	-.618	.986
LEP	.334	.314	.033	.287	-.281	.949
Grade 8 pre-test math	.078	.010	.276	.000	.058	.099
Grade 8 pre-test reading	.067	.011	.234	.000	.046	.088

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A17

Linear regression predicting college credits accrued, POS completers versus all others, East District

	College Credits Accrued					
	n = 907					
	Adjusted R^2 = 0.023				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-22.493	9.620		.020	-41.374	-3.612
POS_all_others (1=POS Completer)	-.846	.369	-.076	.022	-1.571	-.121
Male	-.523	.303	-.058	.084	-1.117	.070
Asian	-1.325	.909	-.056	.145	-3.109	.460
Black	-1.025	.548	-.103	.061	-2.100	.049
Latino	-.208	.709	-.014	.770	-1.599	1.184
Other	-1.759	.938	-.071	.061	-3.600	.083
F/RL eligible	-.219	.339	-.023	.518	-.885	.446
Special Education	-.300	1.112	-.009	.788	-2.482	1.883
LEP	-1.020	.853	-.045	.232	-2.695	.654
Grade 8 pre-test math	.034	.028	.055	.225	-.021	.090
Grade 8 pre-test reading	.034	.029	.054	.245	-.023	.092

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A18

Linear regression predicting CTE GPA, POS completers versus all others, East District

			CTE GPA *n* = 859 Adjusted R^2 = 0.139		95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	3.597	.093		.000	3.413	3.780
POS_all_others (1= POS Completer)	.027	.064	.014	.667	-.098	.153
Male	-.383	.053	-.231	.000	-.487	-.279
Asian	.092	.161	.021	.570	-.225	.408
Black	-.550	.094	-.298	.000	-.734	-.366
Latino	-.305	.126	-.116	.016	-.553	-.057
Other	-.376	.172	-.079	.029	-.712	-.039
F/RL eligible	-.307	.059	-.175	.000	-.422	-.192
Special Education	-.386	.196	-.063	.049	-.770	-.001
LEP	-.125	.146	-.031	.389	-.411	.160

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A19

Linear regression predicting weighted overall GPA, POS completers versus Blue CTE concentrators, East District

			Overall GPA *n* = 226 Adjusted R^2 = 0.463		95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-20.634	1.931		.000	-24.440	-16.828
POS_Blue_CTE_Conc (1=POS Completer)	-.012	.088	-.007	.887	-.186	.161
Male	-.232	.069	-.178	.001	-.367	-.096
Asian	.428	.196	.129	.030	.043	.814
Black	-.007	.120	-.005	.955	-.243	.230
Latino	-.064	.161	-.030	.690	-.381	.253
Other	.373	.225	.092	.099	-.070	.817
F/RL eligible	-.062	.071	-.045	.387	-.202	.079
Special Education	-.683	.293	-.120	.021	-1.260	-.105
LEP	.361	.224	.089	.109	-.081	.803
Grade 8 pre-test math	.047	.006	.499	.000	.034	.060
Grade 8 pre-test reading	.018	.006	.192	.005	.005	.030

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A20

Linear regression predicting STEM credits earned, POS completers versus Blue CTE concentrators, East District

	STEM Credits $n = 226$					
	Adjusted $R^2 = 0.372$				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-34.327	3.742		.000	-41.702	-26.952
POS_Blue_CTE_Conc (1=POS Completer)	.107	.183	.032	.559	-.254	.469
Male	-.420	.143	-.167	.004	-.703	-.138
Asian	.393	.410	.061	.340	-.416	1.202
Black	-.215	.250	-.074	.391	-.707	.278
Latino	-.449	.337	-.108	.184	-1.114	.216
Other	-.108	.472	-.014	.819	-1.039	.822
F/RL eligible	-.201	.150	-.075	.182	-.496	.094
Special Education	-.090	.614	-.008	.884	-1.299	1.120
LEP	.054	.468	.007	.907	-.868	.976
Grade 8 pre-test math	.110	.010	.601	.000	.090	.130

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A21

Linear regression predicting AP credits earned, POS completers versus Blue CTE concentrators, East District

	AP Credits $n = 226$					
	Adjusted $R^2 = 0.401$				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-83.267	8.038		.000	-99.110	-67.424
POS_Blue_CTE_Conc (1=POS Completer)	-.109	.366	-.016	.766	-.830	.612
Male	-.941	.286	-.184	.001	-1.505	-.376
Asian	2.287	.814	.175	.005	.682	3.891
Black	.091	.500	.016	.855	-.894	1.076
Latino	.594	.669	.070	.376	-.725	1.914
Other	-.035	.937	-.002	.971	-1.881	1.812
F/RL eligible	-.456	.297	-.084	.126	-1.041	.129
Special Education	-.780	1.220	-.035	.523	-3.185	1.625
LEP	.407	.934	.026	.664	-1.434	2.247
Grade 8 pre-test math	.141	.027	.381	.000	.089	.194
Grade 8 pre-test reading	.096	.026	.263	.000	.044	.147

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A22

Linear regression predicting college credits accrued, POS completers versus Blue CTE concentrators, East District

	College Credits Accrued					
	$n = 226$					
	Adjusted $R^2 = 0.040$				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-1.278	3.846		.740	-8.858	6.303
POS_Blue_CTE_Conc (1=POS Completer)	.225	.175	.088	.201	-.120	.569
Male	.272	.137	.140	.049	.001	.542
Asian	.054	.389	.011	.891	-.714	.821
Black	-.632	.239	-.285	.009	-1.104	-.161
Latino	-.355	.320	-.111	.269	-.986	.276
Other	-.761	.448	-.126	.091	-1.644	.123
F/RL eligible	-.005	.142	-.003	.970	-.285	.275
Special Education	-.360	.584	-.043	.538	-1.511	.791
LEP	-.353	.447	-.059	.430	-1.234	.527
Grade 8 pre-test math	-.001	.013	-.009	.920	-.026	.024
Grade 8 pre-test reading	.006	.012	.043	.634	-.019	.030

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

Table A23

Linear regression predicting CTE GPA, POS completers versus Blue CTE concentrators, East District

	CTE GPA					
	$n = 226$					
	Adjusted $R^2 = 0.096$				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	3.007	.192		.000	2.628	3.387
POS_Blue_CTE_Conc (1=POS Completer)	.202	.119	.111	.090	-.032	.437
Male	.028	.092	.020	.762	-.154	.210
Asian	.362	.268	.103	.178	-.166	.891
Black	-.408	.161	-.259	.012	-.726	-.089
Latino	-.028	.220	-.013	.898	-.463	.406
Other	-.228	.307	-.054	.457	-.833	.376
F/RL eligible	-.187	.098	-.129	.056	-.380	.005
Special Education	-.700	.398	-.117	.080	-1.485	.085
LEP	.126	.306	.029	.681	-.476	.728

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = confidence interval.

