Copyright

by

Jessica Ann Brown

2016

The Dissertation Committee for Jessica Ann Brown Certifies that this is the approved version of the following dissertation:

Longitudinal Outcomes of CTE Participation: P-16+ Transitions in Texas and the Rio Grande Valley

Committee:

Pedro Reyes, Supervisor

Celeste D. Alexander

Ruben D. Olivarez

Victor B. Saenz

Longitudinal Outcomes of CTE Participation:
P-16+ Transitions in Texas and the Rio Grande Valley

by

Jessica Ann Brown, B.A.; M.A.T.

Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

The University of Texas at Austin

December 2016

Dedication

To my father, Martin Stanley Brown (1950-2005)

I love you.

Acknowledgements

For the majority of my teaching career I taught students who were overlooked by society and schools—middle grades kids whose disadvantaged backgrounds predicted an incomplete education. Many had no concept their life differed from others' experiences. Many understood hardship too well as they were already burdened with inequity. I would have crumbled under similar weights. These kids were far more resilient. They were amazing! Vibrant and witty (and yes, strong-willed), these students required creative management, varied instruction, and my best efforts as a teacher. I learned, and relearned the simplest of lessons. All students want to know more. All students want to learn if given the chance.

My students' faces and stories are often on my mind. I am so very thankful to have been their teacher. I owe my drive to improve our education policies and practices to my kids' influence. Because of them I want to give more students a better chance to learn.

My experiences and motivations are rooted in my instruction at Trinity University. I was taught to be an educator, a good one at that. My undergraduate and graduate studies forced me to think critically about the student, classroom, school, and community. Trinity gave me the tools to teach. And, Trinity instilled in me a philosophy of progressive education I still hold today. It is from this basis I think about policy and change. I believe it makes me a stronger teacher and more thoughtful researcher. I owe thanks to all the professors who provided me a wide, liberal arts education. Very special thanks to Dr. Laura Allen, my master's advisor and personal mentor. She has continually provided me opportunities to grow and is an inspiration as an academic.

Thank you to everyone at The University of Texas at Austin (UT) who has helped me earn knowledge and a doctorate degree. I appreciate all the unique opportunities which have shaped my experience. From a building within view of the Texas State Capitol I have been able to study and practice policy. I have not taken it for granted. UT has provided me a powerful and thorough education.

Special thanks to my committee members, Drs. Olivarez and Saenz, for their advice and aid in my final study. Thank you to Dr. Reyes for seeing me through my dissertation and program. And also, for providing me time at the Texas Education Research Center (ERC). Special thanks to Dr. Celeste Alexander, Cindy Corn, and Matt Giani—my co-workers at the ERC. Working with y'all made handling enormous amounts of data, and enormous data issues, fun. Learning from and with you has been a pleasure. Thank you to RGV LEAD (Rio Grande Valley Linking Economic and Academic Development) for allowing me the opportunity to study your area and programs during my work at the ERC. Collaborating with your group has sparked my interest in Career and Technology Education (CTE) and renewed my enthusiasm for serving underserved students. Lastly, thank you to the friends I have made in my time at UT: Richard, Sandra, Vanessa, Kori, Mike, Dan, and Virginia. My studies would not have been complete without a smart group of peers to share ideas and adventures with.

I would not be who I am today without the many women I lean on and call friend. These ladies have been my mentors in life; teaching me style, grace, humility, strength, and perseverance. I am continually amazed by my friends. They are truly inspiring and empowering people. Special thanks go out to several women who have been huge cheerleaders in my doctoral efforts. Thank you to Jenn and Emily, my mermaid and wild-child. Our talks and visits have gotten me through rough periods and convinced me to keep going, time and time again. Allison, Audrey, and Sarah—The Craft, you ladies are a treasure. Our group always cheers my spirit. Y'all have a special, understated way of reminding me who I am. To all these ladies—and even more unnamed, watching with wonder at how each of you tackle your own lives has taught me to be a wiser and more conscientious person. It has made my own life works better. I send all of you my love and thanks. Thank you for cheering me on in your own special ways.

To Emme, my smallest and best friend, I love you. Emme has been my constant companion in life for over sixteen years, a brown-nosed, snuggly wonder who shares my personality and snark. She has been napping by my computer or in my lap as I completed every part of the Ph.D. program. My sentiments to place Emme as co-author on published works are only half in jest; she has certainly put in the hours. I am so lucky to have such a wonderful, darling cat to call my own.

Thank you to my family, near and far, who love me dearly. Blessings go to my two sisters, bright and successful women in their own fields. Tammy and Amanda are truly people I look up to. They are women who work hard and also raise wonderful, funny kiddoes I adore. To my mother who has been an unceasing support and confidant, thank you. Mom has spent her entire life seeking out knowledge, learning about almost any subject she could. She is an amazing and creative artist. My mother shared with me her many passions, and I am forever grateful for the love of learning. She was the first to teach me colors and opened my eyes to the world. She helped set me on a path to teaching, and keeps me grounded as I continue work in the field. I owe her many thanks for passing down to me a critical mind; I consider it my best feature. Thank you Mom for nurturing my mind and guiding my hand at each step in life.

I could not have completed this path without the support and confidence my father instilled in all his daughters. Thank you Dad for taking me on adventures—the crazy parts of nature, the dangerous escapades in the garage, the humble lessons in

service, the glorious movie marathons, and the days up at your office. Thank you for telling me I was intelligent and for believing I could do whatever I set my mind to. Thank you for allowing me my obstinate ways. Thank you for letting me know you were proud of me, constantly proud of me. I wish, desperately, you were here to share my joy. My Dad, a very *very* dedicated 1973 graduate of The University of Texas, used to jokingly introduce me as his only daughter who did not attend UT. I know looking down he will be excited to finally have a family full of Longhorns. More still, I can almost hear his big-bellied laugh as he remarks on the circuitous route I took getting here. He did always joke I was his smartest daughter… I hope that in all things I continue to find my smarts, but, more importantly, live life as my father's daughter—a master of knowledge, mirth, and compassion.

Longitudinal Outcomes of CTE Participation:
P-16+ Transitions in Texas and the Rio Grande Valley

Jessica Ann Brown, Ph.D.
The University of Texas at Austin, 2016

Supervisor: Pedro Reyes

The jobs of tomorrow are here today. They require enhanced skill sets and higher levels of education. Attainment has already fallen behind economic development, though. To fill these gaps, policymakers have turned towards practices which lead to better transitions between high school, higher education, and the workforce. This study looks at one such reform model. It examines longitudinal student outcomes associated with participation in Career and Technology Education (CTE), specifically Tech Prep programming. The study explores the benefits of participation in Tech Prep across P-16+ transitions in both Texas and the Rio Grande Valley (RGV)—an area known for its unique context and widespread implementation of CTE Tech Prep.

Methods include propensity score matching of students to control for selection bias, and the multilevel modeling of logistic regression on a variety of outcomes associated with Tech Prep participation. The outcome variables investigated encompass five key areas: high school transitions, higher education enrollment, developmental remediation, postsecondary attainment, and workforce participation.

Analysis suggests participation in Tech Prep during high school leads to gains across all P-16+ transition points. Tech Prep increases opportunities to transition to higher education after high school, providing stronger pathways to community college

and greater access for traditionally disadvantaged students. When combined with academic rigor, Tech Prep participation works to improve enrollment and expands matriculation into four-year institutions. Importantly, Tech Prep interacts with a number of student traits, increasing the likelihood of postsecondary attainment. RGV area comparisons indicate significant regional variation, including greater odds of college readiness and postsecondary enrollment.

Results are numerous and provide strong evidence for the efficacy of Tech Prep models in the RGV, Texas, and beyond. Findings inform upon the utility of Tech Prep programs as well as illustrate the possibilities of using longitudinal data to explore effects of educational models on student outcomes. Moreover, implications connect to the greater policy discussion. Knowledge gained from this study offers insight into the current legislative stalemate over federal *Perkins* reauthorization. Additionally, it provides useful guidelines for Texas as schools and districts work to develop CTE programs in response to recent changes in graduation plans under *House Bill 5*.

Table of Contents

List of Tables xvi

List of Figures xix

CHAPTER ONE: INTRODUCTION 1

Problem Statement 1

Jobs of Tomorrow 1

Need for Educated Workers 2

Education and Earnings 4

Intervention and Opportunity 6

Policy Contexts 6

P-16+ Pipeline Initiatives 7

Reforming Vocational Tracks 8

Career and Technical Education 8

Tech Prep Programs 9

Texas and the RGV LEAD Consortium 11

Focus of the Study 14

Research Questions 14

Overview of Methods 14

Significance of the Study 16

Efficacy of Advanced CTE Models 16

Importance of Context 17

Growing Accountability in CTE Policies 18

CHAPTER TWO: LITERATURE REVIEW 20

Theoretical Frameworks 21

Traditional Theories of Human Capital 21

Transitions to an Information Economy 24

Education as a P-16+ Pipeline 28
Connecting Partners in Education 29
Credit Based Postsecondary Transitions 31
Reforming Technical Education 32

Historical Context of Tech Prep 35
Federal Contexts 35
Texas State Contexts 38

Other Programs Not the Focus of the Study 40

Tech Prep Implementation 42
Origins 42
Requirements 43
Implementation 45

Key Components of Tech Prep 52
Articulation Agreements 53
Career and Technical Education 56

Tech Prep Program Outcomes 61
High School 62
Higher Education 63
Workforce Participation 64
Limitations 65

CHAPTER THREE: RESEARCH DESIGN 68

Overview 68
Logic Model 68
Research Questions 71

Data 71
Definition of Tech Prep 71
Longitudinal Data Collection 73
Missing Data 75

Sample Statistics 76

Methods....................77

Propensity Scoring 78

Hierarchical Linear Regression....................86

CHAPTER FOUR: FINDINGS 92

Tech Prep Participation....................93

High School Transitions 98

Transitioning to Higher Education....................106

Transitioning to a Community College....................107

Transitioning to a University 108

Transitioning to the Workforce....................109

Higher Education Enrollment 110

Enrolling in Higher Education 115

Enrolling in a Community College 116

Enrolling in a University....................117

Developmental Remediation....................118

Participating in Developmental Coursework 123

Participating in Developmental Mathematics....................124

Participating in Developmental Reading 125

Participating in Developmental Writing 126

Postsecondary Attainment 127

Earning a Higher Education Credential 133

Earning an Associate's Degree 134

Earning a Bachelor's Degree 135

Earning a Higher Education Certificate 136

Workforce Participation....................137

Transitioning to the Postsecondary Workforce....................140

Transitioning to the Postsecondary Workforce (Two Jobs) 140

CHAPTER FIVE: DISCUSSION **143**

What Influences Tech Prep Participation 144

P-16+ Transitions in Texas 146

High School Transitions 147

Higher Education Enrollment 148

Developmental Remediation 149

Postsecondary Attainment 150

Workforce Participation 151

Summary of Longitudinal Findings 152

Interactions and Impacts of Tech Prep 153

Days Absent 153

Gender 154

Race and Ethnicity 155

Special Populations 157

Dual Credit Courses 158

CTE and Dual-CTE Courses 159

Other Significant Influences 161

Student Traits 161

Campus Characteristics 163

Importance of RGV LEAD 165

The RGV Area 165

RGV Differences in Modeling 167

Tech Prep and RGV LEAD Affiliations 169

Implications for the Future 172

Better Informed Research 172

Challenges for Practitioners 174

Policy Pressures and Reform 176

The Future of Reform 179

REFERENCE MATERIALS **181**

Appendix A: Texas Education Code 181

Appendix B: List of Variables 187

Appendix C: Descriptive Statistics 191

Appendix D: Sample Statistics 200

Glossary 210

References 216

List of Tables

Table 3.1: CTE and Tech Prep Status Identifiers in Data Coding 72

Table 3.2: Longitudinal Data Collection 74

Table 3.3: Multiple Imputation of Variables with Missing Data 76

Table 3.4: Balancing Tests on PSM Covariates 85

Table 3.4: Potential Variables for Explored Outcomes 90

Table 4.1: Odds of Participating in a Tech Prep 97

Table 4.2: Odds of Transitioning to Higher Education 106

Table 4.3: Odds of Transitioning to a Community College 107

Table 4.4: Odds of Transitioning to a University 108

Table 4.5: Odds of Transitioning to the Workforce 109

Table 4.6: Odds of Enrolling in Higher Education 115

Table 4.7: Odds of Enrolling in a Community College 116

Table 4.8: Odds of Enrolling in a University 117

Table 4.9: Odds of Participating in Developmental Coursework (DE) 123

Table 4.10: Odds of Participating in Mathematics DE 124

Table 4.11: Odds of Participating in Reading DE...125

Table 4.12: Odds of Participating in Writing DE 126

Table 4.13: Odds of Earning a Higher Education Credential 133

Table 4.14: Odds of Earning an Associate's Degree 134

Table 4.15: Odds of Earning a Bachelor's Degree 135

Table 4.16: Odds of Earning a Higher Education Certificate 136

Table 4.17: Odds of Transitioning to the Workforce 141

Table 4.18: Odds of Transitioning to the Workforce (Two Jobs)......................142

Table 5.1: RGV Demographic Estimates..166
Table 5.2: Probabilities Across P-16+ Transitions 171
Table C.1: Cohorts and Diploma Types 192
Table C.2: Race/Ethnicity...192
Table C.3: Student Characteristics..192
Table C.4: Special Program Membership 193
Table C.5: Passing Rates on TAKS Exit Exams...193
Table C.6: Average Dual Credit, CTE, and Dual-CTE Course Credits 193
Table C.7: Percent Transitioning to Higher Education.......................................194
Table C.8: Percent Transitioning to the Workforce..194
Table C.9: Percent Transitioning to Higher Education and the Workforce.........194
Table C.10: Salaries Transitioning to Higher Education and the Workforce......195
Table C.11: Percent Transitioning to Only the Workforce.................................195
Table C.12: Salaries Transitioning to Only the Workforce 195
Table C.13: Percent in the Workforce Five Years After Graduation 196
Table C.14: Percent with Credential in the Workforce Five Years After...........196
Table C.15: Salaries Credential in the Workforce Five Years After 196
Table C.16: Percent Without Credential in the Workforce Five Years After......197
Table C.17: Salaries Without Credential in the Workforce Five Years After 197
Table C.18: Total Enrollment in Higher Education..197
Table C.19: College and Career Readiness, Percent Failing 198
Table C.20: Developmental Enrollment by Subject 198
Table C.21: Earned Postsecondary Credentials 198
Table C.22: Percent Post-Postsecondary Graduates Working............................199
Table C.23: Percent Working and Mean Salary by Postsecondary Credential....199

Table D.1: Means and Standard Deviations for Cohort Sample.......................200

Table D.2: Intercorrelations for Cohort Sample 201

Table D.3: Means and Standard Deviations for PSM Sample..........................205

Table D.4: Intercorrelations for PSM Sample 206

List of Figures

Figure 1.1: Educational Attainment by Race/Ethnicity..3

Figure 1.2: Earnings by Education and Race/Ethnicity..5

Figure 1.3: Rio Grande Valley (RGV) Area Counties 11

Figure 2.1: Expected Lifetime Earnings by Education Level 23

Figure 3.1: Logic Model for Advanced CTE and Tech Prep Programs..............70

Figure 3.2: Distribution of Propensity Scores Before and After PSM 82

Figure 3.3: Balance of Covariates Before and After PSM..................................83

CHAPTER ONE: INTRODUCTION

Problem Statement

The jobs, careers, and industries of tomorrow are no longer blueprints for the future. They are here today (Organization for Economic Cooperation and Development [OECD], 2016). At the same time, world markets have become increasingly interconnected, interdependent, and competitive (Crist, Jacquart, & Shupe, 2002; Hernandez, 2014; Ramsey, 1995). Global economies have shifted away from resource and manufacturing industries. Instead, they now look towards *information economies* in which knowledge, technology, and services are important drivers of growth and wealth (Castells, 2010; OECD, 2016). Innovative industries—and their correspondingly novel career opportunities—call for increased skill sets and higher levels of education (Carnevale, Smith, & Strohl, 2010). Facing greater competition and transformation in markets, America is now tasked with growing its educated labor supply.

JOBS OF TOMORROW

The need for more—and better—educated employees in the United States is predicated on several factors inherent in the workforce today. First, there is a growing shift in what job opportunities will be available to young workers. Today many prime-age workforce members, those ages 25-54, are employed in jobs that require a high school diploma or less (National Governor's Association [NGA], 2014). These jobs are quickly disappearing which will leave citizens unemployed or underemployed, stuck with low and unlivable wages (Carnevale et al, 2010).

The retirement of the *baby boomer* generation, coupled with closures in previously popular industries, have shaped the forecast of replacement positions as well (Fitzsimmons, 1999; Symonds, Schwartz, & Ferguson, 2011). Estimates project that both replacement and new job opportunities will necessitate higher levels of educational attainment. Researchers predict two-thirds of positions in the next decades will require some form of postsecondary education (Brown & Schwartz, 2014; Castellano, Stringfield, & Stone, 2003). A quarter of anticipated jobs will entail higher education, though not necessarily a four-year degree (Carnevale et al, 2010). These include professions which demand either an industry recognized certificate or associate's degree.

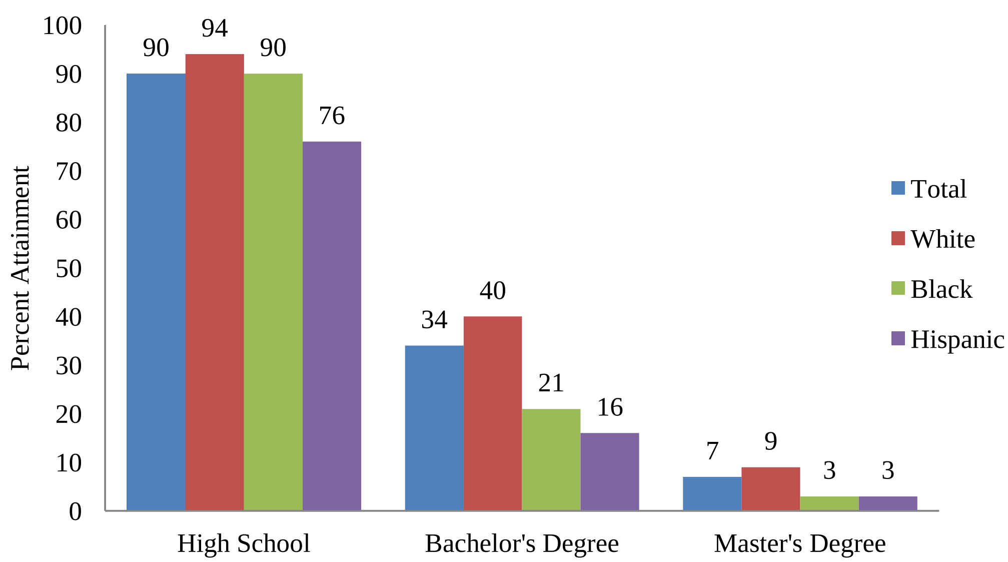
The STEM (Science, Technology, Engineering, and Mathematics) industry provides an excellent example of these shifts. STEM fields are rapidly growing at the same time resource industries (e.g., mining) and manufacturing are in decline. Job opportunities in STEM require more education and very specific skill sets (Hart, 2005). Employment opportunities in STEM, and other advanced fields, are in high demand, while low skill jobs are disappearing. Indeed, currently there are already growing shortages in STEM as well as healthcare, information, and technology industries (Gilbert, 1997; Hart, 2005; National Association of Manufacturers [NAM], 2005).

NEED FOR EDUCATED WORKERS

The demand for a more educated workforce is evident. The United States has lagged, though, in providing opportunities for higher education and skill development (Brown & Schwartz, 2014). While stable at 43%, the United States currently ranks fifth amongst OECD (Organization for Economic Cooperation and Development*)* countries in the percentage of adults with a higher education degree. Postsecondary attainment for younger generations (25-34 years old) is much lower when compared to other countries; the United States ranks 11^{th} (OECD, 2014). Other, developed, countries are increasing attainment at much higher rates.

The latest estimates of educational attainment collected by the National Center for Education Statistics (NCES) suggest that while many are completing a high school diploma, few transition to higher education and complete a postsecondary credential (NCES, 2014). Figure 1.1 shows attainment rates for those ages 25-29. Besides somewhat undersized postsecondary attainment, gaps in minority students gaining postsecondary credentials are also evident. Attainment gaps in higher education have been historic as well. Students in traditionally underserved areas, including minority groups, students from low-socioeconomic (low-SES) classes, and geographic areas (e.g., urban centers or rural extremes) are linked with lower enrollment, persistence, and attainment in higher education (Kao & Thompson, 2003; Ross et al, 2012; Lumina, 2015). While proportions of minority and low-SES students have increased in recent years, gaps have not significantly narrowed (Ross et al, 2012; Lumina, 2015).

Figure 1.1: Educational Attainment by Race/Ethnicity



Note. Estimates based on persons aged 25-29 in 2013.
Note. Per data collection guidelines, people whose ethnicity is identified as Hispanic may be of any race.
Note. Estimates for traditionally disadvantaged minority groups only are shown. Students from Asian backgrounds have higher attainment in all areas.
Source. (NCES, 2014; 2016)

Certain barriers limit access to postsecondary enrollment. Many of these include low college readiness, limited exposure to a college culture, lack of understanding of *hidden rules*, and a shortage of financial resources. (Choy, 2001; Executive Office of the President [EOP], 2014; National Center for Public Policy and Higher Education [NCPPHE], 2008; Sawhill et al, 2012). At present, a relatively smaller proportion of students are gaining a higher level of education than their parents reached, further suggesting limited access (OECD, 2014).

An incomplete education today is a growing concern. Downtrends between secondary and postsecondary attainment, and gaps between underserved populations of students are meaningful in today's economy. It corresponds to fewer job opportunities as well as lower wages (Carnevale et al, 2010; Castellano et al, 2003).

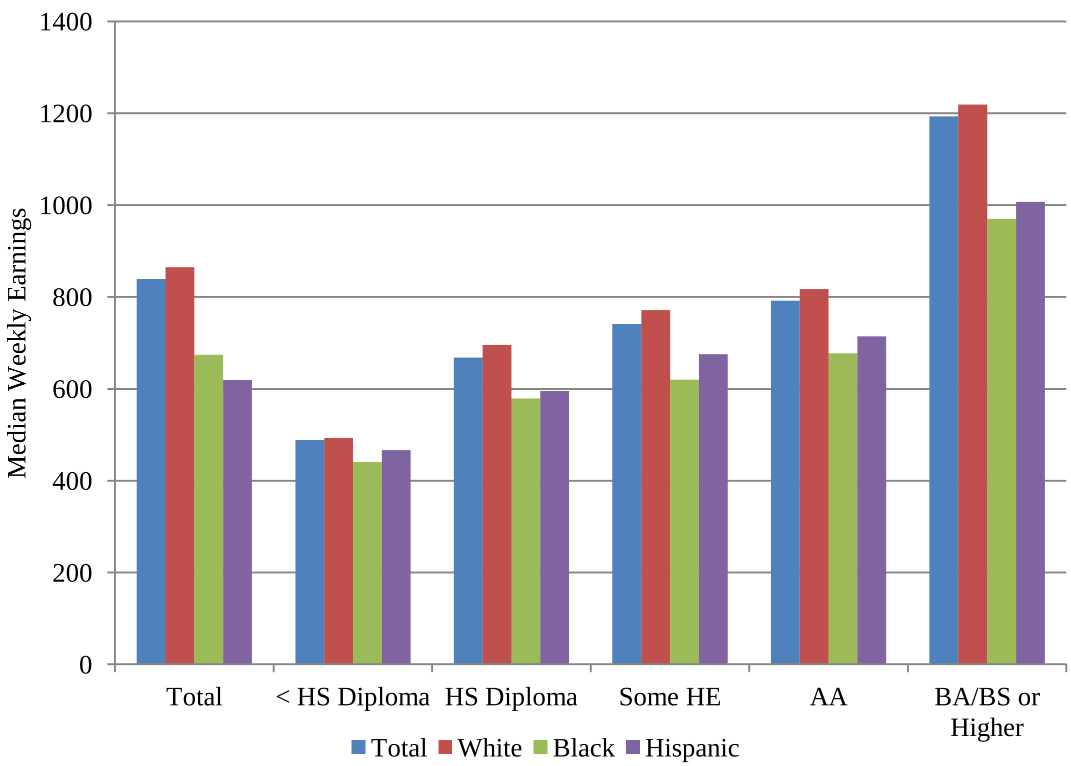
EDUCATION AND EARNINGS

Educational attainment has a direct link to both individual and overall prosperity (Goldberg & Smith, 2008; Hanushek & Woessmann, 2010). For individuals, there is a positive relationship between the level of education reached and economic return. The more education a person receives, the larger the income they are likely to make, both in yearly wages as well as lifetime earnings (Grubb, 1999; Maguire, Starobin, & Laanan, 2012; Mincer, 1989). Levels of degree attainment also matter. Students gaining an associate's degree tend to earn less than those who earn a bachelor's degree (Grubb, 1999).

The impact of a postsecondary degree on earning potential has been replicated over numerous periods of time suggesting a long-held association between investments in education and financial return (Greenstone, Harris, Li, Looney, & Patashnick, 2012; Seidman & Ramsey, 1995). Gaps between college graduates, those with only a high school diploma, and those that did not complete high school have grown wider over time.

The largest gaps are between those with and without a bachelor's degree. Indeed, the United States shows one of the largest differences in earnings internationally between citizens with and without a postsecondary degree (OECD, 2014). For those with a high school diploma or less, wages are particularly small. Lifetime earnings for those who did not complete high school have decreased dramatically over time. At the same time those with postsecondary attainment have seen growth in lifetime earnings (Greenstone et al, 2012).

Figure 1.2: Earnings by Education and Race/Ethnicity



Note. Estimates based on 2014 annual salary averages.
Note. Per data collection guidelines, people whose ethnicity is identified as Hispanic may be of any race.
Source. (U.S. Department of Labor [USDOL], 2015)

Gaps in earnings are observed when comparing race and ethnicity. The widest gaps occur in higher levels of postsecondary attainment—associate or bachelor degree credentials (see Figure 1.2). Gaps in earnings may be explained, in part, by the uneven distribution of educational opportunity through limited access (EOP, 2014; NCPPHE, 2008). Limited access lowers the probability of attainment and correspondingly has negative impacts on earning potential (Lumina, 2015; NCPPHE, 2008).

INTERVENTION AND OPPORTUNITY

The preponderance of research has shown that the lack of a high school degree in this current day relegates a person to a lifetime of poorly paid, unskilled labor opportunities (Seidman & Ramsey, 1995). Further, low postsecondary attainment levels keep many more from experiencing high-paid, middle class job opportunities (Carnevale et al, 2010; Castellano et al, 2003). Gaps between underserved populations extend inequity (Lumina, 2015). Shifting economies in combination with growing demand for skills and education in the future will further exacerbate numerous inequalities—unless appropriate interventions are implemented.

Policy Contexts

Growing requirements for workers and new developments in industry have forced many to rethink policy connections between education and employment. Current policies do not successfully bridge the barriers to postsecondary education which keep certain students from gaining the necessary skills for the jobs of tomorrow. To fill gaps and grow economies, policymakers have turned towards practices which lead to better transitions between high school, higher education, and the workforce.

P-16+ PIPELINE INITIATIVES

Commonly referred to as P-16+ pipelines, these are sets of initiatives which address disconnects in education and attempt to integrate the system for greater effectiveness (Bailey, 2009; Kleinman, 2001). P-16+ is so named for the span it connects: pre-kindergarten, elementary, middle, secondary, postsecondary, and plus (i.e., graduate studies and/or workforce participation). P-16+ research concentrates on identifying which transitions in education have negative impacts on student potential, and what interventions connect transition points to help students reach greater attainment (Bragg & Durham, 2012; Callan, Finney, Kirst, Usdan, & Venezia, 2006; McClafferty, Jarsky, McDonough, & Nunez, 2009; Mustian, Mazzotti, & Test, 2013).

One intervention has been the use of *credit based transition* (i.e., duel credit) programs. These are programs, or stand alone courses, which provide early access to higher education while students are still enrolled in high school. Dual enrollment courses are associated with a number of benefits to students: they grant simultaneous credits towards a diploma and a higher education credential, improve motivations and interests through varied curriculum, expose students to college-going culture and rigor, and prepare students with the needed information to successfully enroll and complete higher education (Bailey et al, 2002; Kim & Bragg, 2008; King & West, 2009). In addition, models are meant to decrease the financial burden and time to degree. Dual enrollment encourages postsecondary attainment, making it a more realistic goal for students who would otherwise be unable to afford the time or money (King & West, 2009; Lewis & Overman, 2008). Credit based transition models are one of several policies meant to ease transitions and improve alignment between high school and higher education.

Reforming Vocational Tracks

Because traditional transitions and traditional content have not served students well in the past, many have combined credit based transition models with other reforms. These include curricula other than the traditional academic track (Bragg, 2006). Educators have turned to diverse options to meet requirements for achievement, ones which also fulfill student interests and develop skills for the future. Technical coursework has been an ideal area for implementation.

Vocational education historically focused on teaching skills at the detriment to academic content (Brown & Schwartz, 2014; Dare, 2006). In addition, programs were often separated and tracked away from academic paths and students, creating divisions which exacerbated gaps and inequalities (Castellano et al, 2003; Dare, 2006). The press for an educated workforce has demanded a new vocational learning platform. Through a series of reforms pushed by policymakers and practitioners alike, vocational education has been reshaped within past decades. Reform has promoted connections between technical content and workforce demands, content and academic skills, and content with postsecondary alignment (Aliaga, Kotamraju, & Stone, 2014).

Career and Technical Education

The use of the term vocational education has fallen out of favor and been replaced with *Career and Technical Education* (CTE). Along with a name change, programs and funding have changed dramatically. The *Carl D. Perkins Vocational and Technical Education Act* (later the *Career and Technical Education Act*) passed in 1984 and has been reauthorized at various times from 1990-2006. Federal *Perkins* legislation was a response to concerns that secondary schools were failing to develop students in the academic and technical skills needed for a 21st century economy (Friedel, 2011; Maguire et al, 2012). Policy mirrors market demands for increased technology and information in a globalized, competitive workforce (Hershey et al, 1998). Federal legislation was the impetus for reform to CTE including curricular improvements, modernization of technical skills, and the expansion of programming to a wider population of students (Friedel, 2011).

CTE has become more integrated, rigorous, and complex. It includes advanced technology and new career paths (Ramsey, 1995). Courses and programs have—and are still—working to integrate core academic standards alongside technical training (Stipanovic, Lewis, & Stringfield, 2012). Newly designed CTE courses offer exposure to career planning and job exploration; they provide industry exposure through hands-on experiences and mentoring (Hutchins & Akos, 2013; Rojewski & Hill, 2014). Program participation translates to both workforce training and postsecondary preparedness.

Studies suggest the use of CTE may help with high school retention and graduation as well enhance the probability of enrollment and persistence in higher education (Allen, 2012; Brown, 2003; Neild & Byrnes, 2014; Zinth, 2014). In addition, students with CTE backgrounds may be better prepared to take on higher paying jobs with or without further, postsecondary training (Mane, 1999). For the first time, technical programs—those sneered at as vocational education in the past—have been called upon to remedy gaps in educational transitions and attainment.

TECH PREP PROGRAMS

Important to *Perkins* legislation and CTE reform, has been the creation of advanced CTE programs—in more recent updates to legislation this is termed as Programs of Study (POS) models. These CTE programs offer integrated academic content, technical skills and experiences, and advanced opportunities through credit based transition models. Many advanced CTE programs offer internships, on-the-job training, and/or certification possibilities through dual credit courses. One such example is Tech Prep programming.

The goal of Tech Prep, or *Technical Preparation Programming*, is to create seamless transitions between high school and higher education. Programs engage students in career focused pathways, prepare students for college and careers, and allow for workplace exposure and mentoring (Bragg, 2000). Tech Prep programs are part of a regimented CTE course plan; they include a planned sequence of study in a defined field during high school which includes postsecondary training and leaves the student with some form of higher education credential upon completion (U.S. Department of Education [USDOE], 2014). Tech Prep programs involve complex partnerships with high schools, higher education providers, and local industries to fully implement and involve students in the curriculum. Partnerships are called regional consortia and they work articulating courses and curriculum across varying institutions. Through program implementation, Tech Prep models have the potential to create coherent transitions in the P-16+ pipeline while providing relevant and rigorous technical curriculum to all students.

Today Tech Prep programs are widespread. A survey of states in 2008 found that over half (29) have active, comprehensive Tech Prep programs (Brush, 2008). Tech Prep has been shown to equalize educational opportunities and expectations resulting in diminished academic tracking and increased participation by all types of students (Dare, 2006; Fishman, 2015). Studies have suggested the use of Tech Prep may help with high school retention and graduation (Cellini, 2006; Stone & Aliaga, 2003). Participation may also lead to a greater probability of enrollment and persistence in higher education (Bailey & Karp, 2003; Bragg, 2006). These findings are especially true for students at greater risk of dropping out and receiving an incomplete education (Bragg, Loeb, Gong et al, 2002; Brown, 2003). CTE Tech Prep programs are seen as promising reform models which can simultaneously inspire students to train at the postsecondary level while also keeping traditionally low performing students interested in education long enough to learn skills and content needed to secure a quality job (Cellini, 2006; Kim, 2014).

TEXAS AND THE RGV LEAD CONSORTIUM

Texas created regional consortia to advance *Perkins* policy and CTE reforms in the early 1990s. As such, the state became widespread, early adopters of the Tech Prep model. One regional consortium, RGV LEAD (Rio Grande Valley Linking Economic & Academic Development), is known for its historic, extensive, and high quality implementation of CTE Tech Prep.

Figure 1.3: Rio Grande Valley (RGV) Area Counties

Source. (Texas A&M, 2016)

RGV LEAD is an intermediary organization which works to partner K-12 public education service providers, institutions of higher education, and local businesses in the south of Texas. Its mission is to leverage regional resources to facilitate college and career focused learning opportunities for students, preparing individuals for educated and skilled positions in today's workforce. Prime focus in this consortium is the development of robust CTE experiences. Specifically, RGV LEAD works to implement Tech Prep programs across the region. The partnership includes 32 Independent School Districts (ISDs), one charter network, four regional universities and community colleges, the K-12 Education Service Center (ESC), and a number of business and professional organizations representing the economic needs of the Texas Rio Grande Valley (RGV) area. The alliance provides resources, funding, and support services to Tech Prep programming in high schools, hosts scholarships for graduating students, and creates opportunities for mentoring and early exposure in career pathways.

The K-12 public school districts (by county), charter networks, community colleges, and universities that are members of RGV LEAD include:

- *Cameron County*: Brownsville ISD, Harlingen CISD, La Feria ISD, Los Fresnos CISD, Point Isabel ISD, Rio Hondo ISD, San Benito CISD, Santa Maria ISD, Santa Rosa ISD, and South Texas ISD;
- *Hidalgo County*: Donna ISD, Edcouch-Elsa ISD, Edinburg CISD, Hidalgo ISD, La Joya ISD, La Villa ISD, McAllen ISD, Mercedes ISD, Mission CISD, Monte Alto ISD, Pharr-San Juan-Alamo ISD, Progreso ISD, Sharyland ISD, Valley View ISD, and Weslaco ISD;
- *Starr County*: Rio Grande City CISD, Roma ISD, and San Isidro ISD;
- *Willacy County*: Lasara ISD, Lyford CISD, Raymondville ISD, and San Perlita ISD;
- *Charter Schools/Networks*: IDEA Public Schools;

- *Community/Technical Colleges:* South Texas College (STC), Texas Southmost College (TSC) and Texas State Technical College (TSTC); and
- *Universities*: The University of Texas Rio Grande Valley (UT RGV).[1]

The area RGV LEAD serves is particularly important. The RGV, or Valley, is a four county area at the southernmost tip of Texas (see Figure 1.3). The Valley includes large rural areas, very poor communities, and a higher percentage of minority populations than the rest of Texas or the nation (U.S. Bureau of Economic Analysis (USBEA], 2016; U.S. Census Bureau [USCB], 2016). The area hosts traditionally low levels of educational attainment and is geographically located in areas less likely to have access to postsecondary pathways or workforce opportunities (Allen, 2012; USCB, 2016). Support for CTE and Tech Prep is especially significant for this disadvantaged and underserved region.

Under the direction of RGV LEAD (formerly known as Tech Prep of the Rio Grande Valley) CTE has been valued since the 1990s as an important tool to increase high school retention and higher education transitions. Tech Prep programs were developed in the area, by the consortium, at an early point during Texas-wide implementation (Brown, 2001). RGV maintains successful Tech Prep programs in all area high schools. Today RGV LEAD has combined efforts and also serves as the regional P-16+ council. RGV LEAD offers support to Tech Prep as one of several comprehensive advanced CTE POS models. In the RGV LEAD service area all POS, including Tech Prep, are inclusive models which deliver concurrent enrollment in CTE courses, and provide pathways to higher education attainment through early access degree programs.

---

[1] UT RGV was once two institutions, The University of Texas at Brownsville and The University of Texas-Pan American. These universities were combined in 2013 to allow for greater funding and the creation of a medical school.

Focus of the Study

CTE Tech Prep has enormous potential in its design. The program is meant to be an attractive, non-traditional pathway to high school completion and higher education attainment. Tech Prep was the first of a growing number of modern CTE models and reforms. Practitioners today are expanding Tech Prep implementation, and also working to provide similar CTE programs through POS. At this point in time it is important to study the impacts of past CTE efforts in order to improve future endeavors.

Research Questions

The purpose of this study is to better understand the ways in which advanced CTE models, such as Tech Prep, may be used to foster college and career transitions. The focus of research explores the impacts of CTE Tech Prep participation on longitudinal outcomes related to the P-16+ pipeline. For this study, one broad question covers the intent of analyses. How do advanced CTE programs, such as Tech Prep programming, affect student outcomes across the P-16+ pipeline? Specific questions guide research. These are:

RQ1. What student- and school-level characteristics influence Tech Prep participation?

RQ2. Relative to comparable students, what impact does Tech Prep participation have on high school transitions, higher education enrollment, developmental remediation, postsecondary attainment, and workforce participation?

Overview of Methods

Given the need for more rigorous analyses of CTE research, the design of this study aligns to criteria for research put forth by the What Works Clearinghouse standards (Fritz et al, 2012; Nimon, 2012). Specifically, the research design meets evidence standards of strong, quasi-experimental studies of comparison groups (Gemici & Rojewski, 2007, WWC, 2014).

Using data from the TEA (Texas Education Agency), THECB (Texas Higher Education Coordinating Board), and TWC (Texas Workforce Commission), cohorts of high school students graduated in 2009 and 2010 are tracked through four years of postsecondary access and five years of workforce participation. Methods for the study consist of *Propensity Score Matching* (PSM) of students to control for selection bias. PSM includes a two-step process which first models the predicted probability of all students enrolling in Tech Prep, and then matches Tech Prep to non-Tech Prep students using a *nearest neighbor* sampling technique (Austin, 2011; Guo & Fraser, 2010; Rosenbaum & Rubin, 1983; 1984). PSM creates a quasi-experimental control group for comparison.

Multilevel logistic regression is then used to ascertain the odds of reaching each P-16+ longitudinal outcome, including comparison estimates of Tech Prep participation and RGV LEAD affiliation. This type of modeling, sometimes referred to as *Hierarchical Linear Modeling* (HLM), allows for more accurate statistical estimates as it takes into consideration the clustering of students nested within schools (Nimon, 2012; Gelman & Hill, 2007; Raudenbush & Bryk, 2002; Stevens, 2009). Analytic strategies presented in this study work together to create a complex set of findings which host multiple possibilities for using Tech Prep as either a targeted or comprehensive P-16+ reform.

Significance of the Study

The jobs of tomorrow have highlighted a pressing need for greater education today. Educational attainment has already fallen behind economic development, though. Existing attainment gaps paired with limited earning possibilities have created considerable, unrelenting increases in inequality (Greenstone et al, 2012). These trends are disquieting and require intense intervention. Reforms need to engender an educated and employed workforce for all, paying attention to diminishing the gaps that currently exist. The growth of advanced CTE to meet both labor and academic demands is a promising tool. This study adds to the greater discussion on reform by providing valuable information as to the long-term impacts of Tech Prep participation. Longitudinal outcomes and comparisons from this study have numerous implications for both policymakers and practitioners in the field.

Efficacy of Advanced CTE Models

Tech Prep works towards preparing students for the jobs of tomorrow in the classrooms of today. Programming is aimed at reducing persistent gaps in educational attainment through increasing transition pathways to higher education. The need to assess the efficacy of these interventions is vital to understanding their use and potential in the wider framework of educational reform. Research to date has been limited and many in the field feel there is a lack of rigorous studies connecting programs to student outcomes (Fritz, Morris, & Richler, 2012; Gemici & Rojewski, 2007; Nimon, 2012; Rojewski, Lee, & Gemici, 2012). Further, studies most often fail to account for inherent bias in their data or calculations (e.g., missing data) (Bozick & Dalton, 2012; Lewis & Overman, 2008; Rojewski & Xing, 2013). Taking research critiques into consideration, this study uses longitudinal data and quasi-experimental design methods to compare outcomes of Tech Prep participants across a number of P-16+ transitions.

The efficacy of Tech Prep programming is explored within the boundaries of current *Perkins* legislation as well as Texas legislative agendas. Findings are linked to the focus of P-16+ on alignment and articulation, college and career readiness standards, and support for educational attainment in underserved students. These connections are crucial to understanding CTE as a comprehensive reform model. Findings also speak to targeted reforms focused on specific students.

IMPORTANCE OF CONTEXT

Within the effort to implement enhanced CTE and P-16+ programs, understanding the context of reform is also important. It allows for better crafted policy and informed practitioners—those able to understand what will work in their specific circumstances. The Valley area and RGV LEAD consortium are included in this study to help better understand the contextual implications of reform. RGV LEAD is a well developed example of regional consortia created under *Perkins* legislation and other state policies. As such it is an ideal region from which to study the impacts of implementation through student participation. More importantly, the geographic area of the RGV provides a unique context to view educational reform.

The four counties making up RGV have high minority populations, increased rates of poverty, and low levels of educational attainment. Large parts of the RGV also fall into geographic areas with limited postsecondary and workforce support. The RGV encapsulates virtually all characteristics which are negatively associated with postsecondary transitions and success (Anderson, 2008; Dicker-Conlin & Rubenstein, 2007; Erisman & Looney, 2007; Fishman, 2015; McSwain & Davis, 2007). This context provides a unique microcosm to test how reform strategies targeted at underserved populations impact educational outcomes (Allen, 2012). In an era where underserved groups have increasingly large gaps in educational outcomes, targeted focus is increasingly important to understanding reform potential (NCPPHE, 2008; Kao & Thompson, Lumina, 2015; 2003; Ross et al, 2012).

GROWING ACCOUNTABILITY IN CTE POLICIES

Requirements of existing accountability standards for academic achievement have put pressures on schools to improve in all areas, including technical education (Anderson, 2008; Chadd & Drage, 2006). *Perkins IV* legislation made steps towards requiring accountability practices by imposing performance indicators for CTE Tech Prep, many of which educators thought would be too burdensome given data restrictions between K-12 and higher education (Friedel, 2011; Klein et al, 2014). Since then, CTE programs have expanded in size and scope. CTE is often part of comprehensive school reforms. Advanced CTE courses are now linked to initiatives such as school choice and curriculum standards redesign (Asunda, Finnell, & Berry, 2015; Castellano, Stringfield, & Stone, 2003; Ramsey, 1995). Further expansion and focus in CTE areas will only increase calls for accountability and changes to both federal and state policy contexts (Hernandez, 2014; Maguire, Starobin, Laanan, & Friedel, 2012).

The need for accurate information on the long-term impacts of CTE and Tech Prep participation is greater than ever. Federal legislators are finally taking up the reauthorization of *Perkins* legislation (Klein, 2015; Boyd, Martin, Davenport, & Smith, 2015). Proposed bills have already passed the House and are now being considered by the Senate for approval (Stratford, 2016; Ujifusa, 2016). Upcoming changes to CTE legislation coupled with recently changed accountability standards through the ESSA (*Every Student Succeeds Act*) will force practitioners and policymakers alike to gather as much knowledge on current and potential programs that may impact student success.

A study which follows requirements for Scientifically Based Research under quasi-experimental methods for What Works Clearinghouse will be a welcomed addition to the policy conversation (Gemici & Rojewski, 2007; WWC, 2014). It informs upon the utility of Tech Prep programs as well as illustrates the possibilities of using longitudinal data to explore effects of educational models on student outcomes. Additionally, the exploration of outcomes for students participating in advanced CTE across a large state with a diverse student population provides helpful insight into the proficiencies and challenges faced by all states and local levels. Longitudinal outcomes and measures may help shape greater CTE policy reform as well as inform accountability policies or performance indicators. The analytic strategies used in this study work together to yield a rich set of findings which strengthen the connections between advanced CTE participation and student success.

CHAPTER TWO: LITERATURE REVIEW

The following review of literature develops the connections between theoretical constructs driving educational reform and the outcomes associated with CTE Tech Prep participation. Economic and social theories of human capital are linked to education as an investment towards long-term success. Benefits, such as the strong relationship between educational attainment and wages, are presented (Becker, 1993; Carnevale et al, 2010; Grubb, 1999). Growing disparities in earning potential are coupled with current-day changes in economy to describe the pressing need for new, and different, education models.

In particular, the P-16+ pipeline is used to illustrate problematic transitions between high school, higher education, and the workforce (Bailey, 2009; Kleinman, 2001; Krueger, 2001). Reforms to vocational education, the shift to Career and Technical Education—CTE, and the development of Tech Prep programs are detailed in chronological order and placed within the contexts of the P-16+ pipeline. Concluding a review of CTE history and legislation, special focus is given to Tech Prep implementation. The defining characteristics of Tech Prep are explained in relation to other CTE and college ready initiatives. Important components include the use of articulation agreements between high school and higher education and the extension of coursework through dual credit opportunities.

An overview of outcomes associated with Tech Prep suggests the program is a viable option for improving high school participation. Moreover, it has potential to boost postsecondary enrollment and attainment (Bailey & Karp, 2003; Bragg, 2006; Cellini, 2006; Stone & Aliaga, 2003). Those who participate in Tech Prep may benefit in future workforce earnings, whether they continue their education or not (Bishop & Mane, 2004;

Bragg, 2006). The chapter closes with a discussion of the limitations in the extant body of literature which are addressed in the current study.

Theoretical Frameworks

TRADITIONAL THEORIES OF HUMAN CAPITAL

The theory driving current reforms in CTE education is to make education more responsive to the needs of American capitalism: boosting economic competition, societal change, and technological innovation (Hernandez, 2014; Lowell, 1995). It is grounded in the notion that education is the best way to increase both individual and shared productivity. Taken from an explanation of earning differentials in economist Adam Smith's *The Wealth of Nations* (1793/2008), human capital theory focuses on acquired capacities of humans, or humans themselves. Capital refers to any addition which works to extend the productivity of the individual in measures of economy. Shultz, a major contributor to modern *human capital theory* suggests,

> "People enhance their capabilities as producers and as consumers by investing in themselves, and that schooling is the largest investment in human capital" (1963, p. 10-11).

Traditional study of the theory calculates a person's rate of return on investments in human capital, including in the formula the cost to acquire the capital and its impacts on future earnings (Maguire, Starobin, & Laanan, 2012). Economists have used such models of human capital to study the impact of education on post collegial outcomes such as short-term and lifetime earnings (Becker, 1963; Carnoy, 2009; Mincer, 1974, 1989).

Detractors argue human capital theory is flawed as not all advancements in education lead to economic prosperity. In addition, critics point to numerous other factors which impact potential earnings (Goldberg & Smith, 2008). Human capital theorists advocate it as a useful rationale from which to study the long-term impacts of education

(Becker, 1993). They suggest that education and training are the most important investment in future earnings, holding individual characteristics constant (Becker, 1963; Grubb, 1999; Mincer, 1974). Studies based from these theories do have practical implications. They are able to quantify disparities between educational attainment and earning capacity (Greenstone et al, 2012; Grubb, 1999; Maguire et al, 2012).

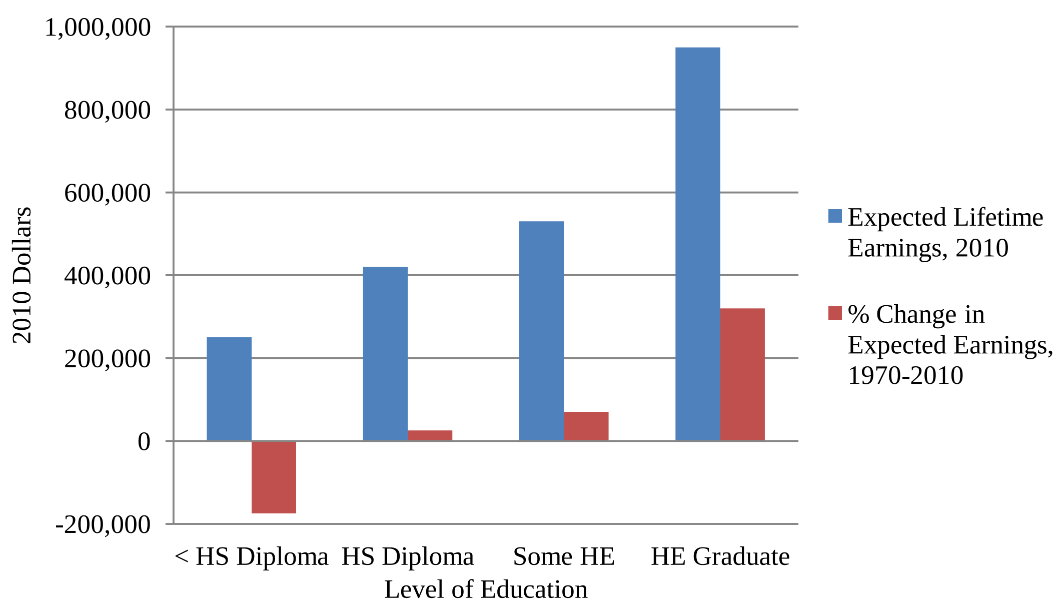
Individual Benefits of Educational Attainment

Research has indeed linked wages to postsecondary attainment. For individuals, there is a positive relationship between the level of education reached and economic return (Grubb, 1999; Hanushek & Woesmann, 2010; Maguire et al, 2012). The association between education and earnings is established, for the most part, in early adulthood. Gaps between those with and without education are attributed to both hard and soft skills. *Hard skills* are proficiencies learned in various subjects and trades while *soft skills* refer to attitudes and abilities associated with learning outcomes—work ethic, motivation, problem solving capacity, time management, etc. (Boudria, 1995; Castellano et al, 2003; Murnane & Levy, 1996).

