DIFFERENT PATHWAYS, DIFFERENT IMPACTS: EXAMINING HOW ALTERNATIVE CERTIFICATION PATHWAYS INFLUENCE STUDENT ACHIEVEMENT IN KENTUCKY

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For mom and dad.

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Aaron James Butler

DIFFERENT PATHWAYS, DIFFERENT IMPACTS: EXAMINING HOW ALTERNATIVE CERTIFICATION PATHWAYS INFLUENCE STUDENT ACHIEVEMENT IN KENTUCKY

Alternative teacher certification has emerged in the past two decades as one policy state leaders can leverage to recruit and prepare high-quality teachers to meet demands that are unique to their student populations. Indeed, in specific circumstances such as addressing teacher shortages, alternative teacher certification can be viewed as an important aspect of a state's overall human capital management strategy. While a growing body of research has emerged examining the impact of alternatively certified teachers on student achievement, few economists and policy scholars have substantially investigated the relative effectiveness of alternative certification pathways within a state licensure framework. This quantitative research study broadens the field's understanding of alternative certification by examining the impact of classroom teachers who received their certification from one of eight different alternative certification pathways available in the Commonwealth of Kentucky. Specifically, the study considers the impact these teachers have on high school student achievement in mathematics and reading as measured by the ACT.

Using administrative data from the Kentucky Center for Education and Workforce Statistics (KCEWS) for academic year 2013-2014 and a propensity score matching method to estimate teacher effects, this study found both positive and negative effects of classroom teachers on student achievement in mathematics and reading. More importantly, the study discovered that these effects differed by the teachers' alternative certification pathway. Teachers who received their certification from an accredited university-based alternative teacher certification program

generally outperformed other alternatively certified teachers in the Commonwealth. In fact, alternatively certified teachers trained through a university-based program were the only alternatively certified teachers to positively impact student achievement in both mathematics and reading when controlling for teacher experience. Taken together, findings from this study offer important implications for the ways in which the Commonwealth certifies alternative certification program providers, establishes expectations for program delivery, and evaluates programs during regular program accreditation cycles.

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Chapter 1: Introduction

Staffing public schools with qualified teachers has been a common and significant problem for policymakers and school administrators in recent years. The latest reports indicate that 68 percent of schools nationwide have at least one vacant teaching position (Malkus, Hoyer, & Sparks, 2015). The issue of teacher shortages has been a persistent problem for the Commonwealth of Kentucky (Cross, 2016; Seiler et al., 2012). The most recent data indicate that 11 percent of public schools in the Commonwealth were unable to fill one out of ten classroom teaching positions (Seiler et al., 2012). Additionally, the Kentucky Department of Education (2018a) has identified 15 grade level and content areas that are in need of additional teachers across the Commonwealth, including English, mathematics, and science. To fill these vacancies, Kentucky's education leaders and their peers throughout the country are turning to alternative teacher certification as one strategy to recruit classroom teachers and nontraditional candidates into the teaching profession (Jupp, 2009; Levin & Quinn, 2003; Seiler et al., 2012; Woods, 2016). The U.S. Department of Education (2015) defines alternative teacher certification as any teacher preparation program other than a traditional undergraduate program which leads to teacher certification or licensure. The focus of these programs is expansive. Given this expansive landscape, this study defines alternative teacher certification in relation to the Commonwealth of Kentucky's existing certification framework.

The rationale for alternative teacher certification is straightforward—by lowering the barriers to entry to the profession, school districts can tap previously untapped pools of potential teachers to fill hard-to-staff teaching positions (Glazerman, Mayer, & Decker, 2006; Grier & Johnston, 2012). Alternative teacher certification programs tend to attract mid-career professionals who wish to transition into the teaching profession and who prefer to do so as

quickly as possible (U.S. Department of Education, 2015). In most cases, individuals entering alternative teacher certification programs already hold at least a bachelor's degree, if not an advanced degree, demonstrating both knowledge and expertise, and possessing applied experience, in a particular subject area. Alternative teacher certification programs respond to the need to fill teaching vacancies with eager candidates by providing professional certification in a high-intensity, short-duration course of study (U.S. Department of Education, 2015).

The availability and popularity of alternative teacher certification programs has increased exponentially in the past two decades as states have increasingly passed legislation expanding opportunities for individuals to earn a teaching certificate. Shen (1999) found that in the period spanning 1986 to 1997 the number of states offering alternative teacher certification programs increased almost three-fold; by 1997, all but nine states offered an alternative pathway. By 2005, 48 states and the District of Columbia were issuing alternative teaching certificates to 60,000 new teachers per year (Feistritzer, 2011). The most recent figures show that approximately one-third of new public school teachers being hired in the U.S. are entering the profession through alternative routes (Marinell & Johnson, 2014).

Given the rapid expansion of alternative teacher certification programs, critics of these programs have expressed increasing concern about the quality of teachers recruited and trained (Suell & Piotrowski, 2006). While advocates of alternative teacher certification argue that traditional teacher preparation programs are unnecessary if teachers have a command of the content area for which they are teaching (Hess, 2004), critics of alternative certification teacher argue that these programs fail to provide novice teachers with adequate amounts of training and supervisions (Darling-Hammond, 1990, 2000) and often lack the support needed to instill professional knowledge (Suell & Piotrowski, 2006). Critiques of this view contend that

traditional teacher preparation programs add little value to teachers' effectiveness in the classroom and, instead, impose substantial costs that can deter talented individuals from entering teaching (Hess, 2004).

Informing this debate is a growing body of research that has examined whether teacher certification policies influence student achievement gains (e.g., Boyd et al., 2011; Boyd, Lankford, Loeb, Rockoff, & Wyckoff, 2008; Constantine et al., 2009; Decker, Mayer, & Glazerman, 2004; Glazerman et al., 2006; Goldhaber & Brewer, 2000). In general, the evidence is mixed in terms of traditional and alternative teacher certification. However, many of these studies investigating the effects of the policy tend to be from a specific alternative certification programs like Teach For America (Clark et al., 2013; Decker et al., 2004; Glazerman et al., 2006; Xu, Hannaway, & Taylor, 2011), the New York City Teaching Fellows (Kane, Rockoff, & Staiger, 2008), or the Troops to Teachers program (Nunnery, Kaplan, Owings, & Pribesh, 2009). These studies often ignore other alternative certification pathways available in the state—i.e., university-based alternative teacher certification. Only recently have researchers begun to analyze the relative effectiveness of teachers who enter the profession through different alternative certification pathways offered within a state (Sass, 2011). This study presumes that state policymakers would benefit from improved information about the relative effects and effectiveness of teacher certification pathways as they consider opportunities for expanding these pathways within their labor market.

In addition, few studies have examined the effectiveness of alternatively certified teachers at the high school level (e.g., Clotfelter, Ladd, & Vigdor, 2010; Goldhaber & Brewer, 2000; Xu et al., 2011), mainly due to concerns of small sample size (Boyd et al., 2011). By leveraging data from the Kentucky Longitudinal Data System, which is maintained by the

Kentucky Center for Education and Workforce Statistics (KCEWS), this study is able to construct a sample of alternatively certified teachers with appropriate power to draw statistical conclusions. Additionally, this study employs a propensity score matching method, as specified by Rosenbaum and Rubin (1983), as an alternative to value-added modeling to estimate teachers' effects on student achievement. Propensity score matching is a type of quasi-experimental design that approximates random assignment by matching a teacher's students to a set of students outside the classroom that, given the likelihood that they are to belong to the teacher's classroom, are indistinguishable from the teacher's own students (Rosenbaum & Rubin, 1983). Teacher effects are estimated by comparing state mandated ACT subject area test scores of alternatively certified teachers' students (i.e., the treatment group) to scores of students assigned to traditionally certified teachers (i.e., the control group). Propensity score matching balances the distribution of covariates across treatment and control groups (Rosenbaum & Rubin, 1983), which makes it possible to estimate unbiased teacher effects (Davison, 2012; Everson, Feinauer, & Sudweeks, 2013; Stuart, 2007). Moreover, the approach does not require the assumption of linearity (Rosenbaum & Rubin, 1983)—an assumption that is often violated in value-added modeling (Sass, Semykina, & Harris, 2014).

Background of the Study

Education leaders in Kentucky have two state-based policies that directly address the problem of teacher shortages in the Commonwealth: emergency certification and alternative teacher certification. Emergency certification, as defined under the Kentucky Administrative Regulations (KAR) 162:030 (2002), allows local school districts who are unable to fill vacant instructional positions with qualified teachers the opportunity to fill the positions with approved college graduates. Emergency certified teachers are not required to have particular content

knowledge or teaching experience in the subject areas they are teaching, though districts must look for both qualities when choosing from available applicants. Moreover, emergency certifications are only valid for one school year. While emergency certifications are a viable option for districts, Seiler et al. (2012) noted that the vast majority (more than 95 percent) of schools with teaching shortages elect to fill their vacancies with alternatively certified teachers.

Given the extent to which Kentucky schools are hiring alternatively certified teachers to fill vacant classroom positions, it is a surprise that a recent review of the literature has identified no peer-review study or doctoral dissertation that has investigated the impact of alternatively certified teachers on student achievement in Kentucky. This study fills this gap in the literature. In addition, this study examines the effects for each of the eight alternative teacher certification pathways in Kentucky, thus determining whether the nature of the certification pathway an alternatively certified teachers completed had a significant effect on the achievement of students. In order to provide additional context to this study, the following section describes traditional and alternative teacher certification policies in the Commonwealth. The section focuses on the requirements teaching candidates must meet in order to obtain either certifications as well as differences in the type of professional training received through each certification pathway.

Traditional Teacher Certification in Kentucky. Traditional pathways to teacher certification in Kentucky for public school teachers at the elementary, middle, and secondary levels are defined in the Kentucky Revised Statute (KRS) 161.028 (2004) and corresponding regulations outlined in KAR 162:010 (2008). The Education Professional Standards Board (EPSB) is the administrative agency responsible for establishing and enforcing the regulations and professional standards for teacher preparation and certification in Kentucky. Teaching candidates who successfully complete all requirements of state-approved college or university

program in the field of education are granted initial certification. Currently, there are 25 state-approved traditional teacher education programs in the Commonwealth (Education Professional Standards Board, 2018b).

Teaching candidates must meet a series of general and professional requirements in order to obtain a traditional teaching certificate. These requirements differ depending on the subject and grade level certification they are seeking. For most certification areas, the general requirements include: a bachelor's degree from an approved teacher education program, a cumulative grade point average of 2.5 on a 4.0 scale (or a 3.0 grade point average on the last 60 hours of credit completed, including undergraduate and graduate coursework), a recommendation from a college or university official stating the specific teacher education program completed, grade level, degree level, and completion date of the program, a passing score on the Praxis II Specialty Area test for each area of certification, a criminal background check within 12 months prior to the date of application, and a completed CA-1 application with appropriate processing fees paid, as defined by KAR 162:010 (2008). A provisional teaching certificate is granted after all requirements have been met. A provisional teaching certificate is valid for one year to allow completion of the beginning teacher internship program, as established under KRS 161.030 (2017). Upon successful completion of the Kentucky Teacher Internship Program (KTIP), the beginning teacher can apply for a professional teaching certificate, which is valid for a four year period.

Alternative Teacher Certification in Kentucky. In addition to traditional pathways to teacher certification, the Kentucky General Assembly has created eight alternative teacher certification routes through the passage, and later amendments, of KRS 161.048 (2010). Each alternative certification pathway is distinct in the requirements and expectations for individuals

pursuing teacher certification. Table 1 provides a summary of the requirements that are unique to each option.

Table 1.
Requirements of Alternative Teacher Certification Pathways in Kentucky

Alternative Teacher Certification Route	Applicant Requirements
Option 1: Exceptional Work Experience	(1) Documents 10 years of exceptional work experience in the area in which certification is being sought; (2) Holds at least a bachelor's degree with a cumulative grade point average of 2.5 on a 4.0 scale or a grade point average of 3.0 on a 4.0 scale for the last 60 hours of credit completed; (3) Has majored in an academic field or possesses a passing score on the academic content assessment designated by the Education Professional Standards Board; (4) Has an official offer of employment from a local school district; (5) Participates in the Kentucky Teacher Internship Program.
Option 2: Local District Program	(1) Holds at least a bachelor's degree with a cumulative grade point average of 2.75 on a 4.0 scale (or a grade point average of 3.0 on a 4.0 scale for the last 30 hours of credit completed); (2) Has a passing score on a written assessment designated by the Educational Professional Standards Board; (3) Has completed a 30-hour course of study in the specialty area or has at least five years of exceptional field experience in the certification area; (4) Has an official offer of employment from a local school district that has an approved training program; (5) Participates in the Kentucky Teacher Internship Program.
Option 3: College Faculty	(1) Holds a master's degree or higher in the certification area; (2) Has as least five years of full-time teaching experience or its equivalent (90 semester credit hours) at an accredited institution of higher education; (3) Has an official offer of employment in a local school district; (4) Participates in the Kentucky Teacher Internship Program.

(continued)

Option 4: Adjunct Instructor	(1) Holds a bachelor's degree with a cumulative grade point average that varies by instructional level: 2.75 on a 4.0 scale for elementary certification, 2.75 on a 4.0 scale in the major/minor area of the certification area for middle or secondary certification, and no grade point requirements for vocational education certification; (2) Has an official offer of employment from a local school district.
Option 5: Armed Forces Veterans	(1) Has at least 6 years of active duty service, service officially credited toward armed services retirement, or a combination of such service; (2) Holds at least a bachelor's degree with a cumulative grade point average of 2.5 on a 4.0 scale; (3) Has a passing score on the academic content assessment designated by the Education Professional Standards Board; (4) Participates in the Kentucky Teacher Internship Program.
Option 6: University-Based Program	(1) Holds at least a bachelor's degree; (2) Meets the university's admission standards; (3) Participates in the Kentucky Teacher Internship Program.
Option 7: Institute Alternative Route	(1) Holds a bachelor's degree with a cumulative grade point average of 3.0 on a 4.0 scale; (2) Has a minimum score of 500 on the verbal section and a minimum score of 4 on the analytical writing section of the Graduate Record Exam with candidates for math/science certification possessing a minimum score of 450 on the quantitative section; (3) Has a passing score on the academic content assessment designated by the Education Professional Standards Board; (4) Has an official offer of employment from a local school district that has an approved training program; (5) Participates in the Kentucky Teacher Internship Program.
Option 8: Teach For America	(1) Holds a bachelor's degree; (2) Has an official offer of employment from a local school district that has an approved training program; (3) Completed all training requirements of the Teach For America program; (4) Has a passing score on the academic content assessment designed by the Education Professional Standards Board; (5) Participates in the Kentucky Teacher Internship Program.