South District. Following are the full regression tables, upon which the outcomes displayed in Tables 5.4 and 5.5 of Chapter 5 are based. We present the tables for POS completers versus all others and then for POS completers versus CTE concentrators.

Table A24

Linear regression predicting weighted overall GPA, POS completers versus all others, South District

	Overall GPA					
	n = 2,488					
	Adjusted R^2 = 0.464				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-1.028	.121		.000	-1.265	-.792
POS_all_others (1= POS Completer)	.022	.022	.015	.306	-.020	.064
Male	-.221	.021	-.158	.000	-.262	-.180
Asian	.125	.045	.043	.005	.038	.212
Black	-.011	.032	-.006	.721	-.074	.051
Latino	-.065	.028	-.039	.022	-.120	-.009
Other	.025	.051	.007	.622	-.075	.126
F/RL eligible	-.098	.026	-.064	.000	-.149	-.047
Special Education	.053	.051	.016	.293	-.046	.153
LEP	.415	.048	.138	.000	.321	.509
Grade 8 pre-test math	.009	.000	.473	.000	.008	.010
Grade 8 pre-test reading	.004	.000	.241	.000	.003	.005

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = Confidence Interval.

Table A25

Linear regression predicting STEM credits earned, POS completers versus all others, South District

	STEM Credits					
	n = 2,488					
	Adjusted R^2 = 0.372				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-3.489	.331		.000	-4.139	-2.840
POS_all_others (1= POS Completer)	-.329	.061	-.088	.000	-.448	-.210
Male	-.074	.059	-.020	.212	-.189	.042
Asian	.785	.126	.104	.000	.538	1.032
Black	-.007	.090	-.001	.942	-.183	.170
Latino	-.113	.080	-.026	.157	-.269	.043
Other	.122	.145	.014	.399	-.162	.405
F/RL eligible	-.322	.073	-.081	.000	-.466	-.179
Special Education	-.537	.143	-.062	.000	-.816	-.257
LEP	.130	.133	.017	.329	-.131	.392
Grade 8 pre-test math	.026	.001	.526	.000	.024	.027

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = Confidence Interval.

Table A26

Linear regression predicting AP credits earned, POS completers versus all others, South District

	AP Credits					
	n = 2,488					
	Adjusted R^2 = 0.457				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-.796	.098	-.123	.000	-16.221	-14.075
POS_all_others (1= POS Completer)	-.220	.095	-.035	.000	-.988	-.605
Male	1.508	.202	.116	.021	-.407	-.034
Asian	.261	.144	.033	.000	1.113	1.904
Black	.175	.128	.023	.070	-.021	.543
Latino	.247	.232	.016	.172	-.076	.425
Other	-.231	.117	-.034	.287	-.208	.701
F/RL eligible	-.126	.230	-.008	.049	-.461	-.001
Special Education	1.087	.218	.080	.583	-.577	.325
LEP	.030	.002	.352	.000	.660	1.515
Grade 8 pre-test math	.024	.002	.332	.000	.026	.033
Grade 8 pre-test reading	-.796	.098	-.123	.000	.021	.027

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = Confidence Interval.

Table A27

Linear regression predicting college credits accrued, POS completers versus all others, South District

	College Credits Accrued					
	n = 2,488					
	Adjusted R^2 = 0.040				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-.644	.079		.000	-.799	-.488
POS_all_others (1= POS Completer)	-.015	.014	-.021	.292	-.043	.013
Male	.000	.014	.001	.980	-.027	.027
Asian	.069	.029	.048	.019	.011	.126
Black	.072	.021	.084	.001	.031	.113
Latino	.015	.019	.019	.413	-.021	.052
Other	.022	.034	.013	.516	-.044	.088
F/RL eligible	-.025	.017	-.034	.138	-.059	.008
Special Education	.028	.033	.017	.397	-.037	.094
LEP	.069	.032	.047	.029	.007	.131
Grade 8 pre-test math	.002	.000	.173	.000	.001	.002
Grade 8 pre-test reading	.000	.000	.049	.110	.000	.001

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = Confidence Interval.

Table A28

Linear regression predicting CTE GPA, POS completers versus all others, South District

	CTE GPA					
	n = 2,085					
	Adjusted R^2 = 0.092				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	3.551	.028		.000	3.497	3.606
POS_all_others (1= POS Completer)	.131	.027	.101	.000	.078	.185
Male	-.063	.027	-.049	.021	-.117	-.010
Asian	.048	.064	.016	.449	-.077	.174
Black	-.275	.041	-.174	.000	-.355	-.195
Latino	-.123	.038	-.080	.001	-.197	-.050
Other	.093	.068	.029	.174	-.041	.227
F/RL eligible	-.177	.034	-.129	.000	-.243	-.111
Special Education	-.315	.062	-.106	.000	-.438	-.193
LEP	-.066	.058	-.025	.251	-.180	.047

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = Confidence Interval.

Table A29

Linear regression predicting weighted overall GPA, POS completers versus CTE concentrators, South District

	Overall GPA					
	n = 1,352					
	Adjusted R^2 = 0.376				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-.749	.165		.000	-1.073	-.424
POS_CTE_Conc (1= POS Completer)	.042	.029	.031	.155	-.016	.099
Male	-.234	.027	-.190	.000	-.288	-.181
Asian	.218	.065	.074	.001	.090	.346
Black	.010	.041	.007	.805	-.071	.091
Latino	-.043	.036	-.030	.238	-.113	.028
Other	-.011	.070	-.003	.876	-.149	.127
F/RL eligible	-.009	.033	-.007	.783	-.074	.055
Special Education	-.002	.060	-.001	.972	-.120	.116
LEP	.337	.057	.137	.000	.225	.450
Grade 8 pre-test math	.008	.001	.417	.000	.007	.009
Grade 8 pre-test reading	.004	.000	.257	.000	.003	.005

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = Confidence Interval.

Table A30

Linear regression predicting STEM credits earned, POS completers versus CTE concentrators, South District

	STEM Credits					
	n = 1,352					
	Adjusted R^2 = 0.305				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-2.674	.419		.000	-3.495	-1.853
POS_CTE_Conc (1= POS Completer)	-.188	.077	-.055	.015	-.339	-.036
Male	-.198	.072	-.064	.006	-.339	-.058
Asian	.977	.172	.133	.000	.638	1.315
Black	.143	.109	.038	.189	-.071	.357
Latino	-.015	.095	-.004	.873	-.202	.171
Other	.107	.186	.013	.566	-.258	.471
F/RL eligible	-.282	.087	-.087	.001	-.452	-.112
Special Education	-.559	.157	-.083	.000	-.867	-.250
LEP	.066	.148	.011	.658	-.225	.357
Grade 8 pre-test math	.023	.001	.498	.000	.021	.025

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = Confidence Interval.