Studies have substantiated differences in the level of higher education attainment; how much postsecondary education a person receives matters. Students gaining an associate's degree tend to earn less than those who earn a bachelor's degree (Grubb, 1999). Though people with two-year degrees traditionally earn less than those with four-year degrees, there are areas in which an associate's degree has greater economic return. Health occupations, engineering, public service, and certain technical areas are linked to larger returns, especially compared to certain bachelor's degrees such as humanities or education programs (Grubb, 1999; Maguire et al, 2012).

The impact of a postsecondary degree on earnings has been replicated over numerous periods of time suggesting a long-held association between human capital investment and financial return (Greenstone et al, 2012). Gaps between college graduates—those with only a high school diploma—and those that did not complete high school have been growing larger over time. Incomes for those with only a high school diploma have remained fairly stagnate over the past forty years, while incomes for higher education graduates have risen significantly (Greenstone et al, 2012; Seidman & Ramsey, 1995). Figure 2.1 shows expected lifetime earnings in 2010 as well as the change in earnings since 1970. In addition to wage gaps, those without a high school degree had projected lower earnings over time while those with postsecondary experiences have increased their potential earnings (Greenstone et al, 2012).

Figure 2.1: Expected Lifetime Earnings by Education Level



Source. (Greenstone et al, 2012)

Educational attainment has been presented as a pathway to improved job prospects, better wages, and—in some cases—a means to reduced poverty (Carnevale et al, 2010; Hirschy, Bremer, & Castellano, 2011; NGA, 2014). More education is also associated with other long term outcomes including improved health, longer life spans, and lower rates of crime and incarceration (Greenstone et al, 2012; Grossman & Kaestner, 1997; Lleras-Muney, 2005; Lochner & Moretti, 2004).

Societal Benefits of Educational Attainment

There are economic benefits to both the individual and to the greater community in educational attainment. Society benefits from groups of individuals gaining higher levels of education. In a macroeconomic approach, governments subsidize human capital by investing in education (Goldberg & Smith, 2008). More educated individuals are more likely to participate in the job market, work more hours, earn more, and are less likely to be unemployed. Educated workers translate to well-compensated tax payers (Berger & Fisher, 2013; French & Fisher; 2009; Greenstone et al, 2012; Hanushek, Ruhose, & Woessmann, 2015). Research has suggested the return on investment into higher education is particularly sound; students pay back the monies spent on their education plus more over their life-span of tax contributions (Berger & Fisher, 2013; Lynch, 2004).

Improvements to education may actually stimulate economic growth. Studies have theorized that increases in skilled labor supplies lead to demand as employers are attracted to areas where workers have the skills required for potential jobs (Berger & Fisher, 2013; NGA, 2014). Indeed, the most vocal groups calling for reform are those which stipulate shortages in skilled workers as outlined in their strategic plans for economic development. Groups span certain geographic areas or industries such as STEM or healthcare (Hart, 2005; Karandjeff & Schiorring, 2011; NAM, 2005; Washington Achievement Council [WAC], 2013).

TRANSITIONS TO AN INFORMATION ECONOMY

While the link between educational attainment and earning potential has been well established, gaps are widening more than ever (Greenstone et al, 2012). This is due, in part, to the change of demands in the economy. In recent decades global economies have shifted away from resource and manufacturing industries, and growth has occurred in information and services. Along with this shift, the need for greater education and skill in the workplace has become more pressing.

Markets everywhere are focusing on information technology, or information economies, as the next step in their economic development. *Information economies* are those in which knowledge, technology, and services are more important to the economic health of a society than the manufacturing of a tangible good. In an information economy, knowledge is seen as the raw material of value (Castells, 2010). The OECD (Organization for Economic Cooperation and Development*)* measures the growth of the information economies worldwide by tracking household expenditures, domestic production, international trade, and business and government expenditures of what it delineates as *Information and Communication Technology* (ICT) (OECD, 2016). They have found substantial ICT growth in past years, and with it, demand for more and different skills in the workplace.

In tandem with economic shifts towards information, the means of trade have also changed. Each year world economies are becoming increasingly interconnected, interdependent, and competitive (Corwin, 1995; Crist et al, 2002; Hernandez, 2014; Ramsey, 1995). America, unfamiliar in the role of a peer rather than singular power, is tasked with growing its educated labor supply in the face of such contexts.

Need for a Skilled Workforce

Other countries have advanced their educational systems at all levels in tandem with economic expansion. Advances include skilled technical labor and postsecondary attainment. Skill development in the United States has lagged in curricular reform, though (Brown & Schwartz, 2014). Education is not currently meeting workforce demands. Projected changes in economic demand will require even more skills and educational opportunities.

Today many prime-age workforce members, those ages 25-54, are working in jobs that require a high school diploma or less. Estimated salaries for jobs with no skill-requirements average $25,000 (NGA, 2014). These jobs are disappearing which will leave citizens unemployed or underemployed, stuck with low and unlivable wages (Carnevale et al, 2010).

Other employment sectors are struggling as well. The mass retirement of current workers, oft referred to as the *baby boomer* generation, is on the horizon (Fitzsimmons, 1999). While a recent recession has kept this generation in the workforce longer than originally expected, larger numbers are starting to retire and many more will soon follow (Symonds et al, 2011). Additionally, the latest recession has also destroyed a number of jobs in manufacturing and natural resources that will never return (Carnevale et al, 2010). Replacement and new job opportunities will require higher skill levels and higher education credentials.

Estimates project two-thirds of jobs in the next decades will require some form of postsecondary education (Brown & Schwartz, 2014; Carnevale et al, 2010; Castellano et al, 2003). Between 25-30% of new jobs in the near future are expected to call for skilled workers, including those filling shortages in medical fields, information technology, and engineering industries (Gilbert, 1997). So called middle skills, or middle class jobs, many of these jobs will require some higher education but not necessarily a four-year degree (Carnevale et al, 2010). These include positions which necessitate either an industry recognized certificate or associate's degree. The average salary for these jobs is currently $53,000 (Brown & Schwartz, 2014).

Projected workforce opportunities and earnings illustrate the need for greater educational attainment. The United States currently shows one of the largest differentials in earnings between citizens with and without a postsecondary degree (OECD, 2014). Those gaps are made more complex by issues of race and class. Students in traditionally underserved areas, including minority groups, students in low-socioeconomic (SES) classes, and geographic areas (e.g., urban centers or rural extremes) are linked with lower enrollment, persistence, and attainment in higher education (Kao & Thompson, 2003; Ross et al, 2012). Attainment gaps in higher education are historic as well as present in current data (Lumina, 2015). While numbers of minority and low-SES students have increased in recent years, the gaps have not significantly narrowed (Ross et al, 2012; Lumina, 2015).

Barriers to postsecondary enrollment for underserved students include low college readiness, limited exposure to a college culture, lack of understanding of *hidden rules* of college for first generation attendees, and a shortage of financial resources. (Choy, 2001; NCPPHE, 2008; Seidman & Ramsey, 1995; USDOL, 2015). A recent report released by the Center on Children and Families at the Brookings Institute, *Pathways to the Middle Class: Balancing Personal and Public Responsibilities* suggests that individuals born into low income households are much less likely to succeed at each stage of life, and less likely to achieve middle class status by adulthood (Sawhill et al, 2012). Gaps such as these will only increase and create further inequality if left unchecked.

Calls for Educational Change

Education has historically been seen as the great equalizer, especially in the United States—the land of opportunity. With no shortage of anecdotal examples, education has been touted as the means for overcoming any number of disadvantages or setbacks. It is the standard by which Americans strive towards the dream of a successful, thriving middle class lifestyle (Greenstone et al, 2012).

The preponderance of studies has shown that the lack of a high school degree in this current day relegates a person to a lifetime of poorly paid, unskilled labor opportunities (Seidman & Ramsey, 1995). Further, low postsecondary attainment levels keep many more from experiencing high-paid, middle class, job opportunities (Carnevale et al, 2010; Castellano et al, 2003). The obligation of educational reform is to create better postsecondary educational opportunities for all.

Growing requirements for workers and developments in the workforce ahead has forced many to rethink policy connections between education and employment. In their set of workforce projections for the upcoming decades, Carnevale and colleagues argued,

> "Experts might contest whether everyone needs some college education—but the labor market clearly has linked middle class employability to postsecondary education and training." (2010, p. 110).

Failing to provide students successful pathways to increased educational attainment is the *de facto* exclusion of certain Americans from reaching the dream of the middle class.

Education as a P-16+ Pipeline

It is clear that the connection between economic growth and competitiveness requires greater education (Amey Eddy, & Campbell, 2010). Persistent, stratifying gaps in educational attainment coupled with lagging postsecondary enrollment and completion rates in recent years—especially compared to other developed countries—have led many to believe that the current high school system may not have the ability to prepare all students academically or developmentally for college. High school providers may not be the only educators falling short, though. The disconnect between secondary and postsecondary education may be at the root of the issue (Bailey & Karp, 2003).

CONNECTING PARTNERS IN EDUCATION

Institutional Disorganization

Institutional oversight at all levels impact learning and earning. Each type of institution has specific difficulties pertaining to moving students towards educational attainment and job security. High schools are faced with the requirement of preparing students for both higher education and workforce demands, all while trying to meet accountability requirements and increasing student retention. Often, standards and expectations do not match between high schools and other groups (Bragg & Layton, 1995). Higher education institutions are sometimes underutilized and require broader course offerings to meet workforce demands. What's more, there is a desperate need to increase participation within populations of traditionally underserved students (Karandjeff & Schiorring, 2011; Maguire et al, 2012; Washbon, 2012). The workforce has traditionally been a silent partner in education. While they are direct beneficiaries of education through employing skilled workers, they have historically provided little feedback or active participation in the system. (Carnevale et al, 2010).

To make matters more difficult, secondary and postsecondary systems are organizationally disparate and customarily lack communication (Crist et al, 2002). They have conflicting financial systems which result in inefficiency and inequity (Bailey, 2009). Often practitioners from these levels feel they have dissimilar goals and find it hard to work with each other to develop common curriculum or strategies (Bragg & Layton, 1995; Parnell, 1985). These differences have worked to reinforce existing inequalities and widen gaps in achievement and educational attainment (Bailey, 2009).

P-16+ Pipelines

From these contexts and concerns has come a strategy to unite the educators, administrators, and policymakers at all levels. Commonly referred to a P-16 or P-16+ pipelines, these are sets of initiatives which address disconnects and attempt to integrate the system for greater effectiveness (Bailey, 2009; Kleinman, 2001). P-16+ is named for the span it connects. It links the start of pre-kindergarten (P) through elementary and secondary education, transitioning to higher education. Higher education ends with a four-year degree at grade 16. The plus (+) represents either further, graduate education or workforce participation. States have created regional *P-16+ Councils* to promote local participation between education, workforce, and community partners. P-16+ Councils work to create more cohesive partnerships as well as implement strategies to align needs at all levels (Krueger, 2001).

Research in respect to P-16+ pipelines concentrates on identifying which transitions have a negative impact on students. Additionally studies have identified interventions which connect transition points and help students reach greater educational attainment (Bragg & Durham, 2012; Callan et al, 2006; McClafferty et al, 2009; Mustian et al, 2013). Special focus has been given to identifying strategies to support underserved populations including disabled and minority students (Fowler et al, 2014; Garrison-Wade & Lehmann, 2009; Moran, Cooper, Lopez, & Goza, 2009; Olivia, 2004, 2008). The common themes in these studies suggest that differences between institutional levels persist and that to reach specific populations, greater partnerships need to be maintained. Moreover, mindsets need to change about schooling and students for improvement to occur (Garrison-Wade & Lehmann, 2009). .

CREDIT BASED POSTSECONDARY TRANSITIONS

The goal of a well connected P-16+ pipeline is to create successful initiatives which bridge the transitions between each step, particularly from high school to higher education (Kim, 2014). A successful reform initiative has been through the use of *credit based transition* programs. These are programs which provide early access to higher education while still within high school. They grant students simultaneous credits towards a high school diploma and a higher education credential (Bailey & Karp, 2003). Credit based transition courses have a number of benefits to students. Programs work to improve motivations and interests, increase multiple skills, expose students to college-going culture and rigor, and prepare students with the needed information to successfully enroll and complete higher education (Bailey et al, 2002; Kim & Bragg, 2008; King & West, 2009).

Credit based classes open up the range of courses provided to students when high schools are limited by budgets or enrollment concerns. Students are able to enroll in more diverse postsecondary courses rather than the narrower selection of classes offered under traditional academic plans (Bailey et al, 2002). These advanced and more varied courses may improve lagging motivation for both slacking seniors and those traditionally uninterested in college (Cellini, 2006; Fowler & Luna, 2009; Kim & Bragg, 2008).

Curriculum standards are raised in credit based transition courses. They are meant to prepare students for the rigors of college coursework. Students are expected to master hard skills, or those academic and technical skills required by the course content, as well as soft skills, elements which allow for better social interactions and problem solving. Soft skills include interpersonal knowledge, observation and articulation, organization and time management, etc. (Boudria, 1995).

Credit based classes expose students to realistic experiences in college settings. Experiences may improve expectations of higher education as well as familiarize students with the increased rigor found at the postsecondary levels. Early experience also informs students about possible hidden rules or curriculums needed to navigate transitions successfully (Hanson, Prusha, & Iverson, 2015). It helps to demystify college cultures and administration. Credit based transitions may help to inform students with regard to useful tools and support networks available in higher education settings (Bailey & Karp, 2003).

Credit based models are seen as a viable mode of creating better linkages between high school and higher education. In addition to providing students with meaningful inspiration, credit based transition is meant to provide a fiscal incentive as well. Decreased financial burdens, and decreased time to degree through credits earned while still in high school, are meant to make a postsecondary credential a more realistic goal for those who otherwise would be unable to afford the time or money (King & West, 2009; Lewis & Overman, 2008). The program is meant to curb the rising costs of postsecondary attainment and work as an inexpensive option for students (Bailey et al, 2002).

REFORMING TECHNICAL EDUCATION

Traditional approaches have not served students well (Bragg, 2006). High school students need curricular options that meet requirements for academic achievement but also fulfill their interests and develop skills for the future (Brown & Schwartz, 2014). Credit based transitions are a method of delivery which have potential in resolving disconnects between K-12 and higher education curriculum standards (Kim & Bragg, 2008). Still, the need arises for a content template from which to implement credit based transitions. Courses or programs need to be formulated and focused towards a desirable opportunity for students. This has been successfully enacted through redesigning vocational education.

Redirecting Vocational Education

Vocational schools of the past focused on teaching skills at the detriment to academic content (Brown & Schwartz, 2014; Dare, 2006). In addition, programs were often separated and tracked away from academic paths and students, creating divisions which exacerbated gaps and inequalities (Castellano et al, 2003; Dare, 2006). The growing complexity of industry and press for an educated workforce has demanded a new vocational learning. Through a series of reforms pushed by policymakers and practitioners alike, vocational education has been reshaped within the past decades. Sometimes referred to as a *new vocationalism* movement, this reform era started in the 1980s and promoted connections between technical content and growing workforce demands, content and academic skills, and content with postsecondary education (Aliaga et al, 2014).

Indeed, the use of vocational education has fallen out of favor and the use of *Career and Technical Education* (CTE) has taken its place (Friedel, 2011). Along with a name change, CTE programming has been reshaped to meet the demands of both knowledge and skills present in today's workplace. CTE has become more integrated and complex, introducing technology and newer career paths (Ramsey, 1995). Courses and programs have—and are still—working to integrate core academic standards alongside technical training (Stipanovic et al, 2012). Newly designed CTE courses offer career planning and job exploration; they provide industry exposure through hands-on experiences and mentoring (Hutchins & Akos, 2013; Rojewski & Hill, 2014).

Most importantly, CTE has developed comprehensive credit based transitions programs which combine technical skills training, academic content for high school core courses, and simultaneous content at the postsecondary level. Tech Prep programs are part of a regimented CTE course plan; they include a sequence of study in a defined field during high school which includes postsecondary training and leaves the student with some form of higher education certificate or degree upon completion (USDOE, 2014). Tech Prep programs involve complex partnerships with high schools, higher education providers, and local industries to fully implement and involve students in the curriculum. Implemented successfully, they have potential to create coherent transitions in the P-16+ pipeline while providing relevant and rigorous curriculum to all students.

CTE Education Today

The combination of academically challenging CTE and credit based programming through Tech Prep today are a move towards *progressive education* ideology. Championed best by Dewey at the very beginning of educational reform in the United States, progressive education has always been seen as a means of integrating experience with learning, shaping content with the changing needs and relative benefit of society (Dewey, 2004/1909; Glassman, 2001). The combination of college and career readiness as part of CTE training can be seen as a blend of both pragmatic and classical views on the purposes of educating children (Herr, 1987; Shimony Russo, Ciaccio et al, 2002).

For the first time, technical programs—those sneered at as vocational education in the past—have been called upon as a remedy to gaps in educational transitions and attainment (Ramsey, 1995). CTE Tech Prep programs are seen as promising reforms which can simultaneously inspire students to train at the postsecondary level while also keeping traditionally low performing students interested in education long enough to learn the skills and content needed to secure a quality job (Cellini, 2006; Kim, 2014). Programs offer a non-traditional path to academic success. Today Tech Prep programs have been shown to equalize educational opportunities and expectations resulting in diminished tracking and increased participation by all types of students (Dare, 2006; Fishman, 2015).

Studies have suggested the use of Tech Prep may help with high school retention and graduation (Cellini, 2006; Stone & Aliaga, 2003). Participation may also lead to a greater probability of enrollment and persistence in higher education (Bailey & Karp, 2003; Bragg, 2006). These findings are especially true for students at greater risk of dropping out and receiving an incomplete education (Bragg et al, 2002; Brown, 2003). Given the need to increase attainment and bridge earning gaps persistent in the workforce, this reform is an opportunity to place students on "stable paths to solid jobs" (Brown & Schwartz, 2014, p. 58).

Historical Context of Tech Prep

A brief history of federal and Texas State legislative policies with other related initiatives follows in order to bring context to CTE, Tech Prep Programs, and the current study.

FEDERAL CONTEXTS

Smith Hughes Act of 1917, PL65-347

- First federal legislation, it is the beginning of government subsidies for vocational education and started a legacy of support in the area;
- Funding for vocational programming required its separation from academic studies.

George-Reed Act of 1929, PL70-702 / George-Ellzey Act of 1934, PL73-245

George-Deen Act of 1936, PL74-673 / George-Barden Act of 1946, PL79-586

1950 Act to Incorporate the Future Farmers of America, PL740 (FFA)

- George Acts along with the FFA Act from the 1930s-1950s increased federal support to vocational education and started specific programs like agriculture, home economics, and mechanics.

Vocational Education Act of 1963, PL88-210

- Amended in 1968 and again in 1976, the act shifted focus to providing for certain student groups rather than programs; it followed concurrent themes in ESEA (Elementary and Secondary Education Act) legislation.

The Carl D. Perkins Vocational Education Act of 1984, PL98-524 (I)

- Expanded, improved, and modernized vocational programming;
- Specified equal access for special populations and gender;
- Allowed for formula funds to be split between K-12 and higher education.

The Carl D. Perkins Vocational and Applied Technology Act of 1990, PL101-392 (II)

- Goal was to eliminate repetition from high school and higher education, and attract more students by showing a clear path to postsecondary education and technical careers;
- Required resources to be targeted at special populations including the poor, disabled, and Limited English Proficient (LEP);
- Provided for the creation of regional consortia of high school and higher education partners;
- Introduced Tech Prep Programs:
    - 2+2 or 4+2 programs with sequential coursework and curricular pathways that lead to a certificate or associate's degree;
- Explicitly required integration of vocational and academic curriculums.

School-to-Work Opportunities Act of 1994, PL103-239 (STWOA)

- Goal was to provide for a comprehensive high school system which transitions to either the workforce or higher education;
- Included the integration of academics and applied learning, work experience, and career guidance;
- Reinforced the Tech Prep model put forth by *Perkins II* legislation, seen by many as umbrella legislation to broaden Tech Prep implementation.

The Carl D. Perkins Vocational and Technical Education Act of 1998, PL10S-332 (III)

- Officially repealed Smith Hughes Act;
- Expanded Tech Prep to include bachelor degree granting programs (e.g., 2+4 or 2+2+2);
- Included language on performance indicators and evaluation.

OVAE Career Clusters, 1999

- Office of Vocational and Adult Education (OVAE) in the U.S. Department of Education officially adopted 16 career clusters for use in CTE programs.[2]

The Carl D. Perkins Career and Technical Education Act of 2006, PL209-270 (IV)

- Name changed to CTE;
- Called for additional rigor in integrating academic and technical content;
- Increased accountability with reporting measures on performance indicators;
- Introduced Programs of Study (POS):
  - Coherent and rigorous content aligned with academic standards and CTE content;
  - Sequenced through articulation agreements, leads to a certificate, associate, or bachelor degree, specifically may include dual credit;
- Allowed states to merge their Tech Prep (Title II) and CTE (Title I) funds.

Congressional Funding, 2011

- Eliminated Tech Prep as a separate funding structure under Perkins and combined all CTE formula funds together;
- States required to use funds to develop POS, most implemented plans include Tech Prep offerings.

Presidential Executive Order 13697 amending 11155, 2015

- Formally expanded the *Presidential Scholars Program* to include recognition for student excellence in CTE;
- Students to be recognized alongside those traditionally granted this award for accomplishment in academics and the arts.

[2] Career Clusters include: 1) Agriculture, Food, & Natural Resources; 2) Architecture & Construction; 3) Arts, A/V Technology, & Communications; 4) Business Management & Administration; 5) Education & Training; 6) Finance; 7) Government & Public Administration; 8) Health Sciences; 9) Hospitality & Tourism; 10) Human Services; 11) Information Technology; 12) Law, Public Safety, Corrections, & Security; 13) Manufacturing; 14) Marketing; 15) Science, Technology, Engineering, & Mathematics (STEM); and 16) Transportation, Distribution, & Logistics.

Perkins Reauthorization, 2015-2016

- In October 2015 members of the Senate Education Committee confirmed they were drafting new *Perkins* legislation;
- The House Education and the Workforce Subcommittee held early hearings on the topic in November 2015;
- The House passed the *Strengthening Career and Technical Education for the 21st Century Act* (405-5) in September of 2016 but it has yet to be taken up by the Senate;
    - Differences of opinion exist on the definition of CTE students for funding and the level of oversight granted to the Department of Education (DOE) for accountability purposes.

(Friedel, 2011; see also: Boyd et al, 2015; Bragg, 2006; Castellano et al, 2003; Hershey et al, 1998; Klein et al, 2014; Klein, 2015; Lewis, 2008; Seidman & Ramsey, 1995; Stipanovic et al, 2012; Ujifusa, 2016).

TEXAS STATE CONTEXTS

Quality Workforce Planning Committees, 1989

- Built out of early federal *Job Training Partnerships* and other policy/grant programs;
- Created formal vocational and technical planning committees within regions;
- Members included representatives from business, training providers, K-12, and higher education;
- Committees conducted regional labor market analysis and identified target occupations for job training and technical education.

Tech Prep Planning Consortia, 1990-1999

- Established Tech Prep consortia in response to *Perkins II*;
- Used same membership *as Quality Workforce Planning Committees* for consortia;
- Size of consortia ranged from one community college with eight ISDs to 10 colleges with 85 ISDs, the average consortia served multiple districts and had one college.

Tech Prep Implementation, 1991

- Implemented Tech Prep in a state-wide, comprehensive manner;
- In the first year 25 regional consortia were given grants:
- Expanded Tech Prep offerings at 57 two-year colleges and over 950 ISDs.

State Level Articulation Guidelines, 1993

- TEA (Texas Education Agency) and THECB (Texas Higher Education Coordinating Board) adopted joint guidelines on state level articulation agreements for Tech Prep plans:
    - Texas Tech Prep programs required 4+2 model;
- Tech Prep and other vocational education indicator codes added to state K-12 data collection system – PEIMS (Public Education Information Management System);
    - Indicator Codes added to higher education data:
    - Degrees (AA) completed as part of Tech Prep were flagged in graduation files;
- Enhanced skills certificates were created to provide recognition in attainment of skills, also flagged in graduation files.

Texas Tech Prep Act of 1999, HB2401

- Prior to codified Texas law:
    - 56 of 57 colleges offered Tech Prep programs;
    - Over 700 ISDs actively participated across the state;
    - 540 articulation agreements;
    - 760 degree programs, 830 certificate exit points, and 370 enhanced skills certificates offered;
- Act established the official parameters of Tech Prep in Texas legislation and policy;
- Defined the membership and roles of Tech Prep consortia;
- Codified in Texas Education Code (TEC) Chapter 61, Subchapter T (see Appendix A for the full text).

Statewide Articulation, 2000

- 62 of 73 community and technical colleges (88%) voluntarily adopted the statewide articulation agreement for eligible Tech Prep courses.

Texas Tech Prep Act of 2005, SB1809

- Emphasized importance of Tech Prep and provided for clarified funding structures;
- Required evaluation of state Tech Prep programs.

Present Day Implementation

- Texas is one of 29 states by 2008 with highly developed Tech Prep programs;
- Developed/implemented statewide K-12 standards for CTE as well as postsecondary standards which align to high school curriculum;
- Texas has 26 consortia which are overseen by the THECB, many consortia serve dual purposes as regional P-16 Councils;
- By last count in 1996, there were over 8,900 individual articulation agreements;
- Several pieces of legislation created small changes to existing Tech Prep policy:
    - SB1410 in 2011 mandated evaluation of Tech Prep programs by consortia in accordance with federal guidelines;
    - SB715 in 2013 defined certain terms for use by counselors;
    - HB5 in 2013 required Tech Prep programs to comply with academic requirements needed to gain a diploma under the created Foundation High School Plan (FHSP);
- TEA dropped the Tech Prep indicator from its PEIMS data collection:
    - Variable started its phase-out with students entering the ninth grade in the 2011-2012 school year;
    - Replaced by CTE and ATC (Advanced Technical Credit)—along with dual credit—indicators in course taking.

(Brown, 2001: see also: Bush, 2008; Nelson, 1994; Schneider, 2008; TEA, 2016; TECHS, 2016)

Other Programs Not the Focus of the Study

There are a number of programs which include CTE, integrated academic curriculum, credit-based transition programs, work experience, or other key components that are seen in Tech Prep programs. Oftentimes, these programs are discussed in tandem with Tech Prep in the extant literature. These programs include well known credit based transitions such as Advanced Placement (AP) courses, International Baccalaureate (IB), or credit-by examination. Also included are career academies or pathways, Early College High Schools (ECHSs), youth apprenticeships, and distance learning. Because these programs are also important reform initiatives and have their own outcomes, a brief summary is given for the programs most often compared to Tech Prep. The focus of the current research project does not include these programs and, as such, the study does not cover their use or impact further.

Career academies most often are organized around one or more career clusters. They have varied results and are dependent on program components (Castellano et al, 2003; Castellano, Sundell, Overman, & Aliaga, 2012). Some academies are actually Tech Prep programs or have Tech Prep options (Kompelien, 1996). ECHSs, sometimes referred to as Middle College Schools (MCSs), are intensive dual enrollment programs. ECHSs have been found to be successful with at-risk students and are linked to higher achievement and increased high school graduation rates. Varying to lower rates of higher education attainment have been associated with ECHSs (Bailey & Karp, 2003; Stipanovic et al, 2012). Youth apprenticeships were a popular notion in the 1990s based on European models of paid apprenticeships. They were implemented in a limited fashion under STWOA but have since fallen out of favor (Kompelien, 1996; Stipanovic et al, 2012). Distance learning has been used as a means of boosting technical education in underserved areas such as rural locales but is not the preferred mode of delivery (Benson et al, 2008; Fishman, 2015; Wilson, Parr, & Parr, 2012).

Tech Prep Implementation

Educators in CTE have been working hard to remove the stigma associated with vocational education. Their efforts and reforms have led to new initiatives which are far different than the programs of yesteryear. These initiatives are not "voc-ed" renamed but rather advanced CTE which require relevant coursework and rigorous math and science concepts, academic objectives framed through occupational and technical contexts (Gilbert, 1997).

ORIGINS

Tech Prep programming was the conception of the 1980s American Association of Community Colleges president, Dale Parnell. Parnell gathered together his experiences as a former high school principal, superintendent, and community college president, coming to the conclusion that the education community was failing the majority of its students (Cellini, 2006). He called this majority the *neglected majority*. He asked,

> "When 75% or more of our high school graduates do not complete the baccalaureate and 25% of those who begin high school do not even finish, one must question the validity of the current educational program for the great mass of individuals in the middle quartiles of the typical high school student body. What kind of educational program will meet the needs of these three out of four students? Can these students experience excellence?" (Parnell, 1985, p. 16-17).

Noting that current students were falling further behind in a progressively more competitive world, he set a goal of increasing educational attainment by improving transitions between high school and higher education (Bailey et al, 2002; Cellini, 2006). Specifically he believed in transitions between high school and community college as a way to bridge the gap in the P-16+ pipeline. Parnell argued that community colleges had spent too much of their focus on the wrong transitions (four-year institutions) and the wrong students, those already planning to attend postsecondary education. He shifted focus to his so-called neglected majority and put forth a program plan which would expose students to higher education while also providing practical and relevant learning experiences through technical education (Parnell, 1985).

The neglected majority, sometimes called the middle majority, are those students whom are neither high nor low achieving. Most of the neglected majority fails to enroll or complete postsecondary education. Common definitions include a range between the 25th and 75th percent of high school class rank, or other achievement measures (Bragg, 2000). The initial aim of Tech Prep programs was to keep middle majority students interested in learning and inspire students to continue their education beyond high school (Cellini, 2006).

Although Tech Prep started out as a program targeted at the neglected, middle majority, over time it has been expanded as a reform measure which can be used to provide college exposure to a wider set of student populations (Bragg, 2000; Cellini, 2006). Tech Prep has been explored as a program to expose students across all spectrums—low achieving, traditionally underserved populations, special populations, gifted students, traditional academically oriented students—to higher education while still in high school (Bragg et al, 2002; Brown, 2003). It is argued that CTE Tech Prep, with its combined focus on academic and technical education, has the ability to overcome racial and class separations—and gaps—persistent in schools today (Bragg & Layton, 1995).

REQUIREMENTS

The goals of Tech Prep programs are to create better articulation between high school and higher education, engage students in career focused pathways, prepare students for college and careers, and allow for workplace exposure and mentoring

(Bragg, 2000). Traditionally, Tech Prep programs are comprised of several key requirements which set it apart from other CTE programs:

- In order to provide a smooth transition between high school and higher education, programs must articulate, or reach concrete agreements, as to how they will partner and provide both secondary and postsecondary content (e.g., articulation agreements);
- Programs are comprised of what is commonly referred to as a 2+2 structure. This includes at least two years worth of secondary instruction followed by two years of postsecondary study and credits. Other structures may include a 4+2 structure starting earlier in high school or 2+2+2 structures which combine high school with higher education at both community college and university levels; and
- Programs must terminate in the completion of a higher education credential. These may include an industry recognized certificate, associate's degree, or bachelor's degree (Hershey et al, 1998; Kim, 2014; Parnell, 1985).[3]

Programs first grew under CTE reform and were further implemented by the nation at large after *Perkins II* set up formalized structures and funding (Bragg, 2000; 2006). Appendix A provides the text of the TEC which is used to administrate Tech Prep programming in Texas; the code outlines the components of Texas Tech Prep in accordance to state and federal laws. Programs under federal purview have additional requirements for Tech Prep:

- To oversee and implement articulation agreements, regional consortia groups consisting of high school and higher education partners need to be formed;

[3] Tech Prep program plans are comprised of both high school and higher education participation, and culminate in a postsecondary credential. Not all students who enroll in Tech Prep complete all parts of the program, though. Some students drop out of Tech Prep. Difficulties in sharing data between secondary and postsecondary institutions make it harder to track each student as they complete all requirements of the Tech Prep program plan.

- Developed programs may be structured under 2+2, 3+2 or 4+2 designs;
- Program content must include curriculum which includes common core proficiencies in math, science, and technology;
- In addition to program courses, programs must provide for preparatory services including recruitment, career counseling, and occupational assessments;
- Joint, in-service professional development for all instructors and preparatory service providers (e.g., counselors) must occur. This includes training for both high school teachers and higher education professors; and
- Equal access for all students should be provided (though earlier legislation had regulations for targeted access for special populations) (Friedel, 2011; Office of Career, Technical, and Adult Education [OCTAE], 2016).

IMPLEMENTATION

Regional Consortia

Federal funds for Tech Prep flow into all states' coordinating bodies as part of formula funding and are then given out to local consortia to administer (Bragg, 2006, Silverberg, Warner, Fond, & Goodwin, 2004; Stone & Lewis, 2010). Consortia are traditionally made up of multiple secondary schools, a few postsecondary institutions, and various workforce and community stakeholders for that region (Bragg, 2006). Consortia structures fluctuate but are usually administered by postsecondary representatives (Hershey et al, 1998).

Though not formalized in state policy, most states reported hosting state level planning teams to initially organize policies and consortia requirements at the start of the implementation process (Bragg & Layton, 1995). Benefits of consortium participation have included communication and cooperation, mobilized interest for change, employer contacts, and focused need for curricular changes in math and science skills (Hershey et al, 1998). As part of a 1998 federal evaluation of Tech Prep, researchers found that around 70% of school districts participated in a Tech Prep consortium (Hershey et al, 1998). Today, consortia have impacted huge amounts of schools. A survey of states in 2008 found that over half (29) provide focused Tech Prep programs (Brush, 2008). Somewhere between 10-14% of the student population is enrolled in Tech Prep or similar advanced CTE programs of study (Bragg, 2006; Stone & Aliaga 2005).

Local Variability

Studies of implementation suggest there is a great deal of variability in both the policies directing Tech Prep and the programs provided to students (Bragg et al 2002; Hershey et al, 1998) The most important finding from implementation studies has been the notion that there is no common definition of Tech Prep (Beaumont, 1995). Because of flexibility in federal policy and funding, there has been wide variation in state and local definitions of the program which has made evaluation and comparison difficult (Cellini, 2006; Lowell, Boggs, & Stumpf, 2005). Further, it has complicated understandings of how additional or auxiliary policies from federal or state governments fit with the model (Beaumont, 1995).

Statewide Implementation

Research at the state level illustrates that policy processes may facilitate CTE Tech Prep programming by providing advanced planning and alignment opportunities (Cantor, 1999; Corwin, 1995; Marsh, 2000). Surveys of state implementation find differing levels of participation and an ever-growing need to expand business relationships (D'Amico, Morgan, Katsinas, & Friedel, 2015). Finding it a viable option for testing the waters of higher education, Tech Prep has expanded in states, though differing levels of participation and commitment still exist among high school and higher education members. (Alexson & Kemnitz, 2004; Harnish & Lynch, 2005; Waller & Waller, 2004).

A survey of Virginia implementation found that developing an implementation plan proved helpful. They created a needs assessment followed by the development of curriculum and courses. Only then did Virginia roll-out Tech Prep programs. In their needs assessment they found creating close liaisons with businesses and developing high-tech, contextual learning opportunities were the best design options in impacting economic development (Cantor, 1999).

Wisconsin started its policies by aligning P-16+ curriculum in 1998. They found that gaps were not in curriculum, but in misaligned student, teacher, and professor expectations. Policymakers worked to address negative perceptions by increasing study skills, support, and advisement opportunities (Alexson & Kemnitz, 2004). Minnesota worked towards implementation in a similar fashion. The state implemented Tech Prep as part of a larger set of postsecondary transition policies. They initiated a formalized campaign to articulate programs, identify and support best practices, and evaluate student achievement outcomes (Crist et al, 2002). Indiana implemented its Tech Prep programs by first funding five demonstration sites. At these sites, professional development opportunities and visits for teachers were conducted to provide feedback. Reponses from professionals and stakeholders were used to create a single model which was then implemented across the state and mandated for all schools (Corwin, 1995).

Texas implementation research has found disparate ideologies on participation and purpose. A survey of community college administrators in Texas established that there was active participation in Tech Prep across the state, though differing perspectives on program impact dependent on the individual institution's level of involvement with their local consortia. Institutions with more active participation in the consortia reported greater gains for students (Brown, 2001). An overview of Texas Tech Prep consortia found that Tech Prep programs and articulated CTE courses had increased dramatically since their inception. Indeed, in 2003 over half of the state's applied science degree programs were also involved with Tech Prep, and 64% of ISDs carried Tech Prep programs. In a scan of consortia member opinions, researchers found that K-12 partners held higher opinions on purpose, leadership, communication, and student success. Analysis showed community college partners were not as well versed in Tech Prep goals and both groups had difficulties communicating during strategic planning (Waller & Waller, 2004).

Local Implementation

Individual program studies have been popular. They often detail the myriad of partners included in their program, the initial planning of programs, and an analysis of implementation thus far (Addison & Lane, 1995; Haag, 2015). Like statewide studies, local studies have shown that strong planning and communication improve program structures and participation (Draeger, 2006). Researchers and practitioners have also shared the tools used to create, implement, and improve programs (Addison and Lane, 1995; Otterstetter, Buser, Kappler et al, 2011). Findings suggest there are many ways to deliver Tech Prep and that local groups work to provide programs that suit their distinct needs.

Looking at a set of advanced technical education programs funded by the National Science Foundation (NSF), researchers found that only half of programs used workforce assessments in program evaluation activities; most used secondary data sources, anecdotal information, or local surveys to find out about workforce demand (Bartlett, Schleif, & Bowen, 2011). Addison and Lane (1995) looked at a program in Iowa which created their own workforce assessments. Their career maps were made to be used by all stakeholders; they were also used in tandem with career inventories and counseling in Tech Prep programs.

A program for athletic healthcare in Utah outlined their model from the application process to the rubrics they used in the project-based senior thesis component (Otterstetter et al, 2011). Various other programs described the changes they have made to their curriculum to include project-based learning and the creation of capstone projects (Haskell & Haskell, 2008). In a program focused on women in engineering and technology fields, implementation study revealed challenges at aligning responsibilities between program partners as well as curricular alignment (Boudria, 1995). A program focused on health science in New Jersey discussed its efforts to promote health practitioner careers in underserved groups including minority, low-SES, and female students (O'Sullivan, Maillet, & D'Anna, 2001). Programs in Maine and New York relayed efforts to implement associate and bachelor degree granting programs for students in medical technologies, mechanical engineering, or agribusiness (Fitzsimmons, 1999; Shimony et al, 2002).

One study overviewed a Tech Prep program in the RGV—Rio Grande Valley that is part of a credit-recovery program. The College Career and Technology Academy takes students who have dropped out or failed exit exams (ages 18-26). Using credit-recovery and dual enrollment, the academy seamlessly transitions students to community college at South Texas College while finishing up high school requirements. The program has been so successful with student achievement and raising retention rates at the local high school, several other districts have replicated the initiative (Allen, 2012).

Lessons From Implementation

Implementation has shown a number of successes and complications in the use of Tech Prep models. Challenges to and within implementation have been numerous. Barriers to implementation have included funding streams and fiscal issues which have varied as much as programs (Bailey et al, 2002; Bragg, 2000; Bragg & Layton, 1995). A recent survey found that targeted state dollars beyond federal funding were rare suggesting state and local support has been dependent on federal apportionments and lack wider investments. (Bragg, 2006).

Challenges within implementation are grouped around two issues, problems bringing stakeholders together and limited change in curricular reform. Studies noted mistrust and skepticism between groups which obstructed articulation of programs (Alexson & Kemnitz, 2004; Bragg, 2000). Miscommunication and lack of common expectations has kept programmatic and curricular changes from occurring (Bragg & Layton, 1995). When programs have worked, administrative formalities of creating and maintaining the consortia partnership have eaten into the time meant to work collaboratively together (Bragg & Layton, 1995; Farmer & Farmer, 1999). Lengthy and multiple articulation agreements have hampered efforts at institutional learning and curricular reform (Bragg & Reger, 2002).

Indeed, in the 1998 federal evaluation, researchers found that implementation had left gaps in curriculum reform that hindered transitions (Hershey et al, 1998). Despite calls to integrate academic and technical education standards, little evidence from studies has shown meaningful changes to secondary or postsecondary curriculum (Brown, 2001). Programs are still working to incorporate academic rigor and vertically align courses with higher education standards (Schneider, 2008). There have been improvements within Tech Prep implementation, though. Curriculum content and standards are becoming more applied, but it is a gradual process (Bragg, 2000; Bragg & Reger, 2002; Hershey et al, 1998). The program has been effective in transitioning vocational education from teaching skills for a specific job to exploring broader career clusters which enable students with a larger set of skills for success (Bragg, 2000).

There are other successes within Tech Prep implementation. The widespread development of programs has led to increased P-16+ partnerships and collaborations at all levels, especially among traditionally oriented academic and technical providers. Further, it has worked to bring employers into the conversation (Bragg, 2000; Hershey et al, 1998). Tech Prep has led to greater awareness around the issue of P-16+ and transitions between high school and higher education (Bragg, 2000).

Successful Tech Prep programs have been shown to have a similar set of structures and practices. These include: formal articulation strategies, rigorous curriculum, meaningful links to theory and practice (i.e., relevance), and outcomes-based curriculum (e.g., project-based learning, authentic assessment). In addition they have opened access for all students and hosted collaboration between high school, higher education, and the workforce (Bragg, 2000). The most comprehensive of programs studied were those which provided professional development for all its stakeholders and those which had well-developed preparatory services to aid instructional programs (Bragg, 2000; Stipanovic & Stringfield, 2013).

The last federal authorization of CTE legislation, *Perkins IV*, had a noticeable decline in the requirements specific to Tech Prep (Friedel, 2011). Instead, requirements for *Programs of Study* (POS) were adopted. POS are very similar to Tech Prep. They provide for articulated CTE courses and sequenced material utilizing both high school and higher education. Also, POS offer pathways to postsecondary enrollment and the attainment of a credential. POSs only differ from Tech Prep in the variety of programs and industries they cover, and the wide population of students which may enroll. Indeed many POS are also Tech Prep programs (Castellano, et al, 2012; Hershey et al, 1998).

Since the growth of POS, Tech Prep has fallen from named legislation. Specific funding for the program was eliminated in 2011; funds were combined with existing CTE formula grants for wider use. Many states chose to use funds to extend Tech Prep to more students or other career areas (National Assessment of Career and Technology Education [NACTE], 2014). When surveyed in 2008, over half of secondary and postsecondary program providers reported that one of the top five POS at their institution was either Tech Prep or a program which had been previously labeled Tech Prep (Klein et al, 2014). Moreover, providers pointed to the foundational work of Tech Prep consortia—existing partnerships, articulation agreements—and successful programs as a well-founded background for implementing POS (Klein et al, 2014).

Key Components of Tech Prep

As put forth by the original conception of Tech Prep conceived by Dale Parnell in 1985, there are important components to Tech Prep which make it different than other reforms and programs. These components include the articulation agreements used to ease the transition between high school and higher education. They allow for partnerships between secondary and postsecondary institutions. The other component is the integration of academic content with CTE skills and training. College and career readiness in advanced CTE offerings is accomplished through dual credit opportunities. The following section defines these components further and connects their importance to successful Tech Prep programming.

ARTICULATION AGREEMENTS

Tech Prep is an example of a credit based transition model (e.g., dual credit). The goal of credit based transitions is to increase the number of high school students that go on to college. Providing early access to college courses is meant to eliminate duplication and align curriculum between institutions (Alexson & Kemnitz, 2004; Fowler & Luna, 2009). The earliest credit based program occurred at Syracuse University under a program named Project Advance. Though the first program occurred at the university level, most programs now exist at the community college level under formal articulation policies (Fowler & Luna, 2009).

Formal articulation provides stability in the transition to a P-16+ format. *Articulation agreements* authorize partnerships between high schools and institutions of higher education. They are the written agreements which plan out pathways to college through courses and credits at both institutions (Alexson & Kemnitz, 2004). These agreements delineate each part of the process. They include:

- What course or courses will be granted credit;
- What students will be eligible to enroll;
- What curriculum will be covered;
- How credit will be given at both K-12 and higher education levels;
- What location(s) courses will be taught at; and
- Who will teach course(s) and what training requirements will the job(s) require (Brown, 2001; Hershey et al, 1998).

Types of articulated programs are usually separated into three categories. The first are *singleton programs* which include one-class courses meant to provide enrichment; examples include a dual credit course or AP class. Articulation agreements for these courses often focus on course-to-course equivalents matching the requirements of the high school class to the postsecondary curriculum. The next level are *comprehensive programs* in which students take most of their courses through a credit based program of study; these include IB programs as well as Tech Prep. Program level articulation provides an outline of all the courses included and delineates which will be granted only high school credit and which will be given dual or college credit (Brown, 2001). Lastly, *enhanced comprehensive programs* go a step further and provide support systems or elective areas in addition to sequenced course structures (e.g., ECHS, career academies, etc.) (Fowler & Luna, 2009).

Articulation requires communication between secondary and postsecondary partners. Discussions of expectations and goals are then followed by curriculum alignment and an outline for the sharing of resources (Amey et al, 2010; Cantor, 1999). Articulated courses grant many benefits to students. They are meant to reduce time to degree in higher education in addition to overall tuition costs (King & West, 2009). Courses are geared to increase engagement and motivate students traditionally uninterested in school or lacking drive due to senioritis (Fowler & Luna, 2009).

Working to formulate agreements has increased opportunities for institutional sharing at all levels. In a term of Amey et al (2010) defines as “partnership capital”, both sides share their organizational and social capital resulting in greater efficiency and capacity to meet demand. Implementation studies suggest successful programs have well-delineated articulation agreements. In its evaluation of early *Perkins* legislation, researchers found that the focus of CTE and Tech Prep had increased formal articulation throughout the nation; most agreements covered course-to-course or single class alignment rather than entire program agreements (Hershey et al, 1998). Other studies also noted that a large number of articulation agreements were formed on existing curriculum (Bragg, 2002; Brown, 2001).

Local and Statewide Agreements

There are two main formats in which articulation takes place, local and statewide. In *local articulation* agreements, a specific high school and higher education partnership make an agreement for a course or set of courses. The agreement only pertains to their unique partnership. It may also incorporate other elements in addition to the course and curriculum layout. In an example of forming local articulation agreements, one study described the steps a Project Lead the Way (PLTW) program took to partner its high school and local postsecondary institutions. As they worked to create a program, the agreement incorporated specific supports unique to their community and student population such as family-driven opportunities to demystify higher education (Starobin & Bivens, 2014).

Statewide articulation provides for either a list of courses or entire programs which may be provided by partnering institutions. Statewide policies have grown over time as individual articulation agreements have become burdensome at all levels—secondary, postsecondary, and the state (Brown, 2001; Waller & Waller, 2004). King and West (2009) describe the implementation of one statewide articulation program. Policymakers held state meetings to review curriculum and courses. Participants were granted access to the numerous local agreements to evaluate, only selecting the best programs and individual courses to include out of individual agreements from all over the state. The best articulation agreements were expanded to all participating institutions. Statewide articulation agreements, in particular, are helpful in that they reduce confusion and enhance transferable credit opportunities for students (King & West, 2009).

Implementation setbacks in Tech Prep programming have most always called for greater time spent to articulate between partners, or the need for statewide agreements (Bragg & Layton, 1995; Bragg & Reger, 2002; Crist et al, 2002; Farmer & Honeycutt, 1999; Laanan, Compton, & Friedel, 2006). Increased Tech Prep participation has been linked to the successful use of articulation agreements, especially the growth of statewide articulation (Bragg, 2000; Brown, 2001; Hershey et al, 1998; Waller & Waller, 2004).

CAREER AND TECHNICAL EDUCATION

Studies have suggested the use of CTE, specifically CTE Tech Prep, may help with high school retention and graduation, as well as lead to a greater probability of enrollment and persistence in higher education (Bishop & Mane, 2004; Kim & Bragg, 2008; Zinth, 2014). Studies link CTE to enrollment in both two- and four-year postsecondary institutions (Neild & Byrnes, 2014). Participation may especially aid students at greater risk of dropping out of high school (Allen, 2012). With its success, CTE policies currently drive the growth of Tech Prep and its structured its program content.

Congress explicitly required the integration of academic and technical content in CTE courses with its reauthorization of *Perkins II* legislation in 1990. Legislation cited the need for more advanced academic skills as they would be required for both growing job opportunities and desired educational outcomes (Seidman & Ramsey, 1995). In doing so, it paved the way towards college and career readiness skills in CTE classrooms. Later additions to *Perkins IV* in 2006 would reify the connection by requiring academic and technical content alignment with both secondary and postsecondary curriculum (Stipanovic et al, 2012). Implementation of integrated academic content and rigor has been limited. Evaluation of progress suggests gradual changes have been made but further alignment needs to occur (Schmalzried & Harvery, 2014; Spindler, 2010; Loera, Nakamoto, Oh & Rueda, 2013; Manley, 2011).

CTE has reformed programs to integrate better exposure to relevant career paths and local workforce experiences. With it there has been a structured increase in career assessments as tools to reach students (Rojewski & Hill, 2014). CTE courses match job exploration, curriculum content, and internship opportunities together. These provide exposure and mentoring experiences. Additional adult partners from the local workforce help shape student goals and demonstrate the importance of continued learning opportunities (Hutchins & Akos, 2013). Implementation studies have suggested successful programs involve supplementary support services. These include career and guidance counseling and program advisory committees which help ensure student success (Stipanovic & Stringfield, 2013; Washbon, 2012).Today efforts remain to increase the number and scope of CTE courses and programs beyond traditional vocational areas (Hutchins & Akois, 2013).

CTE Students

As a greater and more diversified set of students have become involved in CTE course-taking; the definition of a CTE student has evolved. Historically definitions of students depended on dichotomous groupings of either vocational or academic orientation. As academic requirements have increased for all students in recent years, traditional definitions have become less useful (Bishop & Mane, 2004; Meer, 2007). Expansion of CTE courses across the broader student population has made simple groupings even less feasible. Researchers and policymakers have thus turned to definitions reliant on the amount and type of CTE courses students complete. Common groupings include:

- *CTE Students or Participants* - those who complete one or more individual CTE courses in different areas;
- *CTE Concentrators or High Intensity CTE Students* - those who complete several (usually three or more) grouped CTE courses in a specific area (may be in a POS including Tech Prep); and

- *CTE Non-Concentrators* - students taking several CTE courses in a variety of occupational areas (Aliaga et al, 2014).

Grouping requirements, the numbers of courses needed to reach a specific level, and occupational/career markers vary between programs and states (Aliaga et al, 2014; Cox, Hernandez-Gantes, Fletcher, & Howard, 2015; Meer, 2007; Stone & Aliaga, 2005). That considered, an average student today completes 3.6 CTE credits during their high school career (Aliaga et al, 2014). Research using National Educational Longitudinal Study (NELS) data found that minority, urban, and rural students were more likely to enroll in CTE courses as well as students with lower GPAs than general academic students (Stone & Aliaga 2005). Also, slightly more women than men were enrolled in CTE coursework (Cox et al, 2015). Of women enrolled in CTE courses, a breakdown study suggests that enrollment is often segregated along traditional gender lines (Eardley & Manvell, 2006).