The first alternative teacher certification pathway, Option 1, is open to individuals with exceptional work experience. EPSB defines "exceptional work experience" as 'recognized

superiority as compared with others in rank, status, and attainment or superior knowledge and skill in comparison with the generally accepted standards in the area in which certification is sought" (KAR 169:010, 2002). Option 1 teaching candidates must demonstrate talents and abilities commensurate with the Kentucky teaching standards, as established in KAR 161:010 (2017), by submitting a portfolio of professional work experience. While KAR 169:010 (2002) does not officially list minimum qualifications for Option 1, EPSB recommends that Option 1 candidates possess the following: at least 10 years of exceptional work experience in the area in which certification is being sought, a bachelor's degree with a cumulative grade point average of 2.5 on a 4.0 scale (or a grade point average of 3.0 on a 4.0 scale for the last 60 hours of credit completed), have majored in an academic field or a passing score on the academic content assessment designated by the EPSB, and an official offer of employment in a local school district. Option 1 teaching candidates can only teach at the secondary level, as defined by KAR 161:010 (2017).

Option 2 is a district-based alternative teacher certification pathway. The Jefferson County Public Schools Alternative Certification Elementary and Secondary Program (ACES) is the only district-based alternative certification that is approved by EPSB. ACES is an 18-month certification program that requires a three-year commitment to teaching in Jefferson County Public Schools (Jefferson County Public Schools, 2017). Program admission requirements include: a bachelor's degree with a cumulative grade point average of 2.75 on a 4.0 scale (or a grade point average of 3.0 on a 4.0 scale on the last 30 hours of credits completed), a writing sample, and a passing score on the Core Academic Skills for Educators exam (Jefferson County Public Schools, 2017).

Option 3 is open to any professional from a post-secondary institution seeking teacher certification. Option 3 teaching candidates can teach at the elementary, middle, or secondary level if they meet the following requirements: hold a master's or doctoral degree in the content area in which certification is sought and have at least five years of full-time teaching experience or its equivalent (90 semester credit hours) at an accredited institution of higher education. Additionally, EPSB stipulates that all Option 3 teaching candidates submit a criminal background check within 12 months prior to the date of application, as established in KAR 169:034 (2015).

Option 4 is an alternative teacher certification pathway for adjunct instructors teaching at a post-secondary institution. This alternative certification pathway is intended for individuals who have expertise in areas such as art, music, foreign language, drama, science, and other specialty areas. Requirements for Option 4 teaching candidates include: possess an official offer of employment from a local school district and a bachelor's degree with a cumulative grade point average of 2.5 on a 4.0 scale. Candidates seeking middle or secondary certification must also have a grade point average of 2.5 on a 4.0 scale in their major or minor area of concentration in the subject area sought. Candidates seeking vocational education certification must hold a high school diploma and at least four years of appropriate occupational experience. In addition, all Option 4 candidates are required to submit a criminal background check within 12 months prior to the date of application (KAR 169:040, 2015) and to participate in a district orientation program that details topics on student safety, district policies and procedures, and pedagogical assistance commensurate with the Kentucky Teacher Standards for Educator Preparation and Certification, as defined by KAR 169:040 (2015). Option 4 does not lead to a professional

teaching certificate. Instead, candidates meeting all of the requirements are issued an adjunct instructor certificate that is valid for one year.

Veterans of the Armed Forces may apply to become a teacher through the alternative teach certification pathway Option 5. To be eligible for Option 5, Veterans must meet the following requirements: discharged or released from active duty under honorable conditions after six or more years of continuous active duty, a total of at least 10 years of active duty service, service officially credited toward armed services retirement, or a combination of such service, hold at least a bachelor's degree with a cumulative grade point average of 2.5 on a 4.0 scale, possess a passing score on the academic content assessment designated by the EPSB. Upon an offer of employment by a school district, the Option 5 teaching candidate shall receive a one year provisional teaching certificate with approval by EPSB.

Option 6 is a pathway for alternative certification through an approved higher education university. The majority of alternative teacher certifications are issued through Option 6 (Seiler et al., 2012). Kentucky currently has 16 college and universities with alternative certification programs (Education Professional Standards Board, 2018b). While eligibility and program requirements for Option 6 vary by teacher preparation programs, EPSB requires all programs to be in accordance with accreditation standards equal to those in traditional teacher certification programs, as defined by KAR 165:010 (2011).

Option 7 allows individuals in a field other than education to receive a one-year temporary provisional teaching certificate that is renewable for a maximum of three years. This option is not limited to teaching positions in shortage areas. Currently, Northern Kentucky University is the only teacher preparation program to provide an Option 7 program. Option 7 teaching candidates are required to possess the following: a bachelor's degree with a cumulative

grade point average of 3.0 on a 4.0 scale, a minimum score of 500 on the verbal section and a minimum score of 4 on the analytic writing section of the Graduate Record Exam (with candidates for math/science certification possessing a minimum score of 450 on the quantitative section), a passing score on the academic content assessment designated by EPSB, and an official offer of employment from a local school district in the area of certification.

Finally, Option 8 is a pathway specific to Teach For America teachers. Requirements of Option 8 include: hold a bachelor's degree, possess an official offer of employment from a local school district in the area of certification, meet all participation criteria for the Teach For America program, complete all training requirements of the Teach For America program, and possess a passing score on the academic content assessment designated by EPSB. Teach For America teachers, like all alternative teaching candidates from the other seven options, must participate the beginning teacher internship program, as indicated in KAR 161:030 (2017). Of those teaching candidates who successfully complete their program requirements and the internship can apply for a professional teaching certificate.

All alternatively certified teachers—with the exception of teachers who received their certification from Option 4: Certification of an adjunct instructor—are required to participate in the KTIP. Upon their completion of KTIP, alternatively certified teachers may receive a professional teaching certificate that is valid for four years.

Purpose of this Study and Guiding Research Questions

The purpose of this study is to examine the effects different teacher certification pathways have on high school student achievement in the Commonwealth Kentucky. Kentucky has created eight alternative teacher certification pathways, as defined by KRS 161.048 (2010). Each alternative teacher certification pathway is distinct in the requirements and expectations for

teaching candidates. This study aims to determine how classroom teachers who secured their classroom teaching certification using one of the Commonwealth's eight different certification pathways effect high school student achievement in mathematics and reading as measured by the ACT. This study addresses the following research questions:

- How do alternatively certified classroom teachers impact high school student achievement outcomes in mathematics and reading as measured by ACT test scores compared to their traditionally certified peers?
    a. What effect does experience have on alternatively certified classroom teachers' impact on student achievement outcomes?
    b. How does the alternative certification pathway used by the classroom teacher effect student achievement outcomes?

Motivation for the Study

This study provides a much needed focus on alternatively certified teachers in Kentucky. An extensive review of the peer-reviewed literature, including published doctoral dissertations, identified no large-scale, quantitative study that has directly examined this topic using state-level data from Kentucky. Indeed, there are relatively few state-level studies of classroom teachers in Kentucky (see Lochmiller, Sugimoto, Muller, Mosier, & Williamson, 2016 for one recent exception). An investigation of the influences of Kentucky's alternative teacher certification policies on student achievement may inform policymakers and education leaders throughout the Commonwealth of the efficacy of the policies and programs designed to attract nontraditional teaching candidates. Moreover, this study offers superintendents and principals a perspective that may be used to inform hiring practices as a means to impact student performance at the high school level. Parents and community members can also further their understanding of types of

individuals who educate their children. Lastly, this study has the potential to contribute methodologically by adding to the nascent literature on the use of propensity score matching methods to examine teacher effectiveness. To continue introducing this study, the chapter proceeds by discussing the significance of this study, defining key terms used in the study, and an overview of the remaining chapters.

Significance of the Study

This study makes several contributions to the literature on alternative teacher certification and teacher effectiveness. First, this study analyzed administrative data from the KCEWS to examine the effects of teacher certification pathways on high school student achievement. A recent review of the literature has revealed no peer-review studies or doctoral dissertations that have leveraged data from Kentucky to examine this topic. Findings from this study have the potential to make an immediate contribution to the research literature examining the effectiveness of different teacher certification pathways. Moreover, findings may also provide a greater understanding to education leaders throughout the Commonwealth of the efficacy of the policies and programs designed to attract nontraditional teaching candidates. There is a particular need for such a study given the recent influx of alternatively certified teachers in Kentucky over the past decade (Seiler et al., 2012).

The policy implications for this study extend to the work of local superintendents and school principals. Odden and Kelly (2008) observed that recent education reforms have led public school districts to strategically orient and coordinate all of their human resource activities around a common vision of effective teaching. In turn, districts have altered the way they hire, develop, and retain teachers as a way to systematically build and leverage talent across all schools (Odden & Kelly, 2008). Findings from this study offer school leaders across the

Commonwealth a perspective that may be used to inform hiring practices as a means to influence student performance at the high school level.

Lastly, this study has the potential to contribute methodologically by adding to the literature on the use of propensity score matching methods to investigate teacher effectiveness. Few studies have used a quasi-experimental design such as propensity score matching to examine the influence of teacher certification pathways on student achievement (Clark et al., 2013; Turner, Goodman, Adachi, & Decker, 2012). Everson, Feinauer, and Sudweeks (2013) outlined the potential use of propensity score matching methods in estimating teacher effectiveness ratings.

Definitions of Key Terms

The following terms are defined as they were used in this study.

ACT. The ACT (formerly the American College Testing Program) assessment program measures educational development and readiness to pursue college-level coursework in English, mathematics, natural science, and social studies. Performance on the tests does not reflect a student's innate ability and is influenced by a student's education preparedness (ACT, 2015). All grade 11 students attending public high schools in Kentucky are required to take the ACT assessment as mandated by KRS 158.6453 (2016).

Alternative Teacher Certification. The U.S. Department of Education (2015) defines alternative teacher certification as any teacher preparation program other than a traditional undergraduate program which leads to teacher certification or licensure. The Kentucky General Assembly has created eight alternative teacher certification pathways through the passage, and later amendments, of KRS 161.048 (2010). Each alternative teacher certification pathway is distinct in the requirements and expectations for individuals pursuing teacher certification.

Traditional Teacher Certification. Traditional teacher certification refers to teaching candidates who successfully complete all requirements of a state-approved college or university program in the field of education (Preston, 2017). In Kentucky, traditional teacher certification for public school teachers at the elementary, middle, and secondary levels are defined by KRS 161.028 (2004) and corresponding standards as outlined in KAR 162:010 (2008).

Teaching Experience. Teaching experience refers to the total number of years an individual has performed the role of classroom teacher in any capacity, as defined by KRS 157.320.10 (2000).

Propensity Score Matching. Propensity score matching is a type of quasi-experimental design that approximates random assignment by matching treated and untreated subjects who share similar values of the propensity score, which are defined by Rosenbaum and Rubin (1983) to be the probability of treatment assignment conditional on observed baseline covariates. Propensity score matching methods balance the distribution of covariates across treatment and control groups (Rosenbaum & Rubin, 1983), which makes it possible to estimate unbiased teacher effects (Davison, 2012; Everson et al., 2013; Stuart, 2007). Moreover, the approach does not require the assumption of linearity (Rosenbaum & Rubin, 1983).

Organization of the Dissertation

This dissertation is organized into five chapters. Chapter one provides the introduction to the study, including the background and context of the study, a statement of the study's problem, the research questions, the significance of the study, and definitions of key terms. Chapter two reviews the research literature on teacher effectiveness, traditional teacher preparation programs, alternative teacher certification, studies that have examined the relationships between teacher pathways and student achievement, as well as the theoretical framework for the study. Chapter

three describes the research methodology for the study, covering the research design, data sources, data preparation, sample, variables, and procedures for data analysis. Chapter four describes an analysis of the study results. Lastly, Chapter five summarizes the findings of the study and provides implications for policy and practices, conclusions, limitations, and suggestions for further research based on the results of the study.

Chapter 2: Literature Review

This chapter reviews the research literature that informs the empirical background for this study on alternative and traditional teacher certification pathways and the influence of teacher certification pathways on high school student achievement. The review begins with a brief synopsis of the existing research related to teacher quality, specifically the effects of teachers on student achievement, the qualities of effective teachers, and the importance of classroom teaching experience. Next, the review discusses different teacher training and certification pathways and studies that have examined the relationship between certification pathway and student achievement. This study uses a quasi-experimental research design and data from the Kentucky Center for Education and Workforce Statistics (KCEWS) to investigate the effects teacher certification pathways have on high school student achievement in the Commonwealth of Kentucky. Therefore, this review pays particular attention to studies that have examined the topic using either experimental or quasi-experimental research methods or have leveraged longitudinal data from statewide databases. The chapter concludes with a discussion of human capital management, a theoretical framework for this study.

Qualities of Effective Teachers

The teacher effectiveness literature is extensive with numerous studies examining how teachers influence student learning. Studies have consistently shown that the value of having a quality teacher, as measured by their ability to improve student achievement on standardized tests, is greater than any other school factor (Aaronson, Barrow, & Sander, 2007; Goldhaber & Hansen, 2010; Hanushek, 1992; Hanushek & Rivkin, 2010; Rivkin, Hanushek, & Kain, 2005). Moreover, these studies also have found significant variation to exist among teachers' levels of effectiveness in influencing student test scores. For example, Hanushek (1992) found that similar

situated students can gain as much as 1.5 or as little as 0.5 years in achievement in an academic year depending on the teacher to which they were assigned. These findings are of particular importance considering the strong association between high-quality teaching and long-term student outcomes, such as high school graduation, college attendance, earning potential, and quality of life (Chetty, Friedman, & Rockoff, 2014). In reaction to these findings and continuing academic achievement gaps, policymakers at the federal, state, and local levels have raised questions about which qualities and qualifications to promote in future teachers, whom to recruit and hire, which qualities to base future pay scales on, and how to equitably distribute teachers across different types of schools and classrooms (Croninger, Rice, Rathbun, & Nishio, 2007; Stronge, Ward, & Grant, 2011).