Table A31

Linear regression predicting AP credits earned, POS completers versus CTE concentrators, South District

	AP Credits					
	n = 226					
	Adjusted R^2 = 0.388				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-14.986	.752		.000	-16.462	-13.511
POS_CTE_Conc (1= POS Completer)	-.608	.133	-.098	.000	-.869	-.346
Male	-.511	.124	-.090	.000	-.754	-.268
Asian	2.043	.297	.151	.000	1.460	2.625
Black	.374	.188	.054	.047	.005	.742
Latino	.148	.164	.022	.366	-.174	.470
Other	.030	.321	.002	.926	-.599	.659
F/RL eligible	.019	.149	.003	.899	-.274	.312
Special Education	-.097	.273	-.008	.723	-.633	.439
LEP	.908	.261	.080	.001	.396	1.419
Grade 8 pre-test math	.027	.003	.317	.000	.022	.032
Grade 8 pre-test reading	.026	.002	.354	.000	.022	.031

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = Confidence Interval.

Table A32

Linear regression predicting college credits accrued, POS completers versus CTE concentrators, South District

	College Credits Accrued					
	n =1,352					
	Adjusted R^2 = 0.052				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	-.631	.089		.000	-.806	-.457
POS_CTE_Conc (1= POS Completer)	-.008	.016	-.013	.619	-.039	.023
Male	-.003	.015	-.005	.854	-.031	.026
Asian	.098	.035	.076	.005	.029	.167
Black	.038	.022	.058	.084	-.005	.082
Latino	-.002	.019	-.003	.923	-.040	.036
Other	.087	.038	.062	.022	.012	.161
F/RL eligible	-.003	.018	-.006	.856	-.038	.031
Special Education	.024	.032	.021	.450	-.039	.088
LEP	.051	.031	.048	.097	-.009	.112
Grade 8 pre-test math	.001	.000	.135	.000	.000	.002
Grade 8 pre-test reading	.001	.000	.123	.001	.000	.001

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = Confidence Interval.

Table A33

Linear regression predicting CTE GPA, POS completers versus CTE concentrators, South District

	CTE GPA					
	n = 1,352					
	Adjusted R^2 = 0.053				95% *CI*	
Variable	*b*	*SE b*	*ß*	*p*	lower	upper
(Constant)	3.543	.033		.000	3.477	3.608
POS_CTE_Conc (1= POS Completer)	.073	.030	.064	.016	.013	.132
Male	-.044	.028	-.042	.117	-.099	.011
Asian	.032	.068	.013	.641	-.101	.164
Black	-.187	.042	-.147	.000	-.270	-.105
Latino	-.086	.037	-.071	.022	-.159	-.012
Other	.016	.073	.006	.826	-.127	.159
F/RL eligible	-.086	.034	-.079	.011	-.152	-.019
Special Education	-.250	.060	-.111	.000	-.368	-.132
LEP	-.065	.057	-.032	.250	-.177	.046

Note. All coefficients rounded to two digits. LEP = Limited English Proficiency. *CI* = Confidence Interval.

APPENDIX B: Qualitative Technical Appendix

This appendix provides more detail on the qualitative methods employed in this study. In order to measure student outcomes in the intervention and comparison groups, we first needed to determine whether or not the sites were implementing POS. Although some aspects of POS are relatively easy to identify—for example, the availability of credit transfer opportunities—other elements of POS as originally mandated by Perkins IV or as later fleshed out in OVAE's Design Framework for POS (2010) may not be as easy to determine without direct observation or information from participating stakeholders. For that reason, we sought to differentiate, where possible, between POS as implemented at our intervention schools and "business as usual" CTE courses or programs offered at comparison high schools. During annual site visits to the three districts participating in the study, we used classroom observations and stakeholder interviews to tease out the differences between intervention POS and comparison CTE programs. Over the course of the study, as POS became more widely implemented for younger cohorts across districts and schools, the differences between the intervention condition and the counterfactual were becoming less obvious.

Qualitative Data Collection

Site Visits

In order to create richly detailed case studies of the intervention and comparison high schools in the three districts participating in the study, we made annual visits to West and East Districts over a four-year period, beginning when our cohort students were ninth graders (the 2008-2009 school year) and ending when they graduated from high school (the 2011-2012 school year). Due to the delayed entry of South District into the study, we were only able to make one site visit there during the 2011-2012 school year and thus have less qualitative data there than at the other two districts.

To the extent possible, we tried to schedule our site visits at approximately the same time each year. The study's two principal investigators conducted all of the visits. In West, with the exception of an initial two-day scouting visit, annual site visits typically spanned five school days, during which the two researchers each spent one day at the three POS high schools, then split up to each visit two comparison high schools. Comparison schools were chosen for potential visits if they had comparatively larger enrollments of sample students; we visited those schools where the principals agreed to host us (for a total of six schools over the course of the study). In East, site visits lasted between three to five school days. The two-member team spent one to two days at Blue Academy, then divided up the four comparison schools for one-day visits, alternating comparison schools each year (e.g., Researcher 1 visited Emerald and Indigo in 2009-2010 and Heliotrope and Neon in 2010-2011, while Researcher 2 visited Heliotrope and Neon in 2009-2010 and Emerald and Indigo in 2010-2011). In the case of South District, which was the last district to join the study, we collected historical systems data for our cohort's full four years of high school and made one five-day site visit to six high schools during our cohort's senior year (2011-2012). The research team visited four schools together and two schools separately in South District.

Across years, a typical school visit usually included an interview with the school's principal (or, if she or he was not available, an assistant principal for curriculum and instruction), an interview with a guidance counselor, an interview with the school's CTE program coordinator or academy coordinator (if any), one or two student interviews, and two to three classroom observations. We found it easier to create well-balanced schedules in schools using periods (typically 7 or 8 periods in a day) versus those following block schedules. In the case of the latter, in order to fit in an adequate number of observations and interviews, we sometimes conducted classroom observations during the first half of a block class and used the second half for interviews. Lunch periods were also used for interviews with students and staff.

Interviews

We conducted both individual and group interviews (Krueger, 1994) with key stakeholders (i.e., high school students, teachers, guidance counselors, and administrators, including principals, assistant principals, and program or academy coordinators) at all schools visited. Interviews were also conducted with state and district personnel, business and industry partners, and postsecondary personnel. Semi-structured interview protocols were used in all settings; these were updated as needed for stakeholders who were interviewed more than once. Adult interviews usually lasted 45 minutes to 1 hour; student interviews generally ranged from 20 to 30 minutes. We did not attempt to achieve parity of representation of all types of stakeholders at the individual school level, opting instead to capture the perspectives of a broad range of stakeholders across sites. As shown in Table B1, we conducted 95 interviews in West District, 80 in East District, and 44 in South District (where we were able to conduct only one site visit) for a total of 219 interviews. In those interviews, we spoke with a total of 235 POS stakeholders of various kinds.