CTE Outcomes

CTE participation has positive influences on soft skills such as identifying and clarifying career interests along with increased motivation and engagement (Esters & Retallick, 2013; Qi, & Cole, 2011). Other studies have suggested participation may decrease educational and career expectations (Kelly & Price (2009). Differences may be due to implementation variation as students who feel supported report more engagement in courses and are more likely to engage in career planning (Loera et al, 2013).

CTE participation has been shown to improve hard skills as well. These include attendance, academic achievement in multiple subject areas, and the completion of higher level academic subjects (e.g., college ready math) as well as credit accumulation and graduation rates (Bishop & Mane, 2004; Israel, Myers, Lamm, & Galindo-Gonzalez, 2012; Neild, Boccanfuso, & Byrnes, 2015; Pierce & Hernandez, 2015; Richard, Walter,

& Yoder, 2013). Participation has also been associated with reducing dropout rates and increasing postsecondary preparedness (Castellano et al, 2003; Plank, DeLuca, & Estacion, 2008). Bishop and Mane (2004) found higher attendance and graduation rates for CTE students, defined as those devoting at least one-sixth of their time in vocational courses.

Gains from students in advanced CTE courses—those which integrate academic and technical content—are similar to those in academic tracks alone, suggesting that integrated coursework might be another, alternative path to student success and college readiness (Bozick & Dalton, 2012; Dare, 2006). CTE participation combined with academic course taking is associated with improved retention; a middle-range combination of both CTE and academic courses decreases risk of high school dropout (Plank, 2001; Plank et al, 2008).

Those involved in Career and Technical Student Organizations (CTSOs), are associated with greater academic motivation, academic engagement, grades, career efficacy, college aspirations, and employable skills (Alfred et al, 2006; Gentry, Hu, Peters, & Rizza, 2008). Specifically, women and minority students gained both psychosocial and achievement benefits from involvement (Aragon, Alfeld, & Hansen, 2013).

While CTE courses may raise achievement and promote postsecondary transitions for regular students, they may not be sufficient to motivate students with disabilities towards higher education (Gottfried, Bozick, Rose, & Moore, 2014). Notwithstanding, CTE participation has been associated with higher rates of employment for high poverty students with disabilities (Rabren, Carpenter, Dunn, & Carney, 2014).

CTE participation is related to higher earnings, compared to general education students in both the year after high school graduation and seven years out, holding individual characteristics constant (Bishop & Mane, 2004; Castellano et al, 2003). Gender, age, degree attainment, annual earnings, and original occupational pathway are all related to long term earning capacity (Maguire, et al, 2012). CTE increases earning potential whether or not students go on to higher education; those in specific training programs are the most successful in earnings (Mane, 1999; Bishop & Mane, 2004)

In studies comparing workforce outcomes between different CTE career cluster groupings, several relationships become clear. An associate's degree in most clusters is linked to higher earnings including marketing and information technology (Compton et al, 2010). Manufacturing and STEM clusters had diminished returns on earnings over time when linked to degree attainment, suggesting the benefit of continued work experience in the area (Maguire et al, 2012). Women who have earned an associate's degree tend to earn less than men in a variety of comparable CTE career clusters, even less than men without degrees. The persistent, negative earning implications for women involved in CTE are concurrent with wage gaps prevalent across the United States (Eardley & Manvell, 2006; Maguire et al, 2012). In all, CTE participation is associated with greater earning capacity. Indeed, one study used econometrics to control for track selection; his model suggests that if CTE students had been enrolled in an academic track instead, they would have earned less after high school (Meer, 2007).

Advanced CTE Courses, Dual-CTE

Tech Prep programs offer CTE courses which go beyond traditional high school curriculum. They provide linkages to higher education through credit based transitions. Advanced CTE, or dual-CTE, are those courses which provide CTE content while aligning high school and higher education standards. Most often these are courses for which students participate in dual enrollment (Bragg & Reger, 2002; Kim & Bragg, 2008; Stipanovic et al, 2012). A growing body of research suggests that dual enrollment, or dual credit, may improve educational attainment for students who would not otherwise continue their education past high school (Allen, 2010; An, 2013; Hoffman et al, 2009; Kleiner & Lewis, 2009; Lerner & Brand, 2006). Dual credit is a popular option for students in CTE courses as a way to prepare, experience, and transition to higher education.

Researchers have noted the program connections between dual enrollment and Tech Prep, citing their extensive use as a portion of Tech Prep program plans (Clark, 2001; Pierce, 2001). Using the Community College and Beyond data set, significant relationships were found between dual and Tech Prep courses suggesting their prevalent, connected use in programs (Kim, 2014). A survey of schools in 2002 reported that around 51% of schools offered dual-CTE courses, and students enrolled in such courses represented 3% of the school populations (Lewis & Overman, 2008). Several advantages have been identified within dual-CTE. These include higher graduation rates, greater odds of postsecondary enrollment in either a two- or four-year institution, and increased persistence in higher education (Wonacott, 2002; Stipanovic et al, 2012). Further, combined dual-CTE enrollment programs may lead to improved college retention rates for students who do continue on into higher education (Kim & Bragg, 2008; Zinth, 2014).

Tech Prep Program Outcomes

Thus far literature has covered the origins and implementation of Tech Prep as well as associations with common component parts, articulation methods and CTE dual credit course availability. What follows are the outcomes associated with Tech Prep participation. Overall, research yields positive impacts on high school and postsecondary success (Bailey & Karp, 2003; Cellini, 2006; Dare, 2006; Bragg et al, 2002; Stone & Aliaga, 2003). Though the body of literature is not large, findings suggest Tech Prep may be a useful tool in transitioning students from high school to higher education and beyond.

HIGH SCHOOL

Firstly important in high school outcomes are the characteristics of students who enroll in Tech Prep programs. In a study of mature, high fidelity Tech Prep programs—those which had all the components of a comprehensive program—researchers compared outcomes of Tech Prep students with those in general education settings. Across all eight measured consortia, Tech Prep participants differed significantly from other students in characteristics which made them at-risk of not completing college (e.g., first-generation college, part-time enrollment, work and school, etc.). Students also exhibited somewhat lower levels in categories of family income and parental education. Students did not differ according to race or GPA (Grade Point Average). Several of the consortia also enrolled notably more male students (Bragg et al, 2002). When linked to students outcomes, at risk and disadvantaged students have had greater success when enrolled in Tech Prep, school to career, and other advanced CTE programs (Brown, 2003).

Tech Prep students are generally more successful, or similar, in high school achievements when compared to traditional academic paths (Bailey & Karp, 2003; Cellini, 2006; Dare, 2006). The program has been associated with gains in math and science achievement (Kim, 2014; Stone & Aliaga, 2003). Tech Prep students in several mature consortia were found to take more math courses. In these consortia, students often started with a lower ability level and ended high school with higher achievement in math (Bragg et al, 2002). The New York Tech Prep model was associated with positive effects on achievement in English, math, and science as well as overall GPA. Other studies have found little evidence of impact on raising high school GPA (Kompelien, 1996; Stone &

Aliaga, 2003). Lastly, several studies have related Tech Prep participation to an increased probability of high school graduation (Cellini, 2006; Stone & Aliaga, 2003).

HIGHER EDUCATION

The majority of peer reviewed research suggests students involved with Tech Prep are more likely to enter higher education (Bailey & Karp, 2003). Several studies have found that while Tech Prep is positively associated with enrollment in community colleges, participants are less likely to enroll in four-year institutions (Bailey & Karp, 2003; Bragg et al, 2002; Cellini, 2006). This may suggest that participation may divert students directly into two-year institutions directly following high school at the expense of university enrollment.

A large amount of studies focus on the implementation of local programs, providing matriculation percentages for their students. Within these studies numbers vary widely as to how many students from Tech Prep programs enter higher education, from 19-98% with around 50% remaining in the same CTE field of study. Study of a program in Massachusetts created to recruit women into engineering and technology fields found that 65% of their students went on to college in those fields with an additional 10% entering college in other majors (Boudria, 2002). A study of an athletic health care program in Utah had particularly high results for its participants. Over the course of five years, 98% of participants continued on to college with 85% of them in a health related field and 45% declaring exercise science or athletic training as their major. Participant surveys revealed the program helped them to learn about the field, enhance interests, and find out about careers, skills, and the scientific process (Otterstetter et al, 2011).

A study of a healthcare program in Oklahoma reported only 19% of students continuing on to higher education (McCharen, 2008). New York Tech Prep model participants who matriculated to higher education scored better on college readiness exams, required fewer remedial courses, had higher college GPAs, and higher college persistence and attainment (Shimony et al, 2002). A large study of eight high fidelity Tech Prep programs found wide variations. Between 28-75% of Tech Prep students continued on to a two-year college while between 18-58% of traditional track students attended; 5-53% of Tech Prep students attended four-year institutions compared to 17-55% of general education students. No differences were found in the rate of degree completion with a median of 10.5% (Bragg et al, 2002).

Within those who do transition to higher education, there seem to be modest yet positive impacts for Tech Prep students, including the number of semester credit hours earned (Bragg, 2006). Others disagree finding no connection between Tech Prep and postsecondary success (Neumark & Rothstein, 2004; Neumark & Joyce, 2001). While there is some disagreement as to the impacts of higher education enrollment and attainment, other research has linked Tech Prep participation to increased positivity in student goals, perceptions of postsecondary attainment, and workforce participation (Neumark & Joyce, 2001).

WORKFORCE PARTICIPATION

Few studies have followed Tech Prep students into the workforce. In those that did study earnings, Tech Prep participants had comparatively more workforce participation one- and three-years after high school graduation (Bragg, 2006). In the large study of several consortia, workforce participation was more frequent amongst Tech Prep Tech Prep participants (Bragg et al, 2002).

Though research is limited and incomplete, favorable findings suggest Tech Prep has a positive impact on students (Bailey & Karp, 2003; Bragg, 2006; Bragg et al, 2002). It has been shown to actively engage students in preparing for college and career skills while still in high school (Cellini, 2006; Stone & Aliaga, 2003). Further, it has been used to expand CTE beyond traditional enrollments to broader populations of students. One study placed its findings into an important context. Dare (2006) found that Tech Prep students were comparable or even moderately successful in achievement when compared to general academic students. In everyday, practical terms this means that students now have two course pathways to succeed in school rather than the traditional route of college prep. Tech Prep is now an additional path to success beyond traditional academic tracks (Bailey, 2009). The use of Tech Prep to incentivize student learning, increase attainment, and promote college success for all highlights the program as a complex reform for today's CTE rather than the tracking tool of prior eras in vocational education.

LIMITATIONS

The body of research to date has provided limited examples of impact or efficacy. Many have focused instead on qualitative measures of program implementation. Within current quantitative studies, there is space to build upon past study by advancing analytic models and providing more accurate measures of student outcomes. A selected list of limitations within the extant research follows.

Implementation Variation

Implementation of Tech Prep has led to varied definitions of the term and program components (Bragg et al 2002; Hershey et al, 1998). This has made research based on the identification of students in programs an issue. There are few easily identifiable data points from which to select out Tech Prep students. As such researchers use either self-report or coding from transcript data, both of which have limitations in their reliability (Stipanovic et al, 2012). Self-report can produce discrepancies in data while transcripts may produce incorrect estimates due to coding decisions (Aliaga et al, 2014). Research to date also has limited information on the scale and characteristics of programs in relation to others, or even precise information on student characteristics. A detailed study of wide proportion needs to be conducted allowing for multiple comparisons rather than smaller programmatic contrast (Bailey & Karp, 2003).

Lack of Rigor

Growing numbers have critiqued the body of quantitative research in this area for deficient sensitivity to selection bias. Of great importance has been the lack of controls for student and school characteristics (Bozick & Dalton, 2012; Lewis & Overman, 2008; Rojewski & Xing, 2013). To a lesser extent, discussion has been how the factors which impact self-selection into Tech Prep should be explicitly accounted for in modeling (Bishop & Mane, 2004; Kelly & Price, 2009).

As part of continued academic discussion, partly published in thoughtful articles through the Career and Technical Education Research (CTER) journal, researchers in the field have called for better development of methods to study the impact on student outcomes (Bailey & Karp, 2003; Rojewski et al, 2012; Lambeth et al, 2009;). Specific calls have noted the overuse of simplistic analysis techniques—t-tests, correlation, ANOVA—for questions and data which call for more complex inferential methods (Fritz et al, 2012; Gemici & Rojewski, 2007; Nimon, 2012; Rojewski et al, 2012). Discussion relates the use of hierarchical methods as the appropriate tool in most circumstances given the nature of nested data in student, program, and school information (Cohen, Cohen, West, & Aiken, 2003; Fritz et al, 2012). Calls for more rigorous study have also been debated within the contexts of government funding. Authors have acknowledged that while not all important research follows components of governmental Scientifically Based Research (SBR) standards—these include requirements such as What Works Clearinghouse (WWC)—greater attention needs to be given to methods in quantitative, quasi-experimental studies (Gemici & Rojewski, 2007).

Calls for Research

Experts used surveys and discussion at yearly conferences to form a research agenda for CTE and Tech Prep in upcoming years. Areas of needed research include:

- A knowledge base for teaching and learning:
- Curricula and program planning:
- Program delivery methods;
- Accountability; and
- Program relevance and effectiveness (Lambeth, Joerger, & Elliot, 2009).

Research objectives under accountability explicitly relate the need for greater understanding of student outcomes of Tech Prep programs using appropriate, multilevel methods (Cohen et al, 2003; Fritz et al, 2012; Rojewski et al, 2012). Given the stated limitations in current studies, it is an ideal time to assess the efficacy of Tech Prep outcomes along P-16+ pipeline transitions.

CHAPTER THREE: RESEARCH DESIGN

Overview

The purpose of this study is to better understand the ways in which advanced CTE models, such as Tech Prep, may be used to foster college and career transitions. The focus of research explores the impacts of CTE Tech Prep participation on longitudinal outcomes related to the P-16+ pipeline. Given the need for more rigorous assessment within the current body of CTE research, the design of this study aligns to criteria for research put forth by What Works Clearinghouse standards (Fritz et al, 2012; Nimon, 2012). Specifically, the research design works to meet the evidence standards of strong, quasi-experimental studies of comparison groups (Gemici & Rojewski, 2007; WWC, 2014). Methods include propensity score matching of students to control for selection bias, and the multilevel modeling of logistic regression on a variety of outcomes associated with Tech Prep participation. The outcome variables investigated encompass high school transitions, higher education enrollment, developmental remediation, postsecondary attainment, and workforce participation. Findings are explored and connected to current contexts, CTE research, and education policies. They create multiple implications for both policymakers and practitioners. The analytic strategies used in this study work together to yield a rich set of findings which strengthen the connections between advanced CTE participation and student success.

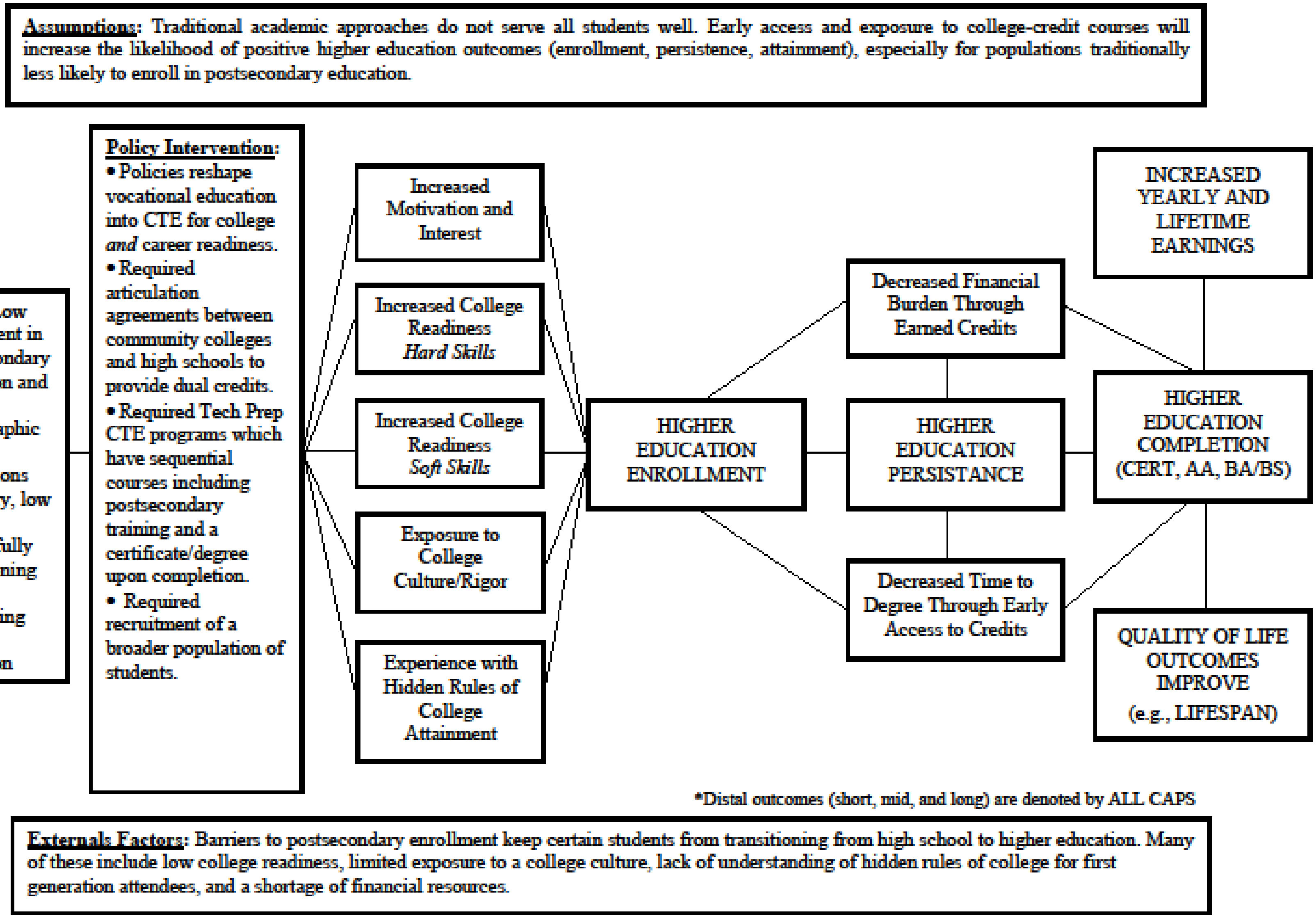
LOGIC MODEL

A literal head-start for high school students, Tech Prep programs offer an articulated pathway from high school to a higher education institution. As part of the program students are granted early college access; they enroll in credit based transition courses (e.g., dual credit) to gain exposure and credits at both institutions.

The theory of action behind Tech Prep is that relevant, diverse, and early college opportunities lead to an increased likelihood of postsecondary outcomes. Assumptions are that traditional academic approaches and content do not provide adequate opportunities for all students. Non-traditional approaches such as CTE Tech Prep may better reach students and help them achieve their college and career goals. It is hypothesized that early exposure to dual credit and CTE help overcome barriers to access for those less likely to enter postsecondary education. These include minority students and students of low socio-economic status (Bragg et al, 2002; Brown, 2003). Figure 3.1 provides a full description of the logic model associated with Tech Prep programs.

Within the logic model, *proximal* outcomes are: to improve motivations and interests, increase multiple skills, expose students to college-going culture and rigor, and prepare students with needed information to successfully enroll and complete higher education. Proximal outcomes increase the chances of postsecondary access. Participation is also believed to increase the odds of postsecondary success through decreasing the financial burdens and time constraints associated with higher education. Measured *distal* outcomes include postsecondary entrance, persistence, and attainment. Associated with attainment are increased earnings and improved long-term quality of life impacts.

Figure 3.1: Logic Model for Advanced CTE and Tech Prep Programs



RESEARCH QUESTIONS

The study is an exploration of the longitudinal outcomes related to participation in advanced CTE programming, Tech Prep. In addition, comparisons between the RGV LEAD consortium area and the rest of Texas are investigated to identify impacts of implementation. For this study, one broad question covers the intent of analyses. How do advanced CTE programs, such as Tech Prep programming, affect student outcomes across the P-16+ pipeline? Specific questions guide research. These are:

RQ1. What student- and school-level characteristics influence Tech Prep participation?

RQ2. Relative to comparable students, what impact does Tech Prep participation have on high school transitions, higher education enrollment, developmental remediation, postsecondary attainment, and workforce participation?

Data

Information for the study comes from the Texas Education Research Center (ERC) clearinghouse.[4] The ERC hosts access to high quality, longitudinal data from the Texas Education Agency (TEA), the Texas Higher Education Coordinating Board (THECB), and the Texas Workforce Commission (TWC). Multiple data sets from all three state agencies are combined using a unique identifier in order to track students over time and different settings.

DEFINITION OF TECH PREP

Past studies have had problems with identifying Tech Prep participants in their analysis (Aliaga et al, 2014; McDavid, Boggs, & Stumpf, 2005). The data for this study overcomes limitations of past research by the use of a unique code within the state data

[4] The research presented here utilizes confidential data from the State of Texas supplied by the Texas ERC at The University of Texas at Austin. The author gratefully acknowledges the use of these data. The views expressed are those of the author and should not be attributed to the Texas ERC or any of the funders or supporting organizations mentioned herein. Any errors are attributable to the author.

system. In 1993, Texas implemented the collection of vocational education coding into its reporting requirements (Brown, 2001). The Texas PEIMS (Public Education Information Management System) collects specific program information on students involved in Tech Prep as well as other CTE program levels.[5]

PEIMS CTE coding is inputted by counselors at the school-level. It first tracks students who took no CTE courses. These are labeled differently from those who participated in CTE courses at differing levels. This coding allows researchers to determine whether students had no exposure to CTE courses, had limited access through individual CTE classes, took a sequential career-oriented program, or were involved in Tech Prep programming (see Table 3.1). This study uses PEIMS developed codes available in TEA data to identify Tech Prep students (e.g., code 3) in their senior year of high school.

Table 3.1: CTE and Tech Prep Status Identifiers in Data Coding

Code	CTE Tech Prep Status
0	No participation in CTE courses
1	Participant in CTE course-taking, but is not participating in a coherent sequence of courses and not Tech Prep
2	Participant in a coherent sequence of courses which develops occupational knowledge, skills, and competencies relating to a career pathway or major; student is currently enrolled in program and taking CTE courses
3	Participant in a Tech Prep program in grades 9-12; programs include an approved CTE coherent sequence of study, courses leading to postsecondary education and training; student is enrolled in CTE or other courses appropriate to that plan

Note. PEIMS started to phase out this specific 0-3 coding in 2011as part of funding structure changes.

[5] PEIMS data codes are presented as they were defined in the years the study covers (i.e., 2009 and 2010 high school years). They differ in other years due to policy and funding changes. Only code 3, which delineates Tech Prep participation, is used in the study. Other students are considered non-Tech Prep.

LONGITUDINAL DATA COLLECTION

Accessing all levels of ERC data, high school cohorts have been matched against higher education and workforce information to compile longitudinal data sets for analysis. Records accessed include information on student demographics and high school participation, postsecondary enrollment and course taking behaviors, higher education graduation files, and workforce participation and wages. Data collection and coding decisions for ERC data are relatively similar to FETPIP (*Florida Education and Training Placement Information Program*) methodologies. Researchers in the CTE field have praised FETPIP reporting methods and requirements as rigorous means of evaluating impact measures across educational transition points (Bragg, 2000; Sambolt & Blumenthal, 2013).

Longitudinal data for high school graduation cohorts from both 2009 and 2010 have been collected. These include basic demographic information as well as unique personal, campus, and district identifiers to be used in multilevel analysis. TEA high school data includes program participation (e.g., Tech Prep, special education, etc.), accountability testing, diploma types, and information on coursework taken from four years of high school (i.e., graduation year plus three academic years prior). Coursework data consist of CTE, dual credit, and dual-CTE courses. Campus-level information is also attached using the graduation year of the student. These contain accountability ratings, school size, and demographics of the student population.

Postsecondary information taken from the THECB includes enrollment in any community college, technical college, private university, or public university in Texas (enrollment in higher education outside of the state is not available in the data).[6]

[6] Prior research on Texas data compared it to information from the National Student Clearinghouse from 2008 and 2009, suggesting less than 9% of seniors leave the state for higher education (Deming, Cohods, Jennings, & Jencks, 2016).

Postsecondary enrollment for each cohort is tracked for four years following high school graduation. Each enrollment year includes the summer(s), fall, and spring semesters. Postsecondary attainment has been collected from the year of high school graduation plus four additional years; this captures higher education graduation concurrent with high school completion as well as four years of potential higher education enrollment. As an example, for the 2009 high school cohort, enrollment data tracks from summer 2009–spring 2013. Postsecondary attainment for the 2009 cohort includes information from 2009-2013. Workforce data from the TWC has been collected on a quarterly basis for five years after graduation and connected to students at varying transition points. Enrollment per year is coded as the summer, fall, winter, and spring quarters to mimic traditional academic calendars. This allows for better tracking of workforce participation in connection to P-16+ transitions.

Table 3.2: Longitudinal Data Collection For High School Graduation Cohorts

	HIGH SCHOOL		POSTSECONDARY		WORKFORCE
Cohort	Courses & Testing	Grad & Campus	Enroll & DevEd	Grad	Work
2009	F2005-SP2006	2009	SU2009-SP2010	2009	3Q2009-2Q2010
	F2006-SP2007		SU2010-SP2011	2010	3Q2010-2Q2011
	F2007-SP2008		SU2011-SP2012	2011	3Q2011-2Q2012
	F2008-SP2009		SU2012-SP2013	2012	3Q2012-2Q2013
				2013	3Q2013-2Q2014
2010	F2006-SP2007	2010	SU2010-SP2011	2010	3Q2010-2Q2011
	F2007-SP2008		SU2011-SP2012	2011	3Q2011-2Q2012
	F2008-SP2009		SU2012-SP2013	2012	3Q2012-2Q2013
	F2009-SP2010		SU2013-SP2014	2013	3Q2013-2Q2014
				2014	3Q2014-2Q2015

Table 3.2 further illustrates the varying types and years of data included in forming longitudinal data sets for each high school graduation cohort. The data sets have been used to create outcomes of interest for each cohort (e.g., enrolled within a year of

graduation, earned an associate's degree, working after postsecondary attainment). Once all connections and variables for each cohort had been created, both cohorts were merged together to create the analysis sample.[7] A full list of the variables are described in Appendix B.

MISSING DATA

Limitations in the extant research have cited several issues with past quantitative studies. These include simplistic methods as well as an inadequate discussion of missing data (Cohen et al, 2003; Fritz et al, 2012; Rojewski & Hill, 2014). In a recent critique, 27 CTE studies were reviewed to find only three which dealt explicitly with missing data (Gemici et al, 2012). Common methods from studies which do mention missing data include listwise, pairwise, and complete-answer deletion methods.

As missing data may occur in both random and non-random manners, the simple deletion of data may reduce power and bias estimates (Lee, 2012). The inclusion of more complex methods for missing data is needed. In this study, missing data, assumed to be *Missing At Random* (MAR), is replaced by the application of multiple imputation. *Multiple imputation* has long been used a tool to provide accurate estimates for missing data. Its key characteristic is the use of multiple iterations (*m*) of simulated values to produce estimates for missing values (Enders, 2010; Ruben, 1987; Schafer, 1997). Multiple imputation methods calculate missing values based off of parameter estimates which have been computed from cases with no missing values. They predict values using regression techniques that input independent predictors, or covariates, made up of important student information and proposed outcome(s) of interest. The method uses multiple iterations—imputations—to converge on the most likely estimate for each missing data value (Ruben, 1987; 1996).

[7] Over 130 individual data files from the Texas ERC were merged to create the longitudinal data sample.

Very few variables in this study presented missing data. And, all had sufficiently low percentages of missing cases making multiple imputation a reliable tool to complete the data while limiting bias and retaining statistical power in analysis (Schafer, 1997; 1999). Table 3.3 shows the specific variables with missing information and the percentage of missing cases within the total sample. Using an iteration of *m*=20, missing cases for each variable have been imputed by regressing the following covariates into multiple imputation models:

- Student-Level Predictors: Mean Days Absent, Ethnicity (White, Black, Hispanic), Gifted Participation, LEP Participation, Tech Prep Participation, and DAP Diploma; and
- Outcomes of Interest: Transition Year Higher Education Enrollment, Transition Year Workforce Participation, Overall Higher Education Enrollment, Developmental Education Participation, Higher Education Attainment, Postsecondary Completion, and Workforce Participation.

Table 3.3: Multiple Imputation of Variables with Missing Data

Variable	Percent Missing
Low-SES	7.68%
Special Education	7.68%
Met Math TAKS	13.52%
Met Reading TAKS	13.48%
Dual Credit Course Hours*	0.23%
CTE Course Hours*	0.23%
Dual-CTE Course Hours*	0.23%

Note. * Denotes variables which have been mean centered.

SAMPLE STATISTICS

Combining all data yields a sample of 534,035 students—259,778 graduates from 2009 and 274, 257 graduates from 2010. Just over 6% of the sample is from the RGV LEAD area. Eleven percent—118,602 students—were coded as Tech Prep in their senior year. In a rundown of the P-16+ outcomes of the study, 57% of the sample transitioned to some form of higher education within a year of their high school graduation; 65% of the sample enrolled in postsecondary education within four years. Of those enrolled (347,175), 43% took developmental education as part of their coursework. Twenty-five percent (85,720) of enrolled students attained a postsecondary credential representing 16% of all high school students from both graduating cohorts.[8] A vast majority of those with a higher education credential entered the workforce within a year of completing their certificate or degree, 83% or 70,954. This represents 13% of the original high school graduate sample. A fuller explanation of the descriptive statistics and the sample, including Tech Prep and RGV LEAD comparisons, may be found in Appendix C. These illustrate the enrollment numbers of Texas students from these two graduating cohorts. For the purposes of the study, this sample is utilized to explore the first research question, asking what student- and school-level factors influence Tech Prep. In addition, the sample is also used to create a more refined and smaller, quasi-experimental sample-set.

Methods

A variety of methods and analytic techniques are applied to the data in order to explore outcomes and answer research questions. Descriptive analysis of inputs and outcomes across the full data sample are viewed in Appendix C. This includes comparisons between students participating in Tech Prep to those not, as well as those in RGV LEAD areas compared to Texas. Comparisons across groups are not sufficient to measure the impact of CTE participation though. A limitation of current research includes the lack of proper controls when comparing students in advanced CTE

[8] Postsecondary graduates include students with any higher education credential within the year concurrent with high school graduation to four years after their diploma (i.e., a four-year graduation rate). This does not include students who are enrolled in higher education and are on track to earn a degree in five or six years, that data is yet to be collected.

programs, such as Tech Prep, against traditional academic tracks. Very few studies control for observable student characteristics or school contexts which impact estimates through selection bias (Bozick & Dalton, 2012; Lewis & Overman, 2008; Rojewski & Xing, 2013). Remedies to control for bias include the matching of students across various curricular programs on observable characteristics. The current study uses matched propensity scores to create comparisons for the treatment group, Tech Prep participators.

PROPENSITY SCORING

Statistical analyses are used to control bias in observational characteristics which differ across Tech Prep participants and other students. Limiting bias occurs through the matching of comparable students or groups. There are many ways by which individuals can be matched. The simplest method is to match one student to another individual if they both share the same characteristics for all variables. This has the advantage that all students in the treated group (i.e., Tech Prep participants) have an identical student in the control group (i.e., students not participating in Tech Prep). The disadvantage is that students are highly varied and the majority of cases would not have an exact match (Rosenbaum & Rubin, 1983; West et al, 2014). To remedy this, summary matching measures which account for differences are used.

Summary measures take many variables and turn them into one set, or measure. Matching students on the basis of having a similar summary measure is called a propensity score. *Propensity Score Matching* (PSM) is employed to create a control group for use in comparison to Tech Prep participation. PSM modeling creates a match based on the predicted probability a student will enroll in the treatment; in this case CTE Tech Prep programming (Rosenbaum & Rubin, 1983; 1984). PSM is a two-step process which first models the predicted probability of all students enrolling in Tech Prep, and then matches Tech Prep to non-Tech Prep students to form a control and treatment group.

Creating a Propensity Score

First, propensity scores are developed by determining the odds of enrollment in Tech Prep for all students. Estimated propensity scores are calculated for each student as the probability of treatment given a number of characteristics or covariates. The formula for propensity scores can be explained as such: e(x) is the propensity score, P is the probability, T = 1 is the treatment indicator with values of 1 for treatment and 0 for control, and X represents a set of observed covariates the treatment is conditional upon (Thoemmes, 2012).

$$e(x) = P(T = 1 \mid X)$$

There is much discussion as to what covariates to include into the propensity scoring model. Decisions on covariates are determined by past theory and research as well as an effort to create a balanced model for the secondary step of matching in PSM (Austin, 2011; Guo & Fraser, 2010; Heckman, Lalonde, & Smith, 1999). Covariates for multivariate models are more difficult to determine given the bias inherent in many clustered (i.e., nested) data (Hughes, Chen, Thoemmes, & Kwok, 2010; Thoemmes & West, 2011). Where possible, it may be useful to include multivariate random slopes to allow for matching within clusters. Where imbalanced or impractical, the use of school-level indicators alone may better account for clustered data; they allow for balanced measures though do not create within-cluster matches (Hughes et al, 2010; Long, Conger, and Iatorola, 2012; West et al, 2014).

Taking into consideration past research, available data, and difficulties inherent in matching students within campuses, the final model for propensity scoring includes both student- and school-level indicators without random effects. This decision allows for the inclusion of campus information while not requiring within-campus matches. It creates a balanced matching of student groups (West et al, 2014). Variables included in the modeling of propensity scores are:

- *Demographic Covariates*: Mean Days Absent, Gender, Low-SES, Ethnicity (Black, White, Hispanic), Gifted & Talented, LEP, and Special Education;
- *Academic Covariates*: Met Math TAKS, Met Reading TAKS, Mean Dual Credit Course, RHSP Diploma, and DAP Diploma; and
- *Campus-Level Covariates*: RGV, Mean Percent White, Mean Percent Low-SES, Acceptable Rated, Exemplary Rated, Small School, and Large School.

Matching Propensity Scores

The covariates detailed above are used to calculate propensity scores which are then matched creating a balanced PSM sample. The estimated probability of Tech Prep participation—the propensity score—is saved as an additional variable for all students. Each student in the treatment group (i.e., Tech Prep participants) is matched to a student not in the group. Using a *nearest neighbor* technique, a Tech Prep participant is first selected. Their propensity score is matched to a student with the closest, or most similar, propensity. That student enters the control group and is taken out of the pool of potential matches (i.e., matching without replacement). The selection and matching process is repeated until there are no longer untreated students which can be matched to a Tech Prep participant (Austin, 2012; Haviland, Nagin, & Rosenbaum, 2007). The threshold for matching is measured by a preset caliper so pairs will not be made between dissimilar students (Austin, 2012; Guo & Fraser, 2010). A caliper is the maximum allowed distance, measured in standard deviations, between propensity scores before a match will not be made. Smaller calipers create more similar matches (West et al, 2014).

PSM Sample

The PSM model was calculated using probit regression then matched using the nearest neighbor technique with no replacement and a caliper of (.001). It created a smaller sub-sample of the original sample drawing only treatment and control matched cases. The resulting sample size is 232,268 students, evenly split between Tech Prep and control groups. Forty-eight percent of the sample is comprised of students graduated in 2009 (110,779) and 52% in 2010 (121,489). Nine percent of the sample represents students from the RGV LEAD consortium area. In P-16+ outcomes, 60% of the sample transitioned to higher education within a year of high school, 68% enrolled in higher education within four years. Of those enrolled, 42% took some form of developmental education. Twenty-five percent of enrolled students attained a postsecondary credential (39,874) representing 17% of the total sample. Of those with a higher education degree or certificate, 83% entered the workforce within a year of completing their certificate or degree (33,225) representing 14% of the total sample.

PSM Balancing

The PSM procedure resulted in a parsimonious model, creating a balanced sample of treated and non-treated cases. In other words, the PSM process created a sample which controls for inherent bias allowing for improved Tech Prep comparisons. PSM procedures call for balancing diagnostics to ensure there are no statistical differences between the treatment and control groups on inputted covariates. These tests help to identify correct specification of the propensity model. Diagnostics include checking the distribution of propensity scores and covariate means before and after PSM (Rosenbaum & Rubin, 1984).

Figure 3.2: Distribution of Propensity Scores Before and After PSM

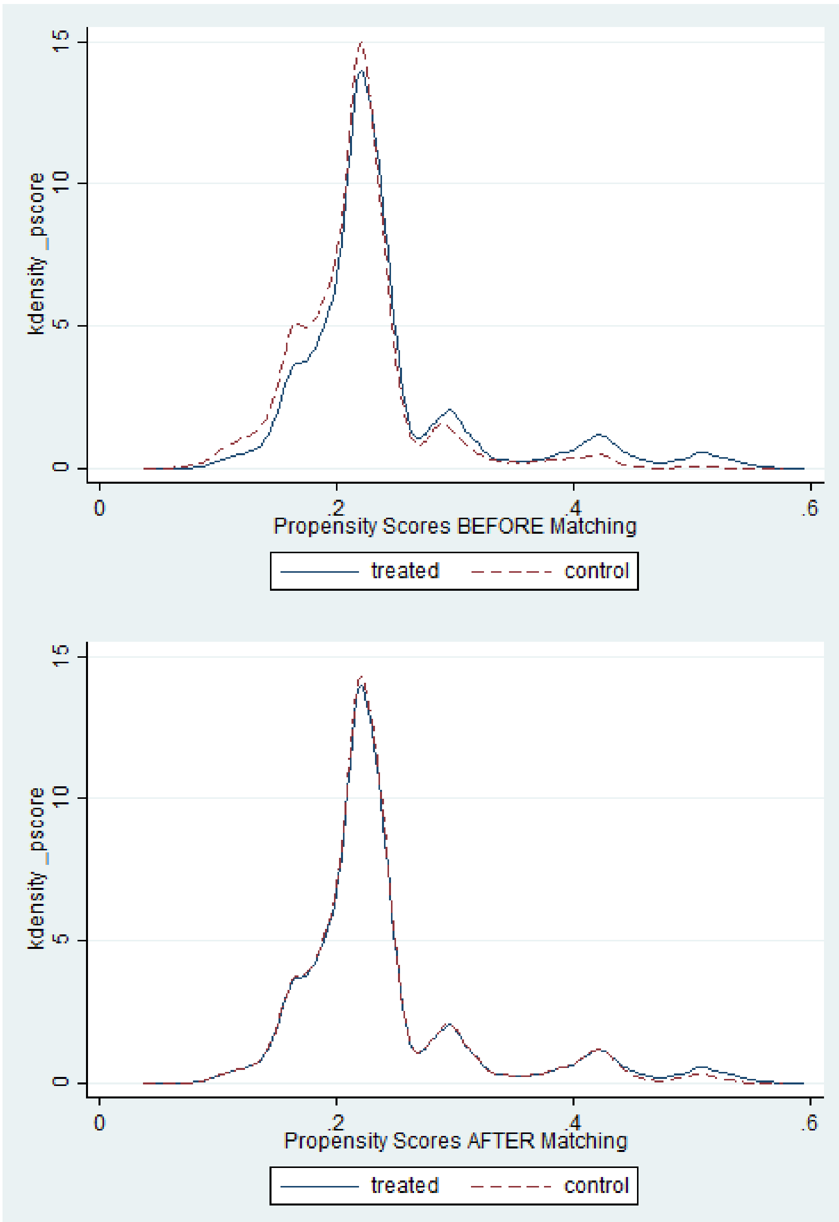
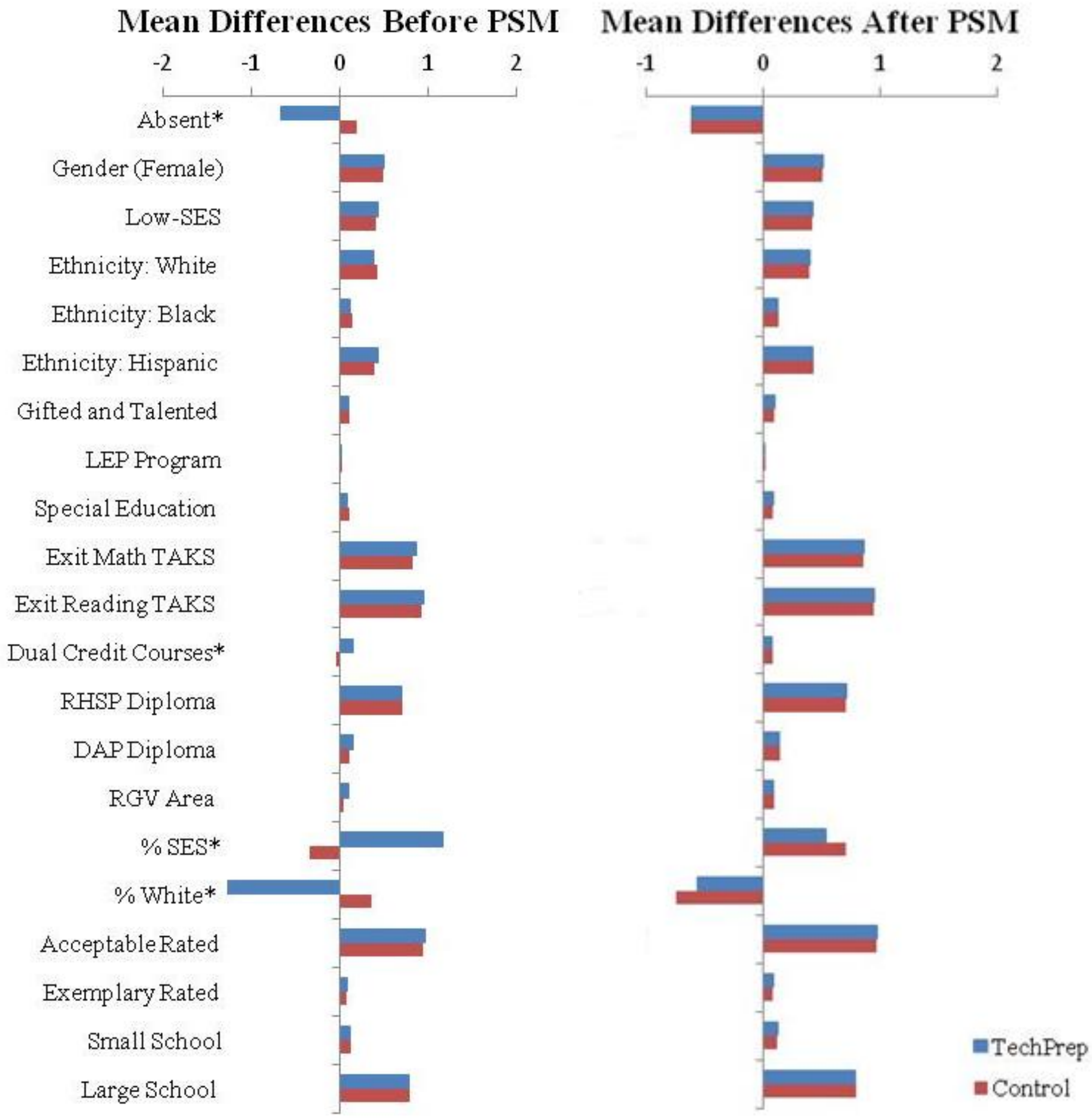


Figure 3.3: Balance of Covariates Before and After PSM



Note. * Denotes a mean or grand mean centered variable.

Figure 3.2 depicts the distribution of propensity scores both before and after PSM procedures. The first chart shows variability between the treatment and control groups before matching while the distribution of propensity scores after matching, in the second chart, is evenly distributed. Figure 3.3 shows plotted bars of means for both Tech Prep and control groups before and after PSM on 21 covariates used in creating the model. The plots illustrate the mean difference before and after PSM for each covariate. Before matching, some variables were unevenly distributed across groups while after, the covariate means in both groups were closer to equal.

In addition to visual inspection, there are statistical tests to determine balance in the PSM sample. Tests include looking at the level of standardized bias in the PSM sample and t-tests of covariate means. Standardized bias is the difference in means (treatment − control) for the covariate divided by the standard deviation. The remaining standardized bias in a covariate after PSM should be less than three percent (Caliendo & Kopeinig, 2005). T-tests between covariates (treatment and control groups) are also considered.

Before matching significant differences are expected, but after PSM covariates should be balanced and leave no significant differences (Caliendo & Kopeinig, 2005; Rosenbaum & Rubin, 1985). Table 3.4 shows both the standardized bias after PSM as well as t-tests for covariate means in the matched sample. No covariate shows significant bias or significant differences ($p<.01$) after matching, suggesting the PSM model is balanced. The goal of the two-step PSM is to produce balanced distributions of cases within the samples of treated and untreated groups (West et al, 2014). All results suggest success in the PSM model and sample.

Table 3.4: Balancing Tests on PSM Covariates

	Mean Treated	Mean Control	% Bias	T-Test
Student				
Days Absent	-0.609	-0.612	0%	0.09
Gender (Female	0.508	0.511	-0.6%	-1.39
Low-SES	0.425	0.426	-0.2%	-0.54
Black	0.401	0.400	0.1%	0.3
Hispanic	0.128	0.128	0.1%	0.17
White	0.427	0.428	-0.3%	-0.62
LEP	0.019	0.021	-0.8%	-2.26
Special Education	0.086	0.087	-0.3%	-0.71
Gifted & Talented	0.098	0.096	0.8%	1.99
Met Exit Math	0.859	0.859	0.1%	0.21
Met Exit Reading	0.948	0.947	0.5%	1.16
Dual Credit	0.073	0.081	-0.5%	-1.09
RHSP Diploma	0.708	0.707	0.3%	0.63
DAP Diploma	0.144	0.143	0.4%	0.92
School				
RGV	0.093	0.095	-0.6%	-1.32
Percent Low-SES	0.538	0.707	-0.7%	-1.64
Percent White	-0.556	-0.740	0.6%	1.56
Rated Acceptable	0.970	0.969	0.8%	2.12
Rated Exemplary	0.084	0.084	0%	0.02
Small School	0.125	0.123	0.8%	2.08
Large School	0.793	0.798	-1.1%	-2.57*

Note. *<.05, no covariates significant at p<.01

A Note on Selection Bias

Propensity scoring has been found as a reliable method to limit selection bias in many areas (Melguizo Kienzl, &Alfonso, 2011; Rosenbaum, 2002; Shadish, et al, 2002). In this study it is used to account for the differential bias of certain student and school characteristics such as student race, background, and school impacts (Guo & Frasier, 2010). The method is unable to account for the selection bias of choosing a program. While the use of selection bias tools are traditionally meant to account for as many factors as possible, it is important to note that in the case of interventions like Tech Prep, the self selection into a program is an important factor which should be tested rather than merely controlled for. The theory of action behind Tech Prep suggests that programs entice students towards involvement and participation. Random assignment into a program, or mathematical models equivalent to random assignment, would not correctly match program intent (Bishop & Mane, 2004; Kelly & Price, 2009). PSM measures help provide a balanced sample from which to test the efficacy of program participation, part of which is includes students' decision to participate in Tech Prep.

HIERARCHICAL LINEAR REGRESSION

Inferential analysis employs the sample created by the PSM procedure to explore impacts of participation in Tech Prep compared to the matched control group. Outcomes are measured at varying points along the P-16+ pipeline. As students are nested within several different structures and institutions, multilevel hierarchical modeling is applied for all statistical procedures (Nimon, 2012; Stevens, 2009). This type of modeling, sometimes referred to as *Hierarchical Linear Modeling* (HLM), allows for better statistical estimates as it takes into consideration the clustering of students within schools. Models also consider the effect of such clusters. Multilevel equations are able to control for the school a student attended when identifying results, and also provide meaningful context based on estimates of campus characteristics (Gelman & Hill, 2007; Raudenbush & Bryk, 2002; Raudenbush, 2002; Riese & Duan, 2003; Schudde, 2011).

Nimon (2012) outlined the need for HLM in CTE studies as he overviewed the body of current research. He established there are issues with researchers aggregating data in ways which limit findings. Few CTE Tech Prep studies have incorporated HLM in their analysis to provide better estimates of clustered data (Alfred et al, 2006; Field, 2003; Melguizo et al, 2011).

Logistic Regression

Outcomes associated with P-16+ pipeline transitions are dichotomous in nature, with yes or no outcomes. As such, statistical analysis employs the use of logistic regression which takes restricted outcomes and forms odds out of the probability of a successful outcome, or a yes in a yes/no situation. The outcome variable of a logistic regression, then, is the log odds that such outcome will occur. Each covariate in the model predicts the difference in the odds that the outcome of interest will occur. Using predictor variables to formulate an odds estimate for the outcome of interest, it may then be turned back into a probability of occurrence (Gelman, & Hill, 2007; Stevens, 2009). In this way, equation models such as these are fitted for each outcome of interest.

$$\ln(\pi_{ij}) = (\beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2ij} + \beta_3 x_{1ij} x_{2ij} \ldots + \varepsilon_i)$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01} W_{1j} \ldots + u_{0j}$$

$$\beta_{1j} = \gamma_{10}$$

In this equation, the dependent variable is the log odds of student *i* in high school *j* experiencing the outcome of interest (e.g., enrollment, attainment, etc). The β terms are the estimates of the impact of the student-level covariates (x_{ij}) on the log odds. Coefficients β_{1-3} are recurrent; they suggest the relationship between a student-level predictor (x_{1ij}), Tech Prep participation (x_{2ij}) and the interaction between the two variables ($x_{1ij}x_{2ij}$). In the intercept, β_0: W_{1j} represents level-two school characteristics related to the outcome in the model, and μ_{0j} represents high school within-campus effects.

Information on effects are displayed in the findings section with statistical tests for fixed effects shown by odds coefficients (γ_{10}) and tests of random effects shown by tests of their corresponding variance (u_{0j}). For interpretive purposes, fixed effects results describe how certain variables impact the outcome of interest wherein random effects are included in the model to better estimate and explain the clustering of variance between and within schools given a certain outcome (Gelman, & Hill, 2007; Kreft, & De Leeuw, 1998).