A growing body of research literature has sought to identify the qualities of effective teachers. Currently, the teacher effectiveness literature has investigated a relatively small set of characteristics that pertain to teachers' academic backgrounds and content knowledge (Stronge et al., 2011). Studies examining the relationship between teachers' academic backgrounds and student achievement have found, in general, positive effects when examining the selectivity ratings of undergraduate institutions (Boyd, Lankford, Loeb, & Wyckoff, 2008; Clotfelter, Ladd, & Vigdor, 2007; Clotfelter et al., 2010), scores on teacher licensure examinations (Clotfelter, Ladd, & Vigdor, 2006; Clotfelter et al., 2007, 2010), and aptitude tests such as the SAT (Boyd et al., 2008; Ehrenberg & Brewer, 1995; Greenwald, Hedges, & Laine, 1996; Stronge et al., 2011). For example, Clotfelter, Ladd, and Vigdor (2010) found in their analysis of North Carolina administrative data that teachers graduating from highly competitive undergraduate institutions showed gains of 0.019 standard deviations in student achievement scores in mathematics and reading than their peers from less competitive universities. Similarly, certification test scores

were also positively associated with student achievement with a 0.011 to 0.015 standard deviation difference in student achievement in elementary grades (Clotfelter et al., 2006, 2007) and up to 0.047 in secondary grades (Clotfelter et al., 2010). Further, Ehrenberg and Brewer (1995) re-examined data from the Coleman Report and found teachers' verbal ability, as measured by the SAT, increased achievement scores for high school students. Boyd et al. (2008) found similar results in their analysis of New York City teachers' scores in the mathematics section of the SAT exam. Collectively, these results speak to the relative importance of a teacher's academic background and their verbal abilities.

In addition to academic background, several studies have examined the relationship between content knowledge and teacher effectiveness. Early empirical work has shown high school mathematics and science teachers with additional subject-related coursework and degrees in these subject areas to be more effective in the classroom (Wayne & Youngs, 2003). However, Wayne and Youngs (2003) noted that these initial studies did not distinguish between subject degrees and degrees in the teaching of particular subjects in their methodologies. Critiques of the early literature have commented that many of these studies failed to differentiate between content knowledge and what Shulman (1986, 1987) referred to as "pedagogical content knowledge," or the ability to express concepts in the context of classroom teaching (Hill, Rowan, & Ball, 2005). Hill, Rowan, and Ball (2005) addressed this issue by developing a measure to gauge teachers' "specialized" content knowledge and skills used to teach mathematics in the classroom. In their national study of first and third grade teachers and students, Hill, Rowan, and Ball (2005), found teachers' "specialized" content knowledge to be significantly related to student achievement. Similar results were found in New York City using the same measure of teacher content knowledge (Rockoff, Jacob, Kane, & Staiger, 2011). Another noteworthy study

in the literature is Harris and Sass' (2011) longitudinal study of Florida teachers. Harris and Sass (2011) were the first to use a set of time-varying covariates and student, teacher, and school fixed effects to examine, among other things, the relationship between teachers' content knowledge and student achievement. The study's findings were mixed in that additional credits of college mathematics coursework for middle school teachers was associated with higher achievement scores, while the opposite was true for elementary school teachers (Harris & Sass, 2011).

These studies have been critiqued in the literature, however. For example, a common critique of these findings is that individually these traits explain a relatively small share of the differences in student achievement gains across teachers (Rivkin et al., 2005). While this may be true, Rockoff, Jacob, Kane, and Staiger (2011) found that when teacher traits were combined with measures of academic background and content knowledge together they predicted moderate to large differences in teacher outcomes. Therefore, as this study presumes, it is a reasonable expectation that differences in alternatively certified teachers' educational background and content knowledge may explain their effectiveness in the classroom.

Additionally, a slightly different line of inquiry has examined the relationship between teachers' non-cognitive traits and student achievement. Stemming from the economic and psychology literatures, non-cognitive characteristics are those academically and occupationally relevant skills and traits that, while not specifically intellectual or analytical in nature, influence behavior and facilitate achievement (Rosen, Glennie, Dalton, Lennon, & Bozick, 2010). Examples of non-cognitive characteristics include perseverance, motivation, self-control, and other aspects of conscientiousness (see Borghans, Duckworth, Heckman, & Ter Weel, 2008 for a detailed list). A study of Teacher For America teachers in New York City found that a one standard deviation increase in a latent non-cognitive variable, which combined measures of

personality traits, feelings of self-efficacy, and scores on a Haberman Star Index, generated increases of 0.033 standard deviations in mathematics test scores and 0.272 standard deviations in teachers' subjective performance evaluations (Rockoff et al., 2011). Bastian (2013), using Teach For America longitudinal achievement data as well, found organizational skills significantly predicted value-added gains in elementary grades, while in high school, teachers' respect for students significantly predicted achievement gains. These results paralleled earlier findings on teachers' organizational ability (Dobbie, 2011). It is important to note that all of these studies use Teach For America data to investigate the topic, thus limiting the external validity of the findings. Still, findings from these studies do show a significant relationship between important non-cognitive traits such as organizational skills, leadership ability, and teacher effectiveness.

Teaching Experience and Student Achievement

There is general consensus in the literature that teachers' years of experience impact student achievement most during the first few years of teaching. The National Center for Analysis of Longitudinal Data in Education Research (CALDER) has conducted multiple studies confirming that novice teachers were generally less effective than more experienced teachers (Clotfelter et al., 2006, 2007, 2010; Ladd, 2009; Sass, 2011). Other peer-reviewed studies have confirmed these findings (Harris & Sass, 2011; Kane et al., 2008; Winters, 2011). Rockoff et al. (2011) observed that teacher experience is one of the only characteristics to consistently relate to teacher effectiveness, as measured by student achievement tests. The authors argued that the skills teachers accumulate in the classroom—such as classroom management skills, content knowledge, and practices in pedagogy—make them more effective in the classroom. Other studies have confirmed these claims, showing that the experience teachers gain during their first

few years of teaching has a stronger impact on teacher effectiveness than most other variables including licensure test scores, advanced degrees, class size, and National Board certification (Clotfelter et al., 2010; Ladd, 2009; Sass, 2011).

Achievement gains associated with experience does not persist throughout teachers' careers (Buddin & Zamarro, 2009; Winters, 2011), nor do gains have an equal effect across grades or subject areas (Boyd et al., 2008; Klecker, 2002). For example, Boyd et al. (2008) and Klecker (2002) found teachers in their second year of teaching to experience the largest gains in student achievement. Similar results were found in follow up studies (Buddin & Zamarro, 2009; Winters, 2011). Studies have shown the positive effects of more experience to level off between the third and fourth years of teaching (Buddin & Zamarro, 2009; Rockoff, 2004; Winters, 2011). Budding and Zamarro (2009) found that after the fifth year of experience gains in mathematics and reading diminish from about 0.033 and 0.067 standard deviation each year. Moreover, Rivken et al. (2005) found large gains in student achievement for teachers with consecutive years of teaching experience. As for grade and subject areas, Boyd et al. (2008) found teacher experience to have a larger impact on student achievement in fourth and fifth grades than in middle school, specifically sixth through eighth grades. A study of teachers in Florida also found years of experience to have a larger impact at the elementary and middle school levels than at the high school level in the area of mathematics (Harris & Sass, 2011).

Traditional Pathways to Teaching

For decades, public school districts across the county have relied on graduates of teacher preparation programs from colleges and universities to recruit and select classroom teachers (Boyd, Lankford, Loeb, Ronfeldt, & Wyckoff, 2011). Candidates who successfully complete these state-approved programs need only to pass the required certification exams to become a

fully licensed teacher. In 2011, approximately 65 percent of newly certificated teachers came from traditional teacher preparation programs and an additional 18 percent were trained through a traditional graduate teacher education program (Feistritzer, 2011).

Traditional preparation programs vary greatly in the requirements for their teaching candidates (Boyd et al., 2011; Constantine et al., 2009; Preston, 2017). However, programs often include required coursework and field experiences. In her review of the literature, Preston (2017) found required coursework to fall into five broad areas: subject matter, pedagogy, foundations of education, technology, and other required courses such as teacher leadership or research methods. Traditional teacher preparation programs are found to devote a significant amount of resources to teaching aspects of pedagogy such as knowledge of instructional methods, learning theories, measurement and testing, and classroom management (Boyd et al., 2011). Together these courses are meant to provide teaching candidates with a theoretical foundation for teaching and learning (Boyd et al., 2011). However, there is concern in the literature that much of the content of this preparation does not generalize to the classroom (e.g., Grossman & McDonald, 2008; McLeskey, Tyler, & Flippin, 2004). A common critique of teacher preparation coursework is that it focuses on what teachers need to know about instructional practices rather than systemically preparing teachers to use instructional practices in the classroom (Grossman & McDonald, 2008). Therefore, it was no surprise when researchers found that teachers who took fewer courses during their preparation program performed as well as teachers with higher coursework requirements (Constantine et al., 2009).

In addition to teacher-specific coursework, traditional programs often require candidates to complete a series of field experiences (Preston, 2017). Preston (2017) described two types of field experiences commonly found in traditional teacher preparation programs: early field

experiences that occur throughout a program, but prior to student teaching, and student teaching itself. While field experiences are opportunities for candidates to forge connections between their coursework and the classroom, Forzani (2014) noted that a separation currently exists between coursework and field experience. Moreover, Grossman and McDonald (2008) pointed out that "university-based teacher educators leave the development of pedagogical skills in the interactive aspects of teaching almost entirely to field experiences, the component of professional education over which we have the least control" (p. 189).

Research examining the relationship between field experience and student achievement has led some scholars to question the importance of student teaching (Goldhaber, Krieg, & Theobald, 2017). For example, Constantine et al. (2009) found that the number of student teaching hours had no discernible effect on teacher performance, whether measured by the number of hours daily, the length of experience in weeks, or the number of full-length school days that student teachers were expected to spend fully in charge of their classrooms. Similar results were found in a study of a large urban district (Ronfeldt & Reininger, 2012). However, there was evidence that location of a teacher's field experience matters. In a study of New York City teachers, Boyd et al. (2008) found that teachers who student taught in schools that were demographically similar to their eventual job placement were more effective at raising student achievement than teachers whose student teaching and job placements were mismatched. Similarly, a recent study in Washington state found that teachers in the sample were more effective if they student taught in a school that was demographically similar to that of their full-time teaching position (Goldhaber et al., 2017).

The research literature also includes mixed reviews of traditional routes into the teaching profession that, when coupled with persistent criticism of universities and colleges of education,

has fueled the emergence of alternative certification pathways as a secondary source of classroom teachers (Zeichner, 2016). In one recent report summarizing trends in teacher certification policy across the county, Zeichner (2016) noted that critics of traditional certification programs often point to their inability to recruit and train teachers to work in hard-to-staff schools, specifically urban and remote rural schools in high-poverty areas. Teacher shortages are often a challenge for schools serving high minority and low-income student populations (Borman & Dowling, 2010; Boyd et al., 2008; Ingersoll, 2001; Lankford, Loeb, & Wyckoff, 2002). Supporters of alternative teacher certification programs argue that alternative teacher pathways are one way to address the issue of teacher shortages (Feistritzer, 2011) while also stimulating innovation in the field of teacher preparation (Mitchel & King, 2016; Wisniewski, 1986; Zeichner, 2016).

Alternative Pathways to Teaching

In 1984, the state of New Jersey passed legislation establishing the first alternative teaching certification pathway in the country (Feistritzer, 2011). The program was intended to attract qualified liberal arts graduates to become elementary and secondary teachers without attending a traditional preparation program and end the state's reliance on "emergency" certificates to fill vacant teaching positions (Feistritzer, 2011). Participants in the program were required to enroll in a state-sponsored, part-time teacher certification program and to partner with an experienced mentor teacher all while working fill-time as a classroom teacher (Humphrey & Wechsler, 2007).

New Jersey's alternative pathway to teaching was replicated the following year by state legislators in Texas and California as a way to attract a wider range of candidates into teaching (Feistritzer, 2011). Over the next decade, the number of alternative pathways increased almost

three-fold to where all but nine states offered an alternative pathway to teacher certification (Shen, 1999). By 2005, 48 states and the District of Columbia were issuing alternative certificates to 60,000 new teachers per year (Feistritzer, 2011). The most recent figures show that roughly one out of every five newly hired public school teachers to have entered through an alternative pathway (DeMonte, 2015).

Since teacher certification policy is determined by individual states, a large amount of variation exists between alternative certification programs across the country (Constantine et al., 2009). Moreover, some states—for example, Kentucky—allow local school districts to create their own alternative certification programs. Feistrizer and Haar (2008) noted, however, that many alternative certification programs share the following characteristics:

- recruit teaching candidates who already have at least a bachelor's degree in fields other than education,
- require rigorous screening processes, such as interviews, tests, and demonstrating mastery of content area,
- provide on-the-job training,
- provide experiences in professional staff development before or during teaching,
- assign mentors to newly placed teachers, and
- establish high performance standards for completion of the program.

Research comparing alternative certification programs to their traditional counterparts has identified a number of a differences among programs. In their study of alternatively certified teachers in New York City, Boyd et al. (2008) found alternatively certified teachers to be trained in the same universities and colleges of education and take many of the same courses as traditionally certified teachers. However, the similarities between the two programs often ended

there. A nationally representative study comparing alternative and traditional certification programs found alternative teacher certification programs to require less than half the total hours of coursework than traditional teacher certification programs (Constantine et al., 2009). While the specific program requirements often differ by state policies (Constantine et al., 2009), alternative programs tend to focus on the practical and technical aspects of teaching rather than the theory (Humphrey & Wechsler, 2007). For example, an alternatively certified teacher may be exposed to courses on classroom management rather than learning theory or child development. Moreover, alternative certification programs often lack preservice training or opportunities to student teach (Humphrey & Wechsler, 2007).