Whenever possible, we asked the same or similar questions of each group of stakeholders so that data could be triangulated. Notable examples include questions about the four mandated elements of POS, like the availability of credit transfer opportunities or the alignment of secondary and postsecondary education. In later years of the study, interview protocols were expanded to capture the presence of the ten components of OVAE's POS Design Framework (2010). Some questions were only posed to specific groups of stakeholders. For example, CTE teachers, administrators, and guidance counselors were asked about (a) their involvement in the implementation of POS (e.g., whether they participated in state- or district-led trainings on POS), (b) how career guidance was integrated into programs, (c) the climate and culture of the school, (d) parent involvement, and (e) their vision for the future of their students. Teachers were asked about the integration of academic and CTE curricula and whether they had opportunities to collaborate with other teachers to plan lessons. Teachers and principals were asked how they used assessment data—both academic and technical—to enhance instruction and improve student outcomes. Teachers and administrators in both secondary and postsecondary settings were asked about the participation of business and industry partners in CTE programs. In West District, we interviewed two of those business and industry partners. Teachers and students were asked to describe the types of assessments used in their academic and CTE classes. Students were asked, as applicable, how they had chosen their POS in high school, about their college and career plans, and whether they thought their friends would graduate from high school. District and state personnel were asked to describe their involvement in the development and

implementation of POS. Postsecondary personnel were asked about the history of alignment efforts between the district and their institution.[7]

Table B1
Interviews conducted at study sites, by district

	West 5 visits		East 4 visits		South 1 visit
	Intervention 3 schools	Comparison 6 schools	Intervention 1 school	Comparison 4 schools	n/a 6 schools
High school					
Administrators	7	9	2	13	13
Counselors	7	2	3	4	6
Teachers (career)	25	7	10	11	0
Teachers (academic)	3	0	2	2	0
Students	15	5	7	13	25
School-level totals	*57*	*23*	*24*	*43*	*44*
District personnel	5		2		0
Business partners	2		0		0
State dept. of education	1		0		0
Community college					
Administrators	3		5		0
Counselors	1		1		0
Instructors (career)	3		6		0
TOTAL interviews	*95*		*80*		*44*
TOTAL interview participants	*103*		*83*		*49*

Note. The total number of interview participants does not equal the total number of interviews because (a) some people (i.e., principals) were interviewed more than once over the course of the study, and (b) some interviews included several people (i.e., an interview with a principal in which the career academy coordinator was also present and contributing to the conversation).

The interview selection process was both purposive and incidental, largely mirroring the development of the site visit schedule. In general, teachers whose classes were being observed that day, or who taught in the same program as the classes being observed, were invited to participate in interviews during their lunch breaks or planning periods. We asked to interview students from the same classes or programs. In all cases, we could only interview those students whose parents had previously returned signed consent forms allowing them to participate.

In 2011-2012, in order to ensure a range of student perspectives, we identified potential interviewees using our definition of at risk (i.e., students who scored at or below the 20th percentile on eighth-grade baseline assessments of math, reading, or science, and who were free-lunch eligible), and we asked the districts' research offices to submit the list to the schools in order to send letters and consent forms home to students in this group. Schools complied, and we selected interviewees from those students whose parents returned the forms.

[7] Interview protocols are available from the authors upon request.

Annual site visits also included interviews with district officials (i.e., administrators from the district CTE offices), business and industry partners, the local community college (including instructors, administrators, and admissions/enrollment counselors), and the state department of education. Most of these interviews took place after the end of the school day.

Classroom Observations

We observed POS classes at the intervention schools and CTE classes at the comparison schools. We also observed some academic classes—both core requirements and classes that might be related to a POS (i.e., Epidemiology)—but these were not a major focus of our work. Indeed, in West District, we observed no academic classes in the comparison schools because we wanted to focus our limited time and resources on understanding CTE in that large district.

Classroom observations ranged from 45-90 minutes, depending on the duration of the class periods or blocks at the school. Like the interview selection process, our selection of classes for observation was both purposive and incidental; schools' schedules and the availability and willingness of teachers to be observed defined our choices. Each year, we sought to observe only those classes in which our cohort was enrolled; in the case of CTE classes, we were able to use school or district four-year POS course sequences to identify appropriate classes (e.g., introductory CTE classes in Grades 9 and 10; advanced or capstone CTE classes in Grades 11 and 12). In choosing CTE courses, we attempted to observe a broad range of programs, taking care to "match," where possible, POS courses in intervention schools with their closest analogues in comparison high schools (e.g., during the same site visit, we observed Introduction to Culinary Arts in a culinary POS and a Foods and Nutrition I class in a comparison school offering family and consumer science courses). In the case of academic classes, we chose to focus on one core academic area each year (e.g., English in Grade 9, math in Grade 10, science in Grade 11) across intervention and comparison schools, in order to get a stronger sense of how these academic subjects were presented in POS versus non-POS settings. All teachers were asked in advance if they were willing to have their classrooms observed and assured that these observations were non-evaluative. Nearly all teachers were amenable to being observed, and many expressed interest in the goals and outcomes of the study.

Our classroom observation protocol included three activities, two completed during the class (marking a time interval form; taking running notes) and one completed later (filling out a detailed classroom observation form using the interval form and running notes as guides). The full observation protocol spanned the range of low-inference to ethnographic observations (cf. Castellano & Datnow, 2004; Datnow, Borman, Stringfield, Rachuba, & Castellano, 2003). Our goal was to capture the full scope and richness of the classroom experience for teachers and students, and the same observation forms were used in both academic and CTE classes. The time interval form was used to generate an overall snapshot of classroom activities. The classroom observation form included questions intended to capture elements of POS (both the four mandated elements and the ten components described by OVAE) as a means of generating comparative data on the intervention versus comparison conditions. This latter form is found in Appendix C. Similar combinations of data gathering instruments have been used successfully in studies of school effectiveness and reform design implementation (Castellano & Datnow, 2004; Datnow et al., 2003; Stringfield et al., 1997; Teddlie & Stringfield, 1993).

The first instrument, the time interval form, is a modified version of the Classroom Observation Measure (COM), developed and validated at the University of Memphis (Ross et al., 1994). It includes one section that requires the observer to take systematic observations of the entire class at regular intervals (timed according to the duration of the class, but generally running between 6-10 minutes). This process yields low-inference data points regarding classroom orientation (e.g., teacher-led, project-based, individual student vs. group work). At the end of the class, observers complete a second, more global section of the form that gauges the extent of various classroom activities (e.g., the amount of direct instruction, independent student work, use of computers or other technology). The purpose of the time interval form is to reduce certain classroom events to variables that can then be compared across classes.