In the findings section log odds, odds, and relevant probabilities associated with those odds are presented for each outcome of interest, whether it is high school transitions, higher education enrollment, developmental remediation, postsecondary attainment, or workforce participation. They are defined and calculated as:

Log odds are the expected outcome of a logistic model: $\ln(\pi_{ij}) = \ln\left(\frac{\pi}{1-\pi}\right)$

Odds are calculated using the equation: $e^{\ln\left(\frac{\pi}{1-\pi}\right)}$

Odds are calculated for coefficients estimates using: $e^{\beta_{ij}}$ or $e^{\beta_1 x_1 + \beta_2 x_2 + \beta_3 x_1 x_2}$

Probabilities are calculated using the equation: $\frac{e^{\ln\left(\frac{\pi}{1-\pi}\right)}}{1+e^{\ln\left(\frac{\pi}{1-\pi}\right)}}$ or $\frac{e^{\beta_{ij}}}{1+e^{\beta_{ij}}}$

Explored Outcomes

Analysis for the study is comprised of multilevel modeling of logistic regression on a selection of 18 outcomes. The full sample of 2009 and 2010 cohorts is used to identify factors important to Tech Prep participation (*N*=534,035). To explore the impacts of Tech Prep participation at varying transition points on the P-16+ pipeline, the PSM sample is employed (*n*=232,268). Special attention in modeling is given to the relationship between Tech Prep participation and outcomes, Tech Prep in relation to other student characteristics, and membership within the RGV LEAD area as a measure of consortia implementation. Outcome modeling is organized into five P-16+ transition areas. The areas and specific outcome models include:

- Tech Prep Participation
- High School Transitions
  - Transitioning to Higher Education Within a Year of High School Graduation (TRHE)
  - Transitioning to a Community College Within a Year of High School Graduation (TRCC)
  - Transitioning to a University Within a Year of High School Graduation (TRU4)
  - Transitioning to the Workforce Within a Year of High School Graduation (TRWK)
- Higher Education Enrollment
  - Enrolling in Higher Education Within Four Years of High School Graduation (ENRHE)
  - Enrolling in a Community College Within Four Years of High School Graduation (ENRCC)
  - Enrolling in a University Within Four Years of High School Graduation (ENRU4)
- Developmental Remediation
  - Participating in Developmental Coursework While Enrolled in Higher Education (DE)
  - Participating in Mathematics Developmental Coursework While Enrolled in Higher Education (DEM)
  - Participating in Reading Developmental Coursework While Enrolled in Higher Education (DER)
  - Participating in Writing Developmental Coursework While Enrolled in Higher Education (DEW)
- Postsecondary Attainment (For Students Enrolled in Higher Education)
  - Earning a Higher Education Credential (HEGRAD)
  - Earning an Associate's Degree (AA)
  - Earning a Bachelor's Degree (BD)
  - Earning a Higher Education Certificate (CERT)
- Workforce Participation
  - Transitioning to the Workforce Within a Year of Earning a Postsecondary Credential (HEJOB)
  - Transitioning to the Workforce (Two Jobs) Within a Year of Earning a Postsecondary Credential (HE2JOB)

Model Specification

Table 3.4: Potential Variables for Explored Outcomes

Outcome	Level-One	Interactions	Level-Two
TECHPREP	Grad2009	TPxGrad	RGV
TRHE	Mean Days Absent	TPxAbsent	GMC % Low-SES
TRCC	Gender	TPxSex	GMC % White
TRU4	Low-SES	TPxSES	Rated Acceptable
TRWK	Black	TPxBlack	Rated Exemplary
ENRHE	Hispanic	TPxHisp	Small School
ENRCC	White	TPxWhite	Large School
ENRU4	LEP	TPxLEP	
DE	Special Education	TPxSped	
DEM	Gifted & Talented	TPxGT	
DER	Tech Prep*	- - - - -	
DEW	Math TAKS	TPxMath	
HEGRAD	Reading TAKS	TPxRead	
AA	Mean Dual Credit	TPxDC	
BD	Mean CTE	TPxCTE	
CERT	Mean Dual-CTE	TPxDCTE	
HEJOB	RHSP Diploma	TPxRHSP	
HE2JOB	DAP Diploma	TPxDAP	
	TRHE*	TPxTRWK	
	TRWK*	TPxTRWK	
	CCR	TPxCCR	
	CCRM	TPxCCRM	
	CCRR	TPxCCRR	
	CCRW	TPxCCRW	
	DE*	TPxDE	
	AA*	TPxAA	
	BD*	TPxBD	
	CERT*	TPxCERT	

Note. * Some outcomes are used as level-one predictors in other outcome models.

Covariates for selected outcomes include information delineated in Table 3.4 which details the potential variables included in all outcome models. Appendix B explains variable names and provides descriptions of their meaning. Outcomes include student-level information, campus-level characteristics, and possible interactions between Tech Prep. Equations allow the treatment effect of Tech Prep to be connected to student-level characteristics; these are tested as interactions to view further, more complex effects. In analyses of all outcomes, backwards modeling is used (Gelman & Hill, 2007; Stevens, 2009). Base modeling starts with all student- and campus-level variables as well as all potential interactions between Tech Prep and student-level indicators. When interactions are found to be insignificant, the equation is trimmed to only significant interactions and main effects. This form of modeling continues iterations until the best fitting equation converges. Final models contain all student- and campus-level effect estimates—regardless of significance—and significant interaction estimates.

CHAPTER FOUR: FINDINGS

The study is an exploration of the longitudinal outcomes related to participation in advanced CTE programming, Tech Prep. Data collected from high school, higher education, and workforce sources are used to track and compare outcomes. Quasi-experimental, PSM methods are employed to further refine data in order to better explore the impacts of Tech Prep participation. In all analyses, multilevel modeling is applied to account for the nested structure of students in schools; these models investigate the effect of CTE Tech Prep participation on transition points within the P-16+ pipeline.

Inferential analyses are presented in the findings section below. The first research question of the study—what student- and school-level characteristics influence Tech Prep participation—is examined with the full data sample from 2009 and 2010 high school graduation cohorts (N=534,035).[9] A multilevel logistic regression is used to investigate potential factors affecting the odds of CTE Tech Prep participation.

The second research question explores the impacts of CTE Tech Prep participation on five key areas: high school transitions, higher education enrollment, developmental remediation, postsecondary attainment, and workforce participation. These are calculated using a quasi-experimental sample which has been propensity scored and matched to decrease selection bias (n=232,268). In all, 17 models are presented which study the influence of student traits, academic indicators, and campus characteristics on outcomes associated with the P-16+ pipeline. Models are organized into the five areas of interest.

For all analyses, student- and school-level fixed effects are presented as well as significant interaction terms. Random effects are discussed as they relate to remaining

---

[9] Descriptive analysis of inputs and outcomes also utilize the full sample; tables are viewed in Appendix B. This includes comparisons between students participating in Tech Prep to those not, as well as those in RGV LEAD areas compared to Texas. Only inferential statistics are discussed in the findings section.

variance. Asterisks mark the level of significance and coefficient estimates signify either an increase or decrease in the log odds of the expected outcome (e.g., a positive coefficient is associated with an increase and a negative coefficient is associated with a decrease in log odds). To put findings into a more meaningful perspective, significant main effects and interaction terms are described in detail. Covariates are transfigured into either odds or predicted probabilities. Descriptions of estimates hold all other variables and estimates in the model constant. Means and standard deviations of covariates, as well as intercorrelations tables for the samples used, are presented in Appendix D. The findings below first describe the characteristics related to participation in Tech Prep then move on to a detailed exploration of impacts at each progressive P-16+ transition point.

Tech Prep Participation

The odds of participation in Tech Prep are calculated using data from the complete sample of 2009 and 2010 high school cohorts (*N*=534,035). The model explores student- and school-level characteristics which impact participation. Table 4.1outlines findings from the multilevel logistic regression calculating the odds of participation in Tech Prep. Many factors significantly impact participation. Graduates in the 2009 cohort are less likely to participate in the CTE program than 2010 graduates; 2009 graduates have a 47% predicted probability of participation. The number of days absent during senior year, while significant, has little impact on participation. Students with 20 more absences than the average are only 1% less likely to enroll in a Tech Prep program. Women are slightly more likely to participate than their male counterparts. And, students of low-socioeconomic—low-SES—backgrounds are significantly more likely to enroll; they have a 53% predicted probability of participation in Tech Prep.

Ethnicity has been effect-coded (e.g., dummy-coded) in all analysis models; factors include Black, Hispanic, and White students leaving Asian and Native American students as the reference grouping. Hispanic students are positively linked to Tech Prep participation with a 54% probability of enrollment. A student identified as LEP (Limited English Proficient) is significantly less likely to enroll in Tech Prep programs. Their probability of enrollment is only 34%. Students from across the spectrum of special programs are also significantly less likely to participate in Tech Prep programs. Special education students have a predicted probability of enrollment of 48% while students in Gifted and Talented (GT) programming have a 41% chance of participation. These results suggest the largest block of participants come from students not enrolled in any sort of targeted support or enrichment programs.

Several variables are included in the model as indicators of achievement and academic rigor. All of these characteristics are significantly and positively linked to participation in Tech Prep. Indicators include whether or not a student passed their mathematics and reading exit exams. Known as the Texas Assessment of Knowledge and Skills (TAKS), these tests are given to students in their junior year of high school; they count towards graduation and state accountability measures. Those who passed both math and reading TAKS are more likely to be enrolled in Tech Prep; those passing math TAKS have a 55% predicted probability of enrollment. Enrollment in dual credit courses are also positively linked to Tech Prep. Students taking the average number of dual credit courses (M=0.63, or slightly above a semester-long course) have a 52% chance of enrollment. With each additional, year-long dual credit course, the probability grows by 1-2%. Lastly, students who graduated with college ready degree plans are linked to greater participation in Tech Prep. Students who gained the Recommended High School

Plan (RHSP) diploma, as well as the more advanced Distinguished Achievement Plan (DAP) degree, both have a 54% predicted probability of enrollment in Tech Prep.

In addition to student-level characteristics, there are a host of school-level indicators which influence participation in Tech Prep. RGV LEAD area affiliation has the largest impact. Students from the RGV consortium have 8.62 greater odds of enrollment. Clearly, students from RGV LEAD high schools are more likely to enroll in CTE Tech Prep compared to students in Texas high schools at large, holding all else constant.

Characteristics of a school's student population impact individual student participation in Tech Prep. Both the percentage of low-SES students and the percent of minority students negatively affect participation.[10] For this and all models, both indicators are *Grand Mean* (GM) centered to better interpret results. The percent of low-SES students on a campus (*GM*=46.87%) results in a predicted probability of 50%, a twenty point increase in low-SES students at a campus results in a lower possibility of individual participation (47%). The impact of student ethnicity is even greater. Each 10 point decrease from the mean percent of white students (i.e., the converse of minority students) results in a 4-5% point drop in the predicted probability of Tech Prep participation. Put another way, the larger the white population of a campus, the greater the odds of participation in Tech Prep for its students; a growing minority population at the campus-level decreases the probability of individual Tech Prep participation.

The state accountability rating of a school, granted the year of the individual students' high school graduation, is only partially significant. Campuses rated *Acceptable* under the Texas accountability rating system have a positive impact on Tech Prep

[10] The percent of minority students at a high school campus is included in the model using the variable percent of white students (GM centered). This number represents all white students, leaving the converse—minority students—as its opposite. A significant, positive relationship to *Percent White* at the campus-level corresponds to higher odds of participation as the average number of White students in a school rises. Conversely this indicates the predicted probability of Tech Prep participation drops as minority enrollment increases.

participation compared to schools which failed to meet accountability requirements. Schools rated as *Exemplary*, the highest possible accountability rating, do not have significant differences though. This suggests the highest performing schools do just as well as Acceptable campuses in supporting CTE participation. Lastly, large high schools—those with enrollments over 750 students—correspond to a greater predicted enrollment in CTE Tech Prep, with a 56% chance of enrollment for students.

The random effects estimates show some variability in the model across schools when accounting for all student- and school-level factors. The variance is 4.674 with a 95% confidence interval between 4.27-5.12%. This estimate suggests that, within measurements of Tech Prep participation, there is still dissimilarity at the campus-level which is unexplained by the present indicators. Random effects are larger for this particular model in the study given it utilizes the full cohort sample. Variance measures for all other models are considerably smaller as they come from a balanced PSM sample.

As a note, the model shown in Table 4.1 is not the equation used in creating propensity scores for the PSM sample. The model, and its factors, did inform the modeling process for propensity scoring but did not result in the final, balanced equation used for matching.

Table 4.1: Odds of Participating in a Tech Prep Program in High School

	Coefficient	SD
FIXED EFFECTS		
Intercept, γ_{00}	-3.063	0.095
Student (Level 1), β_{1j}...		
Grad Year (2009), γ_{10}	-0.102**	0.009
Days Absent, γ_{20}	-0.002**	0.000
Gender (Female), γ_{30}	0.047**	0.008
Low-SES, γ_{40}	0.104**	0.009
Black, γ_{50}	0.018	0.022
Hispanic, γ_{60}	0.146**	0.020
White, γ_{70}	-0.004	0.019
LEP, γ_{80}	-0.648**	0.028
Special Education, γ_{90}	-0.085**	0.016
Gifted & Talented, γ_{100}	-0.354**	0.014
Met Exit Math, γ_{110}	0.198**	0.012
Met Exit Reading, γ_{120}	0.097**	0.018
Dual Credit, γ_{130}	0.068**	0.003
RHSP Diploma, γ_{140}	0.163**	0.013
DAP Diploma, γ_{150}	0.173**	0.018
School (Level 2), β_{0j}		
RGV, γ_{01}	2.154**	0.298
Percent Low-SES, γ_{02}	-0.005**	0.002
Percent White, γ_{03}	0.019**	0.002
Rated Acceptable, γ_{04}	0.115**	0.031
Rated Exemplary, γ_{05}	-0.011	0.029
Small School, γ_{06}	-0.042	0.080
Large School, γ_{07}	0.251**	0.084
	Variance	**SD**
RANDOM EFFECTS		
Institution (Intercept), u_{0j}	4.674	0.216

Note. **p<.01, *<.05
Students=534,035 High Schools=1,776

High School Transitions

The study includes an exploration of the impacts of CTE Tech Prep participation on longitudinal outcomes related to the P-16+ pipeline. The first transition in the pipeline examines the shift from high school graduation to college and/or career participation. This, and all other P-16+ outcomes, are explored using a PSM matched sample which controls selection bias across students in Tech Prep and a generated control group of non-participants (n=232,268). PSM, a quasi-experimental sampling method, allows for greater validity in results and provides a clearer picture of Tech Prep participation compared to similar students who did not enroll in the program.

Transitions from high school to higher education and/or workforce participation are measured in the first year after graduation. Four outcome models are created which encompass enrollment in any postsecondary institution, enrollment in community college and the university level, and entry into the workforce. Models outputs are viewed in Tables 4.2-4.5 while findings from all models are discussed below.

Student Traits

First, students in the 2009 high school cohort are found to have a greater probability of enrollment in higher education, both overall and at the community college and university levels. The predicted probability of transition at any institution is 52%, with similar odds at both the individual institution types. Graduation year is not significantly related to workforce participation.

Tech Prep participation affects transition enrollment in interesting and diverse ways. Many of the student-level indicators interact with Tech Prep, adding complexity to the odds of postsecondary participation. Odds of enrolling in postsecondary education decrease for the control group (i.e., non-Tech Prep students) according to a rise in the number of days absent. The odds of enrollment increase for students in Tech Prep programs. For students not enrolled in Tech Prep, the predicted probability of transition with an average number days absent (*M*=10.16) is 49%; probabilities decrease by 6% for every 10 additional days absent. For students who participated in Tech Prep, the probability of transitioning into higher education is greater (59%). With an additional rise in absenteeism, probabilities grow even higher. Findings suggest Tech Prep may help students who have trouble attending high school. The relationship with absences is similar in the model for community college enrollment though differs for enrollment at the university level. For the odds of enrolling at a university within a year, the probability of Tech Prep and non-Tech Prep students is similar given an average rate of absences (49%). An increase in the number of absences decreases the odds of enrollment for both groups by differing levels; those in the control group maintain a 2% advantage over Tech Prep students. The rate of attendance is strongly related to entry into the workforce upon high school graduation. More than 20 days absent during senior year results in a near perfect probability of workforce entry the year after high school.

Gender maintains a significant interaction with Tech Prep in all three transition enrollment models. Women who participated in Tech Prep have a greater prospect of attending higher education than women in the control group, 66% to 54%. The interaction trend is analogous for community college enrollment and, though smaller in size, similar in higher education enrollment, 53% to 52%. Gender has a very slight impact on workforce participation with greater odds given to women entering the transitional workforce. Students from low-SES backgrounds have a negative relationship within each model. Predicted probabilities for low-SES students participating in higher education range from 41-49%.

Ethnicity proves to be an important interaction. In effect-coded variables, Tech Prep students have greater odds of participation than their control group peers. This interaction is only significant in the model for overall enrollment. The probability of a Black Tech Prep student enrolling in higher education after high school is 58% compared to a Black student in the control group at 52%. Likewise, a Hispanic student in Tech Prep has a 45% predicted probability of enrollment while a similar student in the control group only has a 40% likelihood. Lastly, a White Tech Prep student has a predicted chance of 51% while their peer has a 47% probability. Of note, a white student in the control group has a greater probability of enrollment over a Hispanic student in Tech Prep (47% versus 45%). In the modeling of community college enrollment, only Black students have a positive interaction with Tech Prep (51% versus 47%). Main effects for ethnicity in the university transition model are significant. Black students are slightly more likely to enroll at the university level with 1.15 greater odds. Hispanic students have the lowest predicted probability of enrollment at 31%, holding all else constant. Race and/or ethnicity is positively related to workforce participation within a year of high school graduation. All groups range from 66-70% in their predicted probability of working. The lowest proportion of students entering the workforce after graduation are the reference coded, Asian and Native American groups of students (42%).

LEP students in Tech Prep are more likely to enroll in higher education after high school compared to similar control students, though both have lesser odds of enrollment than students not labeled as LEP. Tech Prep LEP students have a predicted probability of 42% while those in the control group only have a 39% probability. At the community college level, the trend is comparable though the probability of participation is slightly higher, 46% compared to 45%. There is no interaction at the university level, however, LEP is significantly and negatively associated with overall enrollment; LEP students have only a 24% predicted probability of enrollment. Similarly, LEP students have a 32% predicted probability of transitioning to the workforce upon high school graduation. The odds related to special education students are parallel in structure although they are not quite as low. There is a significant, positive interaction between Tech Prep and special education status for overall and community college transition. For overall enrollment, predicted probabilities range from 58% for Tech Prep students to 42% for special education students in the control group. At the university level special education relates to a 27% probability of enrollment. There is a significant interaction in the workforce model. Special education Tech Prep students are more likely to have a job (48%) than those in the control group (41%).

For all enrollment models, students enrolled in GT programs have a greater propensity for postsecondary participation if they are also Tech Prep. For example, in the community college model, GT Tech Prep students have a predicted probability of 48% compared to 36% enrollment for the control group. Of note, the probabilities are much higher at the university level suggesting differences in the type of institution chosen for these students (65-67% for the university-level). Gifted students are slightly less likely to participate in the workforce after high school graduation.

Academic Indicators

When exploring variables that point toward academic rigor and achievement, impacts vary across postsecondary levels. For students who met the exit-level math TAKS, there is a greater predicted probability of enrollment overall as well as at the university level. Those meeting the requirement have a 76% chance of enrollment at a university. Meeting the math requirement results in a slightly lower predicted probability of enrollment at the community college-level. This suggests students who did not pass the test are more likely to enroll at a community college than apply to a four-year university. Reading TAKS interacts with Tech Prep. Tech Prep students who passed the reading TAKS have a greater predicted probability of enrolling in higher education compared to control students, 72% to 61%. The trend is similar at the community college-level. At the university level, reading TAKS is merely associated with a greater probability of transition. Math TAKS is negatively related to workforce participation while reading TAKS is positively related.

The number of dual credit courses a student took in high school positively impacts overall enrollment in higher education after high school. And, dual credit interacts with Tech Prep for even greater odds of transition. Tech Prep students have a higher likelihood of enrollment based on average dual enrollment compared to the control group (63% to 56%). For both groups, an additional year-long course corresponds to an increase in the predicted probability of enrollment by 6-8%. The trend is also present in university enrollment though differences between Tech Prep and control groups are minimal (56% to 55%). At the community college level, dual enrollment corresponds to relatively small changes in the odds of transitional enrollment suggesting dual credit courses are best preparing students to transition to the university level. Dual credit coursework has significant but not meaningful impacts on workforce transitions.

CTE courses students taken during high school has varying impacts on enrollment, especially when including Tech Prep membership in the model. When looking at all overall postsecondary transition, CTE is significantly associated. But, additional courses over the mean (M=5.27) do not result in substantially larger predicted probabilities compared to those who took less CTE. At the community college level, CTE interacts with Tech Prep to provide greater odds of enrollment. Tech Prep students have a predicted probability of 59% compared to 51% for the control group. Additional courses increase the odds for both groups by as much as 7% per year-long credit. At the university level CTE has a positive interaction with Tech Prep and a negative relationship with enrollment. Participation in Tech Prep slightly moderates the negative impact of

CTE but additional coursework for both groups decreases the odds of transition. CTE is positively related to workforce entry and interacts with Tech Prep to provide even higher predicted probabilities of working for those who were in the program. Additional CTE courses increase the odds of working after high school by 3-4%. The number of dual-CTE courses impacts enrollment differently at community college and university levels. Dual-CTE is positively linked to community college enrollment though negatively relates to university enrollment.

Taking together the differing impacts of CTE and dual-CTE, findings suggest these types of courses push students mainly towards workforce and community college transitions, rather than the university level. Interactions with Tech Prep provide evidence that advanced CTE programs do increase successful transitions at all levels and may help broaden opportunities for enrollment.

As one would expect, a college ready degree is positively related to postsecondary transition with a few, interesting, exceptions. Overall, both RHSP and DAP diplomas predict greater odds of enrollment in higher education post-high school. Tech Prep students with a RHSP degree have an even greater likelihood (78%) compared to the control group (72%). Odds of enrollment are the largest for recipients of both diploma types at the university-level. Students with a DAP diploma are negatively associated with enrollment at the community college-level. Tech Prep participation moderates the impact of the association. DAP graduates who participated in Tech Prep have a positive probability of community college enrollment (56%) compared to DAP students in the control group (44%). College ready degrees are negatively associated with workforce transitions. Findings suggest traditional DAP recipients have strong preferences towards universities. Tech Prep programs may either increase the number of students who would not otherwise have completed such an advanced degree plan, or increase the number of

DAP students wishing to complete community college studies as part of their continuing Tech Prep program.

Campus Characteristics

School-level indicators are included in the model to both, control for the type of campus a student attends, and explore the impacts of campus characteristics. Students from RGV LEAD areas have a greater predicted probability of enrollment in all higher education transition models, 61% in overall enrollment, 53% in community college, and 65% in university transitions. These findings suggest RGV is successful in transitioning students to all levels of postsecondary institutions. RGV LEAD students have lower odds of workforce participation upon high school graduation with a 43% predicted probability.

The percentage of low-SES students at a campus only slightly impacts the overall enrollment model; increases in the percentage of students above the mean (*GM*=46.87%) do not significantly decrease an individual student's odds of enrollment. The proportion of minority students at a campus negatively impacts community college enrollment and workforce transitions. The percent of minority students positively impacts university transition. All effects on transitions are minimal, though. An Exemplary performance rating in the state accountability system is negatively associated with community college enrollment and workforce participation, and positively associated with university enrollment. This suggests Exemplary schools are most focused on transitioning students to universities after high school graduation. Small schools are negatively associated with overall enrollment. Large schools are positively associated with enrollment in higher education. The predicted probability of transitioning to higher education for a student from a small school, holding all else constant, is 47% compared to a students from a large school (54%). This trend also exists in the university model though reverses for workforce participation benefitting students from smaller schools. In all, campus-level characteristics play a significant role in predicting a student's probability of transitioning to either college or a career after graduating from high school.

Model Variability

Lastly, random effects estimates illustrate that the models—comprehensive in both student- and school-level characteristics—fail to explain only a small proportion of the differences across schools. Variances range from 0.072 in the modeling of workforce participation to 0.404 for the odds of enrollment at the university level. Overall enrollment in postsecondary education has a computed variance of 0.172 with a 95% confidence interval between 0.15-0.19%. These estimates suggest that, within measurements of high school transition, there is minimal variation left un-modeled between the schools students are graduating from.

Table 4.2: Odds of Transitioning to Higher Education Within a Year of High School Graduation

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-1.698**	0.070			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	0.066**	0.010			
Days Absent, γ_{20}	-0.027**	0.001	*TPxAbsent*, γ_{200}	-0.004**	0.001
Gender (Female), γ_{30}	0.177**	0.013	*TPxSex*, γ_{210}	0.102**	0.019
Low-SES, γ_{40}	-0.344**	0.012			
Black, γ_{50}	0.100*	0.038	*TPxBlack*, γ_{220}	-0.167**	0.053
Hispanic, γ_{60}	-0.400**	0.035	*TPxHisp*, γ_{230}	-0.204**	0.049
White, γ_{70}	-0.132**	0.034	*TPxWhite*, γ_{240}	-0.246**	0.049
LEP, γ_{80}	-0.447**	0.054	*TPxLEP*, γ_{250}	-0.264**	0.076
Special Education, γ_{90}	-0.320**	0.028	*TPxSPED*, γ_{260}	0.236**	0.038
Gifted & Talented, γ_{100}	0.289**	0.026	*TPxGT*, γ_{270}	0.084*	0.036
Tech Prep, γ_{110}	0.406**	0.068			
Met Exit Math, γ_{120}	0.358**	0.014			
Met Exit Reading, γ_{130}	0.444**	0.034	*TPxRead*, γ_{280}	-0.120*	0.047
Dual Credit, γ_{140}	0.253**	0.006	*TPxDC*, γ_{290}	0.017*	0.008
CTE, γ_{150}	0.014**	0.002			
Dual-CTE, γ_{160}	-0.146**	0.011			
RHSP Diploma, γ_{170}	0.953**	0.020	*TPxRHSP*, γ_{300}	-0.103**	0.024
DAP Diploma, γ_{180}	1.172**	0.024			
Transition Work, γ_{190}	0.797**	0.010			
School (Level 2), β_{0j}					
RGV, γ_{01}	0.446**	0.065			
Percent Low-SES, γ_{02}	-0.002*	0.001			
Percent White, γ_{03}	-0.001	0.001			
Rated Acceptable, γ_{04}	0.065	0.037			
Rated Exemplary, γ_{05}	-0.006	0.031			
Small School, γ_{06}	-0.122**	0.039			
Large School, γ_{07}	0.159**	0.039			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.172	0.010			

Note. **p<.01, *<.05 *Students=232,268, High Schools=1,704*

Table 4.3: Odds of Transitioning to a Community College Within a Year of High School Graduation

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-1.693**	0.071			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	0.086**	0.010			
Days Absent, γ_{20}	-0.010**	0.001	*TPxAbsent*, γ_{200}	-0.003*	0.001
Gender (Female), γ_{30}	0.138**	0.013	*TPxSex*, γ_{210}	0.046*	0.018
Low-SES, γ_{40}	-0.184**	0.011			
Black, γ_{50}	-0.102*	0.038	*TPxBlack*, γ_{220}	-0.197**	0.051
Hispanic, γ_{60}	-0.003	0.035	*TPxHisp*, γ_{230}	-0.152**	0.046
White, γ_{70}	-0.020	0.034	*TPxWhite*, γ_{240}	-0.153**	0.046
LEP, γ_{80}	-0.199**	0.054	*TPxLEP*, γ_{250}	-0.289**	0.076
Special Education, γ_{90}	-0.165**	0.027	*TPxSPED*, γ_{260}	0.206**	0.035
Gifted & Talented, γ_{100}	-0.557**	0.025	*TPxGT*, γ_{270}	0.136**	0.034
Tech Prep, γ_{110}	0.324**	0.064			
Met Exit Math, γ_{120}	-0.023	0.014			
Met Exit Reading, γ_{130}	0.271**	0.034	*TPxRead*, γ_{280}	-0.109*	0.046
Dual Credit, γ_{140}	0.032**	0.004			
CTE, γ_{150}	0.053**	0.002	*TPxCTE*, γ_{290}	-0.027**	0.003
Dual-CTE, γ_{160}	0.051**	0.009			
RHSP Diploma, γ_{170}	0.459**	0.016			
DAP Diploma, γ_{180}	-0.225**	0.028	*TPxDAP*, γ_{300}	0.149**	0.030
Transition Work, γ_{190}	0.733**	0.010			
School (Level 2), β_{0j}					
RGV, γ_{01}	0.112	0.072			
Percent Low-SES, γ_{02}	0.001	0.001			
Percent White, γ_{03}	0.002**	0.001			
Rated Acceptable, γ_{04}	0.028	0.036			
Rated Exemplary, γ_{05}	-0.074*	0.030			
Small School, γ_{06}	-0.075	0.041			
Large School, γ_{07}	0.062	0.041			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.217	0.011			

Note. **p<.01, *<.05 *Students=232,268, High Schools=1,704*

Table 4.4: Odds of Transitioning to a University Within a Year of High School Graduation

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-5.165**	0.104			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	0.028*	0.012			
Days Absent, γ_{20}	-0.037**	0.001	*TPxAbsent*, γ_{200}	-0.004*	0.002
Gender (Female), γ_{30}	0.069**	0.016	*TPxSex*, γ_{210}	0.054*	0.023
Low-SES, γ_{40}	-0.255**	0.015			
Black, γ_{50}	0.143**	0.029			
Hispanic, γ_{60}	-0.815**	0.027			
White, γ_{70}	-0.358**	0.026			
LEP, γ_{80}	-1.128**	0.092			
Special Education, γ_{90}	-1.002**	0.051			
Gifted & Talented, γ_{100}	0.632**	0.024	*TPxGT*, γ_{220}	0.080*	0.033
Tech Prep, γ_{110}	-0.003	0.025			
Met Exit Math, γ_{120}	1.162**	0.029			
Met Exit Reading, γ_{130}	0.975**	0.057			
Dual Credit, γ_{140}	0.220**	0.005	*TPxDC*, γ_{230}	0.026**	0.008
CTE, γ_{150}	-0.038**	0.003	*TPxCTE*, γ_{240}	0.029**	0.004
Dual-CTE, γ_{160}	-0.116**	0.017	*TPxDCTE*, γ_{250}	-0.088**	0.019
RHSP Diploma, γ_{170}	1.706**	0.039			
DAP Diploma, γ_{180}	2.396**	0.042			
Transition Work, γ_{190}	0.227**	0.017	*TPxTRWK*, γ_{260}	-0.114**	0.024
School (Level 2), β_{0j}					
RGV, γ_{01}	0.621**	0.098			
Percent Low-SES, γ_{02}	-0.002	0.001			
Percent White, γ_{03}	-0.005**	0.001			
Rated Acceptable, γ_{04}	0.069	0.051			
Rated Exemplary, γ_{05}	0.139**	0.038			
Small School, γ_{06}	-0.181**	0.057			
Large School, γ_{07}	0.220**	0.056			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.404	0.023			

Note. **p<.01, *<.05 *Students=232,268, High Schools=1,704*

Table 4.5: Odds of Transitioning to the Workforce Within a Year of High School Graduation

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-0.321**	0.055			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	0.018	0.013	*TPxGrad, γ_{200}*	-0.041*	0.018
Days Absent, γ_{20}	0.013**	0.001			
Gender (Female), γ_{30}	0.036**	0.009			
Low-SES, γ_{40}	-0.036**	0.011			
Black, γ_{50}	0.650**	0.025			
Hispanic, γ_{60}	0.695**	0.023			
White, γ_{70}	0.868**	0.023			
LEP, γ_{80}	-0.763**	0.034			
Special Education, γ_{90}	-0.370**	0.024	*TPxSPED, γ_{210}*	0.144**	0.032
Gifted & Talented, γ_{100}	-0.100**	0.016			
Tech Prep, γ_{110}	0.132**	0.014			
Met Exit Math, γ_{120}	-0.101**	0.014			
Met Exit Reading, γ_{130}	0.073**	0.022			
Dual Credit, γ_{140}	-0.018**	0.004			
CTE, γ_{150}	0.029**	0.002	*TPxCTE, γ_{220}*	-0.028**	0.003
Dual-CTE, γ_{160}	0.015	0.009			
RHSP Diploma, γ_{170}	-0.144**	0.016			
DAP Diploma, γ_{180}	-0.447**	0.022			
Transition HE, γ_{190}	0.791**	0.010			
School (Level 2), β_{0j}					
RGV, γ_{01}	-0.267**	0.045			
Percent Low-SES, γ_{02}	0.000	0.001			
Percent White, γ_{03}	0.003**	0.001			
Rated Acceptable, γ_{04}	0.063	0.034			
Rated Exemplary, γ_{05}	-0.123**	0.027			
Small School, γ_{06}	0.086*	0.031			
Large School, γ_{07}	-0.081*	0.029			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.072	0.005			

Note. **p<.01, *<.05 *Students=232,268, High Schools=1,704*

Higher Education Enrollment

Three models measure postsecondary enrollment over time (see Tables 4.6-4.8). Each is defined by enrollment in higher education at any point within four years after high school graduation. For students graduated in 2009 this includes attendance from the summer of 2009 to the spring of 2013. For students graduated in 2010 the enrollment period is between the summer of 2010 to the spring of 2014. The odds of postsecondary enrollment are modeled for all higher education participation as well as attendance at a community college or a four-year university (public or private).

Student Traits

Graduation year is a significant, positive main effect in all postsecondary enrollment models. 2009 graduates are more likely to enroll overall and at both institutional levels. Predicted probabilities for the 2009 cohort range from 51-55%, holding all other indicators constant. Attendance is positively related to enrollment at community colleges and negatively impacts university enrollment. Tech Prep participation moderates the impact of student absences at the university level but not in meaningful ways. Tech Prep positively moderates the impact of student absences in the odds of postsecondary participation. Students participating in Tech Prep have greater odds of higher education attendance in comparison to students in the control group.

Tech prep also interacts with gender. Female students who participated in Tech prep have a greater likelihood of postsecondary enrollment (63%) than women in the control group (55%). Women overall have greater odds of participation in higher education. Gender is positively associated with enrollment in both the community college and university models. Students from low-SES backgrounds have a negative relationship within each model. Predicted probabilities for low-SES students participating in higher education range from 41-48%.

In the overall model of higher education participation, several race/ethnicity indicators interact with Tech Prep. Black Tech Prep students are slightly more likely to enroll than Black students in the control group (58% versus 57%). Hispanic Tech Prep students are technically less likely to enroll though the predicted probability of enrollment is equivalent to the control group at 41%. White students in both groups have low predicted probabilities of enrollment (47-48%) but higher odds of enrollment than Hispanic students. The interaction trend for Black students is present in the community college model but not at the university level. In both institutional models, Hispanic students have lower odds of enrollment; the smallest expected probability is for Hispanic students enrolling at the university level (32%).

LEP students have a low chance of enrollment at both the community college and university level. In the overall postsecondary model, Tech Prep interacts with LEP, allowing for somewhat larger participation. Including Tech Prep, predicted probabilities for these students remain very low, ranging from 36-43%—the highest odds to be found at the community college. Special education follows a somewhat similar trend of low enrollment in specific institutional models. In the overall model for postsecondary enrollment, Tech Prep modifies the negative relationship between special education and enrollment. Participation in Tech Prep for special education students results in a positive probability of enrollment (53%) compared to the control group (40%). Gifted participation has a negative relationship with community college enrollment. GT has a positive impact and positive interaction with Tech Prep at the university level and in the overall model. GT Tech Prep students have a 66% chance of higher education enrollment compared to 58% for GT students in the control grouping.

Indicators of workforce participation during the transitional year after high school are positively associated with overall postsecondary enrollment as well as enrollment at the community college. This indicates many students are working and attending higher education at the same time. Transitional workforce participation is negatively associated with university enrollment, even more so for Tech Prep students (44% compared to 46%). This indicates that university students are more likely to solely focus on completing a degree, or more likely to have the means to focus on a degree without having to take on a job.

Academic Indicators

While many rigor indicators produce significant main effects, the majority of significant interactions between achievement indicators and Tech Prep are present in the model predicting the odds of university enrollment. In all models, math and reading TAKS play a significant role. Passing reading TAKS is positively associated with enrollment in all models. Passing math TAKS is associated with overall enrollment and enrollment at the university level; it predicts slightly lower participation at the community college level.

Dual credit courses are also negatively associated with community college enrollment. In the overall model, dual courses are positively related to enrollment and interact with Tech Prep to produce even greater odds of enrollment. For example, the predicted probability of Tech prep students taking the average dual course load is 63% while comparable students in the control group result in a predicted probability of 56%. An increase in a year-long course results in a 9-10% increase in the probability of enrollment for both groups. A similar interaction trend for dual credit is present in the university model of enrollment.

CTE and dual-CTE courses have significant interactions with Tech Prep in the university enrollment model. Both variables are associated with somewhat lower odds of enrollment. For CTE courses, Tech Prep serves to moderate the impact of CTE coursework and limits the negative influence additional courses may have on the predicted probability of enrollment. When viewing the relationship between dual-CTE and university enrollment, Tech Prep participation further exacerbates the negative relationship and creates lower odds of enrollment with each additional course. Tech Prep also interacts with CTE courses at the community college level. In this model CTE, is positively associated with enrollment, but Tech Prep participation slightly decreases odds of enrollment. Dual-CTE in the community college model is also positively associated with enrollment though there is no interaction with Tech Prep. These findings suggest that while CTE and dual-CTE lead to greater community college participation, Tech Prep interactions with CTE has limited impacts in preparing students for four-year institutions.

Much like transitional models of enrollment, college ready diplomas strongly predict enrollment in postsecondary education over time. Both RHSP and DAP degree plans are positively related to overall higher education enrollment. They are significantly related to university enrollment with high predicted probabilities of participation, 79% for RHSP and 88% for DAP. In community college models, DAP diplomas are negatively associated with enrollment suggesting students who have completed the highest high school degree plan are more likely to continue their academic careers at these types of institutions. Predicted probabilities for DAP students at the community college level are 33%.

Campus Characteristics

A large number of school-level indicators impact enrollment. RGV LEAD is significantly related to all models. Students from RGV area high schools, overall and at the university level, are more likely attend higher education. Their predicted probabilities range from 62-66%. At the community college level, RGV students are slightly less likely to enroll over time; their predicted likelihood is 46%. These findings indicate that

RGV LEAD is doing its strongest work at pushing students towards four-year institutions.

The proportions of low-SES and minority students at a campus are significant in both the overall and university models, though the coefficients are very small. These translate to odds which do not meaningfully impact models. Schools rated as Acceptable under the Texas accountability system have a positive impact on overall enrollment in higher education. Exemplary rated schools have a small, negative impact on the odds of enrollment in a community college. Exemplary schools have a positive association with university enrollment; the predicted probability of a student enrolling at a university is 54%, holding all else constant. Small schools are negatively associated with overall and university enrollment, and large schools positively impact university enrollment as well at attendance at any postsecondary institution. These trends are similar to transition models in which Exemplary schools are best at sending students to the university level while small schools struggle to enroll students in higher education during transitions and over time.

Model Variability

Remaining variance in each model ranges from 0.162-0.309. The highest amount of unexplained variance is within the university model which has a confidence interval between 0.28-0.35%. All differences, especially in university attendance, have yet to be explained across high school campuses (n=1,704). There remains minimal, un-modeled variations between the schools students are complete high school at.

Table 4.6: Odds of Enrolling in Higher Education Within Four Years of High School Graduation

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-1.334**	0.067			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	0.109**	0.010			
Days Absent, γ_{20}	-0.018**	0.001	*TPxAbsent*, γ_{200}	-0.004**	0.001
Gender (Female), γ_{30}	0.199**	0.014	*TPxSex*, γ_{210}	0.117**	0.020
Low-SES, γ_{40}	-0.346**	0.012			
Black, γ_{50}	0.285**	0.040	*TPxBlack*, γ_{220}	-0.201**	0.057
Hispanic, γ_{60}	-0.372**	0.036	*TPxHisp*, γ_{230}	-0.235**	0.051
White, γ_{70}	-0.070	0.036	*TPxWhite*, γ_{240}	-0.272**	0.052
LEP, γ_{80}	-0.574**	0.051	*TPxLEP*, γ_{250}	-0.170*	0.071
Special Education, γ_{90}	-0.390**	0.026	*TPxSPED*, γ_{260}	0.264**	0.034
Gifted & Talented, γ_{100}	0.312**	0.028	*TPxGT*, γ_{270}	0.114**	0.040
Tech Prep, γ_{110}	0.227**	0.051			
Met Exit Math, γ_{120}	0.350**	0.014			
Met Exit Reading, γ_{130}	0.367**	0.023			
Dual Credit, γ_{140}	0.259**	0.007	*TPxDC*, γ_{280}	0.032**	0.009
CTE, γ_{150}	0.010**	0.002			
Dual-CTE, γ_{160}	-0.171**	0.012			
RHSP Diploma, γ_{170}	0.854**	0.016			
DAP Diploma, γ_{180}	1.075**	0.025			
Transition Work, γ_{190}	0.956**	0.010			
School (Level 2), β_{0j}					
RGV, γ_{01}	0.494**	0.064			
Percent Low-SES, γ_{02}	-0.003**	0.001			
Percent White, γ_{03}	-0.002**	0.001			
Rated Acceptable, γ_{04}	0.083*	0.038			
Rated Exemplary, γ_{05}	0.021	0.032			
Small School, γ_{06}	-0.123**	0.039			
Large School, γ_{07}	0.173**	0.039			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.162	0.010			

Note. **p<.01, *<.05 *Students=232,268, High Schools=1,704*

Table 4.7: Odds of Enrolling in a Community College Within Four Years of High School Graduation

	Coefficient	**SD**		**Coefficient**	**SD**
FIXED EFFECTS					
Intercept, γ_{00}	-1.906**	0.071			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	0.206**	0.012			
Days Absent, γ_{20}	0.012**	0.001			
Gender (Female), γ_{30}	0.179**	0.011			
Low-SES, γ_{40}	-0.076**	0.014			
Black, γ_{50}	-0.232**	0.036	*TPxBlack*, γ_{210}	-0.085*	0.034
Hispanic, γ_{60}	-0.060*	0.030			
White, γ_{70}	-0.141**	0.029			
LEP, γ_{80}	-0.286**	0.045			
Special Education, γ_{90}	-0.064*	0.024			
Gifted & Talented, γ_{100}	-0.496**	0.019			
Tech Prep, γ_{110}	0.020	0.020			
Met Exit Math, γ_{120}	-0.201**	0.018			
Met Exit Reading, γ_{130}	0.052	0.028			
Dual Credit, γ_{140}	-0.065**	0.004			
CTE, γ_{150}	0.042**	0.003	*TPxCTE*, γ_{220}	-0.030**	0.004
Dual-CTE, γ_{160}	0.078**	0.010			
RHSP Diploma, γ_{170}	-0.007	0.020			
DAP Diploma, γ_{180}	-0.699**	0.026			
Transition HE, γ_{190}	3.092**	0.017			
Transition Work, γ_{200}	0.560**	0.012	*TPxTRWK*, γ_{230}	0.154**	0.023
School (Level 2), β_{0j}					
RGV, γ_{01}	-0.164*	0.070			
Percent Low-SES, γ_{02}	0.000	0.001			
Percent White, γ_{03}	0.000	0.001			
Rated Acceptable, γ_{04}	0.011	0.043			
Rated Exemplary, γ_{05}	-0.076*	0.034			
Small School, γ_{06}	-0.053	0.042			
Large School, γ_{07}	0.067	0.042			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.195	0.011			

Note. **p<.01, *<.05 *Students=232,268, High Schools=1,704*

Table 4.8: Odds of Enrolling in a University Within Four Years of High School Graduation

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-5.980**	0.095			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	0.030*	0.012			
Days Absent, γ_{20}	-0.029**	0.001	*TPxAbsent*, γ_{210}	-0.006**	0.002
Gender (Female), γ_{30}	0.064**	0.012			
Low-SES, γ_{40}	-0.214**	0.015			
Black, γ_{50}	0.041	0.032			
Hispanic, γ_{60}	-0.751**	0.030			
White, γ_{70}	-0.378**	0.029			
LEP, γ_{80}	-0.540**	0.076			
Special Education, γ_{90}	-0.758**	0.040			
Gifted & Talented, γ_{100}	0.567**	0.027	*TPxGT*, γ_{220}	0.101*	0.037
Tech Prep, γ_{110}	0.007	0.023			
Met Exit Math, γ_{120}	0.923**	0.024			
Met Exit Reading, γ_{130}	0.752**	0.048			
Dual Credit, γ_{140}	0.195**	0.006	*TPxDC*, γ_{230}	0.050**	0.009
CTE, γ_{150}	-0.040**	0.003	*TPxCTE*, γ_{240}	0.022**	0.004
Dual-CTE, γ_{160}	-0.135**	0.018	*TPxDCTE*, γ_{250}	-0.073**	0.020
RHSP Diploma, γ_{170}	1.319**	0.032			
DAP Diploma, γ_{180}	1.984**	0.036			
Transition HE, γ_{190}	3.250**	0.021			
Transition Work, γ_{200}	-0.160**	0.018	*TPxTRWK*, γ_{260}	-0.101**	0.025
School (Level 2), β_{0j}					
RGV, γ_{01}	0.683**	0.088			
Percent Low-SES, γ_{02}	-0.006**	0.001			
Percent White, γ_{03}	-0.005**	0.001			
Rated Acceptable, γ_{04}	-0.003	0.050			
Rated Exemplary, γ_{05}	0.180**	0.037			
Small School, γ_{06}	-0.164**	0.053			
Large School, γ_{07}	0.198**	0.051			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.309	0.018			

Note. **p<.01, *<.05 *Students=232,268, High Schools=1,704*

Developmental Remediation

Developmental Education (DE) provides non-credit remediation to help make students college-ready. It is an umbrella term that defines any assistance, whether it falls in the regular semester schedule or not, which helps prepare a student for credit-bearing courses. Its purposes are to help provide the necessary academic supports to improve basic skills and competencies in subject areas, usually mathematics, reading, and writing (Collins, 2009; Lazarick, 1997). There are four equations which model developmental enrollment within higher education. An overall DE participation model is calculated along with participation in the three traditional subject areas.

Regression outputs for all models are in Tables 4.9-4.12. These models only include PSM students enrolled in higher education within four years after high school (*n*=157,209). DE outcomes are defined as a student taking one or more non-credit, developmental course(s) during their enrollment in higher education. Subject area DE outcomes are defined by a student enrolled in one or more non-credit DE course specific to that area.

Student Traits

While many student characteristics significantly impact the predicted probability of DE enrollment, few interact with Tech Prep participation. Most indicators produce main effects. Like postsecondary enrollment, graduates of the 2009 high school cohort are more likely to participate in DE courses. They have a greater predicted probability of overall participation (52%) as well as greater odds of participation in mathematics and reading developmental subjects. The number of days a student was absent during their senior year significantly impacts readiness for credit-bearing courses. Students' odds of enrolling in DE increase with additional absences. This trend is present in the mathematics DE model. In reading and writing, mean absences have minimal, negative impacts. In the model for developmental reading, days absent interacts with Tech Prep participation. Students in Tech Prep are significantly less likely to participate in developmental reading, regardless of the number of days absent.

Women have 1.25 greater odds of enrolling in DE overall and between 1.15-1.31 greater odds of enrolling in reading or math DE courses. In writing DE, men are more likely to enroll in a non-credit course with a predicted probability of 53%. In all models, low-SES students are more likely to enroll in developmental courses. Tech Prep interacts with low-SES in both overall and math DE models. In the overall developmental model, Tech Prep participation has a positive impact, decreasing the chances of DE participation (46% versus 55%). In the mathematics DE model, low-SES Tech Prep students are slightly more likely to enroll in a course. In all DE models, Black and Hispanic students have greater odds of participation than their White peers; Hispanic students have the largest likelihood of DE course enrollment (66%). LEP and special education students have high predicted probabilities of DE participation across all models, between 53-65%. GT students have a very low chances of taking DE, 25% overall.

Enrolling in postsecondary education during the transition year after high school is positively linked to developmental participation. This finding suggests many do not enter higher education direct from high school ready for credit-bearing courses. Working during the transition year is also positively associated with DE across all subject areas. Tech Prep interacts with transitional workforce participation. Tech Prep participation corresponds to lower probabilities of DE overall but slightly higher probabilities of math DE.

Academic Indicators

Included in DE modeling is an additional achievement covariate, a readiness indicator. In Texas, *College and Career Ready* (CCR) standards are measured as part of the *Texas Success Initiative* (TSI). The TSI hosts complex requirements for credit- and non-credit coursework. Meeting TSI standards are based on a variety of different high school tests and college entrance exams.[11] The readiness indicator, CCR Standard, specifies whether a student has met TSI requirements. A student is marked *not* CCR if they fail to meet the requirement at the start of any semester they are enrolled in higher education. Readiness is calculated for the overall model and for CCR standards in each subject area.

CCR standards are—predictably—positively related to enrollment in DE. Many students failing to meet CCR standards enroll in developmental courses. Not all identified as needing DE end up taking DE courses though. Those failing CCR standards have a predicted probability of 86% for students in the control group and 84% for Tech Prep. These numbers represent the odds of enrolling in any DE course. In mathematics modeling, failing to meet subject CCR(M) results in a predicted probability of 84% for math DE participation. For reading and writing, failing to meet subject standards—CCR(R) or CCR(W)—results in higher probabilities of subject related DE, 91-95%.

Indicators of high achievement result, for the most part, in lower odds of DE involvement. For example, both math and reading TAKS are potential tests to prove readiness under TSI. Correspondingly, many who pass these tests are unlikely to enroll in DE. Both TAKS measures are significantly and negatively related to DE enrollment in all models. The number of dual credit courses a student takes decreases the chances of overall developmental participation. Students with average dual coursework (M=0.63) have low odds of DE which interact with Tech Prep. Control students have a predicted

---

[11] More information on TSI and the inputs used to determine CCR variables may be found in the Glossary. Information includes various tests used to measure TSI. For modeling, *CCR Standard*=1 equates to a student who has failed to meet the TSI standards and thus is deemed in need of DE (non-credit coursework). Students equaling *CCR Standard*=0 are considered college and/or career ready.

probability of 45% while Tech prep students have a lower predicted probability of 38%. Each additional, year-long credit lowers the chances of DE participation by 10% for Tech Prep students but only 5% for the control group. The interaction trend is similar in the writing model with even lower odds of participation. In DE math, Tech Prep students have a minimally higher probability of taking DE courses than the control group (48% to 46%). Both groups do not decrease their odds of math DE by large proportions with each additional dual course.

Dual coursework patterns repeat with CTE and dual-CTE courses. Overall, Tech Prep students are less likely to participate in DE than the control group based on average CTE/dual-CTE coursework. Additional CTE courses decrease the odds of DE, more for Tech Prep students than their control group peers. This trend is found for CTE courses in the overall model as well as the reading and writing DE models. In the math DE model, CTE also mirrors dual coursework. Average CTE coursework (M=5.27) corresponds to slightly higher odds of math DE for Tech Prep students compared to the control group (53% to 51%). Findings suggest that Tech Prep programs have mostly positive impacts on college readiness, with students taking dual and rigorous CTE courses having less need for DE. Tech Prep students with higher achievement according to these traits may still have deficiencies in college ready math, leading to non-credit bearing courses.