Differences between alternative and traditional certification programs have led some scholars to be critical of the requirements and training associated with alternative teacher certification programs (e.g., Darling-Hammond, 1990, 2000; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Ravich, 2013; Suell & Piotrowski, 2006). One prominent view is that alternative certification programs provide an inadequate amount of supervision and training to novice teachers (Darling-Hammond, 1990, 2000). Suell and Piotrowshi (2006) argued that the lack of support provided to alternatively trained teachers can lead to a long-term lack of professional knowledge. Other critics contend that alternative certification programs undermine the professionalism of teachers and harm student learning (Darling-Hammond et al., 2005). Opponents of this view contend that traditional teacher preparation programs currently offered by universities and colleges of education add little value to teachers' effectiveness in the classroom and, instead, impose substantial costs that can deter talented individuals from entering teaching (Hess, 2004). In reaction to this debate, Humphrey, Wechsler, and Hough (2008) suggested proponents and opponents of alternative teacher certification programs focus their

attention on the variation between alternative certification programs to determine the characteristics of effective programs. Heeding Humphrey, Wechsler, and Hough's (2008) advice, this study investigated the relative effectiveness of Kentucky's eight alternative teacher certification pathways.

Characteristics of Teachers Entering through Alternative Pathways

Research studies have examined alternatively certified teachers' demographic characteristics, academic backgrounds, content knowledge, and types of jobs they held prior to entering the teaching profession. Marinell and Johnson (2014) analyzed two decades of data (1988-2008) from the National Center for Educational Statistics' Schools and Staffing Survey (SASS) to illustrate several key differences between teachers certified through traditional and alternative pathways. The authors found alternatively certified teachers to be more likely male, African American or Latino, and older compared to their traditionally certified colleagues. The study also found that the proportion of minority alternatively certified teachers to be increasing at a greater rate than corresponding proportion of minority teachers entering through traditional pathways (Marinell & Johnson, 2014). Constantine et al. (2009) found similar results in their analysis of a representative sample of alternative certification programs across 12 states.

Differences are also observed in regard to teachers' academic backgrounds. A relatively large number of studies have found alternatively certified teachers more likely to be graduates of highly competitive universities (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2006; Decker et al., 2004; Glazerman et al., 2006; Kane et al., 2008; Sass, 2011). A study of public school teachers in New York City found alternatively certified teachers to have higher college grade point averages as well as higher scores on the mathematics and verbal sections of the Scholastic Assessment Test (SAT) than their traditionally certified peers (Kane et al., 2008). Similar

findings were found in a study of alternatively certified teachers in Florida (Sass, 2011). Alternatively certified teachers are also more likely to score higher on state licensure exams (Boyd et al., 2011; Boyd et al., 2006; Boyd, Lankford, Loeb, & Wyckoff, 2008). As for content knowledge, recent qualitative work reported that alternatively certified teachers were able to make connections in the classroom that connect to content knowledge gained through prior work experiences (H. Anderson, Fry, & Hourcade, 2014; Simmons, 2016). Additionally, H. Anderson, Fry, and Hourcade (2014) found that alternatively certified teachers were able to answer complex questions that were related to their content knowledge.

Research examining the specific nature of alternatively certified teachers' prior work experiences is limited to descriptive data of individual programs. Some studies reported alternatively certified teachers to come from more elite professional fields such as law, medicine, and engineering (Hart, 2010; Tigchelaar, Brouwer, & Korthagen, 2008; Wilkins & Comber, 2015). Other studies, however, showed alternatively certified teachers coming from less accomplished, non-professional fields (Humphrey & Wechsler, 2007; Morton, Williams, & Brindley, 2006). Johnson (2004) described the 24 alternatively certified teachers in her study of first- and second-year teachers working in Massachusetts public schools as a diverse group, while also noting that alternatively certified teachers:

> …brought with them a familiarity with large and small organizations, for-profit and nonprofit enterprises, entrepreneurial and bureaucratic settings. Some had worked for multiple supervisors, whereas others had been supervisors themselves. They worked freelance or led teams. Some experienced well-defined, progressive on-the-job training, and some devised training for other employees. (p. 25)

Johnson (2004) described a heterogeneous collection of prior work experiences and skills that have the potential to transfer to a classroom setting. However, others have noted that various types of experiences as well as differences in work cultures may create unmet expectations and other misunderstandings (Crow, Levine, & Nager, 1990; Morton et al., 2006).

Teacher Certification Pathway and Student Achievement

Over the past three decades a growing body of research has emerged examining whether teacher certification pathways influence student achievement gains. In general, the evidence is mixed in terms of traditional and alternative pathways to the classroom. For example, Boyd et al. (2011) found teachers entering through alternative certification pathways in New York City to be significantly worse than traditionally certified teachers in elementary and middle school. Research from the study echoed findings from previous studies using data from New York City (Boyd et al., 2008; Rockoff et al., 2011). In their study of longitudinal student achievement data from Texas, Darling-Hammond et al. (2005) found students of alternatively certified teachers to perform significantly worse in three high stakes assessments—the Texas Assessment of Academic Skills (TAAS), the SAT, and the Spanish language test Aprenda—than students of traditionally certified teachers. Clotfelter, Ladd, and Vigdor (2007, 2010) also found alternatively certified teachers in North Carolina to be less effective than traditionally certified teachers in elementary school as well as in high school.

Other studies have found no significant difference between traditionally and alternatively certified teachers. In one of the few studies to use an experimental design to study alternative certification, Constantine et al. (2009) found no significant difference between traditionally and alternatively certified teachers. The authors reasoned that small effect sizes were one possible reason why the findings were inconclusive. Insignificant findings due to small effect sizes were

also found in a study of first grade teachers using data from the National Center for Education Statistic's (NCES) Early Childhood Longitudinal Study (Croninger et al., 2007). Similarly, Goldhaber and Brewer (2000) reported insignificant differences for twelfth grade mathematics and science teachers.

Studies that have reported positive effects from the policy tend to be from specific alternative certification programs like Teach For America (Clark et al., 2013; Decker et al., 2004; Glazerman et al., 2006; Xu et al., 2011), the New York City Teaching Fellows (Kane et al., 2008), or the Troops to Teachers program (Nunnery et al., 2009). Two prominent studies in the literature—Decker, Mayer, and Glazerman (2004) and Glazerman, Mayer, and Decker (2006)—used an experimental design to investigate differences in Teach For America teachers and teachers who received their certification through traditional certification routes. Findings from both studies showed Teach For America teachers to have a significantly positive effect in mathematics (Decker et al., 2004; Glazerman et al., 2006). Results in English Language Arts were inconclusive. Studies of Teach For America teachers using non-experimental design find similar results (Chiang, Clark, & McConnell, 2017; Xu et al., 2011) as well as those studies examining New York City Teaching Fellows (Kane et al., 2008).

Nunnery, Kaplan, Owings, and Pribesh (2009) conducted a study to examine the relative effectiveness of Florida teachers certified through the state's Troops to Teachers program compared to teaching candidates who obtained certification through traditional pathways. Findings from the study showed teachers with prior military experience to have significantly positive effects on students' mathematics scores compared to traditionally certified teachers (Nunnery et al., 2009). The effects on students' reading scores were inconclusive. In their summary of the literature, Constantine et al. (2009) recommended people exercise caution in

generalizing findings from studies that evaluate specific alternative certification programs, noting that "many of these studies appear to have a limited relevance to the broad range of [alternative certification] (AC) programs operating across the country" (p. xvi). The Troops to Teachers programs recruits only former members of the armed services (Troops to Teachers, 2018), and programs like Teach For America and the New York City Teaching Fellows, for example, recruit graduates from top universities and colleges and are quite selective in admission criteria, whereas the entry requirements of the majority of alternative certification programs are less stringent (Walsh & Jacobs, 2007). Constantine et al. (2009) noted that this gap in the literature is easily filled with additional studies that investigate all entry points to the teaching profession.

Another gap in the literature can be found in noting that much of the extant research has been conducted in relatively few places. While studies like the one conducted in New York City by Boyd et al. (2011) provide useful information, few, however, would suggest that New York City is an accurate reflection of teacher labor markets in most of the country (e.g., Guarino, Santibanez, & Daley, 2006). Other studies investigating teacher certification pathways have leveraged state administrative databases, specifically administrative data from North Carolina (Clotfelter et al., 2007, 2010; Xu et al., 2011) and Florida (Nunnery et al., 2009; Sass, 2011). A recent review of the literature has identified no peer-reviewed studies or doctoral dissertations that have leveraged data from the Kentucky Longitudinal Data System to examine the effect teacher certification pathways has on high school student achievement in the Commonwealth of Kentucky.

Human Capital Management as a Theoretical Lens

Human capital management serves as an overarching theoretical perspective in this study. The concept of human capital management emerged in the management literature in the early 1990s when Prahalad and Hamel (1990) suggested that an organization can leverage its human capital—along with other tangible and intangible assets—to be competitive in the market. Over the next three decades, a number of definitions of human capital management emerged in the literature (see Afioui, 2013, for a recent review of the literature). According to Afiouni (2013), the concept of human capital management emphasizes the importance of fit between human resource practices and business strategy. Organizations that align their human resource systems with their core business generate a sustained competitive advantage through the development of competencies that are organization specific and are embedded in an organization's history and culture (Afioui, 2013; Chadwick & Dabu, 2009). Unger et al. (2011) further noted the competitive advantages that stem from an organization's human capital management will pay an even larger role in the future due to increasing knowledge-intensive activities in most work environments.

For school leaders, the act of hiring effective teachers is arguably their most important task as principals (DeArmond & Goldberg, 2005; Harris, Rutledge, Ingle, & Thompson, 2010). Surprisingly, few school leaders possess human capital management systems that align with ways their schools can improve instructional practice and student learning (Milanowski, Heneman, & Kimball, 2011; Odden, 2011). In reaction to this problem in public education, Odden (2011) proposed a comprehensive and strategic approach to human capital management in schools and districts. Based on empirical research and case studies of successful public school districts and education organizations across the country, Odden's (2011) human capital

management framework focuses on the hiring, placement, and development, and retention of highly qualified and effective teachers in public school districts. The main objective behind the framework is to raise student achievement while also reducing the achievement gap (Odden, 2011).

Guiding the framework is the idea of promoting a better "fit" between the teacher and the job (Odden, 2011). Odden (2011) argued that human capital management systems that select and retain teachers who fit the job requirements and value the intrinsic and extrinsic rewards of the job will be successful in the classroom. Research has shown person-job fit to be associated with several desirable outcomes for people and their organizations, such as greater job satisfaction, stronger commitment, higher engagement in in-role and extra-role behaviors, and lower turnover (Hoffman & Woehr, 2006; Kristof-Brown, Zimmerman, & Johnson, 2005; Verquer, Beehr, & Wagner, 2003).

Additionally, the human capital management framework can be extended beyond schools and districts (Odden, 2011). Policymakers can use a human capital management lens to create policies aimed at building and developing the teacher workforce (Odden, 2011). This can include developing a coherent set of policies that work together to attract, develop, deploy, motivate, and retain teachers who have the competencies needed to meet the unique needs of the state or local community. For example, policymakers use the framework to inform their understanding of the different incentives alternative teacher certification programs are using to attract new teaching candidates or compare the various curricula and teacher training materials offered through the eight alternative certification pathways in the Commonwealth of Kentucky.

Within the context of this study, human capital management theory situates both traditional and alternative teacher preparation activities within the same policy-driven

management system. As such, the perspective helps to explain how different preparation activities “feed” the local labor needs of schools. It is possible under such a system that a school might turn to alternatively certified teachers to fill staffing needs in the event that such teachers are more effective than their traditionally trained peers. Remarkably, there is relatively little research about the effectiveness of alternatively certified teachers across different alternative certification pathways. This study addresses this gap in the literature by employing a novel quasi-experimental analytic approach and state longitudinal data system.

Chapter 3: Methodology

This study used a quasi-experimental research design to estimate teachers' effects on student achievement. The unit of analysis for the study were students, and the study sample consisted of grade 11 students attending public high schools in the Commonwealth of Kentucky. Since students in the study were not randomly assigned to their respective teachers, it was impossible to execute an experimental design and compare differences in group effects without bias. Murnane and Willett (2011) noted that quasi-experimental research designs are appropriate in situations where the two comparison groups were formed on a basis other than random assignment. Following Murnane and Willett's (2011) recommendations, I used a quasi-experimental research design—specifically, a propensity score matching technique—in the study as a way to mitigate the selection bias associated with nonrandom assignment of teachers to students.

Propensity score matching is a type of quasi-experimental research design that approximates random assignment by matching students assigned to a teacher's classroom to a set of students outside the classroom that, given the likelihood that they are to belong to the teacher's classroom, are indistinguishable from the teacher's own students (Rosenbaum & Rubin, 1983). For this study, students who were assigned to alternatively certified teachers' classrooms were classified as the treatment group whereas students assigned to traditionally certified teachers were classified as the control group, or comparison group. I estimated teacher effects by comparing achievement test scores on the ACT assessment between the two groups. I used R version 3.4.1 (R Development Core Team, 2017) to conduct all of the statistical analyses in this study.

Data Sources

I obtained data for my study from the Kentucky Center for Education and Workforce Statistics (KCEWS), a state-funded policy research center that administers the Kentucky Longitudinal Data System (KLDS). KLDS is a statewide longitudinal data system that connects individual datasets provided by the Kentucky Department of Education (KDE), the Council on Postsecondary Education (CPE), the Educational Professional Standards Board (EPSB), the Kentucky Higher Education Assistance Authority (KHEAA), and the Kentucky Education and Workforce Development Cabinet (Kentucky Center for Education and Workforce Statistics, 2018). The KCEWS data used in this study included student and teacher information collected by KDE and EPSB, respectively. Both KDE and EPSB administer data standardization and clean-up procedures for all variables prior to their transfer to KCEWS (Education Professional Standards Board, 2018c; Kentucky Department of Education, 2018b). In turn, I acknowledge that potential discrepancies in the data may exist due to the data processing conducted by KDE and EPSB.

Data Preparation and Cleaning

Upon Institutional Review Board (IRB) approval[1] and establishment of an inter-agency memorandum of understanding governing the terms of data use (see Appendix A), KCEWS staff transferred data in 28 comma separated value files in the summer of 2016. The files contained data elements housed in the KLDS and supplied to KCEWS by KDE and EPSB for academic years 2008-2009 through 2013-2014. From these files, I created two datasets: a teacher dataset

[1] The Indiana University IRB reviewed the research study and deemed it to be Non-Human Subjects Research because the study received de-identified information (IRB study #1607467305).

and a student dataset. The teacher dataset contained a record for each teacher employed in a Kentucky public school from 2008-2009 to 2013-2014. The student dataset contained information on students who attended a Kentucky public school in 2013-2014. I processed and cleaned variables in both datasets separately and then linked them to create a final dataset that I used for my propensity score analysis.