Figure B1 depicts a pseudonymous sample time interval form. At the top of the form, the observer enters general information about the classroom observation, including the date, school, class, teacher, and grade level of the students present. Based on length of the class observed, the researcher also enters the specific times that correspond with each interval segment. For example, Figure B1 instructs the researcher to record observations in six-minute intervals. Given that the sheet provides for ten data points, this sample was for a 54-minute class period. Observations begin and end at the bell in order to capture whether teachers are using the full class period or allowing late starts or early wrap-ups. Every six minutes, the researcher makes a snapshot observation of the orientation of the class and marks all relevant items in the column for that interval in Section A. Section A allows the researcher to capture a range of activities and student orientations for each interval. For example, at the third time point in Figure B1 (8:12 a.m.), the majority of the class was receiving teacher-led direct instruction while one student worked independently at a computer workstation and two students engaged in off-topic chatter at the back of the room. In this case, the observer heavily circled "teacher led" (indicating that 40% or more of the students were engaged in this activity) and lightly circled both "independent" and "off task" (indicating that less than 10% of the students were engaged in these activities).

Overall, Section A of this sample form shows that in this class, students were still transitioning into the class when the first bell rang. The teacher then lectured; after this lecture, students worked in small groups and then led the class until the final bell rang. A minor amount of off-task behavior occurred. What Section A does not reveal is the focus of the teacher's lecture, the nature of the students' small-group work, or the content of the student-led portion of the class, among other pertinent details. That kind of information is contained in the observer's running notes and distilled in responses to the questions contained in the classroom observation form.

Section B of the time interval form is used to record the amount of time expended on various pedagogical practices and activities (e.g., sustained writing, use of alternative assessments, use of computers or other technology, dealing with discipline problems) during the class, where *None* = no class time, *A little* = less than or equal to 10% of class time, *Some* = 11% to 39% of class time, and *Extensive* = 40% or more of class time. The sample presented in Figure B1 shows that computers were used extensively during the class period, with the classroom's projection system used somewhat less. In this sample, the observer indicated that activities were neither challenging nor hands-on. Students engaged in some dialogue with each other and the teacher, and the teacher offered a little feedback but did not act as a coach or a facilitator.

Figure B1
Sample time interval form (pseudonymous)

Rigorous Tests of Student Outcomes in CTE Programs of Study
Observation Time Intervals

Record your observations in six-minute intervals. One minute after the bell rings, take the next minute to observe the classroom activity and record your observation (circle it). Do this again six minutes later and so on for the length of the class.

School name:	ABC Academy
Teacher name:	John Q. Public
Class title:	Intro to Information Technology
Grade level(s):	9th grade
Date:	October 19, 2009
Time:	8:00 – 8:54 a.m.
Observer:	Smith

Segment	Actual Time
1	8:00
2	8:06
3	8:12
4	8:18
5	8:24
6	8:30
7	8:36
8	8:42
9	8:48
Bell	8:54

A. Orientation of students (Shading/circle indicate approx. number of students)								≤ 10%	11-39%	≥ 40%
Teacher led	1	(2)	(3)	(4)	5	6	7	8	9	Bell
Team teaching	1	2	3	4	5	6	7	8	9	Bell
Independent	1	(2)	(3)	4	5	6	7	8	9	Bell
Small group	1	2	3	4	(5)	(6)	(7)	8	9	Bell
Pairs	1	2	3	4	5	6	7	8	9	Bell
Student led	1	2	3	4	5	6	7	(8)	(9)	(Bell)
Media led	1	2	3	4	5	6	7	8	9	Bell
Project-based	1	2	3	4	5	6	7	8	9	Bell
Transition activities	(1)	2	3	4	5	6	7	8	9	Bell
Off-task	1	2	(3)	(4)	5	(6)	(7)	8	9	Bell

B. Overall Observation

	None 0	**A Little** ≤ 10%	**Some** 11-39%	**Extensive** ≥ 40%
Direct instruction by teacher	N	L	(S)	E
Independent work by students	N	(L)	S	E
Teacher provided feedback (answers, information, etc.)	N	(L)	S	E
Students engaged in relevant dialogue with each other or with teacher	N	L	(S)	E
Sustained writing	(N)	L	S	E
Computer used as tool or resource	N	L	S	(E)
Other technology used as tool or resource (which?) *projection system*	N	L	(S)	E
Experiential, hands-on learning	(N)	L	S	E
Challenging activities	(N)	L	S	E
Alternative assessment strategies	(N)	L	S	E
Teacher acted as coach/facilitator	(N)	L	S	E
Discipline problems	N	(L)	S	E

In our analyses of the data collected in these time interval forms, means were calculated for the presence of various classroom orientations (Section A) and specific pedagogical practices (Section B). Means were calculated by district to determine the overall percent of all observations for each of the orientations and practices. Within each district, we then compared the means of career to academic classes as well as overall intervention to comparison classes. The second instrument, the classroom observation form (see Appendix C), was used to generate rich descriptions of observed classes. The form asked observers to summarize the classroom setting—including the number of students present (including gender, race/ethnicity, and grade level), the experience and demeanor of the teacher, the condition of the room and its technology and equipment, and the topic of the class—and to assess the presence or absence of various elements of POS and other classroom practices. Questions were derived in part from the four Perkins-mandated elements of POS, the ten supporting components contained in the policy guidance framework, extant research on CTE classroom practices (as reviewed in Castellano et al., 2003), and more general research on effective teaching and learning practices (Newmann & Wehlage, 1995; Tharp, 1997).

Questions related to POS included evidence of integrated curricula (e.g., a career focus in an academic classroom, applied academics in a CTE classroom, evidence of team teaching), dual enrollment opportunities, business partnerships, planned or impromptu career guidance, work-based learning opportunities, and secondary-postsecondary alignment. The form also included a section on soft skills, also known as the SCANS skills (Secretary's Commission on Achieving Necessary Skills, 1991) or employability skills, which have been identified as necessary for success in the workplace. Observers noted whether or not these skills were attended to in the observed class.

The sections of the form that elicit responses on effective teaching and learning were based on similar forms from previous studies (Castellano & Datnow, 2004; Datnow & Yonezawa, 2004) that were modified for this study. The form also incorporated Tharp's (1997) principles for effective classroom instruction:

1. facilitating learning through joint productive activity between teachers and students;
2. developing competence in the language and literacy of instruction throughout all instructional activities;
3. contextualizing teaching and curriculum in the experiences and skills of home and community;
4. challenging students toward cognitive complexity; and
5. engaging students through dialogue.