College ready diplomas (RHSP and DAP) both significantly impact the likelihood of DE participation. Overall, students with college ready degrees have lower odds of DE enrollment. Tech Prep students with a DAP diploma have moderately higher odds of enrolling in DE compared to control group peers in several models: overall DE, math, and reading coursework. The lowest predicted probability of DE participation is from DAP diploma holders in the control group (19%), holding all else constant.

Campus Characteristics

RGV is not significantly related to DE participation overall and corresponds to a lower predicted probability of math DE participation (41%), holding all other indicators in the model constant. This suggests students from RGV LEAD areas are just as prepared as students from in and around Texas, if not better prepared in math, to take credit-bearing courses upon entry to higher education. The proportion of low-SES and minority students on a campus are both significantly related to DE participation. As the proportion of disadvantaged students rise, so do the odds of students from that campus enrolling in DE. This trend is present in overall and math models. In reading and writing models, SES trends are similar but minority trends differ. As the proportion of minority students increases, it slightly decreases the likelihood of developmental participation. Exemplary rated schools are slightly less likely to have students with developmental participation in the overall and mathematics models. In the reading model, Acceptable rated schools are related to lower odds of developmental enrollment.

Model Variability

The random effects estimates show somewhat similar levels of variability in each model across schools when accounting for all student- and school-level factors. Variances range from 0.222-.0360 with the highest variability in the model predicting odds of developmental reading participation. Developmental participation overall has the lowest variance of 0.222 with a 95% confidence interval between 0.20-0.25%. These estimates suggest that, within measurements of developmental participation, there is little dissimilarity at the campus-level which is unexplained by the present indicators.

Table 4.9: Odds of Participating in Developmental Coursework While Enrolled in Higher Education

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-0.602**	0.098			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	0.094**	0.013			
Days Absent, γ_{20}	0.007**	0.001			
Gender (female), γ_{30}	0.227**	0.013			
Low-SES, γ_{40}	0.182**	0.022	*TPxSES, γ_{220}*	-0.091**	0.027
Black, γ_{50}	0.395**	0.037			
Hispanic, γ_{60}	0.648**	0.035			
White, γ_{70}	0.200**	0.034			
LEP, γ_{80}	0.482**	0.080			
Special Education, γ_{90}	0.407**	0.035			
Gifted & Talented, γ_{100}	-1.099**	0.026			
Tech Prep, γ_{110}	-0.235**	0.067			
Met Exit Math, γ_{120}	-0.937**	0.036	*TPxMath, γ_{230}*	0.187**	0.048
Met Exit Reading, γ_{130}	-0.260**	0.042			
Dual Credit, γ_{140}	-0.194**	0.008	*TPxDC, γ_{240}*	-0.051**	0.012
CTE, γ_{150}	0.051**	0.003	*TPxCTE, γ_{250}*	-0.037**	0.004
Dual-CTE, γ_{160}	0.127**	0.021	*TPxDCTE, γ_{260}*	0.064*	0.024
RHSP Diploma, γ_{170}	-0.417**	0.036	*TPxRHSP, γ_{270}*	0.165**	0.047
DAP Diploma, γ_{180}	-1.465**	0.049	*TPxDAP, γ_{280}*	0.358**	0.063
Transition HE, γ_{190}	0.315**	0.020			
Transition Work, γ_{200}	0.284**	0.021	*TPxTRWK, γ_{290}*	-0.082**	0.029
CCR Standard, γ_{210}	1.788**	0.019	*TPxCCR, γ_{300}*	0.085**	0.026
School (Level 2), β_{0j}					
RGV, γ_{01}	-0.140	0.077			
Percent Low-SES, γ_{02}	0.005**	0.001			
Percent White, γ_{03}	-0.002*	0.001			
Rated Acceptable, γ_{04}	0.045	0.051			
Rated Exemplary, γ_{05}	-0.102*	0.040			
Small School, γ_{06}	0.008	0.049			
Large School, γ_{07}	0.044	0.048			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.222	0.013			

Note. **p<.01, *<.05 *Students=157,209, High Schools=1,634*

Table 4.10: Odds of Participating in Mathematics Developmental Coursework While Enrolled in Higher Education

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-1.248**	0.088			
Student (Level 1), $\beta_{1j...}$			**Interactions**		
Grad Year (2009), γ_{10}	0.106**	0.013			
Days Absent, γ_{20}	0.006**	0.001			
Gender (female), γ_{30}	0.265**	0.013			
Low-SES, γ_{40}	0.152**	0.021	*TPxSES, γ_{220}*	-0.100**	0.026
Black, γ_{50}	0.358**	0.036			
Hispanic, γ_{60}	0.633**	0.034			
White, γ_{70}	0.223**	0.034			
LEP, γ_{80}	0.120	0.066			
Special Education, γ_{90}	0.161**	0.031			
Gifted & Talented, γ_{100}	-1.014**	0.026			
Tech Prep, γ_{110}	0.119**	0.028			
Met Exit Math, γ_{120}	-0.711**	0.022			
Met Exit Reading, γ_{130}	-0.028	0.038			
Dual Credit, γ_{140}	-0.174**	0.008	*TPxDC, γ_{230}*	-0.032**	0.010
CTE, γ_{150}	0.047**	0.003	*TPxCTE, γ_{240}*	-0.031**	0.004
Dual-CTE, γ_{160}	0.160**	0.013			
RHSP Diploma, γ_{170}	-0.264**	0.025			
DAP Diploma, γ_{180}	-1.291**	0.043	*TPxDAP, γ_{250}*	0.204**	0.046
Transition HE, γ_{190}	0.310**	0.020			
Transition Work, γ_{200}	0.265**	0.020	*TPxTRWK, γ_{260}*	-0.073*	0.028
CCR Math Standard, γ_{210}	1.622**	0.014			
School (Level 2), β_{0j}					
RGV, γ_{01}	-0.365**	0.078			
Percent Low-SES, γ_{02}	0.003*	0.001			
Percent White, γ_{03}	-0.002*	0.001			
Rated Acceptable, γ_{04}	0.044	0.049			
Rated Exemplary, γ_{05}	-0.090*	0.040			
Small School, γ_{06}	-0.016	0.049			
Large School, γ_{07}	0.090	0.048			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.232	0.014			

Note. **p<.01, *<.05 *Students=157,209, High Schools=1,634*

Table 4.11: Odds of Participating in Reading Developmental Coursework While Enrolled in Higher Education

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-2.575**	0.124			
Student (Level 1), $\boldsymbol{\beta_{1j}}$...			**Interactions**		
Grad Year (2009), γ_{10}	0.043*	0.020			
Days Absent, γ_{20}	-0.003*	0.002	*TPxAbsent,* γ_{220}	-0.005*	0.002
Gender (female), γ_{30}	0.147**	0.019			
Low-SES, γ_{40}	0.270**	0.023			
Black, γ_{50}	0.155*	0.058			
Hispanic, γ_{60}	0.299**	0.056			
White, γ_{70}	-0.361**	0.057			
LEP, γ_{80}	0.580**	0.075			
Special Education, γ_{90}	0.633**	0.037			
Gifted & Talented, γ_{100}	-1.431**	0.060			
Tech Prep, γ_{110}	-0.215**	0.065			
Met Exit Math, γ_{120}	-0.759**	0.035	*TPxMath,* γ_{230}	0.149**	0.048
Met Exit Reading, γ_{130}	-0.500**	0.042			
Dual Credit, γ_{140}	-0.681**	0.022			
CTE, γ_{150}	0.039**	0.005	*TPxCTE,* γ_{240}	-0.041**	0.006
Dual-CTE, γ_{160}	0.593**	0.027			
RHSP Diploma, γ_{170}	-0.348**	0.032			
DAP Diploma, γ_{180}	-1.174**	0.058			
Transition HE, γ_{190}	0.536**	0.041	*TPxTRHE,* γ_{250}	0.137*	0.058
Transition Work, γ_{200}	0.091**	0.022			
CCR Read Standard, γ_{210}	2.958**	0.022			
School (Level 2), $\boldsymbol{\beta_{0j}}$					
RGV, γ_{01}	0.001	0.099			
Percent Low-SES, γ_{02}	0.014**	0.001			
Percent White, γ_{03}	0.004**	0.001			
Rated Acceptable, γ_{04}	-0.205**	0.068			
Rated Exemplary, γ_{05}	-0.096	0.063			
Small School, γ_{06}	0.066	0.069			
Large School, γ_{07}	-0.063	0.066			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.360	0.024			

Note. **p<.01, *<.05 *Students=157,209, High Schools=1,634*

PARTICIPATING IN DEVELOPMENTAL WRITING

Table 4.12: Odds of Participating in Writing Developmental Coursework While Enrolled in Higher Education

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-1.872**	0.112			
Student (Level 1), $\beta_{1j\ldots}$			**Interactions**		
Grad Year (2009), γ_{10}	-0.058**	0.019			
Days Absent, γ_{20}	-0.002*	0.001			
Gender (female), γ_{30}	-0.114**	0.018			
Low-SES, γ_{40}	0.271**	0.021			
Black, γ_{50}	0.161**	0.053			
Hispanic, γ_{60}	0.229**	0.052			
White, γ_{70}	-0.242**	0.052			
LEP, γ_{80}	0.470**	0.069			
Special Education, γ_{90}	0.522**	0.035			
Gifted & Talented, γ_{100}	-1.383**	0.056			
Tech Prep, γ_{110}	-0.060	0.032			
Met Exit Math, γ_{120}	-0.582**	0.024			
Met Exit Reading, γ_{130}	-0.450**	0.039			
Dual Credit, γ_{140}	-0.659**	0.024	*TPxDC, γ_{220}*	-0.056*	0.023
CTE, γ_{150}	0.037**	0.005	*TPxCTE, γ_{230}*	-0.034**	0.006
Dual-CTE, γ_{160}	0.619**	0.027			
RHSP Diploma, γ_{170}	-0.373**	0.030	*TPxDAP, γ_{240}*	0.252*	0.089
DAP Diploma, γ_{180}	-1.330**	0.078			
Transition HE, γ_{190}	0.153**	0.026			
Transition Work, γ_{200}	0.061**	0.020			
CCR Write Standard, γ_{210}	2.265**	0.027	*TPxCCRW, γ_{250}*	0.082*	0.036
School (Level 2), β_{0j}					
RGV, γ_{01}	-0.001	0.088			
Percent Low-SES, γ_{02}	0.011**	0.001			
Percent White, γ_{03}	0.002*	0.001			
Rated Acceptable, γ_{04}	-0.096	0.064			
Rated Exemplary, γ_{05}	-0.070	0.058			
Small School, γ_{06}	0.039	0.062			
Large School, γ_{07}	-0.022	0.060			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.275	0.019			

Note. **p<.01, *<.05 *Students=157,209, High Schools=1,634*

Postsecondary Attainment

The modeling of postsecondary attainment outcomes is completed for PSM students who enrolled in higher education (*n*=157,209). This includes 1,634 high schools in the sample which sent students on to a postsecondary institution. In the PSM sample, 68% enrolled in higher education within four years. Of those enrolled, 42% took some form of developmental education. Twenty-five percent of enrolled students attained a postsecondary credential (39,874) representing 17% of the total PSM sample. Multilevel logistic regression is used to ascertain the odds of attaining a postsecondary credential. The odds of gaining each type of degree and/or certificate are calculated as well. Credential models are: Associate's Degrees (AA), Bachelor's Degrees (BD), and higher education certificates. Fixed effects and coefficients for each model are located in Tables 4.13-4.16.

Student Traits

Unlike trends in enrollment, there is no significant difference between high school graduating cohorts in gaining a postsecondary credential. The number of days a student was absent during their senior year is negatively associated with completing a postsecondary degree or certificate. An additional 10 days absent decreases the predicted probability of completion by 5-10%. In the model for completing a BD, absenteeism interacts with Tech Prep, modifying the negative impacts and increasing the probability of earning a degree.

In all models, save postsecondary certificates, women have greater odds of completion. Women have a 60-69% probability in overall, AA, and BD models compared to a 46% predicted probability of completing a certificate. In all but the BD model, gender interacts with Tech Prep to further boost women's chances of completing a postsecondary credential. In the overall model, women in Tech Prep have a predicted probability of 77% compared to 65% in the control group. An interaction is also present in the certificate model, moderating the negative relationship between gender and the outcome. Women in Tech Prep have a 54% likelihood of gaining a certificate compared to the 46% predicted probability in the control group.

In the overall and BD models, low-SES is negatively associated with gaining a credential. In the AA and certification models, low-SES students have slightly improved odds of completion. Black students have lower chances of gaining a postsecondary credential with a 34% predicted probability in the overall model. Hispanic students have lower odds of completing an overall credential or BD, but higher, positive odds of completing an AA or certification. The highest predicted probability for Hispanic students is in the completion of a certificate at 62%. White students do not significantly differ than others in most models. In the odds of gaining a certificate, White students have a greater likelihood of completion, similar to Hispanic students (64% predicted probability).

LEP students, though less likely to enroll and more likely to need developmental remediation, have greater odds of completing a postsecondary credential. The predicted probability of an enrolled LEP student completing higher education is 58%, 55% for the AA model and 64% for the certification model. The only model in which LEP students have a lower chance of completion is in the odds of attaining a BD, with a 32% predicted probability. These findings suggest that while LEP students struggle to gain access to higher education, they are having success in gaining credentials once enrolled. Prior models suggest special education students also have limited access to higher education and increased developmental need. Unlike LEP students, though, special education students have lower odds of completing a postsecondary credential. The only model where special education students have a greater probability of attainment is in the odds of completing a certification (58%). GT students are more likely to complete a BD and less likely to complete an AA or certification credential. Tech Prep interacts with GT in the AA model to modify the negative odds; Tech Prep GT students have an equal probability (50%) of completion compared to the 39% predicted probability in the control group.

Enrolling within a year of high school is positively associated with postsecondary attainment. Tech Prep interacts with transitional enrollment in the overall attainment model to increase odds of a credential compared to the control group (86% versus 78%). Working within a year of high school is negatively associated with overall attainment, AA, and BD models resulting in lower odds of higher education completion.

Academic Indicators

Academic rigor and achievement variables provide some of the most interesting impacts of the study thus far, especially when taken in context with other P-16+ outcomes modeled. Math TAKS is positively related to the completion of a credential in all models; Tech Prep interacts with Math TAKS in the overall model to augment the odds of completion. Reading TAKS is positively associated with overall completion and both degree models, but is linked with slightly lower odds of completing a certificate.

In the overall, AA, and BD models, dual enrollment is positively related to attainment and corresponds to an increase of 2-3% in the probability of completion with every additional course. In both the overall and BD models, dual credit interacts with Tech Prep to create even greater odds of attainment. For those with an average number of dual credits, Tech Prep students have a 71% predicted probability of postsecondary attainment compared to 53% in the control group. For the certification model, dual credit is negatively associated with completion.

The mean number of CTE courses is negatively associated with attainment in both overall and BD models, and positively associated with attainment in certification and AA models. Tech Prep interacts with CTE in all models. Regardless of the impact to students in the control group, students in Tech Prep have a proportionally greater probability of completing a credential. For example, the predicted probability of a BD for a Tech Prep student taking the mean number of CTE courses (*M*=5.27) is 56% compared to the control group at 49%. Each additional, year-long CTE course results in 6% rise in the probability of a degree for the Tech Prep group but a 1-2% decrease for the control group. These findings, taken in context with the prior models in the study, are important. Models of enrollment suggest that CTE has negative impacts and that Tech Prep, while able to increase participation at some levels, has limited success in promoting access at the university level. Models of completion suggest that Tech Prep participation is far reaching as it promotes higher odds of attainment at all levels—including universities—for CTE students who do transition to higher education.

Dual-CTE courses produce somewhat smaller odds of completion for most models. In the certification model, dual-CTE is associated with greater odds of completion and interacts with Tech Prep to increase probabilities further. Tech Prep students have a 71% predicted probability compared to the 58% probability of the control group. This finding may be an artifact of the Tech Prep program itself as many models include dual-CTE courses and postsecondary certification upon completion as part of their program structure.

Students with a college ready, RHSP diploma are less likely to complete a certificate. In all other models, RHSP and DAP are positively related to attainment. Interestingly, Tech Prep participation interacts with both overall and BD models but in different ways. In the overall model, Tech Prep students with either a RHSP or DAP diploma have greater odds of attainment compared to the control group. In the BD model, Tech Prep participation slightly lowers the odds of attainment when connected to diploma type.

Lastly, DE participation in any subject (math, reading or writing) significantly lowers the probability of postsecondary attainment in all models save the completion of an AA. Moreover, Tech Prep interacts with DE in the AA model to increase the odds of attainment. Tech Prep students who took DE have a predicted probability of 57% completion while the control group has a 56% probability. These chances are far greater than the very low odds in other models; the predicted probability for DE students completing a BD is 18%, holding all else constant.

Campus Characteristics

Though far removed in time from some of the outcomes, the high school campus attended still impacts postsecondary attainment for students. The RGV LEAD area is significantly related to overall, AA, and BD models. RGV negatively impacts the odds of completing a postsecondary degree overall as well as an AA, but it is positively related to the completion of a BD. The RGV predicted probability of completing an AA is 47% while the likelihood of completing a BD is 55% (overall is 47%). These findings are somewhat frustrating given that prior P-16+ models suggest RGV is linked to higher enrollment. Overall, modeling shows RGV has further work to accomplish getting students both enrolled and through higher education to a postsecondary credential. Strengths to date include the transition and persistence of students in the university pipeline.

The proportion of low-SES students at a campus is negatively associated with postsecondary completion overall and in the BD model. It has small but positive impacts on AA and certification models. In all models, changes in odds are minimal resulting in a 1-2% rise or fall in the predicted probability of completion for every 10% change in SES at the campus-level. For both AA and certification models, the percentage of minority students on a campus decreases the probability of completion. In modeling BD completion, the percentage of minority students at the campus-level slightly increases odds of completion. Exemplary rated schools are associated with somewhat larger odds of completing a bachelor's degree and lower odds of completing a certificate. Large schools (n>750) are associated with a higher probability of postsecondary completion as well as earning a BD and a certificate. Exemplary findings correspond with enrollment models suggesting these campuses have particular success with the university level when compared to those campuses labeled Acceptable, or Unacceptable, in the state accountability system.

Model Variability

Lastly, random effects estimates illustrate that models, including both student- and school-level characteristics, explain most of the variations across schools. Variances range from 0.090 in the modeling of overall postsecondary attainment to 0.487 for the odds of completing a higher education certificate. The certificate model has a 95% confidence interval between 0.42-0.57%. No postsecondary credential model contains a significant amount of variability remaining after modeling.

EARNING A HIGHER EDUCATION CREDENTIAL

Table 4.13: Odds of Enrolled Students Earning a Higher Education Credential

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-3.620**	0.110			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	-0.010	0.013			
Days Absent, γ_{20}	-0.054**	0.001			
Gender (female), γ_{30}	0.608**	0.019	*TPxSex*, γ_{220}	-0.134**	0.026
Low-SES, γ_{40}	-0.105**	0.017			
Black, γ_{50}	-0.662**	0.035			
Hispanic, γ_{60}	-0.140**	0.031			
White, γ_{70}	0.000	0.029			
LEP, γ_{80}	0.316**	0.077			
Special Education, γ_{90}	-0.026	0.042			
Gifted & Talented, γ_{100}	0.251**	0.019			
Tech Prep, γ_{110}	0.744**	0.094			
Met Exit Math, γ_{120}	0.575**	0.046	*TPxMath*, γ_{230}	-0.214**	0.059
Met Exit Reading, γ_{130}	0.034	0.051			
Dual Credit, γ_{140}	0.112**	0.005	*TPxDC*, γ_{240}	0.023**	0.007
CTE, γ_{150}	-0.008*	0.003	*TPxCTE*, γ_{250}	0.022**	0.004
Dual-CTE, γ_{160}	-0.039**	0.011			
RHSP Diploma, γ_{170}	0.557**	0.050	*TPxRHSP*, γ_{260}	-0.263**	0.063
DAP Diploma, γ_{180}	1.183**	0.055	*TPxDAP*, γ_{270}	-0.400**	0.068
Transition HE, γ_{190}	1.251**	0.042	*TPxTRHE*, γ_{280}	-0.167**	0.058
Transition Work, γ_{200}	-0.195**	0.014			
Developmental Ed., γ_{210}	-0.555**	0.015			
School (Level 2), β_{0j}					
RGV, γ_{01}	-0.122*	0.057			
Percent Low-SES, γ_{02}	-0.003**	0.001			
Percent White, γ_{03}	0.001	0.001			
Rated Acceptable, γ_{04}	-0.038	0.051			
Rated Exemplary, γ_{05}	0.064	0.033			
Small School, γ_{06}	-0.047	0.040			
Large School, γ_{07}	0.095*	0.037			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.090	0.007			

Note. **p<.01, *<.05 *Students=157,209, High Schools=1,634*

EARNING AN ASSOCIATE'S DEGREE

Table 4.14: Odds of Enrolled Students Earning an Associate's Degree

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-5.185**	0.149			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	-0.017	0.020			
Days Absent, γ_{20}	-0.040**	0.002			
Gender (female), γ_{30}	0.388**	0.030	*TPxSex*, γ_{220}	-0.082*	0.039
Low-SES, γ_{40}	0.079**	0.024			
Black, γ_{50}	-0.469**	0.059			
Hispanic, γ_{60}	0.264**	0.051			
White, γ_{70}	0.088	0.051			
LEP, γ_{80}	0.207*	0.105			
Special Education, γ_{90}	-0.339**	0.098	*TPxSPED*, γ_{230}	0.299*	0.120
Gifted & Talented, γ_{100}	-0.438**	0.051	*TPxGT*, γ_{240}	0.232**	0.065
Tech Prep, γ_{110}	0.191**	0.038			
Met Exit Math, γ_{120}	0.509**	0.043			
Met Exit Reading, γ_{130}	0.215**	0.074			
Dual Credit, γ_{140}	0.081**	0.007			
CTE, γ_{150}	0.047**	0.005	*TPxCTE*, γ_{250}	-0.014*	0.006
Dual-CTE, γ_{160}	-0.009	0.015			
RHSP Diploma, γ_{170}	0.626**	0.053			
DAP Diploma, γ_{180}	0.463**	0.060			
Transition HE, γ_{190}	1.071**	0.049			
Transition Work, γ_{200}	-0.104**	0.021			
Developmental Ed., γ_{210}	0.235**	0.031	*TPxDE*, γ_{260}	-0.141**	0.040
School (Level 2), β_{0j}					
RGV, γ_{01}	-0.122	0.100			
Percent Low-SES, γ_{02}	0.004*	0.001			
Percent White, γ_{03}	0.006**	0.001			
Rated Acceptable, γ_{04}	-0.134	0.074			
Rated Exemplary, γ_{05}	0.010	0.055			
Small School, γ_{06}	-0.077	0.066			
Large School, γ_{07}	-0.009	0.063			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.323	0.023			

Note. **p<.01, *<.05 *Students=157,209, High Schools=1,634*

EARNING A BACHELOR'S DEGREE

Table 4.15: Odds of Enrolled Students Earning a Bachelor's Degree

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-7.302**	0.232			
Student (Level 1), $\boldsymbol{\beta_{1j}}$...			**Interactions**		
Grad Year (2009), γ_{10}	-0.033	0.018			
Days Absent, γ_{20}	-0.069**	0.002	*TPxAbsent,* γ_{220}	-0.011**	0.003
Gender (female), γ_{30}	0.779**	0.018			
Low-SES, γ_{40}	-0.342**	0.025			
Black, γ_{50}	-0.389**	0.045			
Hispanic, γ_{60}	-0.405**	0.039			
White, γ_{70}	0.033	0.035			
LEP, γ_{80}	-0.754**	0.251			
Special Education, γ_{90}	-0.837**	0.111			
Gifted & Talented, γ_{100}	0.553**	0.022			
Tech Prep, γ_{110}	0.283	0.146			
Met Exit Math, γ_{120}	1.200**	0.085			
Met Exit Reading, γ_{130}	0.805**	0.155			
Dual Credit, γ_{140}	0.153**	0.006	*TPxDC,* γ_{230}	0.038**	0.008
CTE, γ_{150}	-0.058**	0.005	*TPxCTE,* γ_{240}	0.029**	0.006
Dual-CTE, γ_{160}	-0.139**	0.015			
RHSP Diploma, γ_{170}	1.117**	0.115	*TPxRHSP,* γ_{250}	-0.407*	0.147
DAP Diploma, γ_{180}	2.016**	0.117	*TPxDAP,* γ_{260}	-0.414*	0.149
Transition HE, γ_{190}	1.933**	0.056			
Transition Work, γ_{200}	-0.265**	0.018			
Developmental Ed., γ_{210}	-1.498**	0.027			
School (Level 2), $\boldsymbol{\beta_{0j}}$					
RGV, γ_{01}	0.220*	0.077			
Percent Low-SES, γ_{02}	-0.013**	0.001			
Percent White, γ_{03}	-0.006**	0.001			
Rated Acceptable, γ_{04}	-0.014	0.074			
Rated Exemplary, γ_{05}	0.092*	0.042			
Small School, γ_{06}	-0.011	0.055			
Large School, γ_{07}	0.296**	0.051			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.152	0.013			

Note. **p<.01, *<.05 *Students=157,209, High Schools=1,634*

EARNING A HIGHER EDUCATION CERTIFICATE

Table 4.16: Odds of Enrolled Students Earning a Higher Education Certificate

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-3.515**	0.199			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	-0.011	0.031			
Days Absent, γ_{20}	-0.021**	0.002			
Gender (female), γ_{30}	-0.142*	0.050	*TPxSex, γ_{220}*	-0.172*	0.063
Low-SES, γ_{40}	0.020	0.038			
Black, γ_{50}	-0.312*	0.122			
Hispanic, γ_{60}	0.586**	0.110			
White, γ_{70}	0.497**	0.110			
LEP, γ_{80}	0.596**	0.113			
Special Education, γ_{90}	0.321**	0.065			
Gifted & Talented, γ_{100}	-0.673**	0.065			
Tech Prep, γ_{110}	0.456**	0.048			
Met Exit Math, γ_{120}	0.040	0.052			
Met Exit Reading, γ_{130}	-0.241**	0.075			
Dual Credit, γ_{140}	-0.144**	0.014			
CTE, γ_{150}	0.101**	0.008	*TPxCTE, γ_{230}*	-0.034**	0.010
Dual-CTE, γ_{160}	0.331**	0.043	*TPxDCTE, γ_{240}*	0.109*	0.041
RHSP Diploma, γ_{170}	-0.286**	0.055			
DAP Diploma, γ_{180}	-0.681**	0.075			
Transition HE, γ_{190}	0.082	0.049			
Transition Work, γ_{200}	0.064	0.034			
Developmental Ed., γ_{210}	-0.359**	0.033			
School (Level 2), β_{0j}					
RGV, γ_{01}	-0.189	0.129			
Percent Low-SES, γ_{02}	0.015**	0.002			
Percent White, γ_{03}	0.011**	0.002			
Rated Acceptable, γ_{04}	0.016	0.107			
Rated Exemplary, γ_{05}	-0.187*	0.083			
Small School, γ_{06}	0.060	0.084			
Large School, γ_{07}	-0.437**	0.083			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.487	0.038			

Note. **p<.01, *<.05 *Students=157,209, High Schools=1,634*

Workforce Participation

The last set of models estimate the odds of entering the workforce within a year of earning a postsecondary credential. It is the furthest point on the P-16+ pipeline measured in the study. Workforce participation is defined as working in any one of the summer, fall, winter, or spring quarters after gaining a postsecondary credential—typically though not always granted in the spring.[12] This coding structure is set in place to capture the largest proportion of students working within a year of higher education graduation.

Students may have earned a credential at any time point in the five postsecondary graduation years captured in the data (i.e., the year concurrent with high school completion plus four years post-high school). Students may have also earned more than one degree and/or more than one type of credential. Multiple graduations are all counted. For, the purposes of modeling, if a student worked within a year of any credential, they are coded as a positive outcome. The sample used for modeling includes PSM matched students who earned a postsecondary credential (*n*=39,874). Two models are shown, the odds of entering the workforce after postsecondary graduation, and the odds of working two jobs after postsecondary graduation.

Student Traits

Gender is positively associated with the odds of transitioning to the workforce within a year of earning a postsecondary credential; women have a predicted probability of 53%. Tech Prep interacts with gender in the model of a second job. Women in the control group have a higher chance of working two jobs (57%) while women who participated in Tech Prep are less likely to work in a second position (52%). All Ethnic

[12] For a student coded as graduating in 2012 (regardless of the graduation date), working within a year includes any workforce participation in the summer 2012, fall 2012, winter 2012, and/or spring2013 wage quarters.

groups measured have a positive odds of employment upon graduation from higher education. The race/ethnic group with the highest predicted probability of workforce participation is comprised of Black students with 64%. Black students are also the most likely to take on a second job after completing a postsecondary credential; Tech Prep interacts with this category producing even greater odds for Black Tech Prep students (68% versus 64%). LEP students are not more likely to work upon graduation, and special education students have significantly lower odds of workforce participation (44%). GT students interact with Tech Prep; those involved in Tech Prep have lower chances of workforce participation (41%) while the control group has even odds of employment (50%). GT students have lower odds of working a second job.

Working the year after high school is positively related to working the year after higher education completion (students have a 71% predicted probability). Transitional employment interacts with Tech Prep to slightly increase the odds of employment after earning a credential; Tech Prep students have a 72% predicted probability. This trend exists in both workforce models suggesting Tech Prep students are even more likely to work, and work second jobs, than their control group peers.

Academic Indicators

Much like demographic or program participation variables, there are few interactions between Tech Prep and academic covariates. Those passing the reading TAKS have 1.28 greater odds of employment upon higher education graduation. The average number of CTE courses is positively associated with employment though, the likelihood of employment does not appreciably increase with additional courses. Dual-CTE courses are negatively associated with employment. Each additional, year-long dual-CTE course decreases the predicted probability of working by 1%. Interestingly, DAP diplomas are negatively related to employment after earning a postsecondary credential. DAP diplomas are negatively related to working a second job as well.

Students who participated in developmental coursework while enrolled in higher education have slightly greater odds of employment after completing a postsecondary credential. All credential types significantly and positively relate to workforce participation. The highest predicted probability of employment is from students with a higher education certification (63%). Tech Prep interacts with students earning a BD to increase the overall odds of employment; the impact is relatively minimal though, holding all else constant. Those with a BD have a predicted probability of 60% employment and those with an AA have a predicted probability of 58%. Trends in degree type are present in the modeling of working a second job. Students earning a certificate have a predicted probability of 63% working a second job. Also BD (58%) and AA (57%) have similar odds of secondary employment.

Campus Characteristics

Very few campus characteristics impact whether or not a student enters the workforce after earning a postsecondary credential. Students from the RGV LEAD area have lower odds of employment after completing a credential. The predicted probability of workforce participation is 45%. This finding suggests that there are limitations to employment for RGV students post-higher education completion. The percent of low-SES and minority students at a campus is positively associated with post-postsecondary employment. A 10% increase in the proportion of disadvantaged students at a high school campus increases the odds of employment for an individual student by 1%. SES and minority student associations are similar in the model for a second job as well.

Model Variability

The variance for the odds of workforce participation after earning a higher education credential is 0.031 with a 95% confidence interval between 0.02-.05%. Some variability—show in the random effects estimates—do persist, even in longitudinal outcomes far removed from the student's time spent in high school.

TRANSITIONING TO THE POSTSECONDARY WORKFORCE

TRANSITIONING TO THE POSTSECONDARY WORKFORCE (TWO JOBS)

Tables 4.17 and 4.18 describe the models for transitioning to the postsecondary workforce as well as taking on a second position in the postsecondary workforce. These tables are both very large and, as such, are located on the next two pages without their corresponding headings (which are located above).

Table 4.17: Odds of Transitioning to the Workforce
Within a Year of Earning a Postsecondary Credential

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-0.222	0.208			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	0.006	0.028			
Days Absent, γ_{20}	-0.003	0.002			
Gender (female), γ_{30}	0.106**	0.029			
Low-SES, γ_{40}	0.056	0.039			
Black, γ_{50}	0.569**	0.072			
Hispanic, γ_{60}	0.564**	0.057			
White, γ_{70}	0.397**	0.052			
LEP, γ_{80}	-0.003	0.173			
Special Education, γ_{90}	-0.231*	0.098			
Gifted & Talented, γ_{100}	-0.019	0.050	*TPxGT,* γ_{250}	-0.166*	0.071
Tech Prep, γ_{110}	-0.192**	0.055			
Met Exit Math, γ_{120}	0.132	0.076			
Met Exit Reading, γ_{130}	0.245*	0.117			
Dual Credit, γ_{140}	0.013	0.007			
CTE, γ_{150}	0.013*	0.005			
Dual-CTE, γ_{160}	-0.040*	0.020			
RHSP Diploma, γ_{170}	-0.068	0.086			
DAP Diploma, γ_{180}	-0.267**	0.091			
Transition HE, γ_{190}	0.090	0.073			
Transition Work, γ_{200}	0.885**	0.039	*TPxTRWK,* γ_{260}	0.265**	0.056
Developmental Ed., γ_{210}	0.078*	0.039			
Associate, γ_{220}	0.314**	0.044			
Bachelor, γ_{230}	0.393**	0.056	*TPxBD,* γ_{270}	0.193**	0.059
Certificate, γ_{240}	0.552**	0.058			
School (Level 2), β_{0j}					
RGV, γ_{01}	-0.184*	0.068			
Percent Low-SES, γ_{02}	0.004**	0.001			
Percent White, γ_{03}	0.003**	0.001			
Rated Acceptable, γ_{04}	0.104	0.097			
Rated Exemplary, γ_{05}	0.027	0.051			
Small School, γ_{06}	0.011	0.069			
Large School, γ_{07}	-0.046	0.058			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.031	0.009			

Note. **p<.01, *<.05 *Students=39,874, High Schools=1,399*

Table 4.18: Odds of Transitioning to the Workforce (Two Jobs) Within a Year of Earning a Postsecondary Credential

	Coefficient	SD		Coefficient	SD
FIXED EFFECTS					
Intercept, γ_{00}	-1.950**	0.171			
Student (Level 1), β_{1j}...			**Interactions**		
Grad Year (2009), γ_{10}	-0.010	0.022			
Days Absent, γ_{20}	0.003	0.002			
Gender (female), γ_{30}	0.283**	0.033	*TPxSex, γ_{250}*	-0.140**	0.046
Low-SES, γ_{40}	0.037	0.031			
Black, γ_{50}	0.570**	0.076	*TPxBlack, γ_{260}*	0.221*	0.082
Hispanic, γ_{60}	0.430**	0.054			
White, γ_{70}	0.274**	0.052			
LEP, γ_{80}	0.064	0.145			
Special Education, γ_{90}	-0.195*	0.083			
Gifted & Talented, γ_{100}	-0.067*	0.031			
Tech Prep, γ_{110}	-0.046	0.054			
Met Exit Math, γ_{120}	0.065	0.060			
Met Exit Reading, γ_{130}	0.087	0.102			
Dual Credit, γ_{140}	0.010	0.006			
CTE, γ_{150}	0.005	0.004			
Dual-CTE, γ_{160}	-0.008	0.016			
RHSP Diploma, γ_{170}	-0.113	0.065			
DAP Diploma, γ_{180}	-0.280**	0.069			
Transition HE, γ_{190}	0.048	0.059			
Transition Work, γ_{200}	0.673**	0.035	*TPxTRWK, γ_{270}*	0.151**	0.050
Developmental Ed., γ_{210}	0.038	0.029			
Associate, γ_{220}	0.279**	0.034			
Bachelor, γ_{230}	0.318**	0.037			
Certificate, γ_{240}	0.514**	0.041			
School (Level 2), β_{0j}					
RGV, γ_{01}	-0.094	0.052			
Percent Low-SES, γ_{02}	0.003**	0.001			
Percent White, γ_{03}	0.003**	0.001			
Rated Acceptable, γ_{04}	-0.114	0.074			
Rated Exemplary, γ_{05}	-0.044	0.039			
Small School, γ_{06}	0.002	0.050			
Large School, γ_{07}	-0.022	0.044			
	Variance	**SD**			
RANDOM EFFECTS					
Institution (Intercept), u_{0j}	0.011	0.005			

Note. **p<.01, *<.05 — *Students=39,874, High Schools=1,399*

CHAPTER FIVE: DISCUSSION

The purpose of this study is to better understand the ways in which advanced CTE models, such as Tech Prep, may be used to foster college and career transitions. The focus of research explores the impacts of CTE Tech Prep participation on longitudinal outcomes related to the P-16+ pipeline. Methods consist of PSM (Propensity Score Matching) of students to control for selection bias. PSM includes a two-step process which first models the predicted probability of all students enrolling in Tech Prep, and then matches Tech Prep to non-Tech Prep students using a nearest neighbor sampling technique. PSM creates a quasi-experimental control group for comparison. Multilevel logistic regression is then used to ascertain the odds of reaching each longitudinal outcome. Eighteen equations are calculated, including estimates of Tech Prep participation and models associated with five key P-16+ areas: high school transitions, higher education enrollment, developmental remediation, postsecondary attainment, and workforce participation.

Within analyses, student- and school-level characteristics are examined in their relation to outcomes. Particular attention is paid to the efficacy of Tech Prep participation. Interactions between Tech Prep and student characteristics are included to further examine how the CTE program affects P-16+ transitions. Regional comparisons within Texas are also incorporated into modeling. One area consortium, RGV LEAD—known for its unique context and widespread implementation of Tech Prep, is included in analysis at the campus-level. The within state contrast explores the impacts of a specific implementation group compared to the outcomes of the greater Texas sample.

While the findings section above is organized by each specific P-16+ transition point, the discussion section below focuses on significant themes across models (e.g., 18 models of overall and institution-specific outcomes). These are organized, first, into a discussion of the student- and school-level characteristics which predict Tech Prep participation. Next, the impacts of Tech Prep participation are summarized across longitudinal outcomes. Following a breakdown of P-16+ transitions, specific Tech Prep interactions are detailed along with other important model inputs (i.e., student- and school-level covariates). This culminates in an examination of RGV LEAD associations. Findings are explored and connected to CTE research, current contexts of reform and practice, and growing education policies. They result in multiple implications for both policymakers and practitioners.

What Influences Tech Prep Participation

The first research question of the study—what student- and school-level characteristics influence Tech Prep participation—is examined with the full data sample from 2009 and 2010 high school graduation cohorts (see Table 4.1). Of individual student traits, gender is significantly related to Tech Prep. Women are slightly more likely to participate; this is contraindicative to past research which found greater participation with male students (Bragg et al, 2002). Hispanic students and students of low-SES backgrounds are more likely to enroll in Tech Prep. This does follow participation rates of other studied Tech Prep programs (Bragg et al, 2002; Brown, 2003; Stone & Aliaga, 2003). Though individual students from disadvantaged groups are more likely to participate, greater proportions of minority or low-SES students at the campus-level negatively affect participation. This suggests that schools serving disadvantaged populations struggle to provide Tech Prep opportunities to their students.

Students in special populations or special programs are less likely to engage in CTE Tech Prep. LEP, special education, and GT students all have lower odds of participation. Negative associations indicate that the largest block of participants come from students not enrolled in any sort of targeted support or enrichment programs. To this end, Tech Prep is meeting the demand of providing opportunities for the middle majority—students whom are neither high nor low achieving. As most of the middle majority fails to enroll or complete postsecondary education, it is a positive indicator that Tech Prep programs may be used to boost P-16+ attainment for these types of students (Bragg, 2000; Cellini, 2006; Parnell, 1985). However, more recent changes to CTE guidelines and policies press for wider enrollment by all types of students (Friedel, 2011). These findings indicate Tech Prep in Texas is lacking inclusive CTE programming for all its students.

Like prior studies of Tech Prep participation, students enrolled in the program are more likely to exhibit traits of academic achievement and rigor (Cellini, 2006). Tech Prep is associated with passing Texas State accountability exams (i.e., TAKS tests) in both reading and mathematics. Moreover, positive associations are made between Tech Prep and college-ready diploma plans in Texas, both RHSP and DAP. Lastly, dual credit courses are positively connected to Tech Prep participation, increasing the predicted probability of enrollment with each additional course taken. These findings are similar to past studies which found CTE and Tech Prep students are generally more successful, or at least similar, in high school achievements when compared to traditional academic paths (Bailey & Karp, 2003; Cellini, 2006; Dare, 2006). Specifically, past studies point to growth in math scores and higher levels of overall achievement, comparable to gains accumulated while completing a RHSP or DAP degree (Kim, 2014; Stone & Aliaga, 2003).

Several campus-level indicators prove significant in the odds of Tech Prep participation. An Acceptable state accountability rating has a positive impact on Tech Prep participation compared to schools which failed to meet accountability requirements.

Schools rated as Exemplary, the highest accountability rating in Texas at the time of the study, do not have significant differences. This indicates that the highest performing schools do just as well as Acceptable campuses in supporting advanced CTE participation. Large schools—those with enrollments over 750 students—correspond to a greater predicted enrollment in CTE Tech Prep than others. This is perhaps due to the greater availability of programming or resources usually found at larger schools (Lee & Loeb, 2000; Leithwood & Jantzi, 2009). And, lastly, RGV LEAD schools have much larger odds of Tech Prep participation when compared to Texas schools as a whole. This suggests differences between the RGV area and the state in implementation.

In all, findings suggest Texas models of Tech Prep draw in a more diverse student group compared to the traditional academic population. Texas Tech Prep students are even slightly more diverse compared to past research studies (Bragg et al, 2002; Stone & Aliaga, 2003). Results show Tech Prep as a positive tool for both middle and high achieving campuses though low achieving campuses, and those serving high proportions of disadvantaged students, demonstrate less success with participation. The state, like many other implementers, has typified difficulties in including special populations of students (Gottfried et al, 2014). However, modeling suggests Tech Prep is a promising and viable program for P-16+ interventions.

P-16+ Transitions in Texas

The second research question explores the impacts of CTE Tech Prep participation on longitudinal outcomes related to the P-16+ pipeline. These are calculated using a quasi-experimental sample which has been propensity scored and matched to decrease selection bias. The odds of each outcome occurrence are determined using multilevel logistic regression; in all, 17 models are presented which study specific impacts of student traits, academic indicators, and campus characteristics. Added to model equations are interactions between student-level information and Tech Prep participation. Regression models are organized into five key areas of interest: high school transitions, higher education enrollment, developmental remediation, postsecondary attainment, and workforce participation. Below is a brief description of significant findings from each key area while additional sections describe Tech Prep interactions, significant student- and school-level indicators, and the importance of RGV in P-16+ transitions.

HIGH SCHOOL TRANSITIONS

Post-high school transitions refer to the year after high school graduation and include four models: participating in any form of higher education, attending either a community college or university, and transitioning to the workforce. Findings are viewed in Tables 4.2-4.5. Overall, students from disadvantaged backgrounds and low achieving students are less likely to enter higher education, and have slightly greater odds of working after high school. These models produce the largest amount of Tech Prep interactions in connection with student traits.

In keeping with prior studies, Tech Prep participation results in greater odds of enrollment in higher education for students, particularly students from disadvantaged backgrounds (Bragg et al, 2002; Brown, 2003). Student achievement and rigor also plays a role, especially in the transition to the university level. In all, there are differences between postsecondary institution types as students transition from high school to higher education. Students from disadvantaged backgrounds and lower achievement groups (e.g., LEP, special education) are more likely to enter community colleges than universities. These differences are often positively moderated by Tech Prep participation. Significant interactions show Tech Prep has its best success in preparing students for enrollment at two-year institutions rather than the university level. Several studies have found that while Tech Prep is positively associated with enrollment in community colleges, participants are somewhat less likely to enroll in four-year institutions (Bailey & Karp, 2003; Bragg et al, 2002; Cellini, 2006). This suggests participation may divert students directly into two-year institutions directly following high school at the expense of university enrollment. This may be due to curriculum associated with the Tech Prep program or better yet due to the institutionalized structures of Tech Prep itself. Programs require partnerships between secondary and postsecondary institutions. Partnership funds, staff, and programs may all work to push students towards the partnering community college in order to continue a Tech Prep program or enroll for a different course of study. Interactions with Tech Prep in this study do provide some evidence that participation broadens opportunities and helps to increase successful transitions at all levels.

There are few impacts Tech Prep has on the decision to enter the workforce within a year of high school graduation. Only special education and the number of CTE courses interact with Tech Prep to increase the odds of workforce participation. Findings provide evidence that CTE and Tech Prep participation may help prepare special education students for career transitions (Gottfried et al, 2014; Raben et al, 2014). Other indicators of note are the effect-coded variables; these suggest race and ethnicity have a strong influence as to whether or not a student joins the workforce upon completing their high school diploma.

HIGHER EDUCATION ENROLLMENT

Three models estimate the odds of enrollment in higher education up to four years after high school graduation: overall, community college, and university attendance. Tables 4.6-4.8 illustrate regression outputs. Many interactions between Tech Prep and student traits impact enrollment over time; these provide for greater odds of postsecondary access for Tech Prep students. Impacts are often the largest at the community college level. In cases where students have lower odds of enrollment (e.g., days absent, LEP, special education), Tech Prep moderates the effect, enhancing the odds of participation. These findings suggest that participation in Tech Prep increases enrollment for students less likely to attend higher education due to special needs or decreased motivation (Gottfried et al, 2014; Stone & Aliaga, 2003)

There are increases to the odds of enrolling at the university level for Tech Prep students who participated in dual credit and CTE courses while in high school. This suggests advanced courses, and dual coursework in particular, may improve four-year matriculation patterns. The patterns are consistent with research that links dual credit to positive postsecondary outcomes (Allen, 2010; An, 2013; Hoffman et al, 2009; Kleiner & Lewis, 2009; Lerner & Brand, 2006). Dual-CTE corresponds to a negative interaction, though. Findings suggest Texas CTE courses require more consideration, building better connections to college and career readiness. Study interactions with dual-CTE run counter to available research (Wonacott, 2002; Stipanovic et al, 2012). Working in the transition year decreases odds of university enrollment over time, especially for Tech Prep students.

DEVELOPMENTAL REMEDIATION

Developmental coursework, or DE, are split into four regression models: participation in any form of DE, and participation in a math course, reading, and/or writing DE course (see Tables 4.9-4.12). The majority of student traits positively impact odds of enrollment in DE; students from disadvantaged backgrounds or those enrolled in special programs often have the highest odds of participating in developmental remediation.

Participation with Tech Prep, in past research, has been linked with greater postsecondary preparedness (Castellano et al, 2003; Plank, DeLuca, & Estacion, 2008). This study finds positive relationships with readiness as well. Tech Prep interacts with indicators of achievement and rigor. While increased achievement decreases the odds of DE, participation in Tech Prep lowers the odds of DE even further. Indicators of achievement which Tech Prep interacts with include: dual credit, CTE, dual-CTE, and college ready diplomas. Tech Prep is associated with greater odds of DE participation in mathematics modeling according to dual credit, CTE courses, and DAP diplomas. This indicates that Tech Prep students with higher achievement according to these traits may still have deficiencies in college ready math leading to non-credit bearing courses. Working in the transition year increases odds of developmental enrollment. Tech Prep interacts with transition employment to decrease odds of DE participation. Overall, Tech Prep programs have mostly positive impacts on college readiness.

POSTSECONDARY ATTAINMENT

Tables 4.13-4.16 show results for attaining a postsecondary credential including gaining any credential, attaining an associate's degree, earning a bachelor's degree, and/or obtaining a higher education certificate. These odds are calculated only for students who enrolled in higher education. Many student traits impact attainment models without interacting with Tech Prep. They most often have negative influences on the odds of obtaining a higher education credential, particularly a bachelor's degree. Students from traditionally disadvantaged backgrounds do have somewhat greater odds of completing an associate's degree.

Tech Prep increases the chances of attaining a higher education credential, especially given indicators of academic achievement and rigor. Participation in Tech Prep interacts with gender, dual credit, CTE, and college diploma type (e.g., RHSP and DAP) to stregthen the predicted probability of earning a postsecondary credential. Tech Prep interacts with gender, special education, GT, and CTE to increase the odds of attaining an associate's degree. Positive interactions between Tech Prep and absences, dual credit, and CTE are found in the bachelor's degree model, though Tech Prep has negative impacts in combination with diploma types. Gender, CTE, and dual-CTE all positively interact with Tech Prep in the odds of obtaining a higher education certificate.

Past research on Tech Prep either found modest impacts in gaining semester credit hours or no relationship between the program and postsecondary attainment (Bragg, 2006; Neumark & Joyce, 2001; Neumark & Rothstein, 2004). In this study, Tech Prep is positively associated with a number of predictors, and participation expands the possibility of postsecondary attainment. Specifically, Tech Prep students who transition to higher education the year after high school have greater odds of attainment. Tech Prep helps women to earn a degree and enhances the impacts of CTE in earning a credential at two- and four-year institutions. Students who are involved with the program and also take rigorous coursework in high school (e.g., dual credit courses, college ready diploma plans, etc.) are more likely to succeed in higher education than similar students in the control group. These findings provide evidence that Tech Prep is a viable tool for success beyond traditional academic tracks (Bragg, 2009).

WORKFORCE PARTICIPATION

CTE participation has previously been connected to greater workforce outcomes compared to traditional academic students in both the year after high school graduation and seven years out (Bishop & Mane, 2004; Castellano et al, 2003). Individual traits such as gender or degree attained also relate to long term earning capacity in connection with CTE (Maguire, et al, 2012). This study finds similar trends in CTE Tech Prep participation. Tables 4.17 and 4.18 describe the odds of workforce participation within a year of completing a postsecondary credential. Several student traits positively impact the odds of working after the completion of a postsecondary credential. Women have greater odds of employment as do students from each ethnic group. Tech Prep participation is associated with lower proportions of women and higher proportions of Black students who take on second jobs. Achievement is, for the most part, linked to greater workforce participation. Working within the transition year after high school leads to a greater probability of working within the transition year after higher education—larger odds still for Tech Prep students. Students with certificates are associated with the highest probability of workforce participation followed by students with bachelor's and associate's degrees (which share similar chances of employment). Tech Prep slightly increases the odds of having a job after earning a bachelor's degree.

SUMMARY OF LONGITUDINAL FINDINGS

Findings provide strong evidence for the efficacy of Tech Prep models in Texas and beyond. Tech Prep participation increases opportunities to transition to higher education after high school, providing stronger pathways to community college and greater odds for traditionally disadvantaged students. When paired with increased rigor and CTE coursework, program participation works to improve enrollment over time and expand matriculation into four-year institutions.