Preparing the Teacher Dataset. I processed variables in the teacher dataset first. The teacher dataset permitted me to identify teachers, teaching assignment, and certification status. These data were necessary as I ultimately matched teachers to students to estimate their effects on student achievement. To identify teachers with active certifications, I created variables that defined the start and end dates for an academic year for public schools in Kentucky (Kentucky Department of Education, 2018c) and flagged teachers with certification dates in these calendar years. Next, I used KDE job codes to identify classroom teachers (see Table 2). A job code served as an indicator of the teacher's daily responsibilities. Some teachers had multiple job codes. To eliminate duplicate records, I retained the teacher record associated with the greatest number of full-time equivalent (FTE) hours. I made this decision as FTE hours often signal the teacher's primary teaching position and is thus used as a proxy to describe the nature/type of a teacher's work. Finally, I linked the teacher dataset to a separate file that contained demographic information using a unique teacher identification number. It is important to note that the dataset containing demographic information was not listed by year. Therefore, it was assumed that the demographic data attached to classroom teachers reflected the most recent information (i.e., 2013-2014 data). Table 3 reports the number of classroom teachers with active teaching certifications identified in the data.

Table 2.
Job Codes Used to Identify Classroom Teachers

Job Code	Description
2010	Preschool Classroom Instructor
2025	Kindergarten Instructor
2030	Primary Classroom Instructor
2040	Elementary Classroom Instructor
2050	Middle School Classroom Instructor
2060	High School Classroom Instructor
2070	Job Training Instructor
2080	Lead Vocational School Instructor
2095	Exceptional Child Instructor
2096	Homebound Teacher
2100	Gifted and Talented Instructor
2210	Resource Teachers
2211	Technology Resource Teachers

Table 3.
Number of Classroom Teachers by School Year, 2009-2014

Year	Number
2008-2009	36,721
2009-2010	37,694
2010-2011	38,576
2011-2012	39,272
2012-2013	39,272
2013-2014	39,391

Notes: Includes teachers who had an active certification and were listed as a classroom teacher.

Processing the Student Dataset. After processing the teacher dataset, I assembled and cleaned variables in the student dataset. I processed student data for years 2012-2013 and 2013-2014. The data prior to 2012-2013 has been excluded for this study as there are known data quality concerns and significant differences in the overarching testing framework. For 2013-2014, I merged student datasets that contained transcript information, assessment scores, and

demographic information using a unique student identification number generated by KCEWS.[2] From the merged dataset, I filtered the dataset to include records for students enrolled in grade 11, the student population of interest for the study. Next, I filtered the 2012-2013 assessment data to contain only student scores for the ACT Plan mathematics and reading tests and the grade 10 KPREP on-demand writing test and merged it to the 2013-2014 dataset. After I linked the student datasets, I created temporary variables that flagged all mathematics and reading courses students were enrolled in during the fall semester. I defined mathematics courses as courses that had the words "mathematics," "math," "algebra," "calculus," "pre-calculus," "geometry," "trigonometry," or their respective abbreviations in their course titles. I defined reading course as those course that contained the words "reading," "English," "language arts," "writing," "composition," "humanities," or their abbreviations in their course titles, respectively. The processed student dataset contained a record for each mathematics and reading course in which a student was enrolled. Identifying the courses within which the student was enrolled allowed me to match the student to their classroom teacher.

Preparing the Final Dataset. To create the final dataset used in my analysis, I filtered the teacher dataset to include information on classroom teachers in 2013-2014 and merged it to the student dataset. The result was a combined teacher-student dataset with 42,510 records. There were 1,092 students who had multiple mathematics teachers or multiple reading teachers listed in the dataset. This was due to students enrolling in multiple mathematics and reading

[2] Per the terms of the memorandum of understanding, KCEWS assigned a unique student identification number that obscures the student's identity and prevents researchers from linking the data supplied to existing state sources. This is done as a privacy measure prior to sharing the information.

courses during the semester. For these students, I randomly selected one mathematics teacher and one reading teacher.

After constructing the dataset, I visually screened all variables for out-of-range values, outlies, and the plausibility of means and standard deviations. I recoded 12 student records with implausible birth years and one record with an implausible value for teacher's classroom experience as missing. Additionally, I identified a small number of outliers in variables measuring current and prior year achievement; however, I took no action because there was no theoretically-relevant reason to recode or delete these student records.

Next, I screened each of the variables in the dataset for patterns in missing values. The pre-screening procedures measured the percent of student records with missing values for each variable in the dataset. Only a few variables—specifically, age, ACT Plan mathematics, ACT Plan reading, ACT Plan English, ACT Plan science, and K-PREP on-demand writing—contained missing values, which would impact 1,327 observations (4.29 percent) in the dataset. Tabachnick and Fidell (2013) noted that a few data points (approximately 5 percent or less) that are missing can be tolerated in large data sets. Following these recommendations, I deleted all observations with missing data in constructing the final analytical dataset. The final dataset contained 41,409 unique records of grade 11 student enrolled in a public high school in the Commonwealth.

Participants

The participants in this study consisted of grade 11 public high school students who completed the ACT test during the 2013-2014 academic year. Students had to have both an identification number of a classroom teacher listed on their transcript as well as valid grade 10 ACT Plan and K-PREP on-demand writing scores to be included in the sample. Moreover, since propensity score matching is highly sensitive to missing data (Guo & Fraser, 2015), I only

included students with complete data in all relevant fields in the analytical sample. Figure 1 details the reductions in sample size for each step of the sample construction. The analytical sample used for data analysis in this study consisted of 30,544 students—with 2,847 students in alternatively certified teachers' classrooms during their grade 11 year of high school and 27,697 in traditionally certified teachers' classrooms.

I compared the study's sample to the population of grade 11 students attending a public high school in the Commonwealth of Kentucky. Table 4 reports the average demographic characteristics, average school characteristics, and average achievement scores on the ACT Plan and KPREP On-demand writing tests. I identified no significant differences between the two student groups for all characteristics. In turn, I concluded the sample was representative of the study's population.

In addition, I performed a power analysis on the sample to determine whether the sample size was adequate in power for the study. I established a target effect size at 0.10 standard deviations, which corresponds to a one-half point change in average ACT test scores (Snyder, de Brey, & Dillow, 2016). This is equivalent to four months of student learning in high school (Bloom, Hill, Black, & Lipsey, 2008). I used the R package "pwr" (Champely et al., 2017) to implement a power analysis for a two-sided, independent t-test. Results of the power analysis indicated that a sample size of n = 2,847 and a significance level of $\alpha = 0.05$ would be able to detect an effect size of $d = 0.10$ with statistical power well beyond the recommended 0.80 level (Cohen, 1988). Similar results were found for a smaller effect size, $d = 0.07$, with the same significance level of $\alpha = 0.05$. However, I found effect sizes less than $d = 0.07$ to have limited power. Considering these results, I determined that the sample size was adequate for my study.

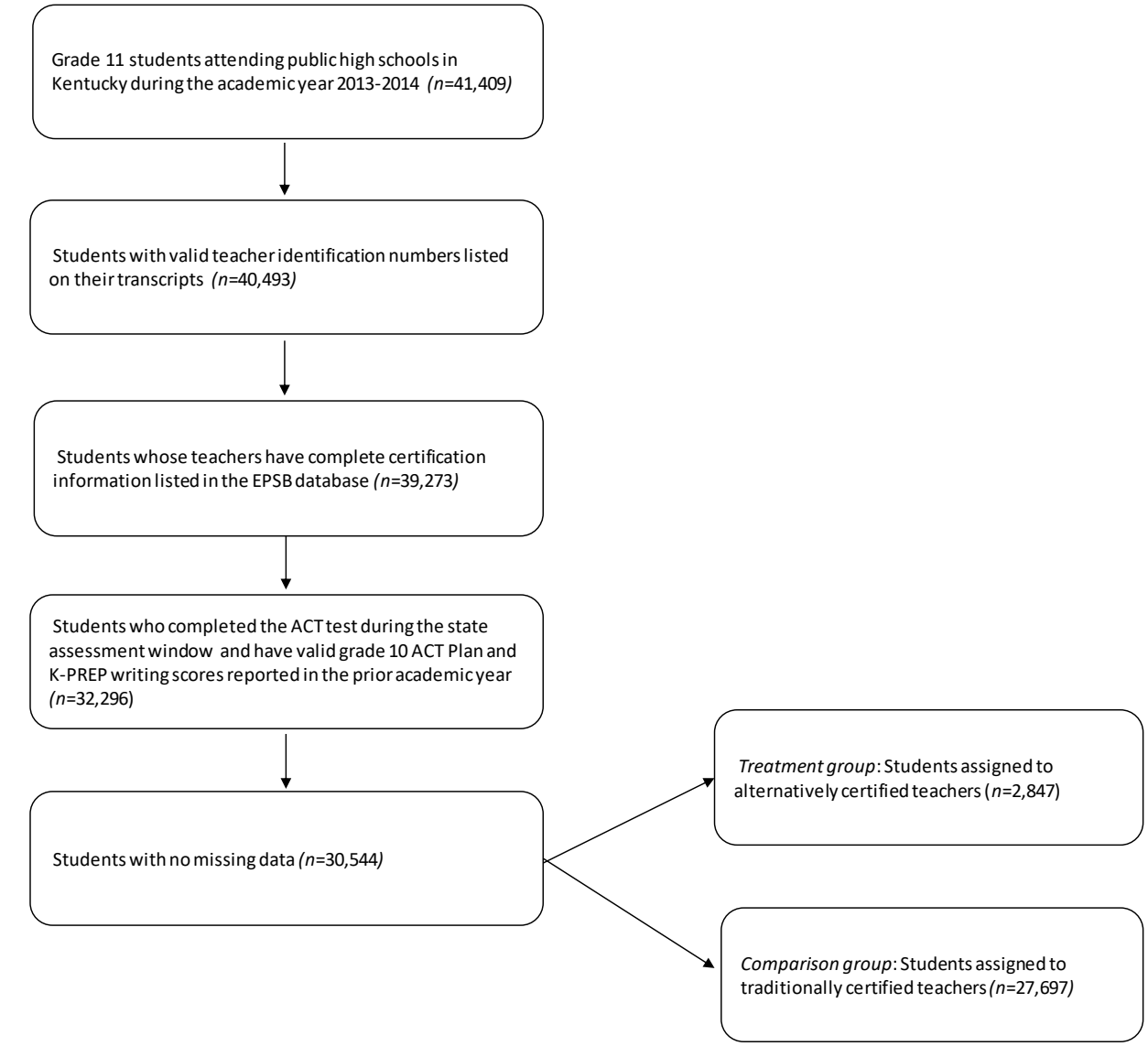

Figure 1. Changes in Sample Size during Sample Construction

Table 4.
Average Characteristics of the Sample, 2013-2014

	Population (N = 41,409)	Sample (n = 30,544)
Demographics		
Average age (years)	17.44 (0.56)	17.44 (0.56)
Gender		
Percent female	49.75	49.85
Percent male	50.25	50.15
Race/Ethnicity		
Percent African American/Black	9.42	9.09
Percent Asian American	1.49	1.47
Percent Hispanic	3.29	3.30
Percent Native American/Native Alaskan	0.16	0.16
Percent White	83.74	84.13
Percent multiple/other	1.91	1.88
Percent Free and/or Reduced Price Lunch eligible	41.36	40.44
Percent Individual Education Plan	7.46	7.25
Percent Limited English Proficient	0.75	0.68
Percent gifted	23.42	23.89
Percent homeless	1.56	1.48
School characteristics		
Enrollment		
Percent of schools with enrollment < 250	1.10	1.10
Percent of schools with enrollment between 250 and 1000	42.03	42.10
Percent of schools with enrollment > 1000	56.86	56.80
Percent in Title One schools	29.01	28.53
Average number of minority students	17.44 (17.56)	17.26 (17.48)
Average number of Free and/or Reduced Price Lunch eligible students	51.79 (16.75)	51.59 (16.70)
Average number of Individual Education Plan students	10.27 (3.30)	10.23 (3.29)
Academic achievement		
Average ACT Plan mathematics score	17.71 (4.34)	17.73 (4.34)
Average ACT Plan reading score	17.37 (4.28)	17.40 (4.28)
Average KPREP writing score	9.82 (2.30)	9.86 (2.29)

Notes. Standard deviations listed in parenthesis. Asian includes Native Hawaiian and other Pacific Islander. No significant differences were found between the population and sample for all characteristics listed. Percentages do not add to 100 for variables with missing values.

Variables

Treatment Variable and Other Teacher Variables. I used teacher certification information to establish treatment and control groups. I defined the "treatment condition" as a student who was enrolled in a classroom taught by an alternatively certified teacher and the "control condition" as a student who was enrolled in a classroom taught by a traditionally certified teacher. I created a dichotomous teacher certification variable indicating whether a teacher was an alternatively certified teacher (1=Yes, 0=No) using EPSB teacher certification codes. Additionally, I used EPSB certification codes to create a separate categorical variable to identify the specific certification pathway (i.e., Option 1-8) for alternatively certified teachers. Table 5 lists the teacher certification codes used to identify alternatively certified teachers and their respective alternative certification pathways. It is important to note that some teachers were identified as having multiple certification pathways. This was mostly explained by changes in certification status after the first two years of teaching. For example, a teacher could enter the profession through Option 6 (a university-based alternative pathway) and after two years apply for a professional certification. The new certification code associated with a professional teaching certification would, in turn, overwrite the teacher's original alternative pathway status. Therefore, this study used teachers' first certification code to determine certification pathway.

In addition to certification type and alternative certification pathway, I included a variable reporting the total years of teaching experience. Teaching experience was a continuous measure of the number of years of experience in the classroom. Descriptions, classifications, and specifications or coding schemes for variables describing teacher certification information are outlined in Table 6.