The classroom observation form included Newmann and Wehlage's (1995) tenets for successful school restructuring: involving students in higher order thinking and substantive conversational exchange, producing complex understandings, and helping students connect substantive, academic knowledge with current events, personal experience, or background.

Finally, the form sought to assess the general culture and climate of the classroom and capture any unusual or noteworthy incidents or activities not otherwise included in the form. Observers were encouraged to reflect on their overall impressions of the class.

Some of the questions on the classroom observation form supplemented the measures of the time interval form. For example, the time interval form showed how often computers or other technology were used during the class, but did not elicit how or why they were used. The classroom observation form asked observers to provide explicit detail on the number of computers or other technology in the room, how those computers were incorporated into instruction, and how expertly and efficiently students used them.

We conducted a total of 125 classroom observations across all districts. Of these, 117 time interval forms and 115 classroom observation forms were analyzable. Omitted from the analyzable totals were (a) elective classes (e.g., art, theater, ROTC) and (b) classes for which either one or the other observation form was not completed (in a few cases, circumstances prevented the completion of forms, although in all cases, running notes were taken). Table B2 summarizes the total number of observations conducted by district and the type of class, minus electives and those observations for which forms were missing, yielding the total analyzable number of observation forms.

Table B2
Number of observations conducted and forms completed, by district and class type

Observations/Forms Completed	Total Observed *N*	Career Classes *N*	Academic Classes *N*	Elective Classes *N*	Classes Omitted from Sample[a] *N*	Analytical Sample *N*
West District Intervention						
Total observations conducted	46	35	10	1	1	
Timed interval form	46	35	10	1	1	45
Classroom observation form	46	35	9	1	1	44
West District Comparison						
Total observations conducted	16	16	0	0	0	
Timed interval form	16	16	0	0	0	16
Classroom observation form	15	15	0	0	0	15
East District Intervention						
Total observations conducted	16	13	3	0	0	
Timed interval form	16	13	3	0	0	16
Classroom observation form	16	13	3	0	0	16
East District Comparison						
Total observations conducted	26	22	3	1	1	
Timed interval form	23	19	3	1	4[b]	22
Classroom observation form	23	19	3	1	4[b]	22
South District						
Total observations conducted	21	17	3	1	1	
Timed interval form	19	15	3	1	3[c]	18
Classroom observation form	19	15	3	1	3[c]	18

Notes. [a] Omitted classes were either electives or classes for which the observation forms were not completed.
[b] Forms not completed for 3 career courses. The elective class is the fourth omitted observation.
[c] Forms not completed for 2 career courses. The elective class is the third omitted observation.

Reliability

We conducted several reliability checks of the classroom observation instruments and our interview transcript coding procedures.

Observation Instruments

Two observation instruments were used: a time interval form and a classroom observation form (cf. Appendix C). We conducted reliability exercises on these forms at two different time periods and at two different schools. The first check took place during the site selection phase and involved observations of a graphic design course and a child development course at a high school that had been considered for participation but was not ultimately selected for inclusion in the study. The second reliability check occurred in West District, prior to beginning the formal data collection process, during a visit to finalize the details of West's participation. The classes we observed for this second round of reliability checking included a 3D animation class, a graphic design class, and two ninth-grade soft skills classes. After completing the classroom observations, we collected the research instruments and tallied the responses.

For the time interval forms, we used Cohen's kappa statistic (1960) to measure inter-rater reliability. This statistic is considered more robust than a simple percentage agreement because it takes into account the probability of the agreement occurring by chance. On the first section of the time interval form, which asks the observer to choose among such classroom orientations as *teacher led* or *project-based* at each interval, the research team reached 71% agreement, which is in the "substantial agreement" range (Landis & Koch, 1977). On the second section of the instrument, which asks the extent to which various practices were observed, such as *sustained writing* or *computer used as tool or resource*, the team scored 65%, also within the "substantial agreement" range. There has been some criticism of Landis and Koch's guidelines for what constitutes substantial agreement, and indeed, in some circles, the kappa statistic itself has been questioned (cf. Maclure & Willett, 1987). As an alternative, the simple agreement percentages between the two observers on the time interval forms were 92% for classroom orientation and 86% for prevalence of practices observed.

The classroom observation form is an open-ended form that solicits more richly detailed information about the classroom (or shop or lab), such as the resources and technology available for use (and in use on that day), what teachers and students did during the observation, and whether specific academic or career education elements were evident that day (e.g., whether students did any math, engaged in activities requiring higher order thinking skills, or produced a product with value outside of the classroom). In determining inter-rater agreement for this form, the criterion for each question on the form was: Is it evident that the observers were seeing the same class? For example, in the case of one of the freshman studies classes observed, for the question, *Was there evidence today of lesson planning and time management on the part of the teacher*, both observers captured one teacher's poor use of time, especially at the end of class. One observer wrote:

> Not enough. It seemed as though she had not planned what she would do after that point. She began a half-hearted discussion about answers to the questions, and what is a short-

> versus a long-term goal. But some students were still working. At 15 minutes to go, she wrapped up the "discussion" and told them to keep working. If they finished this assignment, she said, "find something quiet to do."

The other observer noted:

> Time was not well-used in this class. The reading and seatwork did not fill the whole class, so the teacher told the students 15 minutes before the end of the period that, if they were finished with their work, they should take out a book and be quiet so that other students could finish. By this point, a lot of chatting and disruption had broken out.

We tallied all responses that were and were not in agreement across observers, resulting in an 88% agreement rate across all four observations. Two areas in which the coders diverged are worth noting. First, the question with the highest disagreement across coders asks observers to provide a count of the number, race/ethnicity, and gender of the students in the class (e.g., 26 students: 13 males - 8 Black, 2 Latino, 1 Asian, 2 White; 13 females – 6 Black, 3 Latina, 2 Asian, 2 White). Depending on where an observer is seated in the classroom, it can be difficult to count and classify students according to their gender and race/ethnicity without attracting undue attention during class (e.g., standing to see students in a far corner). In addition, in today's urban districts, race/ethnicity and even gender are not always obvious to an observer.

The second area of divergence was the SCANS skills-based question, *Were students responsible for selecting the appropriate tools or equipment to complete a task*? In different observations, each observer answered "yes" based on a very broad interpretation of tools and equipment: "Yes, in the sense that they were selecting from among the self-motivation techniques the ones that were best for them," and "Yes, the students chose the appropriate tools to work with within their 3D animation software and design programs. These were 'virtual' tools, but tools nonetheless." Neither observer was consistent across reliability observations in the breadth of their conceptualization of tools and equipment. It was useful to identify these areas of observer divergence, but the areas the coders held in common were far greater—giving confidence that the classroom observation form was capturing the classroom experience in reliable ways.