Tech Prep has positive impacts on college readiness as well, decreasing the chances of developmental remediation. Importantly, Tech Prep interacts with a number of student traits, increasing the likelihood of postsecondary attainment at all levels. After postsecondary graduation, Tech Prep moderates the odds of workforce participation. Tech Prep is shown to have far reaching impacts on students long after they complete their high school careers. Impacts vary across P-16+ transitions, institutions, and types of students. Findings suggest Tech Prep is a valuable option to increase P-16+ transitions either for targeted populations or entire campuses.

Interactions and Impacts of Tech Prep

Tech Prep was intentionally modeled using interactions across all P-16+ equations. Methods required interaction terms between Tech Prep and each student indicator. These were first used in full models for each outcome; backwards modeling reduced interaction terms based on significance. Analyses show final models which only include significant interactions between Tech Prep and student-level variables. The number and strength of these interactions vary across P-16+ transitions. Below is a discussion of interactions which occur across multiple models and transition points.

Days Absent

The number of days a student was absent during their senior year proved to be a significant interaction in many outcome models. All models related to the transition between high school and higher education contain a significant interaction between days absent and Tech Prep. For students in the control group, the odds of enrollment decrease given additional absenteeism; odds tend to increase for students in Tech Prep. Findings suggest Tech Prep may help draw in students who have trouble attending high school and transition them to higher education, specifically at the community college level. The rate of attendance is strongly related to entry into the workforce upon high school graduation. More than 20 days absent during senior year results in a near perfect probability of workforce entry.

Attendance is positively related to enrollment at community colleges and negatively impacts university enrollment over time. Tech Prep participation moderates the impact of student absences at the university level but not in meaningful ways. Tech

Prep significantly and positively moderates the impact of absenteeism overall, though. Students participating in Tech Prep have greater odds of postsecondary access in comparison to students in the control group. Students' odds of enrolling in DE increase with additional absences; Tech Prep decreases chances of developmental reading participation. The number of days a student was absent during their senior year is negatively associated with completing any postsecondary degree or certificate. Tech Prep modifies the negative impacts of absenteeism to increase the chances of earning a bachelor's degree.

While prior research suggests CTE participation may lead to fewer absences while in high school, few studies are able to connect absenteeism and Tech Prep with postsecondary outcomes (Bishop & Mane, 2004). It is theorized that more advanced coursework, such as those found in Tech Prep, may increase the motivations of slacking seniors or those traditionally uninterested in college (Cellini, 2006; Fowler & Luna, 2009; Kim & Bragg, 2008). Positive interactions between absenteeism and Tech Prep lend credence to those theories.

GENDER

A small amount of research posits that women gain both psychosocial and achievement benefits from CTE participation; few studies show actual gains (Aragon et al, 2013). Women in this study show greater odds of enrollment, both in transition years and over time. Tech Prep increases those odds at each P-16+ point. Participation in Tech Prep results in a 10% advantage for women above those in the control group. In all models, save postsecondary certificates, women have greater odds of attainment. Interactions with Tech Prep advantage women further, leading to an even greater likelihood of completing a higher education credential. Tech Prep modifies the negative relationship with earning a certificate, creating a positive probability of attainment.

Gender is positively associated with the odds of transitioning to the workforce within a year of earning a postsecondary credential; women who participated in Tech Prep are also less likely to work a second position than their control group peers.

Tech Prep provides a consistent boost to women in all P-16+ transitions. Interactions and main effects included, gender is one of the highest predictors of success. These findings may be somewhat, though not altogether, specific to Texas. Conger (2015) argues that female students have an advantage in university enrollment and attainment. He found that Top 10% admission policies have contributed to increases in admission given women tend to have higher grades (thus higher class rankings) in high school. Conger found women, and specifically Black women, to have the greatest advantage in postsecondary outcomes as a result of admissions policies.

RACE AND ETHNICITY

In several models, race and ethnicity interact with Tech Prep to modify the odds of reaching a P-16+ transition outcome. In most instances, however, ethnicity significantly relates to outcomes on its own. Findings suggest advanced CTE, such as Tech Prep, may help traditionally disadvantaged minority groups bridge gaps in college and career readiness (Kao & Thompson, 2003; Lumina Foundation, 2015). In the transition to higher education, Tech Prep students have greater odds of participation than their control group peers—Black Tech Prep students have greater predicted probabilities than Black students in the control group; Hispanic students in Tech Prep have greater odds of enrollment than their peers; White students in Tech Prep outperform White students in the control group. In this model, White students in the control group, nevertheless, have greater odds of enrollment than Hispanic students, even those involved in Tech Prep. And, Black students overall, and in Tech Prep, have the highest odds of enrollment. The relationship between Black students and Tech Prep is positive in the enrollment model over time. It produces negative impacts for students in Tech Prep for other ethnicities, though. Hispanic and White Tech Prep students are slightly less likely to enroll over time when compared to similar students in the control group.

Overall, Black students have the greatest odds of transitioning to higher education and enrolling over time. Importantly, Black students also have the highest predicted probabilities of enrolling at the university level. Black students have greater odds of DE participation and somewhat lower chances of earning a postsecondary credential. These findings correspond to existing literature on the effects of race compared to postsecondary outcomes; research has shown Black students comparably more likely to attend four-year institutions (Engberg & Wolniaak, 2010).

Hispanic students have differing chances in P-16+ outcomes. Hispanic ethnicity is negatively related to both transitional and overall postsecondary enrollment. Hispanic students have the lowest probabilities of enrollment compared to all other groups, even in models where Tech Prep positively influences participation. For those who do enroll, Hispanic students are more likely to take DE courses and less likely to gain a higher education credential. Hispanic students have slightly higher odds of attaining an associate's degree.

Disparities between ethnic groups display existing and persistent gaps in college access and persistence (Ross et al, 2012). Findings show Tech Prep has limited impact on decreasing these gaps. In particular, participation has only small successes in promoting postsecondary education to Hispanic students. These gaps are more profound given the current and future ethnic makeup of Texas which hosts sizeable proportions of Hispanic students.

SPECIAL POPULATIONS

Special populations and programs include students from a wide spectrum of special requirements; these include high performing students and high need students. Included in this study are LEP, special education, and GT programs. LEP and special education students are found to have lower odds of enrollment and greater odds of developmental need. Tech Prep interacts with both program types to moderate the negative impact. LEP students in Tech Prep have slightly higher probabilities of postsecondary enrollment. Tech Prep special education students have positive probabilities of enrollment compared to negative odds for similar students in the control group.

For transition and total enrollment models, students in GT programs have a greater propensity for postsecondary participation if they are also Tech Prep. Of import, the odds are much higher at the university level suggesting differences in the type of institution chosen by these students. Gifted students are slightly less likely to participate in the workforce after high school graduation. GT students also have very low odds of taking DE courses. GT students are more likely to complete a bachelor's degree and less likely to complete an associate's or certification credential. Tech Prep interacts with GT in the associate's degree model to modify the negative odds toward an equal probability of attainment.

These results, taken together, suggest the largest block of Tech Prep participants come from students not enrolled in any targeted support or enrichment program. They constitute the middle range of students, or the middle majority. Most evidence from study outcomes support the original goals of Tech Prep which were to increase postsecondary access and attainment to students—neither high nor low achievers—in community college settings (Bragg, 2000; Cellini, 2006; Parnell, 1985). There is additional evidence that Tech Prep works to increase attainment for a wider selection of students, especially LEP and special education students accessing community college programs. High spectrum students, such as GT participants, have benefits across P-16+ transitions as well.

DUAL CREDIT COURSES

Recent reports from several states detail positive impacts of dual enrollment on student participation in higher education (Hoffman, Vargos, & Santos, 2009; Karp & Jeong, 2008; Kim & Bragg, 2008). In two studies of Texas students, completion of dual credit coursework had consistent, strong, and positive relationships with postsecondary enrollment, persistence, and attainment (Giani, Alexander, & Reyes, 2014; Struhl and Vargas, 2012). Findings from this study align with past research. Dual credit is associated with greater enrollment, lower developmental remediation, and higher postsecondary attainment. Interactions with Tech Prep produce substantially greater odds of success in P-16+ transitions.

Interactions between dual credit courses and Tech Prep are present in both transitional and total postsecondary enrollment over time. The number of dual credit courses a student took in high school positively impacts enrollment and interacts with Tech Prep for even greater odds. At the community college level, dual enrollment corresponds to minimally higher odds of transitional enrollment (and lower odds of enrollment over time) indicating dual credit courses are best preparing students to transition to the university level.

The number of dual credit courses a student takes decreases the chances of developmental remediation. Students with average dual coursework have low odds of DE participation. This interacts with Tech Prep participation to produce increasingly lower odds with each additional dual credit course. Dual credit is positively linked to earning a higher education credential overall as well as earning either an associate's or bachelor's degree. Dual credit interacts with Tech Prep to produce superior chances of attainment. For the certification model, dual credit is negatively associated with completion. In all, Tech Prep expands the already documented potential of dual credit to promote postsecondary access and attainment (Giani et al, 2014; Hoffman et al, 2009).

CTE and Dual-CTE Courses

The number of CTE courses students took during high school has varying impacts on enrollment, especially when including Tech Prep membership in the equation. In both models of transition and of postsecondary enrollment over time, CTE is significant. But, additional courses over the mean do not result in substantially larger predicted probabilities compared to those who took less CTE. At the community college level, CTE interacts with Tech Prep to provide for greater odds of transitional enrollment. At the university level, models are similar between transition and enrollment over time. Tech Prep moderates a slightly negative association between CTE and university participation, increasing the odds of enrollment.

The number of dual-CTE courses impacts enrollment differently at community college and university levels. Dual-CTE is positively linked to community college enrollment though negatively relates to university enrollment. Odds of university enrollment further decrease with Tech Prep participation.

Taken with the differing impacts of CTE and dual-CTE, findings suggest these types of courses push students mainly towards workforce and community college transitions rather than the university level. Several studies have found that while Tech Prep is positively associated with enrollment in community colleges, participants are less likely to enroll in four-year institutions (Bailey & Karp, 2003; Bragg et al, 2002; Cellini, 2006). This may suggest that participation may divert students directly into two-year institutions directly following high school at the expense of university enrollment. CTE interactions with Tech Prep provide some evidence that advanced CTE programs increase successful transitions to community colleges and also broaden opportunities at all levels.

Tech Prep students are less likely to participate in developmental remediation than the control group based on average CTE/dual-CTE coursework. Additional CTE courses increase the odds of DE for control students, but decreases the odds of DE for Tech Prep students. In mathematics models, though, Tech Prep increases the odds of developmental participation. Findings suggest that Tech Prep programs have mostly positive impacts on college readiness, with students taking rigorous and dual-CTE courses having less overall need for DE participation.

The number of CTE courses taken is negatively associated with attainment in the bachelor's degree model, and positively associated with attainment in the certification and associate's degree models. Tech Prep positively interacts with CTE in all models. Regardless of the impact to students in the control group, students in Tech Prep have a proportionally greater likelihood of completing a credential across all models. The odds of attainment increase with additional CTE courses. Dual-CTE courses produce somewhat smaller odds of completion for most models. In the certification model, dual-CTE is associated with large odds of completion and interacts with Tech Prep to increase probabilities further. This finding may be an artifact of the Tech Prep program itself as many models include dual-CTE courses and postsecondary certification upon completion as part of their program structure (Friedel, 2011).

CTE is positively related to post-high school transitional workforce entry and interacts with Tech Prep to provide increased chances of working. The average number of CTE courses is positively associated with employment after completing a postsecondary credential as well, though the predicted probability of employment does not appreciably increase with additional courses.

Attainment results, taken in context with the prior models in the study, are important. Models of enrollment suggest, while able to increase participation at some levels, CTE has limited success in promoting access at the university level. Models of completion suggest that Tech Prep participation is far reaching as it promotes higher odds of attainment at all levels—including universities—for CTE students who do transition to higher education. These findings follow trends in prior research which suggest both CTE and advanced CTE class models have the capacity to increase enrollment and attainment in postsecondary education (Wonacott, 2002; Stipanovic et al, 2012; Zinth, 2014). Findings demonstrate that Tech Prep models which include high numbers of CTE courses in high school are the largest benefit to students as they transition to higher education, and—notably—as they complete a postsecondary credential.

Other Significant Influences

STUDENT TRAITS

Many student traits interact with Tech Prep across various P-16+ transition points and differing models. Some variables only impact the outcome though, or have very limited interactions with Tech Prep. Descriptions of these covariates are described below. Graduates from the 2009 cohort have greater odds of transitional enrollment as well as enrollment over time, in both community college and university settings. 2009 high school graduates are also more likely to take developmental education courses. There are no differences between cohorts in postsecondary attainment.

Students from low-SES backgrounds are less likely to enroll in higher education the year after high school as well as over time. Low-SES students are more likely to need developmental remediation. Socioeconomic status is negatively associated with gaining a higher education credential.

Students identified as LEP, though less likely to enroll and more likely to need developmental remediation, have greater odds of completing a postsecondary credential. These findings suggest that while LEP students struggle to gain access to higher education, they are having success in attaining postsecondary credentials once enrolled. Special education students also have limited access to higher education and increased developmental need. Unlike LEP students, however, special education students have lower odds of completing a credential. Both LEP and special education students have decreased odds of workforce participation in transition years and after completing a postsecondary credential. Low-SES, LEP, and special education all have minimal interactions with Tech Prep. These results mirror past research which indicate advanced CTE programs may not be sufficient to motivate students from poverty, or students with special needs, toward higher education (Frempong, Xin, & Mensah, 2011; Gottfried et al, 2014; Long, Conger, & Iatarola, 2012).

Passing state accountability exams—TAKS—relates to greater enrollment during high school transitions and over time, though some tests negatively impact the odds of enrollment at the community college level. Those meeting both reading and math TAKS requirements are less likely to need DE remediation and more likely to earn a higher education degree.

College ready high school degrees (e.g., RHSP and DAP diplomas) predict greater odds of enrollment in higher education. Findings suggest DAP recipients have strong preferences towards universities in transitional years and in enrollment over time. College ready diplomas are negatively associated with developmental need. RHSP and DAP recipients have greater odds of earning a postsecondary degree but RHSP is linked to lower odds of earning a certificate. In all workforce models, college ready diplomas are associated with lower probabilities of having a job. Findings suggest the intensity of curriculum and rigor in high school, as shown by TAKS and diploma plans, connect with top levels of attainment. The highest intensity programs increase the odds of attainment at the highest postsecondary levels. This comes at the expense of enrollment in lower institutions and more basic credentials (Adelman, 2006; America Diploma Project [ADP], 2007; Mishook et al, 2012).

CAMPUS CHARACTERISTICS

A number of school-level indicators are included in modeling. These help control for the type of school an individual attends. They also inform upon the meaningful campus characteristics which impact longitudinal outcomes. Prior modeling of Texas data on postsecondary outcomes suggests there is little decay in the effects of high school characteristics over time (Black, Lincove, Cullinane, & Veron, 2015). In other words, persons carry both what they learn in school and the contexts of that school with them into the future.

The proportion of low-SES and minority students on a campus negatively impacts the chances of enrollment during the transition year between high school and higher education. A similar relationship exists for both socioeconomic and minority rates in enrollment over time, but it creates negligibly lower odds. As the proportion of poor students rise, so does the likelihood of a student from that campus enrolling in DE. Minority trends differ. As the proportion of minority students increases at a campus, it slightly decreases the chances of developmental participation. The proportion of low-SES students at a campus is negatively associated with postsecondary completion, creating slightly smaller odds of gaining a credential. The percent of low-SES and minority students at a campus is positively associated with post-postsecondary employment. Prior studies of campus indicators have found mixed results similar to findings in this study. This suggests the impacts associated with the campus population makeup are often complex and vary according to the time period of postsecondary enrollment and the institutional level in question (Black et al; Engberg & Wolniak, 2010; Frempong et al, 2011; Long et al, 2012).

An Exemplary performance rating in the Texas State accountability system is negatively associated with community college enrollment and transitional workforce participation; it is positively associated with university enrollment in the transitional year and over time. This suggests Exemplary schools are best at transitioning students to universities after high school graduation. The highest rated schools are also less likely to have students participate in developmental participation. Exemplary rated schools are associated with somewhat larger odds of completing a bachelor's degree and have lower odds of completing a certificate. Exemplary findings indicate these types of campuses have particular success with the university level when compared to those campuses labeled Acceptable, or Unacceptable, in the state accountability system. Findings are similar to a study of postsecondary attainment in response to accountability pressures in Texas. Researchers found positive associations between accountability ratings and attainment, specifically in gaining a bachelor's degree (Deming et al, 2016).

School size has been previously associated with differences in achievement, availability of curriculum, and differing levels of program participation by its students (Egalite & Kisida, 2016; Leithwood & Jantzi, 2009). There is a great deal of discussion as to what size a school should be, but large schools are usually defined as those with more than 750 students and small schools are those with less than 100 students per grade (Lee & Loeb, 2000; Vander Ark, 2002). Large schools—750 students and above—positively impact enrollment at any postsecondary institution. Small schools (i.e., those with under 400 students) struggle to enroll students in higher education during transitions and over time, especially at the university level. Large schools are associated with slightly higher odds of completing a postsecondary degree, specifically a bachelor's degree; students from large schools are also less likely to earn a certificate. Theories as to large campuses' achievement include a greater variety in curriculum and programs available at large schools as well the likelihood of available resources (e.g., money for programs, proximity to higher education, etc.) found in more developed (i.e., larger) areas (Leithwood & Jantzi, 2009).

Importance of RGV LEAD

The current study evaluates impacts of Tech Prep programming across Texas and one regional consortium, RGV LEAD (Rio Grande Valley Linking Economic & Academic Development)—and area known for its unique context and widespread implementation of Tech Prep. All models include RGV LEAD as part of campus-level predictors. The indicator compares the RGV area schools to the rest of Texas high schools and students. This comparison helps assess the progress of the RGV LEAD consortium in implementation—bringing together high school and higher education partners to provide CTE content to students in Tech Prep programs. As the goal of RGV LEAD, and Tech Prep, is the expansion of college and career readiness, this study tracks outcomes related to multiple transitions along the P-16+ pipeline.

RGV LEAD Area

The RGV, or Valley, is a four-county area located along the southernmost tip of Texas (see Figure 1.1).[13] While the largest city, Brownsville, has almost 200,000 citizens,

[13] RGV is not actually a valley. It is a delta and floodplain area of the Rio Grande River. Early developers of the RGV thought the term "valley" was a more positive descriptor for attracting potential settlers (Rio Grande Valley Texas [RGVT], 2016).

great portions of the RGV are in rural areas. All four counties—Starr, Hidalgo, Willacy, and Cameron—currently rank within the top 100 when listing the poorest counties in the United States by per capita income (USBEA, 2016). When comparing demographic information against the rest of Texas and the nation, RGV counties have much higher percentages of minority populations. Specifically, RGV ranges from 88-96% in Hispanic populations, three-and-a-half times the national average and more than double the Texas mean (see Table 5.1). RGV counties have significantly lower rates of educational attainment than the state and the nation. Attainment is deficient for both high school graduates and postsecondary credential recipients (USCB, 2016).

Table 5.1: RGV Demographic Estimates

	Population	**% Hispanic**	**HS or Higher**	**HE Degree or Higher**	**Per Capita Income**
Starr	62,955	96%	47%	10%	$11,584
Hildago	831,073	91%	62%	16%	$14,222
Cameron	420,392	88%	64%	16%	$14,710
Willacy	21,903	88%	63%	9%	$11,313
Texas	26,956,958	39%	81%	27%	$27,125
USA	318,857,056	17%	83%	29%	$58,714

Source. (USBEA, 2016; USBC, 2016)

The RGV LEAD partnership works to increase college and career attainment in the area. It includes 32 Independent School Districts (ISDs), one charter network, four regional universities and community colleges, the K-12 Education Service Center (ESC), and a number of business and professional organizations representing the economic needs of the Valley area. Tech Prep programs were developed in the RGV, by the consortium, at an early point during Texas-wide implementation (Brown, 2001). Since then, Tech Prep models have increased in size and scope; RGV LEAD maintains successful programs in all area high schools. Today RGV LEAD serves as the Tech Prep program provider and local P-16+ Council.

The RGV area and RGV LEAD consortium are particularly important to the study. Its location and makeup provide a microcosm to some of the most pressing demographic issues facing educational attainment and postsecondary transitions. The RGV hosts a large percentage of minority students, high amounts of poverty, traditionally low percentages of educational attainment, and is geographically located in areas less likely to have access to postsecondary pathways or workforce opportunities (Lumina, 2015; Ross et al, 2012; USCB, 2016). Outcomes learned from such an area would be of significant interest to national models of intervention as well as other state and local reform interventions (Allen, 2012).

RGV Differences in Modeling

Findings from all multilevel logistic regressions show RGV LEAD areas vary significantly from the rest of Texas. This suggests differences in implementation, especially when controlling for the types of schools and types of students within the RGV area. Quantitative results fit with prior qualitative reviews of Texas implementation which indicate variability across Texas consortia (Brown, 2001; Waller & Waller, 2004). It also holds with the larger research surveys which find variations between implementation consortia and models (D'Amico et al, 2015; Hershey et al, 1998).

First, RGV area students are more likely to participate in Tech Prep. Students from the RGV LEAD consortium have 8.62 greater odds of enrollment compared to students from other Texas areas.[14] This is a huge advantage in the probability of participation, holding all else constant. RGV LEAD is the single largest predictor of Tech Prep participation in a model with many significant covariates.

[14] As a note, the modeling of Tech Prep participation is the only model using the whole sample of students rather than the PSM sample.

When looking at transitions within a year of high school graduation, students from RGV LEAD areas have greater odds of enrollment in all higher education models. These findings indicate RGV is successful in transitioning students to all levels of postsecondary institutions—community colleges and universities. When modeling postsecondary enrollment over time, RGV LEAD is significantly related to all models. Students from RGV area high schools, overall and at the university level, are more likely attend higher education. At the community college level, RGV students are slightly less likely to enroll over time. These findings suggest that the RGV consortium is doing its strongest work at pushing students towards four-year institutions.

RGV is not significantly related to DE participation overall and corresponds to a lower predicted probability of math DE participation. This indicates students from RGV LEAD areas are just as prepared as students from in and around Texas—if not better prepared in math—to take credit-bearing courses upon entry to higher education.

RGV negatively impacts the odds of completing a postsecondary credential. When breaking down models into the type of credential, RGV LEAD is negatively associated with the odds of earning an associate's degree but has a slightly positive relationship with the odds of earning a bachelor's degree. These findings are somewhat frustrating given that prior models in the study suggest RGV is linked to higher enrollment. The positive associations between enrollment paired with negative connections with attainment replicate prior studies. These show a limited impact of individual Tech Prep programs/models on higher education completion (Neumark & Joyce, 2011). Overall, modeling shows RGV has further work to accomplish getting students both enrolled and through higher education to a postsecondary credential.

RGV LEAD students are associated with lower odds of workforce participation upon high school graduation. In a similar manner, students from the RGV consortium area have lower odds of employment after completing a postsecondary credential. These findings suggest there are limitations to employment for RGV students in multiple P-16+ transition points. This may be symptomatic of the geographic RGV location. The area traditionally has fewer employment resources, both for recent high school graduates and college graduates returning to areas close to home (USCB, 2016). In addition, there may be unique revenue streams in the area, such as employment opportunities across the border in Mexico. These would not be included in the data and would skew workforce participation and wages.

Strengths to date include the transitions of students to higher education within a year of completing high school, indicators of college readiness shown by decreased need for developmental education, and increased pathways for students into the university pipeline. Qualitative review of Texas Tech Prep implementation reports that more active consortia believe themselves to have greater gains in student outcomes (Brown, 2001). RGV LEAD self identifies as a very active Tech Prep consortium and P-16+ Council. They prove positive gains in this study according to multiple longitudinal outcomes.

TECH PREP AND RGV LEAD AFFILIATIONS

Table 5.2 illustrates the odds of obtaining each P-16+ outcome according to two of the important factors explored in this study. The table calculates the predicted probabilities of RGV and Tech Prep students (and combinations of the two variables) for all P-16+ transition points. These probabilities are estimated from the overall models for each key area. Predicted probabilities are based on RGV and Tech Prep covariates along with the intercept, holding all other variables in the model constant—at zero.[15] While

[15] These estimates hold all scaled ratio variables to their average value (mean centered at zero) and hold nominal variables to their zero classification (e.g., gender=0=male); they also include the intercept in the calculation of the probability to create a unit-specific result, holding constant the school (and school-level factors).

these numbers may seem low, it is important to keep in mind that only 68% of the PSM sample enrolled in a postsecondary institution over time while—fewer—60% entered higher education within a year of high school graduation. Only 17% of the sample completed a postsecondary credential overall. Findings suggest that, at each P-16+ transition point, both Tech Prep and RGV play an important role in advancing the possibility of success. Students involved in Tech Prep, in particular, have greater odds of transitional enrollment into higher education; RGV LEAD affiliation strengthens the odds of enrollment for both Tech Prep and control group students. These trends are also present in models of postsecondary enrollment over time. When viewing transitional workforce participation, Tech Prep alone is associated with the greatest predicted probability of a job. RGV affiliation corresponds to lower odds of workforce participation and negatively impacts Tech Prep students.

In Table 5.2, RGV Tech Prep students are associated with the lowest predicted probability of developmental remediation. Both indicators decrease the odds of DE participation. Tech Prep is associated with the highest odds of postsecondary attainment. While RGV LEAD affiliation does not decrease these odds for Tech Prep students, the odds of attainment for non-Tech Prep students in RGV areas is lower than for similar students across Texas. Lastly, both Tech Prep and RGV LEAD are negatively associated with workforce participation after the completion of a postsecondary credential.

To provide a better illustration of the estimated impacts, an example using additional indicators is provided. A Tech Prep student from the RGV area with the following indicators has a 92% predicted probability of earning a postsecondary credential: female, Hispanic, met both math and reading TAKS, DAP diploma, one course above average for dual credit and CTE courses, and from an Acceptable rated large school. As shown, inputting characteristics of a high achieving student for the RGV LEAD area greatly increases the probability of higher education attainment.

Table 5.2: Probabilities for Tech Prep and RGV Students Across P-16+ Transitions

	Tech Prep	RGV	Probability
Transition Enrollment			
Student 1	X	X	30%
Student 2	X		22%
Student 3		X	22%
Student 4			15%
Transition Workforce			
Student 1	X	X	39%
Student 2	X		45%
Student 3		X	36%
Student 4			42%
Postsecondary Enrollment			
Student 1	X	X	35%
Student 2	X		25%
Student 3		X	30%
Student 4			21%
Developmental Education			
Student 1	X	X	27%
Student 2	X		30%
Student 3		X	32%
Student 4			35%
Postsecondary Credential			
Student 1	X	X	5%
Student 2	X		5%
Student 3		X	2%
Student 4			3%
Post Credential Workforce			
Student 1	X	X	35%
Student 2	X		40%
Student 3		X	40%
Student 4			44%

Note. Probabilities are calculated summing the constant and the variables in question, holding all else constant (i.e., equal to zero) in the models.

The positive outcomes associated with RGV LEAD alone suggest success in increasing college and career opportunities, especially for students traditionally less likely to have access to postsecondary or workforce pathways (Lumina Foundation, 2015; Ross et al, 2012; USCB, 2016). The significant impacts of RGV LEAD, paired with Tech Prep probabilities, indicate that the RGV LEAD implementation models are successful in bridging transitions in the P-16+ pipeline. Geared towards underserved populations, RGV LEAD Tech Prep helps transition students from high school to higher education and beyond (Moran et al, 2009; Olivia, 2008).

Implications for the Future

BETTER INFORMED RESEARCH

Tech Prep works towards preparing students for the jobs of tomorrow in the classrooms of today. Programming is aimed at reducing persistent gaps in educational attainment through increasing transition pathways to higher education. The need to assess the efficacy of these interventions is vital to understanding their use and potential in the wider framework of educational reform. Research to date has been limited and many in the field are aware of the lack of rigorous efforts connecting programs to student outcomes (Rojewski et al, 2012).

The current study helps better inform past research and examine the impacts of such models in preparing students for college and career outcomes. Given the specific coding used in Texas data, this study is able to correctly identify students involved in CTE Tech Prep. Explicit definitions provided in data are superior to past studies which have relied on self identification or complicated coding definitions (Aliaga et al, 2014; Bragg et al 2002; Hershey et al, 1998; Stipanovic et al, 2012). As such, it provides a more reliable estimate for Tech Prep comparisons.

In addition, the study includes the use of quasi-experimental matching methods to decrease selection bias; these create comparison groups which control for student and school characteristics (Bozick & Dalton, 2012; Lewis & Overman, 2008; Rojewski & Xing, 2013). Modeling in the study goes beyond simplistic methods found in many practitioner evaluations of programs (Fritz et al, 2012; Gemici & Rojewski, 2007; Rojewski et al, 2012). It utilizes hierarchical methods to best identify impacts of Tech Prep, accounting for students nested within schools (Cohen et al, 2003; Nimon, 2012). Multilevel models are able to control for the school a student attended when identifying results, and also provide meaningful context based on estimates of campus characteristics.

Findings from the current study add to research by replicating and extending associations between Tech Prep and P-16+ outcomes. They find positive associations between participation and postsecondary enrollment (Bailey & Karp, 2003; Bragg et al, 2002; Cellini, 2006). Tech Prep participation increases opportunities to transition to higher education after high school, providing stronger pathways to community college and greater odds for traditionally disadvantaged students. When paired with increased rigor and CTE coursework, Tech Prep participation works to improve enrollment over time and expands matriculation into four-year institutions. Models show varied but favorable relationships between Tech Prep and postsecondary attainment, differing from previous research (Neumark & Joyce, 2011). Findings also suggest there is implementation variability in the state as RGV LEAD areas are linked, specifically, to greater odds of enrollment (Brown, 2001; Waller & Waller, 2004). These results display great complexity across longitudinal outcomes. They create a host of possibilities for using Tech Prep as either a targeted or comprehensive P-16+ reform.

Future Exploration

Further study should follow students through even longer time points to assess postsecondary outcomes at six year intervals, and identify enrollment in graduate studies as part of post-postsecondary measures. Also, more detailed analysis of workforce participation is yet to be completed. These should investigate salary differentials according to participation. One piece of Tech Prep which was not measured in the study is the completion of a Tech Prep program (only Tech Prep participation was included in the current study). Additional research should combine high school and higher education data to identify the characteristics which impact Tech Prep program completion, resulting in a higher education credential.

The current study provides strong evidence that Tech Prep participation has meaningful impacts on P-16+ transitions. Future research into the Texas Tech Prep program, and similar advanced CTE models such as POS (Programs of Study), will advance research and practice even more.

CHALLENGES FOR PRACTITIONERS

Information from this study works to inform future implementation efforts for Tech Prep but also wider reform contexts. Findings may be linked to the focus of P-16+ alignment and articulation, college and career readiness standards, and support for educational attainment in underserved students. These connections are vital to current reforms in CTE which hope to expand Tech Prep models to a more diverse selection of industries and students through similar CTE POS models.

Research suggests CTE courses and programs have—and are still—working to integrate core academic standards alongside technical training (Stipanovic et al, 2012). Reforms focus on incorporating academic rigor and vertical alignment between secondary and postsecondary curriculum (Brown, 2001; Schneider, 2008). There have been improvements within Tech Prep implementation. Curriculum content and standards are becoming more applied, but it is a gradual process (Bragg, 2000; Bragg & Reger, 2002; Hershey et al, 1998). Findings from this study suggest positive impacts of CTE Tech Prep but also persistent limitations and gaps in the program, specifically in promoting widespread readiness at university levels and perseverance to degree attainment. There is need for additional alignment and deeper, qualitative review of Tech Prep in Texas to better understand what components may best work to foster success.

Importance of Context

Within the effort to implement enhanced CTE and Tech Prep, understanding the context of reform is important. It allows for better crafted local policy and informed practitioners—those able to understand what will work in their specific circumstances. The Valley area and RGV LEAD consortium are included in this study to help better understand some of the contextual implications of reform. RGV LEAD is a well developed example of regional consortia created under federal *Perkins* legislation and other state policies. As such it is an ideal region to view the impacts of Tech Prep through student participation. More importantly, the geographic area of the RGV provides a unique context to study educational reform for disadvantaged students.

Findings suggest that Tech Prep is a viable P-16+ model, especially in the RGV area and particularly for its underserved population of students. This study only tells part of the story though. Models suggest that RGV LEAD implementation of Tech Prep differs from the state as a whole and results in significantly greater odds of completing various P-16+ transitions. While models control for individual characteristics and campus-level differences, these findings do not indicate *why* RGV LEAD is associated with greater participation in Tech Prep or higher levels of postsecondary enrollment.

To better understand RGV LEAD impacts and implementation, a breakdown of the P-16+ partnership and specific Tech Prep components should be explored. Barriers and challenges should be compared to achievements in implementing Tech Prep over time. Within the study, other comprehensive and targeted reform initiatives must be connected to implementation to provide a full picture of the college ready improvements in the area. Bright areas—those schools or districts with high levels of success in Tech Prep—should be highlighted to find best practices. This type of qualitative review would provide a more complete picture of implementation paired with the present quantitative findings. In addition, a study of implementation would provide a roadmap for others looking to create or modify their own Tech Prep programs.

POLICY PRESSURES AND REFORM

Requirements of existing accountability standards for academic achievement have put pressures on schools to improve in all areas, including technical education (Anderson, 2008; Chadd & Drage, 2006). *Perkins IV* legislation took steps towards requiring accountability practices by imposing performance indicators for CTE Tech Prep, many of which educators thought would be too burdensome given data restrictions between K-12 and higher education (Friedel, 2011; Klein et al, 2014). Since then, CTE programs have expanded in size and scope. CTE is often combined as part of comprehensive school reforms. Advanced CTE courses are now linked to initiatives such as school choice and curriculum standards redesign (Asunda et al, 2015; Castellano et al, 2003; Ramsey, 1995). Further expansion and focus in CTE areas will only increase calls for accountability and changes to both federal and state policy contexts (Hernandez, 2014; Maguire et al, 2012).

The need for accurate information on the long-term impacts of CTE and Tech Prep participation is greater than ever. Accountability practices have been reshaped under the ESSA (*Every Student Succeeds Act*) reauthorization of ESEA (*Elementary and Secondary Education Act*). Upcoming CTE legislation coupled with recently changed accountability standards will force practitioners and policymakers to gather more information on current and potential programs that may impact student success.

Federal Legislation

Future changes to both federal and state/local CTE policies are imminent. Federal legislators have finally taken up the reauthorization of *Perkins* legislation (Klein, 2015; Boyd et al, 2015). Hearings on *Perkins* reauthorization started soon after the passage of ESSA, and in September 2016 the House voted to pass a reauthorization of the legislation. Entitled the *Strengthening Career and Technical Education for the 21st Century Act*, this bill has bipartisan support and passed 405-5. The proposed legislation provides states and local education agencies (i.e., school districts) greater freedom in CTE goals and accountability. It allows for flexibility in spending and focuses federal dollars based on the number of students taking CTE (Ujifusa, 2016). This differs from past versions of *Perkins* which proportioned monies based on CTE programs and courses (Friedel, 2011).

A Republican-backed Senate version of *Perkins* reauthorization contains language which has currently stalled passage of the legislation. It requires the Department of Education (DOE) to cede most of its control over federal CTE dollars and reduces most, if not all, accountability measures. Hearings on the bill have been cancelled in the Senate. Though unlikely, the earliest reauthorization may occur is in the lame duck session between the 2017 election and inauguration (Stratford, 2016; Ujifusa, 2016).

The two largest points of contention which as are yet to be determined in *Perkins* reauthorization are the level of accountability which CTE courses and programs will face, and the number of CTE courses which will define a student as CTE for funding purposes.

Former *Perkins* legislation—those which first outlined Tech Prep programming—required accountability in the form of tracking longitudinal outcomes. This has proved difficult given existing data capacities in education (Friedel, 2011; Klein et al, 2014). The argument for future legislation is whether to fold CTE into existing accountability measures, much like current state accountability standards. Or, to provide for greater flexibility and less accountability, as the ESEA reauthorization to ESSA has brought about less accountability and oversight at the federal level (Stratford, 2016).

It is likely funding in *Perkins* reauthorization legislation will not be specific to programs, but rather allotted to states and districts according to student participation. The number of courses which define a student as a CTE participator or CTE concentrator (e.g., enrolled in an advanced CTE program like Tech Prep) have not been finalized. Grouping requirements, the numbers of courses needed to reach a specific level of CTE, and occupational/career markers all vary between programs and states (Aliaga eta al, 2014; Cox et al, 2015; Meer, 2007; Stone & Aliaga, 2005). That considered, an average student today completes 3.6 CTE credits during their high school career (Aliaga et al, 2014). This study found the average number of CTE courses for all students at 5.26 and 5.98 for the PSM sample. This suggests Texas has greater than average enrollment, perhaps supporting positive impacts found in the study as well as enhanced future funding possibilities.

However the new *Perkins* legislation is codified, the current study helps to inform policy as it describes longitudinal impacts of Tech Prep participation across a wide and diverse state. It is a model for additional POS which include CTE and credit based curriculum in an effort to improve P-16+ transitions. Further, it allows for greater planning for the future distributions of funds across models and students in relation to CTE and advanced CTE participation.

State Legislation

Federal policy contexts are not the only area in which this study may inform changes in CTE policy. The state of Texas has increased CTE participation through reforms in its graduation plans, or diplomas. Passed in 2013 (and implemented for incoming freshman in the 2014-2015 school year), *House Bill 5* reshaped its RHSP and DAP graduation plans into the Foundation High School Program (FHSP). This new diploma plan involves basic courses, has possible advanced features, and requires students to select an endorsement program (Education Service Center 20 [ESC20], 2016). Endorsements include core and elective courses which result in the selection of a career cluster. These new graduating requirements have pushed CTE to the forefront of reform as all students are required take a greater number of CTE courses in fulfillment of their career cluster. Further, it has increased opportunities to expand Tech Prep programs and similar CTE POS, which fulfill endorsement requirements while also providing dual enrollment opportunities.

Findings from this study are particularly important as they show Tech Prep as a promising tool to bridge gaps in P-16+ transitions while also fulfilling new diploma requirements. Interactions between Tech Prep and previous iterations of college ready degrees (e.g., RHSP, DAP) impact student outcomes in several models. These outcomes, as well as other findings, inform new graduation policies. Results from the study can be used to plan and implement FHSP diploma programs while also increasing college readiness in other areas linked to CTE and Tech Prep.

THE FUTURE OF REFORM

The jobs, careers, and industries of tomorrow are upon us today. Attainment has already fallen behind economic development, though. An incomplete education will not provide students with the skills needed in current or future economies (Carnevale et al, 2010; Castellano et al, 2003). To fill gaps, reforms must bridge transitions between high school, higher education, and the workforce.

The growth of CTE and advanced CTE (i.e., Tech Prep), which utilize career-based curriculums paired with credit based transitions, are a promising tool to meet academic and labor demands. These strategies offer an additional pathway to higher education beyond the traditional route of academic/college preparation. They have the potential to engender success in a wider selection of students, those students who often fail to enroll and succeed in traditional pathways (Dare, 2006; Parnell, 1985).

This study adds to the greater discussion on P-16+ transition models by providing valuable information as to the long-term impacts of CTE programs. Results are numerous and provide strong evidence for the efficacy of Tech Prep models in the RGV, Texas, and beyond.

This study allows policymakers and practitioners alike to search out best practices using the detailed impact models and interactions studied. These may lead to comprehensive reforms and/or targeted Tech Prep models to reach certain students. Findings inform on the utility of Tech Prep programs as well as illustrate the possibilities of using longitudinal data to explore effects of educational models on student outcomes. Additionally, the exploration of outcomes for students participating in advanced CTE across a large state with a diverse student population provides helpful insight into the proficiencies and challenges faced by all states and local levels. Longitudinal outcomes and measures may help shape greater CTE policy reform as well as accountability policies or performance indicators across the broader educational spectrum. The analytic strategies used in this study work together to yield a rich set of findings which strengthen the connections between advanced CTE participation and student success.

REFERENCE MATERIALS

Appendix A: Texas Education Code

SUBCHAPTER T. TECH-PREP EDUCATION

TITLE 3. HIGHER EDUCATION

SUBTITLE B. STATE COORDINATION OF HIGHER EDUCATION

CHAPTER 61. TEXAS HIGHER EDUCATION COORDINATING BOARD

Sec. 61.851. DEFINITIONS. In this subchapter:
(1) "Articulation agreement" means a written commitment between the participants in a tech-prep consortium to a program designed to provide students with a nonduplicative sequence of progressive achievement leading to degrees or certificates in a tech-prep education program.
(2) "Junior college" means an institution of higher education that awards associate degrees as provided by Chapter 130.
(3) "Tech-prep consortium" means a regional collaboration of school districts, institutions of higher education, businesses, labor organizations, and other participants to work together to effectively implement a regional tech-prep program.
(4) "Technical college" means a campus of the Texas State Technical College System established under Chapter 135.
Added by Acts 1999, 76th Leg., ch. 1422, Sec. 2, eff. Sept. 1, 1999.

Sec. 61.852. TECH-PREP PROGRAM. (a) A tech-prep program is a program of study that:
(1) combines at least two years of secondary education with at least two years of postsecondary education in a nonduplicative, sequential course of study based on the foundation high school program adopted by the State Board of Education under Section 28.025;
(2) integrates academic instruction and vocational and technical instruction;
(3) uses work-based and worksite learning where available and appropriate;
(4) provides technical preparation in a career field such as engineering technology, applied science, a mechanical, industrial, or practical art or trade, agriculture, health occupations, business, or applied economics;
(5) builds student competence in mathematics, science, reading, writing, communications, economics, and workplace skills through applied, contextual academics and integrated instruction in a coherent sequence of courses;
(6) leads to an associate degree, two-year postsecondary certificate, or postsecondary two-year apprenticeship with provisions, to the extent applicable, for students to continue toward completion of a baccalaureate degree; and

(7) leads to placement in appropriate employment or to further education.
(b) Notwithstanding Subsection (a)(1), a tech-prep consortium is encouraged to include four years of secondary education in a tech-prep program.
Added by Acts 1999, 76th Leg., ch. 1422, Sec. 2, eff. Sept. 1, 1999.
Amended by:
Acts 2013, 83rd Leg., R.S., Ch. 211 (H.B. 5), Sec. 71(a), eff. June 10, 2013.

Sec. 61.853. REGIONAL TECH-PREP CONSORTIA: GOVERNING BOARD; DIRECTOR; FISCAL AGENT. (a) Each regional tech-prep consortium is governed by a governing board composed of private sector and public sector leaders in the ratio agreed to by the participants in the consortium. A consortium at local option may consolidate governing board members and staff with an eligible local entity to achieve administrative efficiencies and operational coordination. The combined entity shall maintain a proper separation of funds and comply with all applicable legal requirements involving the use of separate funds.
(b) The governing board shall determine the policies of the tech-prep consortium in accordance with the consortium's written bylaws. The bylaws must specify the major relationships, decision-making and operational processes, and other significant policies of the consortium, including the procedures for filling vacancies on the governing board.
(c) According to the terms of a written agreement between a governing board and the fiscal agent, a consortium director shall be selected.
(d) The governing board shall select a community college, junior college, technical college, university, regional education service center, independent school district, or other eligible entity to act as the tech-prep consortium's fiscal agent and to provide human resource and business office services for the consortium. The fiscal agent serves under the terms of a written agreement between the governing board and the fiscal agent.
(e) An entity established after January 1, 2005, may not be a tech-prep consortium for purposes of this subchapter unless the entity is established or otherwise formed after that date as a result of an action taken under Subsection (f)(1) or (2).
(f) In accordance with rules adopted by the board, if a tech-prep consortium fails to meet standards established under Section 61.858, that consortium:
(1) may be consolidated with an existing consortium to serve the regions formerly served by both consortia; or
(2) may be abolished and a new consortium may be established to serve the region formerly served by the abolished consortium and to meet the goals of the abolished consortium's tech-prep program.
(g) In adopting rules for purposes of Subsection (f), the board shall specifically describe:
(1) the type of failure to meet standards that may result in an action being taken under Subsection (f)(1) or (2), including whether an action may result only from a severe or repeated deviation from a standard or from the failure to meet one or more particular standards; and
(2) which action authorized under Subsection (f) may be taken for each type of failure to meet standards.
Added by Acts 1999, 76th Leg., ch. 1422, Sec. 2, eff. Sept. 1, 1999.

Amended by:
Acts 2005, 79th Leg., Ch. 441 (S.B. 1809), Sec. 1, eff. September 1, 2005.

Sec. 61.854. TECH-PREP CONSORTIUM ALLOTMENT. (a) In each fiscal year, the board, as the agent of the Texas Education Agency, shall allot the federal tech-prep implementation money this state receives to the regional tech-prep consortia for regional administration according to regionally developed plans designed to meet federal, state, and regional goals. The board shall allot the money to tech-prep consortia in accordance with a formula adopted by the board, after a public hearing and in consultation with interested state entities and local consortia, that addresses the differing needs of the consortia due to urban or rural populations, special populations, number of tech-prep programs and students, and other factors determined by the board.
(b) An eligible tech-prep consortium that desires assistance under this section must submit an application to the board on a form prescribed by the board for that purpose. The form must address the formula adopted by the board under Subsection (a).
(c) If a tech-prep consortium has a completed application on file under Subsection (b), the board shall make a payment in the amount of the consortium's allotment under Subsection (a) to the consortium's fiscal agent.
Added by Acts 1999, 76th Leg., ch. 1422, Sec. 2, eff. Sept. 1, 1999.

Sec. 61.855. GRANTS FOR TECH-PREP EDUCATION. (a) From amounts made available under Section 61.854, the board, in accordance with this subchapter and with a formula adopted by the board, shall award grants to tech-prep consortia for tech-prep programs described by Subsection (d).
(b) To be eligible for a grant, a tech-prep consortium must be composed of:
(1) a local educational agency, intermediate educational agency, area vocational and technical education school serving secondary school students, or a secondary school funded by the Bureau of Indian Affairs; and
(2) one of the following institutions of higher education:
(A) a nonprofit institution of higher education that offers:
(i) a two-year associate degree program or a two-year certificate program and that is qualified as a junior college or technical college to award associate degrees under Chapter 130 or 135, including an institution receiving assistance under the Tribally Controlled Community College Assistance Act of 1978 (25 U.S.C. Section 1801 et seq.) and its subsequent amendments as a tribally controlled postsecondary vocational or technical institution; or
(ii) a two-year apprenticeship program that follows secondary instruction, if the nonprofit institution of higher education is not prohibited from receiving assistance under Part B, Title IV, of the Higher Education Act of 1965 (20 U.S.C. Section 1071 et seq.) and its subsequent amendments as provided by Section 435(a) of that Act (20 U.S.C. Section 1085(a)) and its subsequent amendments; or
(B) a proprietary institution of higher education that offers a two-year associate degree program and that:

(i) is qualified as an institution of higher education under Section 102 of the Higher Education Act of 1965 (20 U.S.C. Section 1002) and its subsequent amendments; and

(ii) is not subject to a default management agreement plan required by the United States secretary of education.

(c) In addition to entities described by Subsection (b), a tech-prep consortium may include:

(1) an institution of higher education that awards a baccalaureate degree; and

(2) employers or labor organizations.

(d) A tech-prep program must:

(1) be implemented under an articulation agreement between the participants in the consortium;

(2) consist of two to four years of secondary school preceding graduation and:

(A) two or more years of higher education; or

(B) two or more years of apprenticeship following secondary instruction;

(3) have a common core of required proficiency based on the foundation high school program adopted by the State Board of Education under Section 28.025, with proficiencies in mathematics, science, reading, writing, communications, and technologies designed to lead to an associate's degree or postsecondary certificate in a specific career field;

(4) include the development of tech-prep program curricula for both secondary and postsecondary participants in the consortium that:

(A) meets academic standards developed by the state;

(B) links secondary schools and two-year postsecondary institutions, and, if practicable, four-year institutions of higher education through nonduplicative sequences of courses in career fields, including the investigation of opportunities for tech-prep students to enroll concurrently in secondary and postsecondary course work;

(C) uses, if appropriate and available, work-based or worksite learning in conjunction with business and all aspects of an industry; and

(D) uses educational technology and distance learning, as appropriate, to involve each consortium participant more fully in the development and operation of programs;

(5) include in-service training for teachers that:

(A) is designed to train vocational and technical teachers to effectively implement tech-prep programs;

(B) provides for joint training for teachers in the tech-prep consortium;

(C) is designed to ensure that teachers and administrators stay current with the needs, expectations, and methods of business and of all aspects of an industry;

(D) focuses on training postsecondary education faculty in the use of contextual and applied curricula and instruction; and

(E) provides training in the use and application of technology;

(6) include training programs for school counselors designed to enable school counselors to more effectively:

(A) provide information to students regarding tech-prep programs;

(B) support student progress in completing tech-prep programs;

(C) provide information on related employment opportunities;

(D) ensure that tech-prep students are placed in appropriate employment; and
(E) stay current with the needs, expectations, and methods of business and of all aspects of an industry;
(7) provide equal access to the full range of tech-prep programs for individuals who are members of special populations, including by the development of tech-prep program services appropriate to the needs of special populations; and
(8) provide for preparatory services that assist participants in tech-prep programs.
(e) A tech-prep consortium that receives a grant under this section must use the money awarded to develop and operate a tech-prep program described in Subsection (d).
(f) A tech-prep program may:
(1) provide for the acquisition of tech-prep program equipment;
(2) acquire technical assistance from state or local entities that have designed, established, and operated tech-prep programs that have effectively used educational technology and distance learning to deliver curricula and services and to develop an articulation agreement; and
(3) establish articulation agreements with institutions of higher education, labor organizations, or businesses located in or out of the region served by the tech-prep consortium, especially with regard to using distance learning and educational technology to provide for the delivery of services and programs.
Added by Acts 1999, 76th Leg., ch. 1422, Sec. 2, eff. Sept. 1, 1999.
Amended by:
Acts 2013, 83rd Leg., R.S., Ch. 211 (H.B. 5), Sec. 72(a), eff. June 10, 2013.
Acts 2013, 83rd Leg., R.S., Ch. 443 (S.B. 715), Sec. 39, eff. June 14, 2013.

Sec. 61.856. GRANT APPLICATION. (a) Each regional tech-prep consortium that desires to obtain a grant under this subchapter must submit an application to the board at the time and in the manner the board prescribes.
(b) An application under this section must:
(1) contain a five-year plan for the development and implementation of tech-prep programs;
(2) show that the application has been approved by the tech-prep consortium's governing board; and
(3) show that the entity selected as the consortium's fiscal agent has agreed to serve in that capacity.
(c) The board shall approve the application if the application meets the requirements of this section and Section 61.854(b).
(d) The board shall give special consideration to an application for a tech-prep program that:
(1) provides for effective employment placement activities for students or for the transfer of students to baccalaureate degree programs;
(2) is developed in consultation with business, industry, institutions of higher education, and labor organizations;
(3) effectively addresses the issues of school dropout prevention, returning to school after dropping out, and the needs of special populations;

(4) provides education and training in areas or skills in which there are significant workforce shortages, including the information technology industry; and

(5) demonstrates how tech-prep programs may help students achieve high academic and employability competencies.