Table 5.
Certification Codes Used to Identify Alternative Teacher Certification Pathways

Pathway	Certification Code
Option 1	1100, 1101, 1102, 1103, 1104, 1105, 1106, 1107, 1108, 1109, 1110, 1111, 1112, 1113, 1114, 1115, 1116, 1117, 1118, 1119, 1120, 1121, 1122, 1123, 1124, 1125, 1126, 1127, 1128, 1129, 1130, 1131, 1132, 1133, 1134, 1135, 1136, 1137, 1138, 1139, 1140, 1141, 1142, 1143, 1144, 1145, 1146, 1147, 1296, 1370, 1375, 1416, 1437, 1438, 1447, 1485, 1486, 1529, 1547, 1548, 1648, 1694, 1695, 1702, 1704, 1705, 1706, 1819, 1820
Option 2	632, 633, 634, 1798, 1799, 1800, 1801, 1802, 1803, 1804, 1805, 1852
Option 3	381, 1308, 1309, 1310, 1311, 1312, 1313, 1314, 1315, 1316, 1317, 1318, 1319, 1320, 1321, 1322, 1323, 1324, 1325, 1326, 1327, 1328, 1329, 1330, 1331, 1332, 1333, 1334, 1335, 1336, 1337, 1338, 1339, 1340, 1341, 1342, 1343, 1344, 1345, 1346, 1347, 1348, 1349, 1350, 1351, 1352, 1353, 1453, 1745, 1756, 1767, 1768, 1769, 1770, 1771, 1772, 1773, 1774, 1775, 1776, 1777, 1778, 1779, 1780, 1781, 1782, 1783, 1784, 1816, 1817, 1818, 1821, 1822, 1823, 1842, 1843, 1844, 1866, 1867, 1868, 1884, 1885, 1886, 1904, 1905, 1906, 1907, 1908, 1909
Option 4	111, 1484, 1490, 1491, 1492, 1493, 1494, 1495, 1496, 1500, 1501, 1502, 1503, 1504, 1505, 1507, 1508, 1510, 1512, 1513, 1514, 1515, 1524, 1525, 1531, 1532, 1533, 1534, 1597, 1598, 1599, 1600, 1635, 1636, 1647, 1652, 1656, 1693, 1698, 1790, 1792, 1796, 1812, 1813, 1814, 1815, 1841, 1892, 1893, 1895, 1897, 1899, 1900, 1903, 1911, 1913, 1917
Option 5	1251
Option 6	1292, 1293, 1294, 1295, 1307, 1354, 1355, 1356, 1357, 1358, 1359, 1360, 1361, 1362, 1363, 1365, 1366, 1367, 1414, 1417, 1418, 1420, 1421, 1424, 1425, 1431, 1432, 1442, 1456, 1516, 1544, 1545, 1546, 1615, 1616, 1617, 1618, 1619, 1620, 1621, 1622, 1623, 1624, 1625, 1655, 1709, 1734, 1739, 1740, 1741, 1742, 1791, 1829, 1830, 1831, 1862, 1915
Option 7	1760, 1761, 1762, 1763, 1764, 1832
Option 8	1871, 1872, 1873, 1874, 1875, 1876, 1877, 1878, 1879, 1880, 1881, 1887, 1894, 1912

Table 6.
Description of the Study's Treatment Variable and Other Teacher Variables

Variable	Description	Type	Coding
treatment	Indicator whether teacher's first certification was an alternative teaching certification (i.e., Option 1-8); Variable is also referred to as the treatment variable in the study	Binary	1=Yes, 0=No
cert_pathway	Alternative teacher certification pathway	Categorical	1=Traditional, 2=Option 1, 3=Option 2, 4=Option 3, 5=Option 4, 6=Option 5, 7=Option 6, 8=Option 7, 9=Option 8
experience	Number of years of teaching experience	Continuous	

Measures of Mathematics and Reading Achievement. For measures of mathematics and reading achievement, I used achievement scores from the ACT assessment. Developed by Pearson, the ACT assessment is a multiple-choice test covering four skill areas: English, mathematics, reading, and science. The tests emphasize reasoning, analysis, problem solving, and the integration of learning from various sources, as a means to gauge students' college readiness in Kentucky (Kentucky Department of Education, 2016a). Student performance on the ACT test was chosen for this study for two reasons. First, all grade 11 students attending a public high school in Kentucky are required to take the ACT as part of the Commonwealth's high school and college readiness standards—see Kentucky Revised Statute (KRS) 158.6453 (2016). Students who score above state-determined thresholds are deemed college ready by the Commonwealth (Kentucky Council on Postsecondary Education, 2016). Second, a fairly substantial body of research has found the ACT test to be a reliable and valid measure of

students' success during the first year of college (e.g., Allen & Robbins, 2010; Nobel & Sawyer, 2004; Sawyer, 2013).

This study used ACT assessment scores in mathematics and reading from the academic year 2013-2014. Students can take the ACT assessment multiple times throughout the year, however, I restricted the analysis to only ACT scores obtained during the state's testing window, which was March 4-18, 2014 (Kentucky Department of Education, 2014). ACT scores were measured as a continuous variable with possible scores ranging from 1 to 36 (ACT, 2015). In addition, I transformed ACT scale scores into standardized scores (i.e., z-scores) with a mean of 0 and a standard deviation of 1 as a way to express test scores in a common unit (McCaffrey, Lockwood, Koretz, Louis, & Hamilton, 2004). Table 7 provides a summary of the outcome variables used in this study.

Table 7.
Description of Outcome Variables

Variable	Description	Type	Coding
act_rd	ACT scale score in grade 11, reading section	Continuous	
act_ma	ACT scale score in grade 11, mathematics section	Continuous	

Covariates. This study included 18 covariates in the models for propensity score matching and teacher effect estimation. I used information on students' background characteristics, prior achievement on standardized tests, and school characteristics for the covariates. The following section summarizes the covariates included in my study, organized by type.

Student demographic characteristics. Table 8 describes the covariates used in the study to account for students' socio-demographic characteristics included. I included a binary variable used to identify students' gender (1=Female, 2=Male) and categorical variable for students' race/ethnicity (1=Black, 2=Asian, 3=Hispanic, 4=Native American, 5=White, 6=Multiple/Other). I used students' birth year to derive a continuous measure of their age (in years). In addition, I created a set of dichotomous measures to indicate whether students were eligible for the federal free and/or reduced price lunch program (1=Yes, 0=No), had an Individualized Education Program (1=Yes, 0=No), were classified as limited English proficiency (1=Yes, 0=No), or were classified as gifted (1=Yes, 0=No). Additionally, I created a dichotomous indicator for whether students were homeless (1=Yes, 0=No) if students had identified as being homeless at any point during the school year.

Prior student achievement. I also included covariates using student prior achievement information in the study. As depicted in Table 9, I used achievement scores from the grade 10 ACT Plan assessments in mathematics and writing and the KPREP on-demand writing test to create covariate measures of students' grade 10 achievement in high school. KDE describes the ACT Plan assessment a "pre-ACT" test and a powerful predictor of a student's success on the ACT test (Kentucky Department of Education, 2016b). I transformed student scale scores for the ACT Plan tests into standardized scores with a mean of 0 and a standard deviation of 1. I also transformed grade 10 KPREP on-demand writing scores into standardized scores.

Table 8.
Description of Student Demographic Covariates

Variable	Description	Type	Coding
age	Student age	Continuous	
gender	Student gender	Binary	1=Female, 0=Male
race	Student race/ethnicity	Categorical	1=Black, 2=Asian, 3=Hispanic, 4=Native American, 5=White, 6=Multiple/Other
frpl	Indicator whether student was eligible for the school lunch program	Binary	1=Yes, 0=No
iep	Indicator whether student has an Individualized Education Program	Binary	1=Yes, 0=No
lep	Indicator whether student was classified as Limited English Proficiency	Binary	1=Yes, 0=No
gifted	Indicator whether student was classified as Gifted	Binary	1=Yes, 0=No
homeless	Indicator whether student was homeless	Binary	1=Yes, 0=No

Table 9.
Description of Student Prior Year Achievement Covariates

Variable	Description	Type	Coding
plan_rd	ACT Plan scale score in grade 10, reading section	Continuous	
plan_ma	ACT Plan scale score in grade 10, mathematics section	Continuous	
kprep_wr	KPREP scale score in grade 10, on-demand writing section	Continuous	

School-level information. I created seven covariates using school-level information. I derived a continuous variable measuring the average number of minority students in a school from the data, as well as similar measures of the average number of students who were eligible for the federal free and/or reduced price lunch program, possessed an Individual Education Program, or were classified as having limited English proficiency. I included a continuous measure of schools' total enrollment and a dichotomous measure to indicate whether schools received Title I funding during the 2013-2014 school year. Additionally, I included two continuous measures of schools' average scale scores for the ACT mathematics and reading assessments in grade 11. Table 10 details the covariates representing school-level factors.

Table 10.
Description of School-Level Covariates

Variable	Description	Type	Coding
pct_minority	Percentage of minority student in a school	Continuous	
pct_frpl	Percentage of students eligible for the school lunch program	Continuous	
pct_iep	Percentage of students who have an Individualized Education Plan	Continuous	
enroll	Total school enrollment	Continuous	
title_one	Indicator whether school received Title I funding	Binary	1=Yes, 0=No
act_math_mean	School average ACT scale score in grade 11, mathematics section	Continuous	
act_read_mean	School average ACT scale score in grade 11, reading section	Continuous	

Data Analysis

Descriptive Analysis. I began by conducting a descriptive analysis of the Kentucky teacher workforce. Specifically, I examined the number of classroom teachers working in Kentucky public schools from 2008-2009 through 2013-2014. I disaggregated the results by teacher certification type to compare changes in the population of alternatively certified teachers to their traditionally certified peers. I also examined differences in number and percentage of alternatively certified teachers who received their teaching certification from one of Kentucky's eight alternative-certification pathways. Additionally, I compared average demographic characteristics, academic characteristics, and amount of classroom teaching experience of alternatively certified teachers to traditionally certified teachers. I used independent *t*-tests and chi-squared analysis to determine if there were significant differences in the group means (Tabachnick & Fidell, 2013). A descriptive analysis is a common starting point in economic and policy studies as it is important to understand the composition of the workforce being examined (McEwan, 2012).

Propensity Score Matching. I addressed my core research questions using propensity score matching. Propensity score matching allowed me to test the impact of alternatively certified teachers on their students' achievement relative to traditionally certified teachers. Based on recommendations by Guo and Fraser (2015) and Leite (2017), data analysis included five steps: (1) covariate selection, (2) propensity score estimation, (3) propensity score method implementation, (4) covariate balance evaluation, and (5) treatment effect estimation. I discuss each step in detail below.

Covariate selection. Deciding which variables to include in the propensity score model was my first step in propensity score matching. Guo and Fraser (2015) suggested that covariates

be selected *a priori* and be grounded in theory and previous empirical work. I identified 18 covariates in my dataset that had been used in as confounding variables in two similar studies that investigated the effects of teacher certification on student achievement in high school (Clotfelter et al., 2010; Sass, 2011). In addition, I examined bivariate relationships between covariates and the study's outcome measures—achievement scores from the ACT mathematics and reading tests (Table 11)—to demonstrate potential confounding between covariates and outcome measures to show that the assumption of ignorable treatment assignment has been met (Austin, 2011). Results from the Pearson correlation tests showed all covariates to be significantly associated, $p < 0.01$, with both outcome measures. However, several variables (gender, iep, homeless, pct_minority) were found to have weak correlations, $|r| < 0.10$, with both ACT assessments. I decided to retain these variables in the model, following Guo and Fraser's (2015) recommendation for researchers to error on theoretical reasoning when deciding which covariates to include in their models.

Table 11.
Correlations between Covariates and ACT Mathematics and Reading Tests

	Correlation Coefficients	
Covariates	ACT Mathematics	ACT Reading
Age	-0.15***	-0.16***
Gender	0.04***	-0.06***
Race/Ethnicity	0.14***	0.17***
Free and/or Reduced Price Lunch	-0.29***	-0.28***
Individual Education Plan	-0.24***	-0.24***
Limited English Proficiency	-0.08***	-0.10***
Gifted	0.45***	0.44***
Homeless	-0.07***	-0.07***
ACT Plan Mathematics	0.81***	0.66***
ACT Plan Reading	0.62***	0.77***
KPREP Writing	0.55***	0.58***
School Title One	-0.13***	-0.12***
School Enrollment	0.17***	0.13***

School Free and/or Reduced Price Lunch	-0.28***	-0.25***
School Minority	-0.01*	-0.04***
School Individual Education Plan	-0.18***	-0.15***
School Average ACT Mathematics	0.34***	0.27***
School Average ACT Reading	0.31***	0.30***

Notes. N = 30,544; *p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Propensity score estimation. Next, I estimated propensity scores for each student in the study's sample. Researchers have used a variety of methods to estimate propensity scores—for example, discriminant analysis, probit models, logistic regression models, classification trees, and generalized boosted regression models (e.g., McCaffrey, Ridgeway, & Morral, 2004; Rosenbaum & Rubin, 1983; Stone, Obrosky, Singer, Kapoor, & Fine, 1995) to name a few. Yanovitsky et al. (2005) noted in their review of the literature that logistic regression models were the most widely used approach to estimate propensity scores. Logistic regression models are also robust, transparent, and reproducible in estimating propensity scores (Steiner & Cook, 2013). Thus, in keeping with this guidance, I used a logistic regression model (Tabachnick & Fidell, 2013) to specify propensity scores, which estimated the log-odds of an observation being in the treatment group, t, given a vector of baseline covariates (listed in Tables 5-7), $\boldsymbol{x}$, as:

$$log\frac{P(t=1|\boldsymbol{x})}{1-P(t=1|\boldsymbol{x})}=\hat{\beta}.$$

Matching. I matched students in alternatively certified teachers' classrooms (treatment) to students assigned to other traditionally certified teachers (control) using the estimated propensity scores. I elected to implement a propensity score matching method—opposed to other propensity score methods, such as stratification, inverse probability of treatment weighting, and covariate adjustment—because my outcome estimate of interest was the average treatment on the

treated (ATT), the number of treatment and control cases in my sample, and my choice to include additional covariance adjustments when estimating teacher effects. Steiner and Cook (2013) noted that matching on the propensity scores are typically used when the causal estimated is ATT and when the pool of control observations is large. Previous research studies have successfully implemented propensity score matching using samples that are considerably smaller (e.g., Belfi, Haelermans, & De Fraine, 2016; Caliendo & Kopeinig, 2008; Wei, Patel, & Young, 2014) than the sample used for my study. Moreover, I observed a large region of common support between treatment and control in my sample, suggesting that the loss of information from matching would be small (Austin, 2011; Steiner & Cook, 2013). One drawback of propensity score matching is the potential for some residual bias caused by inexact matching (Steiner & Cook, 2013). However, Steiner and Cook (2013) noted that researchers can mitigate this residual bias with the additional covariance adjustment in the outcome analysis. Thus, following Steiner and Cook's (2013) recommendations, I included additional covariates in the outcome analysis.