Interview Transcript Coding

To establish inter-rater reliability for the study's interview transcript coding process, the two study team members each coded five interview transcripts: one each for a student, a counselor, a teacher, a principal, and a business partner. These coded transcripts were then compared, code by code. If a code was found next to an interviewee comment on one researcher's transcript, it was sought on the other transcript in the same place. The number of agreements across coded transcripts was tallied and a percentage produced. Only coder agreement was being tallied, not the appropriateness of the code for any particular comment in the transcript. This method of establishing agreement means that in some cases, some interview data that should have been coded may not have been coded. However, if we had coded every mention of every topic, the reports created in our chosen qualitative data analysis software package, HyperResearch, would have been too large and unwieldy for axial coding analyses; such reports would have contained extraneous data. Instead, we created coding guidelines, such as whether coding an instance of a

topic would further our knowledge of that concept. We depended on the researcher's eye and judgment to distinguish and code content-rich data, not extraneous data.

For example, the following section of a transcript was initially coded as *postsecondary partnerships*, but when the researchers reviewed the coding for reliability, it was agreed that no new information appears in this comment that could help us understand the specific postsecondary partnerships at this site, and thus the code was not warranted.

> *Principal:* Those courses, you know, are going to lead to certification. They're going to lead to college credit because of the relationship between us and the Rochester Institute of Technology, Project Lead the Way. They can get college credits for scoring at a certain level on those courses, on the exams, and so those kids kind of have to apply for that.

This site's partnership with the Rochester Institute of Technology is mediated through Project Lead the Way (PLTW). High schools across the country that participate in PLTW share this same partnership. As such, although this excerpt is nominally about a postsecondary partnership, it does not tell us about the school's local partnerships that yield opportunities for high school students to visit the college campus, take classes, and begin to see postsecondary education as their natural next step.

The inter-rater reliability results for these transcripts ranged from 30% to 58% agreement. In reviewing the results, one reason for the low agreement was that some of the codes, although not duplicative, could be used in pairs or groups. A good example is the various codes related to assessment: We coded instances of interviewee comments on *state assessment*, *academic assessment*, and *technical assessment*. The codes were based on some of the interview questions and the types of assessment between which we wanted to differentiate. However, in some conditions, *state assessment* was double-coded with either *academic assessment* or *technical assessment*. Sometimes one coder would double code but the other coder would not, lowering our agreement ratio. Other examples of such code pairs are *dual credit* and *postsecondary partnerships*, *work-based learning* and *business partnerships*, and *common planning time* and *teacher collaboration*. In some contexts, either one or the other of the codes in these pairs was used and inter-rater agreement was high. In other contexts, the codes were used in the pairs or groupings, and agreement was still high. But in certain contexts, only one coder used the code groupings, effectively lowering the agreement ratio in the inter-rater reliability exercises. These code pairs/groupings were identified and queries of the HyperResearch database took them into account, usually by querying both codes to ensure all relevant information was included in the code report.

The writing process for this report provided a means by which to overcome this low inter-rater agreement ratio. Given that the two co-principal investigators conducted all of the study's site visits and coded all of its transcripts, these researchers became very familiar with their own corpus of interviews and were able to bring this familiarity to their readings of each other's drafts. As an example, if a specific point was made by one of the researchers in a draft section of the report, the other researcher drew on her experience of the interview data in order to provide any needed confirmatory (or tempering) examples not used by the first author. Given the size of

the qualitative database, it was more often the case that we had too many examples to illustrate a point than too few. Again, collaboration helped determine which examples were finally used in the report.

Transcript coding was a mammoth task that had to be delimited in a manageable way. Although we did not achieve high inter-rater reliability, we believe that we captured the major themes in the transcripts and identified and corrected for any major discrepancies when we queried and used the data.

APPENDIX C: Classroom Observation Form

Part I: General Classroom/Lab/Shop

I1a. The Students (# students, race, gender, grade level)

I1b. Are any of the students in a program nontraditional for their gender?

I2. The Teacher (approx. age or experience level, race, gender, demeanor, level of engagement)

I3. Class Description Briefly, what was this class about? What was the subject? What was the topic for today?

I4a. Facilities, Resources, & Climate (Is there adequate space for everyone? Lighting? Books? Equipment? Work stations? How is the state of repair/disrepair?)

I4b. Describe and comment on the integration of technology in instruction.

I4c. Describe the technology in the classroom/shop/lab. Does it appear to be state of the art? Describe how the students were interacting with the technology (the extent to which it was used at all, the level of student engagement with the technology, etc.). If possible, ask the teacher if the technology is adequate for the purpose of the class.

Part II: Programs of Study (POS)

II.1. Integrated Curriculum

II1a. Did the teacher incorporate concepts from both academic and CTE topics? Describe. (For example, did a math teacher use an example from an academy topic, did the computer teacher say part of the students' grade on an assignment/project would be based on their spelling and punctuation, etc.)

II1b. Did you see any evidence today of teachers teaming across classes or team teaching to integrate CTE and academic curricula? Describe.

II.2. Work Based Learning (WBL)

II2a. Were student work experiences used for academic activities or assignments? Do you know if this work experience was connected to the class?

II2b. Did students bring up their WBL experiences (i.e., internships)? If so, what did they say?

II.3. Assessment

II3a. Did you see any assessment going on in the class? If so, describe. Did you see the use of portfolios, demonstrations, or exhibits?

II3b. Did the assessments focus on academic AND CTE competencies? Example?

II.4. Other POS Elements

II4a. Did you see any evidence today of articulation with postsecondary programs/standards/curricula? (in discussion, on posters, anything)

II4b. Did you see any evidence today of business partnerships? Describe.

II4c. Did you see any evidence today of dual enrollment opportunities? Describe.

II4d. Did the teacher incorporate planned or impromptu career guidance or advice today? Describe.

II4e. Were the standards for the course (CTE or academic) posted anywhere?

II4f. Did you see any evidence today of career technical student organizations (CTSOs)? Describe.

II4g. Were "all aspects of an industry" part of the class discussion or activity?

II4h. Was the local labor market the focus of class discussion/activities?

Part III: SCANS Skills

III.1. SCANS Workplace Competencies

III1a. Did students work as teams on projects or activities? (This is more than just working in groups to answer questions at the end of the chapter.) If so, look for and describe the following:

- Were the teams representative of the diversity of the class?
- Did students appear to work well together?
- Were students teaching other students?
- Were students negotiating solutions to problems?
- Were students leading the team toward completion of team goals?
- Did most students contribute, act responsibly during the activity?
- Describe the activity requiring team work

III1b. Did the activity require the management of time, money, materials, or human resources? Was there any evidence that students took any of this into account in their work?