(e) In awarding grants under this subchapter, the board shall ensure an equitable distribution of assistance between urban and regional consortium participants.

Added by Acts 1999, 76th Leg., ch. 1422, Sec. 2, eff. Sept. 1, 1999.

Sec. 61.857. REPORT; REVIEW OF FIVE-YEAR PLAN. (a) Each regional tech-prep consortium that receives a grant under this subchapter shall annually prepare and submit to the board a written report on the effectiveness of the tech-prep programs for which the consortium received assistance. The report must include a description of the manner in which the consortium awarded any subgrants in the region served by the consortium.

(b) After the second year of the five-year plan required under Section 61.856(b)(1), the consortium shall review the plan and make any changes necessary.

Added by Acts 1999, 76th Leg., ch. 1422, Sec. 2, eff. Sept. 1, 1999.

Sec. 61.858. TECH-PREP CONSORTIUM EVALUATION. (a) The board shall develop and implement a statewide system to evaluate each tech-prep consortium. The evaluation must include:

(1) an assessment of the consortium's performance during the past year in comparison to the goals and objectives stated in the five-year plan contained in the consortium's grant application to the board under Section 61.856;

(2) an identification of any concerns the board has regarding the consortium's performance; and

(3) recommendations for improvement by the consortium in the next year.

(b) The board shall evaluate each tech-prep consortium annually. At least once every four years, or more frequently as provided by board rule, the annual evaluation shall be conducted on-site.

(c) Not later than November 1 of each year, the board shall provide a written report to each tech-prep consortium with the results of the evaluation. The report must:

(1) contain the findings, concerns, and recommendations resulting from the evaluation required under Subsections (a) and (b);

(2) communicate to the consortium the results of the board's evaluation, specifically including the elements required by Subsection (a);

(3) identify areas in which the consortium has made improvement or should take steps to improve its performance; and

(4) identify best practices of tech-prep consortia.

Added by Acts 2005, 79th Leg., Ch. 441 (S.B. 1809), Sec. 2, eff. September 1, 2005.
Amended by:
Acts 2011, 82nd Leg., R.S., Ch. 446 (S.B. 1410), Sec. 2, eff. September 1, 2011.

Appendix B: List of Variables

	IDENTIFIERS
	LEVEL-ONE VARIABLES IN ANALYSIS
	LEVEL-TWO VARIABLES IN ANALYSIS
	INTERACTIONS IN ANALYSIS
	OUTCOME VARIABLES
ID2	Student Identifier
CAMPUS	Campus #
DISTRICT	District #
GRAD09	HS Graduate of 2009
GRAD10	HS Graduate of 2010
ABSENT	Total Days Absent (out of 180)
MABSENT	Mean Centered Total Days Absent During Senior Year
SEX	Gender (1=Female)
ETHNIC	1=Native American 2=Asian 3=Black 4=Hispanic 5=White
WHITE	White Dummy Code
BLACK	Black Dummy Code
HISP	Hispanic Dummy Code[16]
ASIAN	Asian Dummy Code
NATAMER	Native American Dummy Code
GIFTED	Gifted and Talented Program Participation
LEP	Limited English Proficient Identified
VOCED	Level of CTE Participation (3=Tech Prep)
TECHPREP	Tech Prep Participation
SES	Low-SES: Free-Reduced Lunch/Other Welfare Identified
SESmi	Multiple Imputation Low-SES (No Missing Cases)
SPED	Special Education Program Participation
SPEDmi	Multiple Imputation Special Education (No Missing Cases)
M_MET	Passed Math TAKS Exit on First Attempt (April of 11th Grade)
M_COM	Commended on Math TAKS Exit on First Attempt
R_MET	Passed Reading TAKS Exit on First Attempt
R_COM	Commended on Reading TAKS Exit on First Attempt
M_METmi	Multiple Imputation Passed Exit TAKS Math

[16] A note on the use of the term Hispanic: I, the author, was conscientious in my decision to use this term. In my daily life I much prefer the term Latino, or rather Latinx, given its gendered usage. It is more inclusive and provides a greater context for understanding connections between geographic areas of origin and personal identity. Both terms have issues as a social construct of ethnicity. Neither term provides for ideal comparison as the variable does not necessarily correspond with race (as Black and White constructs were formed to do). Given these considerations, my inclination for clean data won out. I use the term Hispanic because it is the variable used in the census at the time of the study as well as in the Texas data collection window. To me, using one imperfect term consistent over the data seemed a better choice than adding any further transformations. It is up to the reader to either interchange these words with one another, and/or keep in mind comparisons of race and ethnicities which are all imperfectly measured.

M_COMmi	Multiple Imputation Commended Exit TAKS Math
R_METmi	Multiple Imputation Passed Exit TAKS Reading
R_COMmi	Multiple Imputation Commended Exit TAKS Reading
DC	Number of Dual Credit Courses in 4 Years
CTE	Number of CTE Courses in 4 Years
DC_CTE	Number of CTE Courses Taken for Dual Credit in 4 Years
MDC	Mean Centered Number of Dual Credit Courses
MCTE	Mean Centered Number of CTE Courses
MDC_CTE	Mean Centered Number of Dual Credit/CTE Courses
MDCmi	Multiple Imputation Mean Dual Credit Courses
MCTEmi	Multiple Imputation Mean CTE Courses
MDC_CTEmi	Multiple Imputation Mean Dual-CTE Courses
RHSP	Recommended High School Plan Diploma
RHSP_DAP	College Ready Diploma (RHSP or DAP)
DAP	Distinguished Achievement Plan Diploma
RGV	RGV LEAD Consortium Area
REGION	Texas Education Service Center (ESC) Region
P_SES	% Low-SES at the Campus-Level
P_LEP	% LEP at the Campus-Level
P_ATRSK	% At Risk of Dropping Out at the Campus-Level
P_CTE	% CTE Participation at the Campus-Level
P_SPED	% Special Education at the Campus-Level
P_BLACK	% Black at the Campus-Level
P_HISP	% Hispanic at the Campus-Level
P_WHITE	% White at the Campus-Level
MP_SES	Grand Mean Centered % Low-SES at the Campus-Level
MP_LEP	Grand Mean Centered % LEP at the Campus-Level
MP_CTE	Grand Mean Centered % CTE Participation at the Campus-Level
MP_SPED	Grand Mean Centered % Special Education at the Campus-Level
MP_BLACK	Grand Mean Centered % Black at the Campus-Level
MP_HISP	Grand Mean Centered % Hispanic at the Campus-Level
MP_WHITE	Grand Mean Centered % White at the Campus-Level
A_RATE	Acceptable Accountability Rating of Campus
RE_RATE	Recognized or Exemplary Accountability Rating of Campus
E_RATE	Exemplary Accountability Rating of Campus
SMSCHL	Small School (N<400)
VYSMSCHL	Very Small School (N<100)
LGSCHL	Large School (N>750)
TRCC	Transition Year (Year After HS) Enrolled in Community College
TRU4	Transition Year Enrolled in 4-Year University
TRHE	Transition Year Enrolled in Higher Education (Any Institution)
TRSCH	Transition Year Semester Credit Hours
HEENR	Enrolled in Any Higher Education Within 4 Years of HS
CCENR	Enrolled at Community College Within 4 Years

U4ENR	Enrolled at 4-Year University Within 4 Years
TOTSCH	Total Semester Credit Hours Over 4 Years
TRWork	Transition Year Working
TRWork2	Transition Year Working 2 Jobs
TRWork3	Transition Year Working 3 Jobs
TRSal_1	Transition Year Salary for Job 1
TRSal_2	Transition Year Salary for Job 2
TRSal_3	Transition Year Salary for Job 3
TRSal_TOT	Transition Year Total Salary
Y5Work	Working 5 Years After High School Graduation
Y5Work2	Working 2 Jobs 5 Years After
Y5Work3	Working 3 Jobs 5 Years After
Y5Sal_1	Salary for Job 1 5 Years After
Y5Sal_2	Salary for Job 2 5 Years After
Y5Sal_3	Salary for Job 3 5 Years After
Y5Sal_TOT	Total Salary 5 Years After High School Graduation
DE	Developmental Education Enrollment (Any Subject)
DE_M	Developmental Math Enrollment
DE_R	Developmental Reading Enrollment
DE_W	Developmental Writing Enrollment
CCR	TSI (TX College Ready Standard) Status Before Enrollment Total
CCRM	TSI Status in Math (1=Failed to Meet Standard)
CCRR	TSI Status Before Enrollment in Reading
CCRW	TSI Status Before Enrollment in Writing
WAIVER	Those Granted TSI Waivers
FAIL_M	Failing One of More Math DE Courses
FAIL_R	Failing One of More Reading DE Courses
FAIL_W	Failing One of More Writing DE Courses
HIGH_M	High-Level of DE Math Course Taken (Close to College-Level)
HIGH_R	High-Level of DE Reading Course Taken
HIGH_W	High-Level of DE Writing Course Taken
MED_M	Medium-Level of DE Math Course Taken (Intermediate)
MED_R	Medium-Level of DE Reading Course Taken
MED_W	Medium-Level of DE Writing Course Taken
LOW_M	Low-Level of DE Math Course Taken (Fundamental/Basic)
LOW_R	Low-Level of DE Reading Course Taken
LOW_W	Low-Level of DE Writing Course Taken
Grad2009	Degree/Certificate Gained in 2009
Grad2010	Degree/Certificate Gained in 2010
Grad2011	Degree/Certificate Gained in 2011
Grad2012	Degree/Certificate Gained in 2012
Grad2013	Degree/Certificate Gained in 2013
Grad2014	Degree/Certificate Gained in 2014
AA	Associate’s Degree Gained Within 4 Years of HS Graduation

BD	Bachelor's Degree Gained Within 4 Years of HS Graduation
CERT	Certificate Gained Within 4 Years of HS Graduation
HEGRAD	Any Degree/Certificate Gained Within 4 Years of HS Graduation
HEjob	Those Employed Within Year after Any Degree/Certificate
AAjob	Employed Year After AA (Within Any Graduating Year)
BDjob	Employed Year After B.A/B.S
CERTjob	Employed Year After Gaining a Certificate
HE2job	Working 2 Jobs after Higher Education Attainment
HE3job	Working 2 Jobs after Higher Education Attainment
HEsal	Salary Year After Higher Education Attainment
AAsal	AA Salary Year After Completion
BDsal	BD Salary Year After Completion
CERTsal	Certificate Salary Year After Completion
PSMTP	Propensity Score Matching Tech Prep Variable (PSM Sample)
TP_GRAD	Interaction Between PSMTP and GRAD09
TP_ABS	Interaction Between PSMTP and MABSENT
TP_SEX	Interaction Between PSMTP and SEX
TP_WH	Interaction Between PSMTP and WHITE
TP_BL	Interaction Between PSMTP and BLACK
TP_HS	Interaction Between PSMTP and HISP
TP_GT	Interaction Between PSMTP and GIFTED
TP_LEP	Interaction Between PSMTP and LEP
TP_SES	Interaction Between PSMTP and SESmi
TP_SP	Interaction Between PSMTP and SPEDmi
TP_MTK	Interaction Between PSMTP and M_METmi
TP_RTK	Interaction Between PSMTP and R_METmi
TP_DC	Interaction Between PSMTP and MDCmi
TP_CTE	Interaction Between PSMTP and MCTEmi
TP_DCTE	Interaction Between PSMTP and MDC_CTEmi
TP_RHSP	Interaction Between PSMTP and RHSP
TP_DAP	Interaction Between PSMTP and DAP
TP_TRHE	Interaction Between PSMTP and TRHE
TP_TRWK	Interaction Between PSMTP and TRWK
TP_HE	Interaction Between PSMTP and HEENR
TP_DE	Interaction Between PSMTP and DE
TP_CCR	Interaction Between PSMTP and CCR
TP_CCRM	Interaction Between PSMTP and CCRM
TP_CCRR	Interaction Between PSMTP and CCRR
TP_CCRW	Interaction Between PSMTP and CCRW
TP_HEGR	Interaction Between PSMTP and HEGR
TP_AA	Interaction Between PSMTP and AA
TP_BD	Interaction Between PSMTP and BD
TP_CERT	Interaction Between PSMTP and CERT

Note. Outcomes in some models are included as level-one predictors in other models.

Appendix C: Descriptive Statistics

This section includes descriptive statistics on the full sample from the 2009 and 2010 high school graduation cohorts (*N*=534,035). Information is broken down by Tech Prep and control group comparisons (i.e., students not enrolled in Tech Prep programs) as well as Texas and RGV LEAD comparisons.

These analyses are the types of information which first drew the author, I, to the RGV area and Tech Prep subject of study. For several years, I have completed data analysis for the RGV LEAD consortium and P-16+ Council (Brown, 2015; Brown & Alexander, 2014). Reports included gathering longitudinal outcome information on Tech Prep students in area programs. Data was presented as comparisons seen below but also disaggregated to individual districts so they might see exactly how their campuses and students in Tech Prep (compared to controls) fared once leaving high school. Information on actual outcomes was presented but not connected with inferential analyses.

These descriptive statistics provide details as to Tech Prep participation as well as RGV comparisons. However, they do not give sufficient information to assess the impacts of participation on P-16+ outcomes. As such they are not included in the main body of the findings chapter. They are presented here to give additional detail to the study and allow for some brevity in the findings section, which is already heavy with 18 different regression models.

Table C.1: Cohorts and Diploma Types

		2009	2010	RHSP	DAP
RGV	Control	9,436	10,202	72%	14%
	Tech Prep	6,416	6,895	57%	37%
	Total	15,852	17,097	66%	23%
Texas	Control	203,461	211,972	70%	11%
	Tech Prep	56,317	62,285	70%	16%
	Total	259,778	274,257	70%	12%

Table C.2: Race/Ethnicity

		Asian	Black	Hispanic	White	Total
RGV	Control	4%	14%	39%	42%	415,433
	Tech Prep	4%	13%	44%	39%	118,602
	Total	4%	14%	40%	42%	534,035
Texas	Control	<1%	<1%	96%	3%	19,638
	Tech Prep	1%	<1%	93%	6%	13,311
	Total	1%	<1%	95%	4%	32,949

Note. Native American students represent <1 in all areas.

Table C.3: Student Characteristics

		Absent	Gender	SES
RGV	Control	13.06	48%	84%
	Tech Prep	10.00	53%	75%
	Total	11.82	50%	80%
Texas	Control	10.35	50%	40%
	Tech Prep	9.49	51%	43%
	Total	10.16	50%	41%

Note. Days absent is presented as an average.

Table C.4: Special Program Membership

		LEP	SPED	GT
RGV	Control	11%	13%	9%
	Tech Prep	3%	4%	14%
	Total	8%	9%	11%
Texas	Control	3%	10%	11%
	Tech Prep	2%	8%	10%
	Total	3%	10%	11%

Table C.5: Passing Rates on TAKS Exit Exams

	Math		Reading	
RGV	**Met**	**Comm.**	**Met**	**Comm.**
Control	75%	16%	87%	17%
Tech Prep	88%	27%	95%	26%
Total	80%	20%	90%	20%
	Math		**Reading**	
Texas	**Met**	**Comm.**	**Met**	**Comm.**
Control	83%	27%	93%	27%
Tech Prep	86%	25%	95%	25%
Total	83%	27%	93%	27%

Table C.6: Average Dual Credit, CTE, and Dual-CTE Course Credits

		DC	CTE	D-CTE
RGV	Control	0.95	5.32	0.38
	Tech Prep	2.42	8.43	1.35
	Total	1.54	6.57	0.77
Texas	Control	0.58	4.68	0.09
	Tech Prep	0.78	7.27	0.28
	Total	0.63	5.26	0.13

Table C.7: Percent Transitioning to Higher Education

	Enrolled in Any HE	Community College	Public University	Semester Credit Hours
RGV				
Control	51%	33%	20%	21.87
Tech Prep	72%	41%	36%	23.96
Total	60%	36%	27%	22.89
Texas				
Control	56%	34%	21%	22.68
Tech Prep	62%	41%	23%	22.98
Total	57%	36%	21%	22.75

Table C.8: Percent Transitioning to the Workforce

	All Grads with Jobs	Grad in HE with Jobs	Grads with Jobs (no HE)
RGV			
Control	53%	62%	44%
Tech Prep	57%	62%	44%
Total	55%	62%	44%
Texas			
Control	63%	71%	54%
Tech Prep	67%	72%	58%
Total	64%	71%	55%

Table C.9: Percent Transitioning to Both Higher Education and the Workforce

	Working	2 Jobs	3 Jobs
RGV			
Control	62%	15%	1%
Tech Prep	62%	15%	2%
Total	62%	15%	2%
Texas			
Control	71%	20%	2%
Tech Prep	72%	21%	2%
Total	71%	20%	2%

Table C.10: Salaries of Those Transitioning to Both Higher Education and the Workforce

	Job 1 Salary	Job 2 Salary	Job 3 Salary	Total Salary
RGV				
Control	$4,702.71	$186.05	$6.84	$4,895.61
Tech Prep	$4,649.61	$224.01	$18.16	$4,891.77
Total	$4,676.72	$204.63	$12.38	$4,893.73
Texas				
Control	$4,967.40	$234.89	$12.32	$5,214.60
Tech Prep	$5,546.41	$260.06	$13.42	$5,819.88
Total	$5,109.41	$241.06	$12.59	$5,363.05

Table C.11: Percent Transitioning to Only the Workforce

	Working	2 Jobs	3 Jobs
RGV			
Control	44%	12%	2%
Tech Prep	44%	12%	1%
Total	44%	12%	1%
Texas			
Control	54%	17%	2%
Tech Prep	58%	19%	2%
Total	55%	17%	2%

Table C.12: Salaries of Those Transitioning to Only the Workforce

	Job 1 Salary	Job 2 Salary	Job 3 Salary	Total Salary
RGV				
Control	$6,215.91	$289.05	$13.69	$6,518.65
Tech Prep	$6,594.76	$298.46	$23.74	$6,916.95
Total	$6,321.58	$291.68	$16.49	$6,629.74
Texas				
Control	$6,800.81	$319.02	$17.36	$7,137.19
Tech Prep	$7,694.25	$371.31	$17.91	$8,083.46
Total	$6,984.59	$329.78	$17.47	$7,331.84

Table C.13: Percent in the Workforce Five Years After High School Graduation

	All with Jobs	HE Grads with Job	No HE Grad with Job
RGV			
Control	65%	83%	62%
Tech Prep	71%	80%	68%
Total	67%	81%	65%
Texas			
Control	69%	82%	67%
Tech Prep	73%	83%	71%
Total	70%	82%	68%

Table C.14: Percent with a Higher Education Credential in the Workforce Five Years After High School Graduation

	Working	2 Jobs	3 Jobs
RGV			
Control	83%	32%	6%
Tech Prep	80%	28%	4%
Total	81%	29%	5%
Texas			
Control	82%	30%	5%
Tech Prep	83%	30%	5%
Total	82%	30%	5%

Table C.15: Salaries of Those with a Higher Education Credential in the Workforce Five Years After High School Graduation

	Job 1 Salary	Job 2 Salary	Job 3 Salary	Total Salary
RGV				
Control	$18,828.25	$2,354.89	$813.68	$19,787.33
Tech Prep	$18,972.10	$2,089.70	$878.98	$19,743.06
Total	$18,908.19	$2,213.96	$844.87	$19,762.73
Texas				
Control	$23,203.56	$2,249.48	$742.85	$24,064.57
Tech Prep	$23,036.17	$2,334.04	$870.93	$23,926.15
Total	$23,161.91	$2,270.36	$774.35	$24,030.13

Table C.16: Percent of Those with Without a Higher Education Credential in the Workforce Five Years After High School Graduation

	Working	2 Jobs	3 Jobs
RGV			
Control	62%	22%	4%
Tech Prep	68%	24%	4%
Total	65%	23%	4%
Texas			
Control	67%	26%	5%
Tech Prep	71%	27%	5%
Total	68%	26%	5%

Table C.17: Salaries of Those with Without a Higher Education Credential in the Workforce Five Years After High School Graduation

	Job 1 Salary	Job 2 Salary	Job 3 Salary	Total Salary
RGV				
Control	$14,588.05	$2,026.36	$724.29	$15,339.29
Tech Prep	$14,219.96	$1,947.20	$664.19	$14,948.75
Total	$14,442.02	$1,994.56	$702.47	$15,184.35
Texas				
Control	$17,012.46	$1,951.05	$639.86	$17,822.60
Tech Prep	$18,333.63	$2,097.73	$670.19	$19,183.99
Total	$17,311.93	$1,983.81	$646.34	$18,131.18

Table C.18: Total Enrollment in Higher Education

	Enrolled in Any HE	Community College	Public University	Semester Credit Hours
RGV				
Control	59%	46%	27%	60.24
Tech Prep	79%	57%	47%	74.48
Total	67%	50%	35%	66.99
Texas				
Control	64%	50%	29%	64.73
Tech Prep	70%	57%	32%	66.83
Total	65%	52%	30%	65.23

Table C.19: College and Career Readiness, Percent Failing

	Math DE	Reading DE	Writing DE
RGV			
Control	43%	36%	37%
Tech Prep	32%	26%	26%
Total	38%	31%	32%
Texas			
Control	37%	27%	26%
Tech Prep	34%	25%	24%
Total	36%	26%	26%

Table C.20: Developmental Enrollment by Subject

	Overall DE	Math DE	Reading DE	Writing DE
RGV				
Control	53%	41%	25%	24%
Tech Prep	40%	31%	16%	15%
Total	47%	36%	21%	20%
Texas				
Control	43%	38%	15%	15%
Tech Prep	43%	38%	14%	14%
Total	43%	38%	15%	15%

Note. Developmental need and participation is measured only for enrolled students.

Table C.21: Earned Postsecondary Credentials

	Any HE Credential	HE Certificate	Associate's Degree	Bachelor's Degree
RGV				
Control	19%	3%	7%	9%
Tech Prep	27%	5%	10%	14%
Total	23%	4%	8%	11%
Texas				
Control	24%	2%	7%	15%
Tech Prep	26%	4%	9%	12%
Total	25%	3%	7%	14%

Note. Credentials are measured only for students who enrolled in higher education.

Table C.22: Percent Post-Postsecondary Graduates Working

	% HE Grads Working	% HE Grads Working 2 Jobs	% HE Grads Working 3 Jobs	HE Grad Salary
RGV				
Control	83%	34%	6%	$16,901.33
Tech Prep	80%	30%	5%	$16,945.68
Total	81%	32%	5%	$16,926.02
Texas				
Control	82%	31%	5%	$21,818.21
Tech Prep	84%	33%	5%	$20,924.91
Total	83%	32%	5%	$21,595.39

Table C.23: Percent Working and Mean Salary by Postsecondary Credential

	CERT Grad %	CERT Salary	AA Grad %	AA Salary	BD Grad %	BD Salary
RGV						
Control	14%	$15,199.01	30%	$12,366.90	41%	$21,673.90
Tech Prep	13%	$13,877.12	28%	$13,840.81	42%	$21,017.20
Total	13%	$14,478.16	29%	$13,165.95	41%	$21,298.64
Texas						
Control	8%	$20,114.43	23%	$14,984.94	49%	$26,522.56
Tech Prep	14%	$20,024.22	28%	$17,014.80	41%	$25,685.46
Total	10%	$20,082.75	24%	$15,575.26	47%	$26,343.96

Appendix D: Sample Statistics

Table D.1: Means and Standard Deviations for Cohort Sample

	Mean	**SD**
Grad Year (2009)	0.486	0.450
Days Absent*	0.000	10.290
Gender	0.499	0.500
Low-SES	0.411	0.492
Black	0.137	0.344
Hispanic	0.403	0.491
White	0.416	0.493
Special Education	0.100	0.300
LEP	0.030	0.172
Gifted & Talented	0.110	0.313
Tech Prep	0.222	0.416
Met Exit Math	0.833	0.373
Met Exit Reading	0.934	0.248
Dual Credit*	0.000	1.622
CTE*	0.000	3.204
Dual-CTE*	0.000	0.624
RHSP Diploma	0.703	0.457
DAP Diploma	0.120	0.325
RGV	0.062	0.241
% Low-SES*	0.000	24.899
% White*	0.000	28.127
Rated Acceptable	0.955	0.207
Rated Exemplary	0.082	0.274
Small School	0.133	0.339
Large School	0.790	0.408

Note. * Denotes mean or grand mean centered variables.
N=534,035

Table D.2: Intercorrelations for Cohort Sample

	0	1	2	3	4	5	6	7
0. Grad Year (2009)	1	-.019**	.004**	-.031**	-.004**	-.018**	.021**	.006**
1. Days Absent	-.019**	1	.038**	.103**	.003	.074**	-.050**	.065**
2. Gender	.004**	.038**	1	.018**	.011**	.009**	-.014**	-.086**
3. Low-SES	-.031**	.103**	.018**	1	.099**	.410**	-.452**	.120**
4. Black	-.004**	.003	.011**	.099**	1	-.328**	-.336**	.067**
5. Hispanic	-.018**	.074**	.009**	.410**	-.328**	1	-.694**	-.003
6. White	.021**	-.050**	-.014**	-.452**	-.336**	-.694**	1	-.025**
7. Special Education	.006**	.065**	-.086**	.120**	.067**	-.003	-.025**	1
8. LEP	.002	.011**	-.019**	.142**	-.063**	.179**	-.144**	.118**
9. Gifted & Talented	.011**	-.083**	.016**	-.100**	-.056**	-.066**	.082**	-.112**
10. Tech Prep	-.012**	-.035**	.012**	.024**	-.018**	.037**	-.025**	-.028**
11. Met Exit Math	.007**	-.115**	-.001	-.143**	-.115**	-.095**	.149**	-.265**
12. Met Exit Reading	-.014**	-.048**	.064**	-.121**	-.046**	-.083**	.106**	-.285**
13. Dual Credit	-.022**	-.106**	.057**	-.063**	-.062**	-.025**	.063**	-.110**
14. CTE	-.021**	-.045**	-.017**	.126**	.015**	.100**	-.081**	.035**
15. Dual-CTE	-.011**	-.036**	.015**	.076**	.008**	.081**	-.089**	-.038**
16. RHSP Diploma	-.007**	-.048**	.041**	.012**	.017**	.041**	-.044**	-.338**
17. DAP Diploma	-.010**	-.128**	.065**	-.102**	-.100**	-.041**	.074**	-.118**
18. RGV	-.003*	.041**	.000	.203**	-.100**	.285**	-.195**	-.007**
19. % Low-SES	-.064**	.094**	.009**	.493**	.074**	.465**	-.466**	.045**
20. % White	.029**	-.091**	-.016**	-.405**	-.150**	-.485**	.577**	-.006**
21. Rated Acceptable	-.105**	-.039**	-.005**	-.063**	-.086**	-.025**	.074**	-.028**
22. Rated Exemplary	-.083**	-.050**	.006**	-.113**	-.055**	-.100**	.115**	-.030**
23. Small School	-.004**	.029**	-.007**	.027**	-.052**	-.031**	.089**	.049**
24. Large School	.003	-.008**	.006**	-.031**	.047**	.051**	-.113**	-.053**

	8	9	10	11	12	13	14	15
0. Grad Year (2009)	.002	.011**	-.012**	.007**	-.014**	-.022**	-.021**	-.011**
1. Days Absent	.011**	-.083**	-.035**	-.115**	-.048**	-.106**	-.045**	-.036**
2. Gender	-.019**	.016**	.012**	-.001	.064**	.057**	-.017**	.015**
3. Low-SES	.142**	-.100**	.024**	-.143**	-.121**	-.063**	.126**	.076**
4. Black	-.063**	-.056**	-.018**	-.115**	-.046**	-.062**	.015**	.008**
5. Hispanic	.179**	-.066**	.037**	-.095**	-.083**	-.025**	.100**	.081**
6. White	-.144**	.082**	-.025**	.149**	.106**	.063**	-.081**	-.089**
7. Special Education	.118**	-.112**	-.028**	-.265**	-.285**	-.110**	.035**	-.038**
8. LEP	1	-.057**	-.035**	-.140**	-.346**	-.057**	-.029**	-.017**
9. Gifted & Talented	-.057**	1	-.022**	.147**	.088**	.162**	-.065**	.020**
10. Tech Prep	-.035**	-.022**	1	.041**	.031**	.051**	.336**	.128**
11. Met Exit Math	-.140**	.147**	.041**	1	.266**	.136**	-.005**	.037**
12. Met Exit Reading	-.346**	.088**	.031**	.266**	1	.086**	-.006**	.026**
13. Dual Credit	-.057**	.162**	.051**	.136**	.086**	1	.056**	.503**
14. CTE	-.029**	-.065**	.336**	-.005**	-.006**	.056**	1	.162**
15. Dual-CTE	-.017**	.020**	.128**	.037**	.026**	.503**	.162**	1
16. RHSP Diploma	-.028**	-.079**	-.008**	.129**	.126**	-.139**	.026**	-.029**
17. DAP Diploma	-.055**	.281**	.064**	.151**	.090**	.367**	-.014**	.104**
18. RGV	.070**	.002	.112**	-.021**	-.030**	.145**	.105**	.261**
19. % Low-SES	.136**	-.030**	.025**	-.140**	-.112**	.020**	.185**	.158**
20. % White	-.129**	-.004**	-.024**	.114**	.093**	.001	-.081**	-.155**
21. Rated Acceptable	-.023**	.007**	.040**	.046**	.037**	.019**	.014**	.003*
22. Rated Exemplary	-.035**	.052**	.008**	.082**	.050**	.058**	-.047**	-.025**
23. Small School	-.002	-.048**	-.016**	-.045**	-.021**	.018**	.028**	-.044**
24. Large School	.019**	.038**	.005**	.041**	.018**	-.046**	-.067**	.044**

	16	17	18	19	20
0. Grad Year (2009)	-.007**	-.010**	-.003*	-.064**	.029**
1. Days Absent	-.048**	-.128**	.041**	.094**	-.091**
2. Gender	.041**	.065**	.000	.009**	-.016**
3. Low-SES	.012**	-.102**	.203**	.493**	-.405**
4. Black	.017**	-.100**	-.100**	.074**	-.150**
5. Hispanic	.041**	-.041**	.285**	.465**	-.485**
6. White	-.044**	.074**	-.195**	-.466**	.577**
7. Special Education	-.338**	-.118**	-.007**	.045**	-.006**
8. LEP	-.028**	-.055**	.070**	.136**	-.129**
9. Gifted & Talented	-.079**	.281**	.002	-.030**	-.004**
10. Tech Prep	-.008**	.064**	.112**	.025**	-.024**
11. Met Exit Math	.129**	.151**	-.021**	-.140**	.114**
12. Met Exit Reading	.126**	.090**	-.030**	-.112**	.093**
13. Dual Credit	-.139**	.367**	.145**	.020**	.001
14. CTE	.026**	-.014**	.105**	.185**	-.081**
15. Dual-CTE	-.029**	.104**	.261**	.158**	-.155**
16. RHSP Diploma	1	-.568**	-.025**	.049**	-.076**
17. DAP Diploma	-.568**	1	.090**	-.072**	.059**
18. RGV	-.025**	.090**	1	.379**	-.326**
19. % Low-SES	.049**	-.072**	.379**	1	-.797**
20. % White	-.076**	.059**	-.326**	-.797**	1
21. Rated Acceptable	-.004**	.036**	.038**	-.133**	.133**
22. Rated Exemplary	-.033**	.117**	-.047**	-.264**	.218**
23. Small School	-.099**	-.031**	-.061**	.056**	.157**
24. Large School	.097**	.015**	.061**	-.067**	-.201**

	21	22	23	24
0. Grad Year (2009)	-.105**	-.083**	-.004**	.003
1. Days Absent	-.039**	-.050**	.029**	-.008**
2. Gender	-.005**	.006**	-.007**	.006**
3. Low-SES	-.063**	-.113**	.027**	-.031**
4. Black	-.086**	-.055**	-.052**	.047**
5. Hispanic	-.025**	-.100**	-.031**	.051**
6. White	.074**	.115**	.089**	-.113**
7. Special Education	-.028**	-.030**	.049**	-.053**
8. LEP	-.023**	-.035**	-.002	.019**
9. Gifted & Talented	.007**	.052**	-.048**	.038**
10. Tech Prep	.040**	.008**	-.016**	.005**
11. Met Exit Math	.046**	.082**	-.045**	.041**
12. Met Exit Reading	.037**	.050**	-.021**	.018**
13. Dual Credit	.019**	.058**	.018**	-.046**
14. CTE	.014**	-.047**	.028**	-.067**
15. Dual-CTE	.003*	-.025**	-.044**	.044**
16. RHSP Diploma	-.004**	-.033**	-.099**	.097**
17. DAP Diploma	.036**	.117**	-.031**	.015**
18. RGV	.038**	-.047**	-.061**	.061**
19. % Low-SES	-.133**	-.264**	.056**	-.067**
20. % White	.133**	.218**	.157**	-.201**
21. Rated Acceptable	1	.065**	.006**	.011**
22. Rated Exemplary	.065**	1	.045**	-.074**
23. Small School	.006**	.045**	1	-.758**
24. Large School	.011**	-.074**	-.758**	1

Table D.3: Means and Standard Deviations for PSM Sample

	Mean	**SD**
Grad Year (2009)	0.477	0.499
Days Absent*	0.000	9.483
Gender	0.509	0.500
Low-SES	0.425	0.494
Black	0.128	0.334
Hispanic	0.427	0.495
White	0.400	0.490
Special Education	0.087	0.281
LEP	0.020	0.140
Gifted & Talented	0.097	0.296
Tech Prep	0.500	0.500
Met Exit Math	0.859	0.348
Met Exit Reading	0.947	0.224
Dual Credit*	0.000	1.701
CTE*	0.000	3.330
Dual-CTE*	0.000	0.734
RHSP Diploma	0.707	0.455
DAP Diploma	0.143	0.350
RGV	0.094	0.292
% Low-SES*	0.000	24.839
% White*	0.000	28.500
Rated Acceptable	0.969	0.172
Rated Exemplary	0.084	0.278
Small School	0.124	0.330
Large School	0.795	0.403
College Ready (CCR)	0.290	0.454
CRR Math	0.238	0.426
CRR Reading	0.172	0.377
CRR Writing	0.168	0.374

Note. * Denote mean or grand mean centered variables.
n=232,268

Table D.4: Intercorrelations for PSM Sample

	0	1	2	3	4	5	6	7
0. Grad Year (2009)	1	-.017**	.006**	-.031**	-.002	-.016**	.018**	.005*
1. Days Absent	-.017**	1	.040**	.098**	-.005*	.067**	-.036**	.058**
2. Gender	.006**	.040**	1	.024**	.023**	.013**	-.029**	-.085**
3. Low-SES	-.031**	.098**	.024**	1	.076**	.423**	-.451**	.093**
4. Black	-.002	-.005*	.023**	.076**	1	-.331**	-.313**	.056**
5. Hispanic	-.016**	.067**	.013**	.423**	-.331**	1	-.705**	-.017**
6. White	.018**	-.036**	-.029**	-.451**	-.313**	-.705**	1	-.002
7. Special Education	.005*	.058**	-.085**	.093**	.056**	-.017**	-.002	1
8. LEP	.001	.010**	-.015**	.114**	-.050**	.139**	-.113**	.106**
9. Gifted & Talented	.008**	-.072**	.013**	-.073**	-.049**	-.032**	.049**	-.096**
10. Tech Prep	-.004	.000	-.003	-.001	.000	-.001	.001	-.001
11. Met Exit Math	.000	-.107**	-.005*	-.118**	-.102**	-.070**	.116**	-.258**
12. Met Exit Reading	-.017**	-.041**	.063**	-.097**	-.039**	-.059**	.078**	-.281**
13. Dual Credit	-.024**	-.101**	.056**	-.046**	-.063**	-.005*	.043**	-.106**
14. CTE	-.022**	-.050**	-.028**	.107**	-.010**	.096**	-.063**	.035**
15. Dual-CTE	-.008**	-.034**	.007**	.085**	.000	.100**	-.103**	-.040**
16. RHSP Diploma	-.012**	-.024**	.024**	.020**	.036**	.027**	-.044**	-.303**
17. DAP Diploma	-.011**	-.124**	.074**	-.074**	-.104**	.004*	.037**	-.118**
18. RGV	.000	.049**	-.001	.238**	-.121**	.338**	-.235**	-.020**
19. % Low-SES	-.059**	.085**	.012**	.497**	.031**	.492**	-.464**	.017**
20. % White	.026**	-.078**	-.026**	-.404**	-.122**	-.513**	.590**	.024**
21. Rated Acceptable	-.096**	-.036**	-.004*	-.037**	-.052**	-.021**	.047**	-.016**
22. Rated Exemplary	-.093**	-.047**	.001	-.115**	-.051**	-.111**	.123**	-.014**
23. Small School	-.004*	.012**	-.022**	.004	-.059**	-.060**	.126**	.052**
24. Large School	-.003	.008**	.024**	-.002	.059**	.085**	-.157**	-.059**
25. College Ready	.027**	.023**	.038**	.048**	.102**	.043**	-.100**	.027**
26. CRR Math	.033**	.034**	.049**	.031**	.100**	.028**	-.082**	.042**
27. CRR Reading	.032**	.007**	.020**	.060**	.084**	.047**	-.098**	.067**
28. CRR Writing	.025**	.007**	-.012**	.043**	.074**	.031**	-.075**	.069**

	8	9	10	11	12	13	14	15
0. Grad Year (2009)	.001	.008**	-.004	.000	-.017**	-.024**	-.022**	-.008**
1. Days Absent	.010**	-.072**	.000	-.107**	-.041**	-.101**	-.050**	-.034**
2. Gender	-.015**	.013**	-.003	-.005*	.063**	.056**	-.028**	.007**
3. Low-SES	.114**	-.073**	-.001	-.118**	-.097**	-.046**	.107**	.085**
4. Black	-.050**	-.049**	.000	-.102**	-.039**	-.063**	-.010**	.000
5. Hispanic	.139**	-.032**	-.001	-.070**	-.059**	-.005*	.096**	.100**
6. White	-.113**	.049**	.001	.116**	.078**	.043**	-.063**	-.103**
7. Special Education	.106**	-.096**	-.001	-.258**	-.281**	-.106**	.035**	-.040**
8. LEP	1	-.043**	-.005*	-.114**	-.302**	-.047**	-.019**	-.013**
9. Gifted & Talented	-.043**	1	.004*	.123**	.073**	.167**	-.016**	.037**
10. Tech Prep	-.005*	.004*	1	.000	.002	-.002	.373**	.082**
11. Met Exit Math	-.114**	.123**	.000	1	.250**	.127**	.003	.037**
12. Met Exit Reading	-.302**	.073**	.002	.250**	1	.079**	-.006**	.025**
13. Dual Credit	-.047**	.167**	-.002	.127**	.079**	1	.060**	.541**
14. CTE	-.019**	-.016**	.373**	.003	-.006**	.060**	1	.160**
15. Dual-CTE	-.013**	.037**	.082**	.037**	.025**	.541**	.160**	1
16. RHSP Diploma	-.019**	-.111**	.001	.099**	.108**	-.169**	-.002	-.027**
17. DAP Diploma	-.041**	.265**	.002	.142**	.083**	.357**	.023**	.091**
18. RGV	.066**	.033**	-.003	-.013**	-.023**	.175**	.085**	.280**
19. % Low-SES	.104**	.014**	-.003	-.104**	-.082**	.063**	.175**	.189**
20. % White	-.099**	-.037**	.003	.082**	.063**	-.026**	-.072**	-.180**
21. Rated Acceptable	-.014**	.003	.004*	.033**	.024**	.014**	.011**	-.001
22. Rated Exemplary	-.027**	.034**	.000	.067**	.040**	.044**	-.035**	-.040**
23. Small School	-.008**	-.032**	.004*	-.033**	-.019**	.030**	.042**	-.052**
24. Large School	.024**	.019**	-.005*	.028**	.018**	-.057**	-.077**	.052**
25. College Ready	-.006**	-.086**	.021**	-.120**	-.020**	-.086**	.027**	-.004
26. CRR Math	-.016**	-.074**	.011**	-.145**	-.018**	-.073**	.016**	-.008**
27. CRR Reading	.022**	-.061**	.007**	-.103**	-.058**	-.064**	.016**	.000
28. CRR Writing	.020**	-.049**	.011**	-.082**	-.057**	-.060**	.017**	.001

	16	17	18	19	20	21	22	23
0. Grad Year (2009)	-.012**	-.011**	.000	-.059**	.026**	-.096**	-.093**	-.004*
1. Days Absent	-.024**	-.124**	.049**	.085**	-.078**	-.036**	-.047**	.012**
2. Gender	.024**	.074**	-.001	.012**	-.026**	-.004*	.001	-.022**
3. Low-SES	.020**	-.074**	.238**	.497**	-.404**	-.037**	-.115**	.004
4. Black	.036**	-.104**	-.121**	.031**	-.122**	-.052**	-.051**	-.059**
5. Hispanic	.027**	.004*	.338**	.492**	-.513**	-.021**	-.111**	-.060**
6. White	-.044**	.037**	-.235**	-.464**	.590**	.047**	.123**	.126**
7. Special Education	-.303**	-.118**	-.020**	.017**	.024**	-.016**	-.014**	.052**
8. LEP	-.019**	-.041**	.066**	.104**	-.099**	-.014**	-.027**	-.008**
9. Gifted & Talented	-.111**	.265**	.033**	.014**	-.037**	.003	.034**	-.032**
10. Tech Prep	.001	.002	-.003	-.003	.003	.004*	.000	.004*
11. Met Exit Math	.099**	.142**	-.013**	-.104**	.082**	.033**	.067**	-.033**
12. Met Exit Reading	.108**	.083**	-.023**	-.082**	.063**	.024**	.040**	-.019**
13. Dual Credit	-.169**	.357**	.175**	.063**	-.026**	.014**	.044**	.030**
14. CTE	-.002	.023**	.085**	.175**	-.072**	.011**	-.035**	.042**
15. Dual-CTE	-.027**	.091**	.280**	.189**	-.180**	-.001	-.040**	-.052**
16. RHSP Diploma	1	-.636**	-.026**	.037**	-.065**	-.012**	-.040**	-.080**
17. DAP Diploma	-.636**	1	.091**	-.012**	.009**	.030**	.093**	-.019**
18. RGV	-.026**	.091**	1	.458**	-.395**	.032**	-.065**	-.079**
19. % Low-SES	.037**	-.012**	.458**	1	-.785**	-.079**	-.257**	.017**
20. % White	-.065**	.009**	-.395**	-.785**	1	.081**	.224**	.210**
21. Rated Acceptable	-.012**	.030**	.032**	-.079**	.081**	1	.054**	.015**
22. Rated Exemplary	-.040**	.093**	-.065**	-.257**	.224**	.054**	1	.063**
23. Small School	-.080**	-.019**	-.079**	.017**	.210**	.015**	.063**	1
24. Large School	.081**	.006**	.080**	-.024**	-.261**	.002	-.094**	-.742**
25. College Ready	.067**	-.105**	.027**	.080**	-.101**	-.015**	-.046**	-.032**
26. CRR Math	.043**	-.095**	.012**	.063**	-.084**	-.017**	-.042**	-.025**
27. CRR Reading	.031**	-.074**	.031**	.078**	-.094**	-.012**	-.033**	-.021**
28. CRR Writing	.019**	-.060**	.038**	.062**	-.073**	-.012**	-.026**	-.016**

	24	25	26	27	28
0. Grad Year (2009)	-.003	.027**	.033**	.032**	.025**
1. Days Absent	.008**	.023**	.034**	.007**	.007**
2. Gender	.024**	.038**	.049**	.020**	-.012**
3. Low-SES	-.002	.048**	.031**	.060**	.043**
4. Black	.059**	.102**	.100**	.084**	.074**
5. Hispanic	.085**	.043**	.028**	.047**	.031**
6. White	-.157**	-.100**	-.082**	-.098**	-.075**
7. Special Education	-.059**	.027**	.042**	.067**	.069**
8. LEP	.024**	-.006**	-.016**	.022**	.020**
9. Gifted & Talented	.019**	-.086**	-.074**	-.061**	-.049**
10. Tech Prep	-.005*	.021**	.011**	.007**	.011**
11. Met Exit Math	.028**	-.120**	-.145**	-.103**	-.082**
12. Met Exit Reading	.018**	-.020**	-.018**	-.058**	-.057**
13. Dual Credit	-.057**	-.086**	-.073**	-.064**	-.060**
14. CTE	-.077**	.027**	.016**	.016**	.017**
15. Dual-CTE	.052**	-.004	-.008**	.000	.001
16. RHSP Diploma	.081**	.067**	.043**	.031**	.019**
17. DAP Diploma	.006**	-.105**	-.095**	-.074**	-.060**
18. RGV	.080**	.027**	.012**	.031**	.038**
19. % Low-SES	-.024**	.080**	.063**	.078**	.062**
20. % White	-.261**	-.101**	-.084**	-.094**	-.073**
21. Rated Acceptable	.002	-.015**	-.017**	-.012**	-.012**
22. Rated Exemplary	-.094**	-.046**	-.042**	-.033**	-.026**
23. Small School	-.742**	-.032**	-.025**	-.021**	-.016**
24. Large School	1	.038**	.030**	.025**	.019**
25. College Ready	.038**	1	.875**	.712**	.703**
26. CRR Math	.030**	.875**	1	.584**	.566**
27. CRR Reading	.025**	.712**	.584**	1	.760**
28. CRR Writing	.019**	.703**	.566**	.760**	1

Glossary

Advanced Technical Credit (ATC) – courses that allow high schools to offer credit for enhanced technical content which is taught at the college level by teachers with special training.

Articulation Agreements **–** authorize dual credit partnerships between high schools and institutions of higher education. They are the written agreements which plan what course or courses will be granted credit, what students will be eligible to enroll, what curriculum will be covered, how credit will be given at both K-12 and higher education levels, what location(s) courses will be taught at, and who will teach course(s), and what training requirements will the job(s) require.

Associate of Arts (AA) – known as an associate's degree, these are typically granted after a two-year course of study or around 60 semester credit hours. Degrees include general education requirements, electives, and work towards a specific theme or major. Most are given out by community and technical colleges.

Bachelor of Arts or Science (BA or BS) **–** known as a bachelor's degree, these are typically granted at four-year institutions after a similar length of study, around 120 semester credit hours. While BAs and BSs are the most common degrees, there are bachelor degrees in other subjects as well. These degrees include course hours in general education, electives, and a large number of courses in a specific major (concentrated area of study).

Career and Technical Education (CTE) – formally known as vocational education, CTE courses and programs focus on hands-on skills, applied sciences and technologies, and career preparation in coordination with academic study. They are usually organized into 16 *Career Clusters* which represent an even larger set of career pathways.[17]

Carl D. Perkins Legislation – are set of federal guidelines and funding allotments given first to vocational education then to Career and Technology Education (CTE). The first act was established in 1984; it has been reauthorized in 1990 as *Perkins II*, 1998 as P*erkins III*, 2006 as *Perkins IV*, and is currently under consideration in the Congress.

Certificate – a higher education credential which is granted following completion of a specific training program. Most commonly thought of are professional training programs in technical areas though certificates range in any number of subject areas, industries, levels, and opportunities. Certificates are also offered as add-ons to other degree programs such as post-baccalaureate or postgraduate certification. Certifications tracked in this study only refer to those below the post-baccalaureate level.

College and Career Readiness (CCR) – academic and skill standards in schools which work towards students being prepared both for postsecondary transitions after high school as well as career readiness.

College Readiness Standards – refer to the need for developmental education. In Texas they are measured by the *Texas Success Initiative* (TSI). TSI sets minimum requirements for math, reading, and writing at the state level though institutions may set higher requirements. The TSI refers to both the complex set of state minimum requirements and the tracking protocols for developmental students.[18]

---

[17] Career Clusters include: 1) Agriculture, Food, & Natural Resources; 2) Architecture & Construction; 3) Arts, A/V Technology, & Communications; 4) Business Management & Administration; 5) Education & Training; 6) Finance; 7) Government & Public Administration; 8) Health Sciences; 9) Hospitality & Tourism; 10) Human Services; 11) Information Technology; 12) Law, Public Safety, Corrections, & Security; 13) Manufacturing; 14) Marketing; 15) Science, Technology, Engineering, & Mathematics (STEM); and 16) Transportation, Distribution, & Logistics.

[18] Requirements for meeting TSI obligations are as follows:

Developmental Education **–** provides non-credit remediation to help make students college-ready. It is an umbrella term that defines any assistance, whether it falls in the regular semester schedule or not, which helps prepare a student for credit-bearing courses. Its purposes are to help provide the necessary academic supports to improve basic skills and competencies in subject areas, usually mathematics, reading, and writing.

Distinguished Achievement Program (DAP) – the highest graduation plan in Texas at the time of study; includes 26 credits in the state-approved curriculum and a combination of advanced measures (plus any additional district requirements).

Dual Career and Technology Education Credit (Dual-CTE) – refers to CTE courses which are taken for both high school and higher education credit simultaneously.

Dual Credit – courses which allow students to simultaneously enroll in both high school and higher education courses earning credit in both.

Foundation High School Plan (FHSP) **–** the new graduation plan in Texas created in 2013 under *House Bill 5*. Starting in 2014-2015 freshman entering Texas high

---

- A prior earned degree from an accredited institution;
- Transfer student from a private, independent, or out-of-state higher education institution;
- Active or veteran military;
- Grandfathered exemptions;
- Active exit-level state accountability tests or college entrance exam scores; portions of tests may exempt a student from all TSI standards or only the subject area. Tests include:
  - State of Texas Assessment of Academic Readiness (STAAR) or Texas Assessment of Knowledge and Skills (TAKS)
  - American College Testing (ACT) or Scholastic Assessment Test (SAT) by the College Board;
- Completion of college-level coursework in a subject related field including:
  - Advanced Placement (AP)
  - International Baccalaureate (IB)
  - Dual Credit;
- Scores set at the institution or by TSI on one or more of possible college ready exams, overall or by subject area:
  - Texas Higher Education Assessment (THEA) or Texas Academic Skills Program (TASP)
  - ACT ASSET or COMPASS tests
  - Northwest Evaluation Association's Measures of Academic Progress (MAP)
  - College Board ACCUPLACER test (THECB, 2015).

schools are required to complete a new set of high school graduation plans including the FHSP, the Foundation High School Plan plus Endorsement (FHSP+), and the Foundation High School Plan plus Distinguished Level of Achievement (FHSP+DLA). All graduation plans require students to choose an endorsement, or set of electives related to a career cluster.