I used the R package "MatchIt" (Ho, Imai, King, & Stuart, 2011) to implement the matching procedures (see Appendix B for R code used for matching). I employed 1:1 nearest neighbor procedure without replacement to match a student in the treatment group to a student in the control group that shared the most similar propensity score. Nearest neighbor matching is a flexible technique that can be applied easily to multivariate analysis (Guo & Fraser, 2015); however, the technique is limited to studies with large sample sizes, and it loses information by excluding study participants because of a narrowed region of common support (Guo & Fraser, 2015; Rosenbaum & Rubin, 1983). Steiner and Cook (2013) suggested researchers implementing propensity score matching procedures compare results of different matching strategies to

determine which strategy is the most precise in matching observations in the treatment group to those in the control group. I compared matching results to other matching strategies, such as 1:*M* matching and caliper matching, on the proportion of observations used in the matching and the balance of the covariates form the propensity score models. Covariate balance tests indicated a 1:1 nearest neighbor matching strategy without replacement to be the best first for the data.

Assessing covariate balance. I assessed the balance in observed covariates to determine if any systematic differences were present between treatment and control group students with the same estimated propensity score. Covariate balance tests allow researchers to conclude that the matched groups do not differ in terms of observable characteristics except treatment status (Stuart, 2010). Thus, I examined the standardized mean difference in covariate means to assess balance. One common way to assess covariate balance in propensity score matching (Austin, 2011; Steiner & Cook, 2013), standardized mean difference is often referred to as the "standardized bias" and is similar to an effect size when comparing covariates before and after matching (Rosenbaum & Rubin, 1983) and is calculated using Cohen's *d* (Cohen, 1988). In addition, I visually inspected the treatment and control groups' covariate distributions using histograms as well as characteristics of bivariate distributions (Sekhon, 2011). See Appendix C for the results of this analysis.

Treatment effect estimation. After creating a matched sample using propensity score matching, I estimated the effects of different teacher certification pathways on high school student achievement in mathematics and reading. I also estimated the effects of alternatively certified teachers' pathway on high school achievement as well as teachers' classroom experience. I used multiple regression modeling to estimate the treatment effect. The use of multiple regression modeling to estimate treatment effects after matching enables researchers to

mitigate the likelihood of any omitted variable bias that may be left over after matching (Austin, 2011; Rosenbaum & Rubin, 1983; Steiner & Cook, 2013). I estimated separate multiple regression models for teacher certification type and alternative teacher certification pathways. Below are descriptions of the methods I used for each outcome.

Teacher certification type. I estimated ATT for students in alternatively certified teachers' classrooms (treatment) using multiple regression analysis, as specified by the following model:

$$Y = \beta_0 + \beta_1 T + \beta_2 E + \beta_3 \boldsymbol{X} + \epsilon,$$

where the variable Y represented the student's ACT assessment score, in scale score units, in mathematics or reading. T was a binary variable indicating whether a student's teachers was an alternatively certified teacher (1=Yes, 0=No). The categorical variable E represented the amount of teaching experience for the student's teacher. I included this variable in the model to investigate the sub-question to whether teaching experience was related to the achievement of students who are taught by alternatively certified teachers. $\boldsymbol{X}$ was a vector of student characteristics, including gender, race/ethnicity, eligibility for the school lunch program, Special Education status, and English language learner status. Lastly, ϵ represented the model's error term.

Alternative teacher certification pathways in Kentucky. I estimated teachers for each of the eight alternative teacher certification pathways in Kentucky on high school student achievement in mathematics and reading. Following is the multiple regression model I used in my analysis:

$$Y = \beta_0 + \beta_1 P + \beta_2 E + \beta_3 \boldsymbol{X} + \epsilon,$$

where the variable Y represented the student's ACT assessment score, in scale score units, in mathematics or reading. P was a categorical variable indicating the alternative certification pathway for the student's teacher. Again, the categorical variable E represented the amount of teaching experience for the student's teacher, and $\boldsymbol{X}$ was a vector of student characteristics, including gender, race/ethnicity, eligibility for the school lunch program, Special Education status, and English language learner status. ϵ represented the model's error term.

In addition, I checked assumptions of multiple regression for both models. As previously mentioned, I visually screened all variables included in the models for outliers. I also examined residuals scatterplots to test assumptions of normality, linearity, and homoscedasticity between predicted ACT mathematics and reading scores and errors of prediction.

Chapter 4: Findings

Teacher shortages have been a persistent problem for public school districts throughout the Commonwealth of Kentucky for the past two decades (Cross, 2016). The most recent data indicates that 11 percent of public schools in Kentucky struggle to fill one out of ten classroom teaching positions (Seiler et al., 2012), though retention, mobility, and attrition analyses suggest that these issues may be isolated in certain districts (Lochmiller et al., 2016). An increasing number of school leaders in the Commonwealth are turning to alternatively certified teachers to fill vacant classroom positions (Seiler et al., 2012). In fact, the most recent figures show that more than 95 percent of Kentucky public schools with teaching shortages opt to fill their vacancies with alternatively certified teachers (Seiler et al., 2012). The expanding number of alternatively certified teachers in the Commonwealth has led some to question the quality of teachers recruited and trained by alternative certification programs (Mueller, 2012). To date, however, an extensive review of the peer-reviewed literature, including published doctoral dissertations, has yet to identify a study that directly examines Kentucky's alternatively certified teachers.

Within this chapter, I describe results from this quantitative research study which examined the effects of teacher certification pathway on high school student achievement in the Commonwealth of Kentucky using data obtained from the Kentucky Center for Education and Workforce Statistics (KCEWS). In particular, I describe how classroom teachers who secured their teacher certification through the Commonwealth's eight different alternative teacher certification pathways effect high school student achievement in mathematics and reading as measured by the ACT. The chapter begins with descriptive results of the teacher workforce in Kentucky as a means to provide context to the study. Next, I describe results obtained from

propensity score matching—the research methods used to test the impact of alternatively certified teachers on their students' achievement. Finally, I report averaged treatment effects on the treated for alternatively certified teachers on student achievement in mathematics and readings as measured by the ACT test scores compared to their traditionally certified peers.

Descriptive Results of Classroom Teachers in Kentucky

To provide context to this study, I began this study by conducting a descriptive analysis of the teacher workforce in Kentucky. A descriptive analysis is a common starting point in economic and policy studies (McEwan, 2012). I examined trends for classroom teachers, comparing the number of alternatively certified teachers employed in public school districts to figures for traditionally certified teachers. I also compared demographic characteristics for alternatively and traditionally certified teachers employed in public schools in Kentucky during 2013-2014. This information articulates the policy context within the Commonwealth of Kentucky and thus serves to contextualize my analytic results.

Trends in Alternative Certification in the Commonwealth of Kentucky. As reported in Table 12, the number of classroom teachers employed in Kentucky public schools increased 7.3 percent from 36,721 in 2008-2009 to 39,391 in 2013-2014. There was, however, relatively no change in teacher counts from 2011-2012 to 2013-2014. These results are similar to figures reported in a recent Institute of Education Sciences (IES) study of Kentucky's teacher workforce (Lochmiller et al., 2016). The number of alternatively certified teachers increased at a stable rate until 2013-2014. As a proportion of the Commonwealth's teaching workforce, the percentage of alternatively certified teachers increased from 3.6 percent in 2008-2009 to 6.0 percent in 2013-2014. The percentage of traditionally certified teachers, however, decreased form 96.4 percent to 94.0 percent during the same time period. Together, these findings suggest that that the number

of alternatively certified teachers in Kentucky are increasing in number and as a percentage of the Commonwealth's teaching workforce, thus warranting additional research about Kentucky's alternatively certified teachers.

Table 12.
Number of Classroom Teachers by Certification Type, 2009-2014

	2008-2009		2009-2010		2010-2011		2011-2012		2012-2013		2013-2014	
	Num.	**Pct.**	**Num.**	**Pct.**	**Num.**	**Pct.**	**Num.**	**Pct.**	**Num.**	**Pct.**	**Num.**	**Pct.**
Traditional	35,394	96.4	36,060	95.7	36,631	95.0	37,086	94.4	37,060	94.0	37,022	94.0
Alternative	1,327	3.6	1,634	4.3	1,945	5.0	2,186	5.6	2,364	6.0	2,369	6.0
Total	36,721	100.0	37,694	100.0	38,576	100.0	39,272	100.0	39,424	100.0	39,391	100.0

Notes. Teachers had to possess valid EPSB certification information and be listed as a primary teacher on at least one student's transcript to be included in the table.

Table 13 reports the number of alternatively certified teachers disaggregated by Kentucky's eight alternative-certification pathways. As noted previously, Kentucky allows classroom teachers to receive certification through one of eight alternative teacher certification pathways. Option 1 is option to individuals with at least 10 years of exceptional work experience. Option 2 is a district-based alternative certification pathway. Currently, Jefferson County Public Schools' Alternative Certification Elementary and Secondary Program (ACES) is the only district-based alternative certification that is approved by the Education Professional Standards Board (EPSB) (Jefferson County Public Schools, 2017). Option 3 is open to any professional from a post-secondary institution seeking teacher certification, and Option 4 is an alternative teacher certification pathway for adjunct instructors teaching at a post-secondary institution. Veterans of the Armed Forces may apply to become classroom teachers through Option 5. Option 6 is a pathway for alternative certification through an approved higher education university, and Option 7 allows individuals in a field other than education to receive a one-year temporary provisional teaching certificate that is renewable for a maximum of three

years. Lastly, Option 8 is a pathway specific to teachers participating in the Teach For America program. Collectively, these pathways form the basis of the Commonwealth's alternative certification system.

From 2008-2009 to 2013-2014, the majority (88.7 percent) of alternatively certified teachers entered the Commonwealth's teaching workforce through a university-based alternative certification program (Option 6). The number of alternative certified teachers in university-based programs increased by 82.9 percent from 1,149 teachers in 2008-2009 to 2,102 in 2013-2014. This increase was not surprising as Option 6 represented the Commonwealth's broadest alternative teacher certification pathway. Sixteen colleges and universities offer alternative certification programs for classroom teachers throughout the Commonwealth using this certification option (Education Professional Standards Board, 2018a). This suggests that the majority of alternatively certified classroom teachers continue to pursue their certification through an accredited college or university program. While this may not be the case in other state policy settings, it illustrates the extent to which Kentucky's colleges and universities continue to play an active role in certifying classroom teachers regardless of their career pathway. As such, it makes Kentucky a unique policy context within which to understand the effects of alternative certification program.

Table 13.
Number of Classroom Teachers by Kentucky's Alternative Teacher Certification Pathway, 2009-2014

	2008-2009		2009-2010		2010-2011		2011-2012		2012-2013		2013-2014	
	Num.	**Pct.**	**Num.**	**Pct.**	**Num.**	**Pct.**	**Num.**	**Pct.**	**Num.**	**Pct.**	**Num.**	**Pct.**
Option 1	54	4.1	49	3.0	51	2.6	51	2.3	51	2.2	46	1.9
Option 2	14	1.1	34	2.1	38	2.0	55	2.5	54	2.3	53	2.2
Option 3	32	2.4	31	1.9	30	1.5	37	1.7	39	1.6	39	1.6
Option 4	33	2.5	27	1.7	30	1.5	32	1.5	36	1.5	34	1.4
Option 5	40	3.0	39	2.4	39	2.0	38	1.7	40	1.7	42	1.8
Option 6	1,149	86.6	1,448	88.6	1,750	90.0	1,952	89.3	2,107	89.1	2,102	88.7
Option 7	5	0.4	6	0.4	7	0.4	6	0.3	8	0.3	7	0.3
Option 8	0	0.0	0	0.0	0	0.0	15	0.7	29	1.2	46	1.9
Total	1,327	100.0	1,634	100.0	1,945	100.0	2,186	100.0	2,364	100.0	2,369	100.0

Notes. Teachers had to possess valid EPSB certification information and be listed as a primary teacher on at least one student's transcript to be included in the table.

Characteristics of Alternatively Certified Teachers in Kentucky Schools and Districts. The characteristics of the Commonwealth's teacher workforce were stable between 2008-2009 and 2013-2014. Table 14 reports demographic characteristics for classroom teachers employed in public schools in Kentucky during 2013-2014. Of the 39,391 teachers employed across the Commonwealth in 2013-2014, the majority of teachers were white (92.6 percent), female (77.8 percent), and between the ages 32-49 (57.6 percent). As for academic characteristics, most classroom teachers in Kentucky possessed a bachelor's degree (58.1 percent) or master's degree (41.8 percent). In addition, most teachers had 4-14 years of classroom experience (48.5 percent). The percentage of novice teachers with 0-3 years of experience in the Commonwealth was 17.6 percent, and the percentage of experienced teachers with 15 or more years of classroom teaching experience was (32.5 percent). The percent of teachers with a National Board for Professional Teachers Standards Certification (NBPTS) was 6.0 percent.

In comparing demographic characteristics of alternatively certified teachers to their traditionally certified peers, I identified a few significant differences between the two teacher groups. First, alternatively certified teachers were younger than the Kentucky teacher workforce as a whole. A majority of alternatively certified teachers were between the ages 32-39 (37.2 percent) or 31 or younger (33.0 percent), whereas traditionally certified teachers 26.4 percent and 20.7 percent for the respective age groups. Second, a greater proportion of alternatively certified teachers were male (38.1 percent) compared with 20.9 percent of traditionally certified teachers. Third, a greater proportion of alternatively certified teachers identified as a member of a racial or ethnic minority with 14.0 percent of alternatively certified teachers identifying as a racial or ethnic minority compared with 7.0 percent of traditionally certified teachers. These differences are similar to those identified in prior research on the characteristics of alternatively certified teachers (Constantine et al., 2009; Marinell & Johnson, 2014).