III1c. In what ways did the students work with information? (Discuss all that apply: acquire, evaluate, organize, maintain, interpret, or communicate information, use computers to process information.) Or did the teacher/textbook just supply or transmit information that the students simply reproduced (e.g., textbook-tied worksheets, etc.)?

III1d. Were students responsible for selecting the appropriate tools or equipment to complete a task? Were they responsible for maintaining or troubleshooting these tools?

III.2. SCANS Basic Skills, Thinking Skills

III2a. Did you observe any student reading? Describe.

III2b. Did you observe any student writing? Describe.

III2c. Did you observe any arithmetic or mathematics? Describe.

III2d. Did students participate in discussions or presentations? Describe.

III2e. Did students teach or lead a portion of the class? Describe.

III2f. Was decision-making part of any class activities? Describe.

Part IV: Restructured Teaching and Learning (cf. Newmann & Wehlage)

IV1. Were students conducting disciplined inquiry (e.g., using ideas/concepts to interpret, explain, or solve specific concrete information or activities. Note if this instance includes students providing coherent accounts of their understanding in elaborated written communications.)? Explain how you know this.

IV2. Were students engaging in higher order thinking skills? Describe.

IV3. Was the focus of the class ever on issues connected to the local community?

IV4. Were students engaged in producing a "product" that would have value or use beyond the classroom? Explain how you know this.

Part V: General Classroom Culture

V.1. Pedagogy

V1a. Who initiated teacher-student interaction? Was it about clarifications and known-answer questions, or higher-level?

V1b. Did the teacher use multiple instructional strategies?

V1c. Was there evidence today of lesson planning and time management on the part of the teacher?

V1d. Did students appear to understand what they were learning? Did they have the appropriate background knowledge/scaffolding?

V.2. Expectations

V2a. Describe the *explicit* and *implicit* expectations for this class? Did the expectations seem to be equally demanding for all students?

V2b. Was there evidence that students were being held to specific academic or technical standards?

Part VI: Brief Descriptions

VI.1. Miscellaneous Classroom Activities

Please use the space below to note any classroom activities that were not captured by the above questions (i.e., options for students who are behind, mention of an individual graduation plan).

VI.2. Reflections

Reflect on the classroom note your overall perceptions. Anything unusual, disturbing, dull, or unique?

APPENDIX D: Senior Exit Survey Respondent Characteristics

In order to take into account any potential bias with respect to the senior survey, crosstabs were run on any baseline differences between survey respondents and nonrespondents as well as differences between intervention respondents and comparison respondents. The tables follow, first for West District and then East District. Senior exit surveys were not conducted at South District.

Table D1
Background characteristics of senior survey takers and nontakers, by intervention status, West District

	Intervention		Comparison	
	Takers (N = 456)	Nontakers (N = 719)	Takers (N = 325)	Nontakers (N = 504)
Characteristics	(%)	(%)	(%)	(%)
Gender				
Male	45.6	52.0*	34.8	30.8
Female	54.4	48.0	65.2	69.2
Race/Ethnicity				
Black	11.8	10.0	5.8	10.1
White	41.9	40.3	40.9	38.9
Latino	32.5	32.4	35.4	34.7
Asian	12.5	16.8	16.6	15.7
Other	1.3	0.4	1.2	0.6
Free-lunch eligible	27.6	27.3	26.2	29.4
Limited English Proficient (LEP)	1.1	2.9*	2.8	2.8
Special Education	2.0	3.3	5.2	6.3
	Mean (SD) (n = 428)	*Mean (SD)* (n = 663)	*Mean (SD)* (n = 320)	*Mean (SD)* (n = 496)
Grade 8 pre-test math scale score	367.12 (73.10)	369.11 (77.60)	374.23 (81.14)	365.97 (80.34)
Grade 8 pre-test reading scale score	345.15 (53.30)	343.56 (54.71)	351.37 (59.30)	344.71 (56.34)

* $p < .05$.

Table D2

Background characteristics of students who took senior survey, by intervention status, West District

	Took Survey	
	Intervention (N = 456)	Comparison (N = 325)
Characteristics	(%)	(%)
Gender		
Male	45.6	34.8**
Female	54.4	65.2
Race/Ethnicity		
Black	11.8	5.8**
White	41.9	40.9
Latino	32.5	35.4
Asian	12.5	16.6
Other	1.3	1.2
Free-lunch eligible	27.6	26.2
Limited English Proficient (LEP)	1.1	2.8
Special Education	2.0	5.2*
	Mean (SD) (n = 428)	*Mean (SD)* (n = 320)
Grade 8 pre-test math scale score	367.12 (73.10)	374.23 (81.14)
Grade 8 pre-test reading scale score	345.15 (53.30)	351.37 (59.30)

* $p < .05$. ** $p < .01$.

Table D3

Background characteristics of senior survey takers and nontakers, by intervention status, East District

	Intervention		Comparison	
Characteristics	Takers (N = 158) (%)	Nontakers (N = 218) (%)	Takers (N = 242) (%)	Nontakers (N = 510) (%)
Gender				
Male	53.2	51.4	47.9	50.8
Female	46.8	48.6	52.1	49.2
Race/Ethnicity				
Black	75.3	67.9	76.4	67.6*
White	8.2	12.4	5.8	13.7**
Latino	8.9	11.5	7.4	12.2
Asian	3.8	3.7	6.2	2.4**
Other	3.8	4.6	4.1	4.1
Free-lunch eligible	65.8	70.2	67.4	65.9
Limited English Proficient (LEP)	2.5	5.5	1.7	6.3**
Special Education	1.9	2.8	0.8	2.9
	Mean (SD)	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
Grade 8 pre-test math scale score	363.82 (6.83)	362.78 (7.03)	363.45 (7.22)	362.63 (7.68)
Grade 8 pre-test reading scale score	360.05 (7.10)	359.80 (7.12)	359.77 (6.65)	359.65 (7.87)

* $p < .05$. ** $p < .01$.

Table D4

Background characteristics of those who took senior survey, by intervention status, East District

	Took Survey	
	Intervention (N = 158)	Comparison (N = 242)
Characteristics	(%)	(%)
Gender		
Male	53.2	47.9
Female	46.8	52.1
Race/Ethnicity		
Black	75.3	76.4
White	8.2	5.8
Latino	8.9	7.4
Asian	3.8	6.2
Other	3.8	4.1
Free-lunch eligible	65.8	67.4
Limited English Proficient (LEP)	2.5	1.7
Special Education	1.9	0.8
	Mean (SD)	*Mean (SD)*
Grade 8 pre-test math scale score	363.82 (6.83)	363.45 (7.22)
Grade 8 pre-test reading scale score	360.05 (7.10)	359.77 (6.65)

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