Hierarchical Linear Modeling – a multilevel regression modeling technique which takes into account the hierarchical or nested structure of data. It allows for the estimation of variance shared between groups and within groups.

Log Odds - the expected outcome of a logistic model: $\ln(\pi_{ij}) = ln\left(\frac{\pi}{1-\pi}\right)$.

Minimum High School Program (MHSP) – the minimum graduation plan in Texas at the time of study; includes at least 22 credits in the state-approved curriculum (plus any additional district requirements)

Odds Ratio – the measure of association between a variable and an outcome of interest. It represents the odds that an outcome will occur compared to the odds it will not occur. Calculated as: $\left(\frac{\pi}{1-\pi}\right)$.

P-16+ Pipeline – strategies to unite the educators, administrators, and policymakers responsible for learning at all levels. They are sets of initiatives which address disconnects and attempt to integrate the system for greater effectiveness. Named for the span it connects: pre-kindergarten, elementary, middle, secondary, postsecondary, and plus (graduate studies or workforce participation).

Probability – the likelihood an outcome will occur; expressed as a number between 0 and 1; calculated as: $\frac{e^{ln\left(\frac{\pi}{1-\pi}\right)}}{1+e^{ln\left(\frac{\pi}{1-\pi}\right)}}$

Propensity Score Matching – a statistical matching technique meant to limit selection bias between treatment and control groups. The two step process includes the creation of a propensity score—an estimation of the probability of treatment—and the matching of students according to their expected probability using any one of a number of matching methods (e.g., nearest neighbor). After matching, balancing tests are used to confirm that the propensity estimation and matching resulted in an unbiased sample based on the selected covariates.

Recommended High School Program (RHSP) – the college ready graduation plan in Texas at the time of study; includes 26 credits in the state-approved curriculum (plus any additional district requirements).

RGV LEAD (Rio Grande Valley Linking Economic & Academic Development) – a regional consortium which works to partner P-16+ resources and institutions. The partnership includes 32 local school districts, one charter network, five regional universities and community colleges, the K-12 Education Service Center (ESC), and a number of business and professional organizations representing the economic needs of the Texas Rio Grande Valley area. The alliance provides resources, funding, and support services to Tech Prep programming in high schools, hosts scholarships for graduating students, and creates opportunities for mentoring and early exposure in career pathways.

Rio Grande Valley (RGV) – a four-county area located along the southernmost tip of Texas; the counties include Starr, Hidalgo, Willacy, and Cameron counties.

Tech Prep – part of a regimented CTE course plan; programs consist of a planned sequence of study in a defined field during high school which includes secondary training and leaves the student with some form of postsecondary credential upon completion. Tech Prep programs involve complex articulation agreements and partnerships with high schools, higher education providers, and local industries to fully implement and involve students in the curriculum.

Texas Assessments of Knowledge and Skills (TAKS) – The Texas State accountability test given to students in the years between 2003-2011. The test was given to students in grades 3, 5, 6, 7, 8, 9, 10, and 11 and consisted of mathematics and reading, as well as writing, social studies, and science in some years. Exit-level tests were given to students for the first time in their junior year (11^{th} grade). Exit tests consisted of the following subjects: mathematics, reading, and writing. Students were required to pass exit-level tests to graduate and were given several opportunities to retake the tests if they failed the first sitting. For analysis in this study, the variable refers only to the first test sitting of the exit-level tests.

Texas Education Agency (TEA) – the Texas State agency which oversees K-12 education and collects data on primary and secondary students.

Texas Education Research Center (ERC) – the Texas ERC, located at The University of Texas at Austin, is a research center that supports scientific inquiry and data-driven policy analysis using a clearinghouse of state level information. The Texas ERC provides access to high quality, longitudinal data from K-12, higher education, and workforce agencies.

Texas Higher Education Coordinating Board (THECB) **–** the Texas State agency which oversees postsecondary education institutions and collects data on higher education enrollment, persistence, and attainment.

Texas Workforce Commission (TWC) **–** the state agency which oversees labor in Texas; collects quarterly unemployment or wage data as well as conducting workforce needs analysis.

References

1950 Act to Incorporate the Future Farmers of America, PL740

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high School through college.* Washington, DC: U.S. Department of Education

Alexson, R. G., & Kemnitz, C. P. (2004). Curriculum articulation and transitioning student success: Where are we going wrong and what lessons have we learned? *Educational Research Quarterly, 28(2*), 19.

Aliaga, O. A., Kotamraju, P., Stone, J. R.. (2014). Understanding participation in secondary career and technical education in the 21st century: Implications for policy and practice. *The High School Journal, 97(3),* 128-158. doi:10.1353/hsj.2014.0002

Allen, D. (2010). *Dual enrollment: A comprehensive literature review & bibliography.* New York, NY: The City University of New York. Retrieved from http://www.cuny.edu/academics/k-to-12/databook/library/DE_LitReview_August2010.pdf

Allen, L. (2012). *Back on track through college in the Rio Grande Valley: From dropout recovery and postsecondary success.* Washington DC: Jobs For The Future.

Amey, M. J., Eddy, P. L., & Campbell, T. G. (2010). Crossing boundaries creating community college partnerships to promote educational transitions. *Community College Review, 37(4)*, 333-347. doi:10.1177/0091552110365725

An, B. P. (2013). The impact of dual enrollment on college degree attainment: Do low-ses students benefit? *Educational Evaluation and Policy Analysis, 35(1),* 57-75. doi:10.3102/0162373712461933

Anderson, S. (2008). Math infusion in agricultural education and career and technical education in rural schools. *Rural Educator [H.W. Wilson - EDUC], 30(1)*, 1.

Aragon, S. R., Alfeld, C., & Hansen, D. M. (2013). Benefits of career and technical student organizations' on female and racial minority students' psychosocial and achievement outcomes. *Career and Technical Education Research, 38(2),* 105-124. doi:10.5328/cter38.2.105

Asunda, P. A., Finnell, A. M., & Berry, N. R. (2015). Integration of the common core state standards into CTE: Challenges and strategies of career and technical teachers. *Career and Technical Education Research, 40(1)*, 48-62. doi:10.5328/cter40.1.48

Austin, P. S. (2011). An introduction to propensity score methods for reducing the effects of confounding variables in observational studies. *Multivariate Behavior Research, 46(3)*, 399-424. doi:10.1080/00273171.2011.568786

Bailey, T. (2009). Bridging the high-school divide. In Ladd, H. F., & Fiske, E.B. (Eds.) *Handbook of Research in Education Finance and Policy* (pp. 724-737). New York, NY: Routledge.

Bailey, T. (2009). Challenge and opportunity: rethinking the role and function of developmental education in community college. *New Directions for Community Colleges, 145*, 11-30.

Bailey, T. R., & Karp, M. M (2003). *Promoting college access and success: A review o f credit-based transition programs.* Washington DC: U.S. Department of Education, Office of Vocational and Adult Education.

Bailey, T. R., Hughes, K. L., & Karp, M. M. (2002). What role can dual enrollment programs play in easing the transition between high school and postsecondary education? *Journal for Vocational Special Needs Education, 24(2-3),* 18.

Bartlett, K. R., Schleif, N. L., & Bowen, M. M. (2011). The use of workforce assessment as a component of career and technical education program evaluation. *Career and Technical Education Research, 36(2),* 105-118. doi:10.5328/cter36.2.105

Beaumont, R. (1995). Tech prep and school to work: Working together to foster educational reform. *The High School Journal, 79(2),* 107-112.

Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis.* New York: Columbia University Press.

Becker, G. S. (1993). *Human capital: A theoretical and empirical analysis, with special reference to education* (3rd ed.). New York: Columbia University Press.

Benson, A. D., Johnson, S. D., Duncan, J., Shinkareva, O. N., Taylor, G. D., & Treat, T. (2008). Community college participation in distance learning for career and technical education. *Community College Journal of Research and Practice, 32(9),* 665-687. doi:10.1080/10668920600859848

Berger, N. & Fisher, P (2012). *A well-educated state is key to state prosperity.* Washington DC: Economic Analysis and Research Network.

Bishop, J. H., & Mane, F. (2004). The impacts of career-technical education on high school labor market success. *Economics of Education Review, 23(4),* 381-402. doi:10.1016/j.econedurev.2004.04.001

Black, S.E., Lincove, J., Cullinane, J., & Veron, R. (2015). Can you leave high school behind? *Economics of Education Review, 46*, 52-63.

Boden, K. (2011). Perceived academic preparedness of first-generation Latino college students. *Journal of Hispanic Higher Education, 10(2),* 96-106. doi:10.1177/1538192711402211

Boudria, T. J. (2002). Implementing a project-based technology program for high school women. *Community College Journal of Research and Practice, 26(9),* 709-722. doi:10.1080/10668920290111293

Boyd, R. E., Martin, S. A., Davenport, A. F. Smith, A. B. (2015, November 2) Speaker Ryan's education outlook; CTE reauthorization; Department publishes cash management/REPAYE final rules. Chicago, IL: *The National Law Review.* Retrieved online from: http://www.natlawreview.com/article/speaker-ryan-s-education-outlook-cte-reauthorization-department-publishes-cash

Bozick, R., & Dalton, B. (2013;2012;). Balancing career and technical education with academic coursework: The consequences for mathematics achievement in high school. *Educational Evaluation and Policy Analysis, 35(2)*, 123-138. doi:10.3102/0162373712453870

Bragg, D. D. (2000). Maximizing the benefits of Tech-Prep initiatives for high school students. *New Directions for Community Colleges, 2000(111),* 23-30. doi:10.1002/cc.11103

Bragg, D. D. (2006). Transitions to college: Academic pathways from high school to the community college. *Journal of Applied Research in the Community College, 13(2),* 117.

Bragg, D. D., & Durham, B. (2012). Perspectives on access and equity in the era of (community) college completion. *Community College Review, 40(2),* 106-125.

Bragg, D. D., & Layton, J. D. (1995). Tech prep implementation in the United States: The once and future role of community colleges. *Community College Review, 22(4),* 3-16. doi:10.1177/009155219502200402

Bragg, D. D., & Layton, J. D. (1995). The role of the urban community college in educational reform. *Education and Urban Society, 27(3),* 294-312. doi:10.1177/0013124595027003005

Bragg, D. D., Loeb, J. W., Gong, Y., Deng, C-P., Yoo, J., & Hill, J. L. (2002). *Transition from high school to college and work for tech prep participants in eight selected consortia*. St. Paul, MN: National Research Center for Career and Technical Education, University of Minnesota. Retrieved from: http://www.nccte.org/publications/infosynthesis/r%26dreportrTransition-Bragg%20ALL.pdf

Bragg, D., & Reger, W. (2002). *New lessons about tech prep implementation: Changes in eight selected consortia since reauthorization o f the federal tech prep legislation in 1998*. St. Paul, MN: University of Minnesota, National Research Center for Career and Technical Education.

Brown, B.L. (2003). The benefits of career and technical education. Trends and issues alert. *Clearinghouse on Adult, Career, and Vocational Education, 49.*

Brown, C. G., & Schwartz, R. (2014). College prep for all? *Education Next, 14(3),* 56-60.

Brown, C. H. (2001). Two-Year colleges and tech prep partnerships: A Texas perspective. *New Directions for Community Colleges, 2001(115),* 51-62. doi:10.1002/cc.30

Brown, J. (2015) *RGV LEAD's 2015 regional data report*. Austin, TX: The Texas Education Research Center.

Brown, J., & Alexander, C. (2014) *RGV LEAD's 2014 regional data report*. Austin, TX: The Texas Education Research Center.

Brush, M. (2008). *50 state comparison: Career/technical education: Tech prep or similar focus (2+2).* Denver, CO: Education Commission of the States

Caliendo, M., & Kopeinig, S. (2005, May). *Some practical guidance for the implementation of propensity score matching* (IZA DP No. 1588). Berlin, Germany: Forschungsinstitut zur Zukunft der Arbeit Institute for the Study of Labor.

Callan, P. M., Finney, J. E., Kirst, M. W., Usdan, M. D., & Venezia, A. (2006). *Claiming common ground: State policymaking for improving college readiness and success*. San Jose, CA: National Center for Public Policy and Higher Education.

Cantor, J. A. (1999). Tech prep as a catalyst for community college instructional program development. *Community College Journal of Research and Practice, 23(4)*, 357-369. doi:10.1080/106689299264765

Carl D. Perkins Career and Technical Education Act of 2006, PL209-270

Carl D. Perkins Vocational and Applied Technology Act of 1990, PL101-392

Carl D. Perkins Vocational and Technical Education Act of 1998, PL10S-332

Carl D. Perkins Vocational Education Act of 1984, PL98-524

Carnevale, A.P., Smith, N., & Strohl, J. (2010). *Help wanted: Projections of jobs and education requirements through 2018*. Washington DC: Center on Education and the Workforce.

Carnoy, M. (2009). Policy research in education: The economic view. In Sykes, G., Schneider, B., & Plank, D. N. (Eds.), *Handbook of Education Policy Research*. (pp. 27-38). New York, NY: Routledge. 27-38

Castellano, M., Harrison, L., & Schneider, S. (2008). State secondary career and technical education standards: Creating a framework from a patchwork of policies. *Career and Technical Education Research, 33(1)*, 25-44. doi:10.5328/CTER33.1.25

Castellano, M., Stringfield, S., & Stone, J. R. (2003). Secondary career and technical education and comprehensive school reform: Implications for research and practice. *Review of Educational Research, 73(2)*, 231-272. doi:10.3102/00346543073002231

Castellano, M., Sundell, K., Overman, L. T., & Aliaga, O. A. (2012). Do career and technical education programs of study improve student achievement? preliminary analyses from a rigorous longitudinal study. *International Journal of Educational Reform, 21(2),* 98.

Castells, M. (2010). *The rise of the network society: The information age: Economy, society, and culture volume I* (2nd Ed.). Malden, MA: Wiley-Blackwell.

Cellini, S. R. (2006). Smoothing the transition to college? The effect of tech-prep programs on educational attainment. *Economics of Education Review, 25(4),* 394-411. doi:10.1016/j.econedurev.2005.07.006

Chadd, J., & Drage, K. (2006). No child left behind: Implications for career and technical education. *Career and Technical Education Research, 31(2),* 79-99. doi:10.5328/CTER31.2.79

Choy, A. (2001). *Students whose parents did not go to college: Postsecondary access, persistence, and attainment: Findings from the condition of education*. Washington DC: National Center for Education Statistics.

Clark, R. W. (2001, June). *Dual credit: A report o f programs and policies that offer high school students college credits.* Seattle, WA: University o f Washington: Institute for Educational Inquiry.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). NJ: Erlbaum.

Collins, M.L. (2009). *Setting up success in developmental education: How state policy can help community colleges improve student outcomes*. Boston, MA: Jobs For the Future.

Compton, J. I., Laanan, F. S., & Starobin, S. S. (2010). Career and technical education as pathways: Factors influencing postcollege earnings of selected career clusters. *Journal of Education for Students Placed at Risk (JESPAR), 15(1),* 93-113. doi:10.1080/10824661003635044

Conger, D. (2015). High school grades, admission policies, and the gender gap in college enrollment. *Economics of Education Review, 46*, 144-147.

Corwin, S. H. (1995). Tech prep - an education that really works. *Educational Horizons, 73(4),* 181.

Cox, E. D., Hernández-Gantes, V. M., & Fletcher, J., Edward C. (2015). Student participation in career academies within a school district: Who participates, what makes a difference? *Career and Technical Education Research, 40(1),* 11-27. doi:10.5328/cter40.1.11

Crist, C., Jacquart, M., & Shupe, D. A. (2002). Improving the performance of high school students: Focusing on connections and transitions taking place in Minnesota. *Journal for Vocational Special Needs Education, 24(2-3),* 41.

D'Amico, M. M., Morgan, G. B., Katsinas, S. G., & Friedel, J. N. (2015). State director views on community college workforce development. *Career and Technical Education Research, 39(3),* 191-211. doi:10.5328/cter39.3.191

Dare, D. E. (2006). The role of career and technical education in facilitating student transitions to postsecondary education. *New Directions for Community Colleges, 2006(135),* 73-80. doi:10.1002/cc.249

Deming, D.J., Cohods, S., Jennings, J., & Jencks, C. (2016). School accountability, postsecondary attainment, and earnings. *The Review of Economics and Statistics, 0,* 0. doi:10.1162/REST_a_00598.

Dewey, J. (2004). *Democracy and education*. Mineoloa, NY: Dover Publications, Inc. (Original work published 1909).

Dickert-Conlin, S., & Rubenstein, R. (2007). *Economic inequality and higher education: Access, persistence, and success*. New York: Russell Sage Foundation.

Draeger, M. (2006). How students benefit from high-tech, high-wage career pathways. *New Directions for Community Colleges, 2006(135)*, 81-89. doi:10.1002/cc.250

Eardley, E., & Manvell, J. (2006). Legal remedies for girls' under-representation in nontraditional career and technical education. *International Journal of Manpower, 27(4),* 396-416. doi:10.1108/01437720610679232

Educational Service Center 20. (2016). *House Bill 5.* San Antonio, TX: Author. Retrieved from: http://www.esc20.net/default.aspx?name=ais_sup.HB5

Egalite, A.J., & Kisida, B. (2016). School size and student achievement: A longitudinal analysis. *School Effectiveness and School Improvement, 27(3),* 406-417. doi:10.1080/09243453.2016.1190385

Elementary and Secondary Education Act of 1965, PL89-10

Enders, C. K. (2010). *Applied missing data analysis.* New York: Guilford Press.

Engberg, M.E., & Wolniak, G.C. (2010). Examining the effects of high school contexts on postsecondary enrollment. *Research in Higher Education, 51*, 132-153. doi:10.1007/s11162-009-9150-y

Erisman, W., & Looney, S. (2007). *Opening the door to the American dream: Increasing higher education access and success for immigrants*. Washington DC: Institute for Higher Education Policy.

Esters, L. T., & Retallick, M. S. (2013). Effect of an experiential and work-based learning program on vocational identity, career decision self-efficacy, and career maturity. *Career and Technical Education Research, 38(1),* 69-83. doi:10.5328/cter38.1.69

Every Student Succeeds Act of 2015, PL114-95

Executive Office of the President (2014). *Increasing college opportunity for low-income students: Promising models and a call to action*. Washington DC: Author.

Exex. Order No. 13697, 80 Fed. Reg. 36689 (June 25, 2015).

Farmer, E.I, & Honeycutt, D. (1999). community college administrators and faculty opinions of tech prep. *Community College Journal of Research and Practice, 23(8),* 717-725. doi:10.1080/106689299264413

Field, D. W. (2003). Applied technology proficiency of high school students in applied and traditional courses. *Journal of Vocational Education Research, 28*, 15-34.

Fishman, D. (2015). School reform for rural America: Innovate with charters, expand career and technical education. *Education Next, 15(3),* 8.

Fitzsimmons, J. (1999). Maine technical college system: "building bridges". *Community College Journal of Research and Practice, 23(3),* 227-241. doi:10.1080/106689299264864

Florida Department of Education (2016). *FETPIP methodology*. Tallahassee, FL: Author. Retrieved from: http://www.fldoe.org/accountability/fl-edu-training-placement-info-program/fetpip-methodology.stml#what

Fowler, C. H., Test, D. W., Cease-Cook, J., Toms, O., Bartholomew, A., & Scroggins, L. (2014). Policy implications of high school reform on college and career readiness of youth with disabilities. *Journal of Disability Policy Studies, 25(1),* 19-29. doi:10.1177/1044207313518072

Fowler, M., & Luna, G. (2009). High school and college partnerships: Credit-based transition programs. *American Secondary Education, 38(1),* 62-76.

Frempong, G., Xin, M. & Mensah, J. (2011). Access to postsecondary education: Can schools compensate for socioeconomic disadvantage? *Higher Education, 63,* 19-32. doi:10.1007/s10734-011-9422-2

Friedel, J. N. (2011). Where has vocational education gone? The impact of federal legislation on the expectations, design, and function of vocational education as reflected in the reauthorization of the Carl D. Perkins career and technical education act of 2006. *American Educational History Journal, 38(1-2),* 37.

Fritz, C. O., Morris, P. E., & Richler, J. J. (2012). Effect size estimates: Current use, calculations, and interpretations. *Journal of Experimental Psychology: General. 141(1),* 2-18. doi:10.1037/a0024338

Garrison-Wade, D. F., & Lehmann, J. P. (2009). A conceptual framework for understanding students' with disabilities transition to community college. *Community College Journal of Research and Practice, 33(5),* 415-443. doi:10.1080/10668920802640079

Gelman, A., & Hill, J. (2007). *Data analysis using regression and multilevel/hierarchical models.* New York, NY: Cambridge University Press.

Gemici, S., & Rojewski, J. W. (2007). Evaluating research in career and technical education using scientifically-based research standards. *Career and Technical Education Research, 32(3),* 143-159. doi:10.5328/CTER32.3.143

Gemici, S., Rojewski, J. W., & Lee, I. H. (2012). Treatment of missing data in workforce education research. *Career and Technical Education Research, 37(1)*, 75-99. doi:10.5328/cter37.1.75

Gentry, M., Hu, S., Peters, S. J., & Rizza, M. (2008). Talented students in an exemplary career and technical education school: A qualitative inquiry. *Gifted Child Quarterly, 52(3),* 183-198. doi:10.1177/0016986208319300

Gentry, M., Peters, S. J., & Mann, R. L. (2007). Differences between general and talented students' perceptions of their career and technical education experiences compared to their traditional high school experiences. *Journal of Advanced Academics, 18(3),* 372.

George-Barden Act of 1946, PL79-586

George-Deen Act of 1936, PL74-673

George-Ellzey Act of 1934, PL73-245

George-Reed Act of 1929, PL70-702

Giani, M., Alexander, C., & Reyes, P. (2014). Exploring variation in the impact of dual-credit coursework on postsecondary outcomes: A quasi-experimental analysis of Texas students. *The High School Journal, 97(4),* 200-218.

Gilbert, S. W. (1997). Integrating tech prep into science teacher preparation. *School Science and Mathematics, 97(4)*, 206-211. doi:10.1111/j.1949-8594.1997.tb17368.x

Glassman, M. (2001). Dewey and Vgotsky: Society, experience, and inquiry in educational practice. *Educational Researcher, 30(4),* 3-14. doi:10.3102/0013189X030004003

Goldberg, J., & Smith, J. (2008). The effects of education on labor market outcomes. In Ladd, H. F., & Fiske, E.B. (Eds.) *Handbook of Research in Education Finance and Policy* (pp. 688-708). New York, NY: Routledge.

Gottfried, M. A., Bozick, R., Rose, E., & Moore, R. (2014). Does career and technical education strengthen the STEM pipeline? comparing students with and without disabilities. *Journal of Disability Policy Studies*, 1-13. doi:10.1177/1044207314544369

Greenstone, M., Harris, M., Li, K., Looney, A, & Patashnick, J. (2012). *A dozen economic facts about k-12 education.* Washington DC: The Hamilton Project.

Grossman, M, & Kaestner, R. (1997). Effects of education on health. In Behrman, J. R., & Nevzer, S. (Eds.) *The Social Benefits of Education. Ann Arbor*, MI: University of Michigan Press.

Grubb, W. N. (1999). Learning and earning in the middle part I: The economic benefits of a sub-baccalaureate education. *Economics of Education Review, 21(4),* 299-321.

Grubb, W. N. (1999). Learning and earning in the middle part II: The economic benefits of a sub-baccalaureate education. *Economics of Education Review, 21(5),* 401-14.

Guo, S., & Fraser, M. (2010). *Propensity score analysis: Statistical methods and applications.* Thousand Oaks, CA: Sage Publications.

Haag, P. W. (2015). The challenges of career and technical education concurrent enrollment: An administrative perspective. *New Directions for Community Colleges, 2015(169),* 51.

Hanushek, E. A., & Woessmann, L. (2010). Education and economic growth. In Brewer, D. J., & McEwan, P.J. (Eds.) *Economics of Education*, 60-67. Amsterdam: Elsevier.

Hanushek, E. A., Ruhose, J., & Woessmann, L. (2015). *Human capital quality and aggregate income differences: Development accounting for U.S. states* (NBER Working Paper No. 21295). Cambridge, MA: National Bureau of Economic Research.

Harnish, D., & Lynch, R. L. (2005). Secondary to postsecondary technical education transitions: An exploratory study of dual enrollment in Georgia. *Career and Technical Education Research, 30(3)*, 169.

Hart, P.D. (2005). *Rising to the challenge: Are high school graduates prepared for college and work? A study of recent high school graduates, college instructors and employers*. Washington DC: Achieve, Inc.

Haskell, K. S., & Haskell, T. O. (2008). What differences technology makes for a high school career center. *Theory into Practice, 47(3),* 252-252. doi:10.1080/00405840802154013

Haviland, A., Nagin, D. S., & Rosenbaum, P. R. (2007). Combining propensity score matching and group-based trajectory analysis in an observational study. *Psychological Methods*, *12,* 247-267.

HB2401. *76th Legislative Session of the Texas State Legislature*. (1999).

HB5. *83rd Legislative Session of the Texas State Legislature*. (2013).

Heckman, J., LaLonde, R., & Smith, J. (1999). The economics and econometrics of active labor market programs. In O. C. Ashenfelter & D. Card (Eds.), *Handbook of Labor Economics* (pp. 1865-2097). Amsterdam: Elsevier.

Herr, E. L. (1997). Education as preparation for work: Contributions of career education and vocational education. *Journal of Career Development, 13(3),* 16-30.

Hershey, A.M., Silverberg, M.K., Owens, T., and Hulsey, L.K. (1998). *Focus for the Future: The Final Report of the National Tech-Prep Evaluation*. Princeton, NJ: Mathematica Policy Research, Inc.

Hirschy, A. S., Bremer, C. D., & Castellano, M. (2011). Career and technical education (CTE) student success in community colleges: A conceptual model. *Community College Review, 39(3),* 296-318. doi:10.1177/0091552111416349

Hoffman, N., Vargas, J., & Santos, J. (2009). New directions for dual enrollment: Creating stronger pathways from high school through college. *New Directions for Community Colleges, 145*, 43-58.

Hughes, J. N., Chen, Q., Thoemmes, F., & Kwok, O. M. (2010). An investigation of the relationship between retention in first grade and performance on high stakes tests in third grade. *Educational Evaluation and Policy Analysis, 32,* 166–182. doi:10.3102/0162373710367682

Hutchins, B. C., & Akos, P. (2013). Rural high school youth's access to and use of School-to-Work programs. *The Career Development Quarterly, 61(3),* 210-225. doi:10.1002/j.2161-0045.2013.00050.x

Israel, G. D., Myers, B. E., Lamm, A. J., & Galindo-Gonzalez, S. (2012). CTE students and science achievement: Does type of coursework and occupational cluster matter? *Career and Technical Education Research, 37(1)*, 3-20. doi:10.5328/cter37.1.3

Kao, G., & Thompson, J. S. (2003). Racial and ethnic stratification in educational achievement and attainment. *Annual Review of Sociology, 29*, 417-442.

Karandjeff, K., & Schiorring, E. (2011). Career and technical education (CTE) transfer research project: Improving transfer pathways for California community college students in CTE programs. *Journal of Applied Research in the Community College, 18(2)*, 42.

Karp, M. M., & Jeong, D. W. (2008). *Conducting research to answer your questions about dual enrollment.* New York, NY: U.S. Department of Education.

Kelly, S. , & Price, H. (2009). Vocational education: A clean slate for disengaged students? *Social Science Research, 38,* 810-825. doi:10.1016/j.ssresearch.2009.05.002

Kim, J. (2014). Relationship of tech prep and dual credit to college readiness and retention. *College Student Journal, 48(3),* 337.

Kim, J., & Bragg, D. D. (2008). The impact of dual and articulated credit on college readiness and retention in four community colleges. *Career and Technical Education Research, 33(2),* 133-158. doi:10.5328/CTER33.2.133

King, S. B., & West, D. (2009). Statewide articulation agreements between high schools and community college career and technical programs. *Community College Journal of Research and Practice, 33(6),* 527. doi:10.1080/10668920802662438

Kirst, M. W., Venezia, A., & Nodine, T. (2009). State policy to support college-going high schools for underserved students. In *State policy and early college high schools: The case of California*. Symposium conducted at American Educational Research Association, San Deigo, CA.

Klein, A. (2015, October 21). Congress set to begin work on career and technical education programs. *Education Week.* Retrieved online from: http://blogs.edweek.org/edweek/campaign-k-12/2015/10/congress_set_to_begin_work_on_.html

Klein, S., Richards, A., White, R., Staklis, S., Alfeld, C., Dailey, C.R., Charner, I., & Poliakoff, A. (2014). *Evaluation of the implementation of the Carl D. Perkins Career and Technical Education Act of 2006: Finance, accountability, and programs of study.* Research Triangle Park, NC: RTI International.

Kleiner, B., & Lewis, L. (2009). *Dual enrollment of high school students at postsecondary institutions: 2002-2003.* Washington DC: U.S. Department of Education.

Kompelien, K. S. (1996). Focusing on coherent career plans: The fifth C of career planning programs. *Journal of Career Development, 23(1),* 51-60. doi:10.1007/BF02471269

Kreft, I., & D Leeuw, J. (1998). *Introducing multilevel modeling*. London: Sage.

Krueger, C. (2001). P-16: Building a cohesive education system from preschool through postsecondary. *Peer Review, 4(1)*.

Laanan, F. S., Compton, J. I., & Friedel, J. N. (2006). The role of career and technical education in iowa community colleges. *Community College Journal of Research and Practice, 30(4),* 293-310. doi:10.1080/10668920500479184

Lambeth, J. M., Joerger, R. M., & Elliot, J. (2009). Implications for focusing research in career and technical education and workforce development. *Career and Technical Education Research, 34(3),* 137-153. doi:10.5328/CTER34.3.137

Lazarick, L. (1997). Back to the basics: Remedial education. *Community College Journal,* 11-15.

Lee, I. H. (2012). Strategies for handling missing data with maximum likelihood estimation in career and technical education research. *Career and Technical Education Research, 37(3),* 297-310. doi:10.5328/cter37.3.297

Lee, V., & Loeb, S. (2000). School size effect in Chicago elementary schools: Effects on teachers' attitudes and students' achievement. *American Educational Research Journal, 37*, 3–31.

Leithwood, K. & Jantzi, D. (2009). A review of empirical evidence about school size effects: A policy perspective. *Review of Education Research, 79(1),* 464-490.

Lerner, J.B., & Brand, B. (2006). *The college ladder: Linking secondary and postsecondary education for success for all students.* Washington DC: American Youth Policy Forum.

Lewis, M. V. (2008). Effectiveness of previous initiatives similar to programs of study: Tech prep, career pathways, and youth apprenticeships. *Career and Technical Education Research, 33(3),* 165-188. doi:10.5328/CTER33.3.165

Lewis, M. V., & James R Stone III. (2013). Perspectives in HRDOrigins, chronology, and current status of the national research center for career and technical education: 1963-2012. *New Horizons in Adult Education & Human Resource Development, 25(2),* 107.

Lewis, M. V., & Overman, L. (2008). Dual and concurrent enrollment and transition to postsecondary education. *Career and Technical Education Research, 33(3),* 189-202. doi:10.5328/CTER33.3.189

Lewis, M. V., & Stone, J. R., III. (2013). Origins, chronology, and current status of the national research center for career and technical education: 1963-2012. *New Horizons in Adult Education & Human Resource Development, 25(2),* 107.

Lleras-Muney, A. (2005). The relationship between education and adult mortality in the United States. *Review of Economic Studies, 72(1),* 189–221.

Lochner, L., & Moretti, E. (2004). The effect of education on crime: Evidence from prison inmates, arrests, and self-reports. *The American Economic Review, 94(1),* 155–189.

Loera, G., Nakamoto, J., Oh, Y. J., & Rueda, R. (2013). Factors that promote motivation and academic engagement in a career technical education context. *Career and Technical Education Research, 38(3),* 173-190. doi:10.5328/cter38.3.173

Long, M.C., Conger, D., & Iatorola, P. (2012). Effects of high school course-takings on secondary and postsecondary success. *American Educational Research Journal, 49 (2),* 285-322).

Lowell, A. (1995). Implementing the technology preparation (tech-prep) curriculum. *Journal of Technology Studies, 21(1),* 48-58.

Lumina Foundation. (2015). *A stronger nation through higher education: Ten-year time horizon brings Goal 2025into sharp focus*. Indianapolis, IN: Author.

Lynch, R. (2004). *Rethinking growth strategies: How state and local taxes and services affect economic development.* Washington DC: Economic Policy Institute.

Maguire, K. J., Starobin, S. S., Laanan, F. S., & Friedel, J. N. (2012). Measuring the accountability of CTE programs: Factors that influence postcollege earnings among community college students. *Career and Technical Education Research, 37(3),* 235-261. doi:10.5328/cter37.3.235

Mane, F. (1999). Trends in the payoff to academic and occupation-specific skills: The short and medium run returns to academic and vocational high school courses for non-college bound students. *Economics of Education Review*, *18*, 417-437.

Manley, R. A. (2011). The decentralization of Perkins: History, impact, and recommendations for future CTE legislation. *Career and Technical Education Research, 36(2),* 119-152. doi:10.5328/cter36.2.119

Marsh, J. A. (2000, September). *Connecting districts to the policy dialogue: A review of literature on the relationship of districts with states, schools, and communities* (W-00-1). Seattle, WA: Center for the Study of Teaching and Policy.

McCharen, B. (2008). The success of implementing programs of study in health careers through career clusters and pathways. *Career and Technical Education Research, 33(3),* 203-215. doi:10.5328/CTER33.3.203

McClafferty Jarsky, K., McDonough, P. M., & Núñez, A. (2009). Establishing a college culture in secondary schools through P-20 collaboration: A case study. *Journal of Hispanic Higher Education,8(4),* 357-373.

McDavid, J. A., Boggs, B. D., & Stumpf, D. (2005). Mississippi tech-prep coordinators: Identifying challenges of the job. *Community College Journal of Research and Practice, 29(4)*, 277-288. doi:10.1080/10668920590911869

McDonald, B. M. (2011). Career satisfaction following technical education. *Career and Technical Education Research, 36(3),* 155-170. doi:10.5328/cter36.3.155

McSwain, C., & Davis, R. (2007). *College access for the working poor: Overcoming burdens to succeed in higher education.* Washington DC: Institute for Higher Education Policy.

Meer, J. (2007). Evidence on the returns to secondary vocational education. *Economics of Education Review, 26*, 559-573. doi:10.1016/j.econedurev.2006.04.002

Melguizo, T., Kienzl, G. S., & Alfonso, M. (2011). Comparing the educational attainment of community college transfer students and four-year college rising juniors using propensity score matching methods. *The Journal of Higher Education*, *82*(3), 265-291.

Mincer, J. (1974). *Schooling, experience, and earnings*. New York, NY: Columbia University Press for the National Bureau of Economic Research.

Mincer, J. (1989). Human capital and the labor market: A review of current research. *Educational Researcher, 18,* 27-34.

Mishook, J., Gurantz, O., Borsato, G. N., Hewitson, M., Martinez, M., McGinnis, E., et al. (2012). *College readiness indicator.* Providence, RI: Annenberg Institute, Brown University. Retrieved from http://annenberginstitute.org/sites/default/files/VUE35a.pdf

Moran, C., Cooper, C. R., López, A., & Goza, B. (2009). Developing effective P-20 partnerships to benefit Chicano/Latino students and families. *Journal of Hispanic Higher Education, 8(4),* 340-356.

Murnane, R. J., & Levy, F. (1996). *Teaching the new basic skills: Principles for educating children to thrive in a changing economy*. New York: Free Press.

Mustian, A., Mazzotti, V. L., & Test, D. W. (2013). Disseminating evidence-based practices in secondary transition. *Journal of Positive Behavior Interventions, 15(4),* 197-204.

National Assessment of Career and Technical Education (NACTE). (2014). *National assessment of career and technical education: Final report*. Washington DC: U.S. Department of Education.

National Assessment of Career and Technical Education (NACTE). (2014). *Putting "career" in "college and career ready": The report of the independent advisory panel of the National assessment of career and technical education*. Washington DC: U.S. Department of Education.

National Association of Manufacturers, Manufacturing Institute's Center for Workforce Success, and Deloitte Consulting. (2005). *2005 skills gap report: A survey of the American manufacturing workforce.* New York: Deloitte Development LLC.

National Center for Public Policy and Higher Education. (2008). *Measuring up: The national report card on higher education.* San Jose, CA: Author.

National Center on Education and the Economy. (1990). *Commission on the skills of the American workforce. America's choice: High skills or low wages: The report of the Commission on the skills of the American workforce.* Rochester, NY: Author.

National Governor's Association. (2014). *America works: Education and training for tomorrow's jobs*. Washington DC: Author.

Neild, R. C., Boccanfuso, C., & Byrnes, V. (2015). Academic impacts of career and technical schools. *Career and Technical Education Research, 40(1),* 28-47. doi:10.5328/cter40.1.28

Neild, R.C., & Byrnes, V. (2014). *Impacts of career and technical schools on postsecondary outcomes: A case study of a large urban school district.* Baltimore, MD: Center for Social Organization of Schools, Everyone Graduates Center—Johns Hopkins University.

Nelson, C. H. (1994). Tech prep in Texas: An implementation strategy. *Community College Journal of Research and Practice, 1994(18)*, 99–112.

Neumark, D., & Joyce, M. (2001). Evaluating school-to-work programs using the new NLSY. *Journal of Human Resources, 36(4),* 666–702.

Neumark, D., & Rothstein, D., 2004. *School-to-career programs and transitions to employment and higher education*. Unpublished manuscript.

Nimon, K. (2012). To aggregate or not and potentially better questions for clustered data: The need for hierarchical linear modeling in CTE research. *Career and Technical Education Research, 37(3),* 213-233. doi:10.5328/cter37.3.213

Office of Career , Technical, and Adult Education (2016). *Tech prep education. U.S. Department of Education*. Washington DC: U.S. Department of Education. Retrieved online from: https://www2.ed.gov/about/offices/list/ovae/pi/cte/techprep.html

Organization for Economic Cooperation and Development (2014). *Education at a glance 2014*. Paris, France: Author. Retrieved from: http://www.oecd.org/edu/United%20States-EAG2014-Country-Note.pdf

Organization for Economic Cooperation and Development (2016). *The economic impact of ICT: Measurement, evidence and implications.* Paris, France: Author. Retrieved from: http://www.oecd.org/sti/theeconomicimpactofictmeasurementevidenceandimplications.htm

Otterstetter, R., Buser, S., Kappler, R., Herold, K., Mullet, N., & Mullins, N. (2011). A model for collaborative laboratory experiences between higher education and a high school technical preparation program: Promoting higher education, mentoring, and research. *Advances in Physiology Education, 35(4),* 460-463. doi:10.1152/advan.00103.2010

Parnell, D. (1985). *The Neglected Majority*. Washington DC: American Association of Community Colleges, 1985.

Pierce, D. R. (2001). *Student pathways through high school to college*. Denver, CO: Education Commission of the States. Retrieved from http://www.ecs.Org/c/eaminghouse/26/71/2627.htm.

Pierce, K. B., & Hernandez, V. M. (2015). Do mathematics and reading competencies integrated into career and technical education courses improve high school student state assessment scores? *Career and Technical Education Research, 39(3),* 213-229. doi:10.5328/cter39.3.213

Plank, S. (2001). *Career and technical education in the balance: An analysis of high school persistence, academic achievement, and postsecondary destinations*. Columbus, OH: National Dissemination Center for Career and Technical Education.

Plank, S. B., DeLuca, S., & Estacion, A. (2008). High school dropout and the role of career and technical education: A survival analysis of surviving high school. *Sociology of Education, 81(4),* 345-370. doi:10.1177/003804070808100402

Qi, W., & Cole, J. S. (2011). Career and technical education students who transition to four-year institutions: An exploratory study. *Journal of the First-Year Experience & Students in Transition, 23(2),* 75.

Rabren, K., Carpenter, J., Dunn, C., & Carney, J. S. (2014). Actions against poverty: The impact of career technical education. *Career Development for Exceptional Individuals, 37(1),* 29-39. doi:10.1177/2165143414522091

Ramsey, K. A. (1995). The new vocationalism in urban school reform. *Education and Urban Society, 27(3),* 260-273. doi:10.1177/0013124595027003003

Raudenbush, S. P., & Bryk, A. (2002). *Hierarchical Linear Models, 2nd ed*. Thousand Oaks, California: Sage.

Richard, E. D., Walter, R. A., & Yoder, E. P. (2013). The effect of capstone cooperative education experiences, and related factors, on career and technical education secondary student summative assessment scores. *Career and Technical Education Research, 38(1),* 19-37. doi:10.5328/cter38.1.19

Rio Grande Valley Texas, RGVT. (2016). *Rio Grande valley of south Texas*. Harlingen, TX: Author. Retrieved from: http://riograndevalleytx.us/

Rojewski, J. W., & Hill, R. B. (2014). Positioning research and practice in career and technical education: A framework for college and career preparation in the 21st century. *Career and Technical Education Research, 39(2),* 137-150. doi:10.5328/cter39.2.137

Rojewski, J. W., & Xing, X. (2013). Treatment of Race/Ethnicity in career-technical education research. *Career and Technical Education Research, 38(3*), 245-256. doi:10.5328/cter38.3.245

Rojewski, J. W., Lee, I. H., & Gemici, S. (2012). Use of "t"-test and ANOVA in career-technical education research. *Career and Technical Education Research, 37(3),* 263-275. doi:10.5328/cter37.3.263

Rosenbaum, P. R. (2002). *Observational studies, 2nd ed*. New York, NY: Springer.

Rosenbaum, P., & Rubin, D. (1983). The central role of propensity score observational studies for causal effects. *Biometrika, 70*, 41-55. doi:10.1093/biomet/70.1.41.

Rosenbaum, P., & Rubin, D. (1985). Constructing control group using multivariate matched sampling methods that incorporate the propensity score. *American Statisticians, 39*, 35-39.

Rosenbaum, P.R., & Rubin, D.B. (1984). Reducing boas in observational studies using subclassification on the propensity score. *Journal of the American Statistical Association, 79(387)*, 516-524).

Ross, T., Kena, G., Rathburn, A., KewalRamani, A., Zhang, J., Kristapovich, P., & Manning, E. (2012). *Higher education: Gaps in access and persistence study* (NCES 2012-046). Washington DC: National Center for Education Statistics.

Rubin, D. B. (1996). Multiple imputation after 18+ years. *Journal of the American Statistical Association, 91,* 473-489.

Rubin, D.B. (1987) *Multiple imputation for nonresponse in surveys*. New York: Wiley & Sons.

Sambolt, M., & Blumenthal, D. (2013). *Promoting college and career readiness: A pocket guide for state and district leaders.* Washington DC: American Institutes for Research.

SB1410. *82nd Legislative Session of the Texas State Legislature*. (2011).

SB1809. *79th Legislative Session of the Texas State Legislature*. (2005).

SB715. *83rd Legislative Session of the Texas State Legislature*. (2013).

Schafer, J. L. (1997). *Analysis of incomplete multivariate data*. Boca Raton, FL: Chapman & Hall.

Schafer, J.L. (1999). Multiple imputation: A primer. *Statistical Methods in Medical Research, 8(1),* 3–15. doi:10.1191/096228099671525676.

Schmalzried, J. E., & Harvey, M. W. (2014). Perceptions of special education and career and technical education collaboration and communication. *Career Development for Exceptional Individuals, 37(2)*, 84-96.

School-to-Work Opportunities Act of 1994, PL103-239

Seidman, P. F., & Ramsey, K. A. (1995). Vocational education and school reform: New connections from school to work: 1. *Education and Urban Society [H.W. Wilson - EDUC], 27*, 235.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston: Houghton Mifflin.

Shimony, R., Russo, J. W., Ciaccio, L., Sanders, J. W., Rimpici, R., & Takvorian, P. M. (2002). Medical laboratory technology: A New York state tech-prep model that improves academic skills. *The Journal of Educational Research, 95(5),* 300-307. doi:10.1080/00220670209596603

Shultz, T. W. (1963). *The economic value of education*. New York, NY: Columbia University Press.

Silverberg, M., Warner, E., Fong, M., & Goodwin, D. (2004). *National assessment of vocational education: Final report to Congress.* Washington DC: U.S. Department of Education.

Smith Hughes Act of 1917, PL65-347

Smith, A. (2008). *An inquiry into the nature and causes of the wealth of nations*. New York, NY: Oxford University Press. (Original work published 1793).

Spindler, M. (2010). A taxonomic description of the science integrating learning objectives in career and technical education programs of study. *Career and Technical Education Research, 35(3),* 157-173. doi:10.5328/cter35.312

Starobin, S. S., & Bivens, G. M. (2014). The role of secondary school and community college collaborations to increase latinas in engineering in a rural community. *New Directions for Community Colleges, 2014(165)*, 17-23. doi:10.1002/cc.20087

Stevens, J. (2009). Applied Multivariate Statistics for the Social Sciences (5th ed.). New York: Routledge.

Stipanovic, N., & Stringfield, S. (2013). A qualitative inquiry of career exploration in highly implemented career and technical education programs of study. *International Journal of Educational Reform, 22(4),* 334.

Stipanovic, N., Lewis, M. V., & Stringfield, S. (2012). Situating programs of study within current and historical career and technical educational reform efforts. International *Journal of Educational Reform, 21(2),* 80.

Stone, J. R. I., Alfeld, C., & Pearson, D. (2008). Rigor and relevance: Enhancing high school students' math skills through career and technical education. *American Educational Research Journal [H.W. Wilson - EDUC], 45(3),* 767.

Stone, J. R., Aliaga, O. A. (2005). Career and technical education and school-to-work at the end of the 20th century: Participation and outcomes. *Career and Technical Education Research, 30(2),* 125-144.

Stone, J. R., III, & Lewis, M. V. (2010). Governance of vocational education and training in the united states. *Research in Comparative and International Education, 5(3),* 274.

Stratford, M. (2016, September 20). *Career education bill breaks down in Senate*. Politico. Retrieved from: http://www.politico.com/tipsheets/morning-education/2016/09/career-education-bill-breaks-down-in-senate-216421

Struhl, B., & Vargas, J. (2012, October). *Taking college courses in high school: A strategy for college readiness.* Washington DC: Jobs For the Future. Retrieved from http://www.jff.org/sites/default/files/TakingCollegeCourses_101712.pdf

Symonds, W. C., Schwartz, R. B., & Ferguson, R. (2011). *Pathways to prosperity: Meeting the challenge of preparing young Americans for the 21st century*. Cambridge, MA: Harvard University.

Texas Early College High School. (2016) *Overview of early college high schools in Texas*. Austin, TX: Texas Education Agency. Retrieved from: http://www.txechs.com/what_is_echs.php

Texas Education Agency (2011). *Hispanics are majority in public schools*. Austin, TX: Author. Retrieved from: http://www.tea.state.tx.us/index2.aspx?id=2147499598.

Texas Education Agency. (2016)*Texas science, technology, engineering and mathematics initiative (T-STEM).* Austin, TX: Author. Retrieved from: http://tea.texas.gov/T-STEM/

Texas Higher Education Coordinating Board. (2015). *CBM reporting manuals*. Austin, TX: Author. Retrieved from http://www.txhighereddata.org/index.cfm?objectId=3874B639-B8B5-1533-24CEAC194113B058

Texas P-16 Public Education Information Resources. (2013). *Dual credit and total enrollments, fall semesters*. Austin, TX: The Texas Higher Education Coordinating Board. Retrieved from http://www.texaseducationinfo.org/tea.tpeir.web/topic_dualcred.aspx

Thevenot, B. (2010, February 10). Dual-credit classes in high school on the rise. *The Texas Tribune*. Retrieved from: http://www.texastribune.org/2010/02/19/dual-credit-classes-in-high-school-on-the-rise/

Thoemmes F.J., & Kim E.S. (2011). A systematic review of propensity score methods in the social sciences. *Multivariate Behavior. Research,46,* 90–118. doi:.10.1080/00273171.2011.540475

U.S. Bureau of Economic Analysis. (2014). *Survey of current business, regional data, per capita personal income.* Washington DC: Author. Retrieved from: http://www.bea.gov/scb/

U.S. Census Bureau. (2016). *Quick facts*. Washington DC: U. S. Department of Commerce. Retrieved from: http://www.census.gov/quickfacts/table/PST045215/00

U.S. Department of Education, Office of Vocational and Adult Education. (2012). *Investing in America's future: A blueprint for transforming career and technical education*. Washington DC: Author

U.S. Department of Education: Office of Career, Technical, and Adult Education. (2016). Tech p*rep education*. Retrieved from: http://www2.ed.gov/about/offices/list/ovae/pi/cte/techprep.html

U.S. Department of Labor Bureau of Labor and Statistics. (2015). *Labor force characteristics by race and ethnicity, 2014* (Report 1057). Washington DC: Author.

U.S. Department of Labor Bureau of Labor and Statistics. (2015). *College enrollment and work activity of 2014 high school graduates* (USDL-15-0608). Washington DC: Author.

Ujifusa, A. (2016, October 5). Storm clouds loom over push for ed-tech law's renewal. *Education Week, 36(7),* 18-19.

Vander Ark, Tom. (2002). The case for small high schools. *Educational Leadership, 59(5),* 55- 59.

Vocational Education Act of 1963, PL88-210

Waller, S. K., & Waller, L. (2004). Texas tech prep environmental scan of partner opinions: An assessment of effectiveness. *Community College Journal of Research and Practice, 28(7),* 625-635. doi:10.1080/10668920390253862

Washbon, J. L. (2012). Learning and the new workplace: Impacts of technology change on postsecondary career and technical education. *New Directions for Community Colleges, 2012(157),* 43-52. doi:10.1002/cc.20005

Washington Achievement Council. (2013). *A skilled and educated workforce*. Washington DC: Author.

West, S.G., Cham, H., Thoemmes, F., Renneberg, B., Schulze, J., & Weiler, M. (2014). Propensity scores as a basis for equating groups: Basic principles and application in clinical outcome research. *Journal of Consulting and Clinical Psychology, 82(5),* 906-919.

What Works Clearinghouse. (2014). *Procedures and standards handbook* (version 3.0). Washington DC: The U.S. Department of Education.

Wilson, J. S., II, Parr, B. A., & Parr, K. S. (2012). Student perceptions of distance education in a career and technical teacher education program. *Career and Technical Education Research, 37(2),* 157-169. doi:10.5328/cter37.2.157

Wonacott, M.E. (2002). Dropouts and career and technical education. Myths and realities. *Clearinghouse on Adult, Career, and Vocational Education, 23*.

Zinth, J.D. (2014). *CTE dual enrollment: A strategy for college completion and workforce investment*. Denver, CO: Education Commission of the States