Table 14.
Demographic Characteristics of Classroom Teachers by Certification Type, 2013-2014

	All teachers		Traditionally certified teachers		Alternatively certified teachers	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Total	39,391	100.0	37,022	100.0	2,369	100.0
Age						
31 or younger	8,444	21.4	7,663	20.7	781	33.0
32-39	10,655	27.0	9,773	26.4	882	37.2
40-49	12,048	30.6	11,586	31.3	462	19.5
50 or older	8,208	20.8	7,965	21.5	243	10.3
Gender						
Female	30,632	77.8	29,173	78.8	1,466	61.9
Male	8,643	21.9	7,740	20.9	903	38.1
Race/Ethnicity						
African American/Black	1,355	3.4	1,172	3.2	183	7.7
Asian American	148	0.4	127	0.3	21	0.9
Hispanic	234	0.6	199	0.5	35	1.5
Native American	26	0.1	23	0.1	3	0.1
White	36,458	92.6	34,421	93.0	2,037	86.0
Multiple/other	1,137	2.9	1,048	2.8	89	3.8
Highest degree						
Bachelor's	22,869	58.1	20,889	56.4	1,980	83.6
Master's	16,451	41.8	16,070	43.4	381	16.1
Doctoral	71	0.2	63	0.2	8	0.3
Experience range						
0-3 years	6,949	17.6	6,044	16.3	905	38.2
4-9 years	11,143	28.3	9,937	26.8	1,206	50.9
10-14 years	7,977	20.3	7,901	21.3	76	3.2
15-19 years	6,336	16.1	6,304	17.0	32	1.4
20 or more years	6,448	16.4	6,425	17.4	23	1.0
Advance certification						
National Board Certification	2,349	6.0	2,114	5.7	34	1.4

Notes. Teachers had to possess valid EPSB certification information and be listed as a primary teacher on at least one student's transcript to be included in the table. Percentages do not add to 100 for variables with missing values.

I also identified differences in teachers' academic characteristics and amount of classroom teaching experience. First, fewer alternatively certified classroom teachers held a master's degree (16.1 percent) compared to their traditionally certified peers (43.4 percent). Second, alternatively certified classroom teachers had fewer years of total teaching experience. The majority of alternatively certified teachers had 0-9 years of classroom experience (89.1

percent), whereas 43.2 percent of traditionally certified teachers had the same amount of experience. The percentage of alternatively certified teachers with 10 or more years of classroom experience was 5.5 percent, which was significantly less than the 55.7 percent for traditionally certified teachers. Finally, a smaller percentage of alternatively certified teachers had achieved a NBPTS endorsement (1.4 percent) than their traditionally certified peers (5.7 percent). This finding is not surprising considering earlier studies found successful NBPTS certification applications to be associated with additional years of classroom experience (Cavalluzzo et al., 2014; Goldhaber, Perry, & Anthony, 2003). Collectively, these findings indicate that alternatively certified teachers in Kentucky were a younger, more diverse group than their traditionally certified peers. These differences potentially demonstrate how Kentucky's policy of alternative teacher certification has diversified the Commonwealth's teacher workforce. However, differences in academic characteristics between the alternatively certified teachers and traditionally certified teachers as well as variation in classroom teaching experience may contribute to dissimilarities in the relative effectiveness of the two groups of teachers. Prior research has indicated that these characteristics are associated with differences in teacher effectiveness (e.g., Boyd, et al., 2011; Boyd, Lankford, Loeb, Rockoff, et al., 2008; Clotfelter et al., 2007, 2010; Rockoff et al., 2011).

In summary, alternatively certified teachers employed in public school districts in Kentucky from 2008-2009 to 2013-2014 increased in number and as a percentage of the Commonwealth's teacher workforce. In contrast, the number of traditionally certified teachers remained stable during the same time period. University-based alternative certification programs (Option 6) were the primary entry points for alternatively certified teachers to the Commonwealth's teacher workforce, suggesting that Kentucky's colleges and universities

continue to play an active role in certifying classroom teachers regardless of their career pathway. In addition, a greater percentage of alternatively certified teachers were male and non-white than traditionally certified teachers. Alternatively certified teachers were also more likely to be younger than their traditionally certified peers. Differences in teachers' academic characteristics and amount of classroom teaching experience were also detected with alternately certified teachers less likely to have a master's degree and more likely to have fewer years of classroom experience than traditionally certified teacher. Differences in personal and academic characteristics, as well as the amount of classroom experience, between alternatively certified teachers and their traditionally certified peers may point to further differences in the classroom (Boyd et al., 2008; Clotfelter et al., 2007, 2010; Stronge et al., 2011). The next section describes the results from the data analysis, which used propensity score matching to investigate the effects of alternatively certified teachers on student achievement outcomes in mathematics and reading compared to teachers with traditional certification. This section articulates the central analytic findings of this study.

Results of Propensity Score Matching

I used propensity score matching to examine the influence of different teacher certification pathways on high school student achievement outcomes in mathematics and reading as measured by ACT test scores. Propensity score matching is a type of quasi-experimental design that is intended to minimize selection bias and other confounding factors present in observational data (Rosenbaum & Rubin, 1983). The goal of propensity score matching is to minimize differences between the treatment and control groups on all pre-treatment covariates related to treatment selection and the dependent variable (Rosenbaum & Rubin, 1983). In order to minimize differences between the two groups, I assigned each student a propensity score

representing the likelihood of being assigned to an alternatively certified teacher's classroom on observed covariates. The propensity scores were then used to remove the effects of observable confounding in the data and to establish equivalent treatment and control groups. These equivalent groups were then used to estimate the effects of the treatment on the outcome. The following sections describe the results obtained from the propensity score matching used in this study.

Propensity Score Estimates. The logistic regression model produced propensity scores ranging from 0 to 1 for all students in the sample. Each propensity score represents a student's probability of being assigned to an alternatively certified teacher, conditional on all covariates in the model (see Appendix D for a summary of the model coefficients used to estimate the propensity scores). Figure 2 presents the distributions of propensity scores for students in alternatively certified teachers' classrooms (treatment group) and traditionally certified teachers' classrooms (control group). The histograms illustrate that the distribution of propensity scores for students in the treatment group overlaps completely with the distribution of propensity scores for control group students. Guo and Fraser (2015) noted that inadequate overlap in estimated propensity scores may lead to issues in matching treated and control cases. Therefore, I concluded that an adequate match could be found for every student in an alternative teacher's classroom.

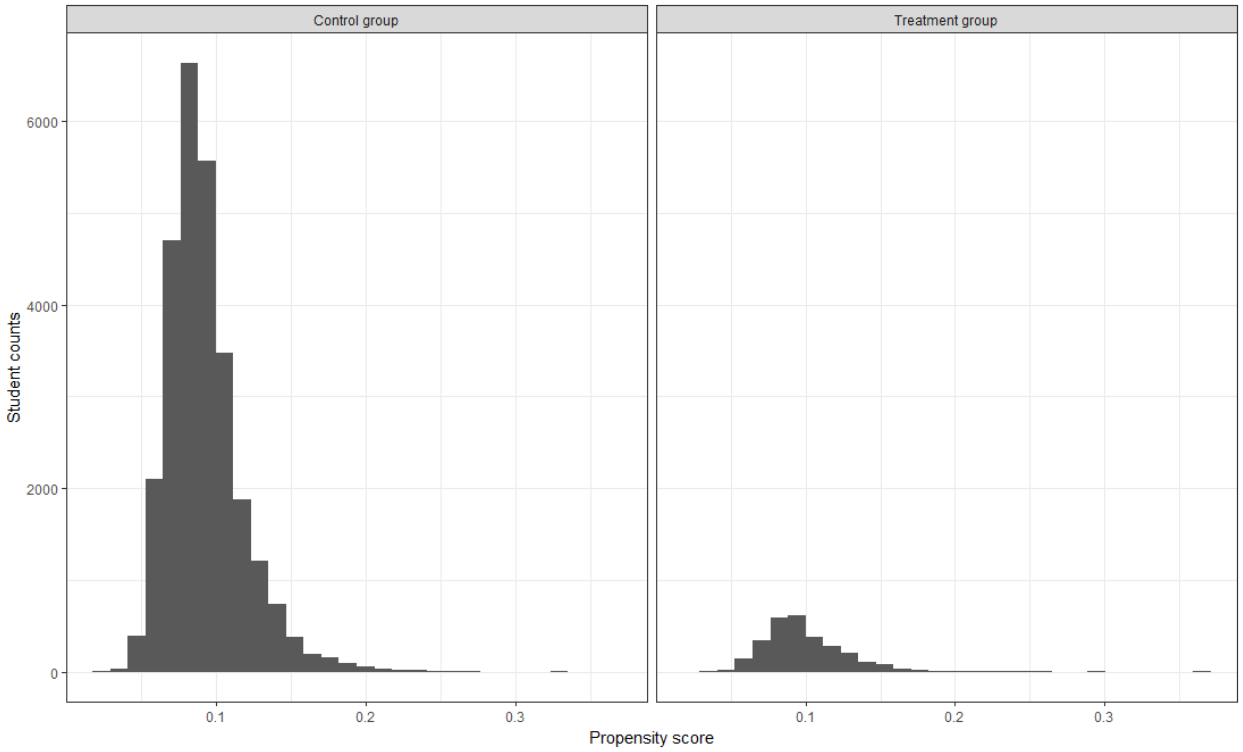

Figure 2. Distributions of Propensity Scores for Treatment and Control Groups, Before Matching

Matching Results. I implemented nearest neighbor matching in R using the "MatchIt" package (Ho et al., 2011) to match students in the treatment group to those in the control group at a 1:1 ratio, without replacement, and no matching caliper. In addition, I matched treatment and control group students using different matching ratios, replacement procedures, and matching calipers; however, results from covariate balance tests showed a match ratio of 1:1, without replacement, and no matching caliper to be the best fit for these data. In the end, all students in the treatment group (n = 2,847; 100 percent) were matched to a student in the control group to determine the effects alternatively certified teachers had on student achievement outcomes in mathematics and reading. Additionally, I compared the distribution of propensity scores of the treatment and control groups before and after matching. As illustrated in Figure 3, the propensity

scores of the treatment and matched control groups overlap. This suggests that the matching processes worked well.

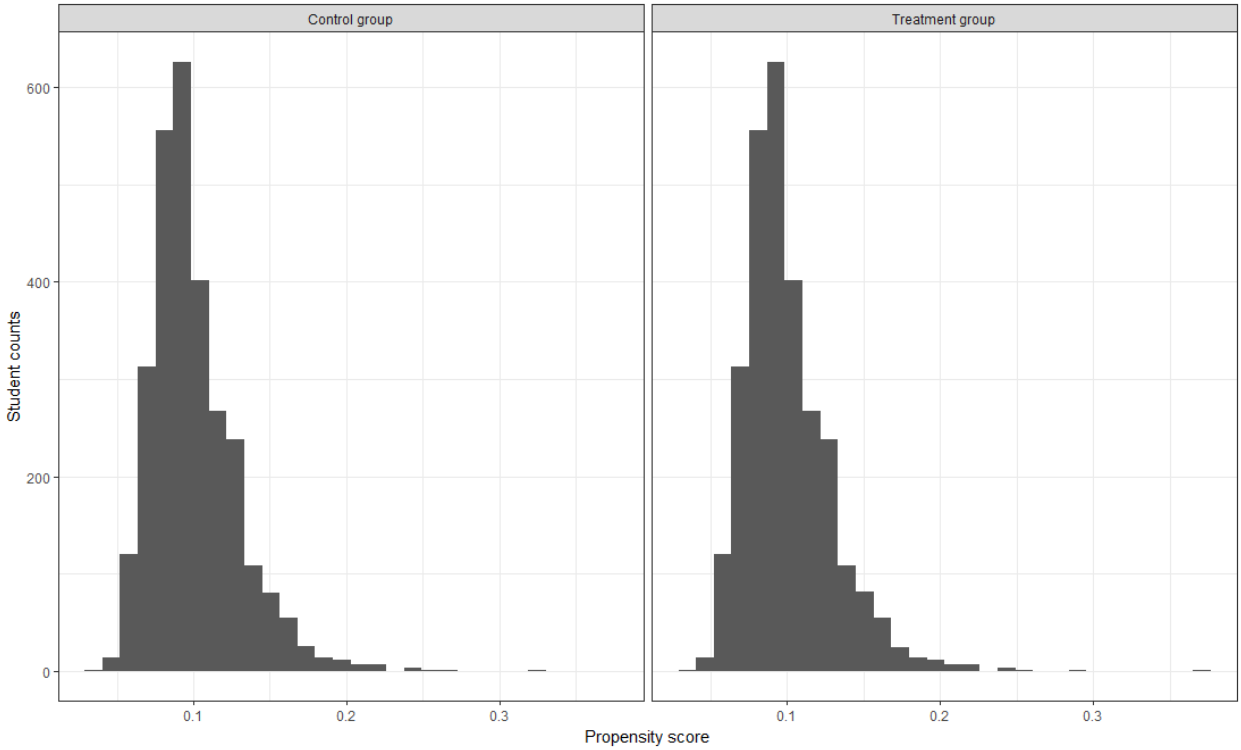

Figure 3. Distributions of Propensity Scores for Treatment and Control Groups, After Matching

Results of Covariate Balance Tests. The standardized difference of means is one of the most commonly used numerical balance diagnostics to test whether covariate balance is achieved (Harder, Stuart, & Anthony, 2010). Also known as the "standardized bias" (Rosenbaum & Rubin, 1983), the standardized difference of means is similar to an effect size and is compared before and after matching (Harder et al., 2010). A smaller standardized difference of means after propensity score matching indicates that adequate overlap in propensity scores was achieved, which, in turn, signals that the matched treatment-control group are similar on all pre-treatment covariates. Following Harder, Stuart, and Anthony's (2010) recommendations, I estimated the

standardized difference in means for each of the 18 covariates used to estimate the propensity scores before and after matching (Figure 4). The line with circle points in Figure 3 connects the standardized difference of means for covariates before matching took place, whereas the line with square points indicates the standardized difference of means for covariates after matching. The dotted line represents the balance threshold I used for this study, which was set at $d = 0.10$ (Harder et al., 2010). Results showed that all covariates (100 percent) were below the balance threshold ($d = 0.10$). Moreover, the standardized difference of means for 16 of 17 covariates (94 percent) decreased after matching. Together, the results of the covariate assessment plot show that sufficient balance was achieved for the matched sample per Harder, Stuart, and Anthony's (2010) recommendations.

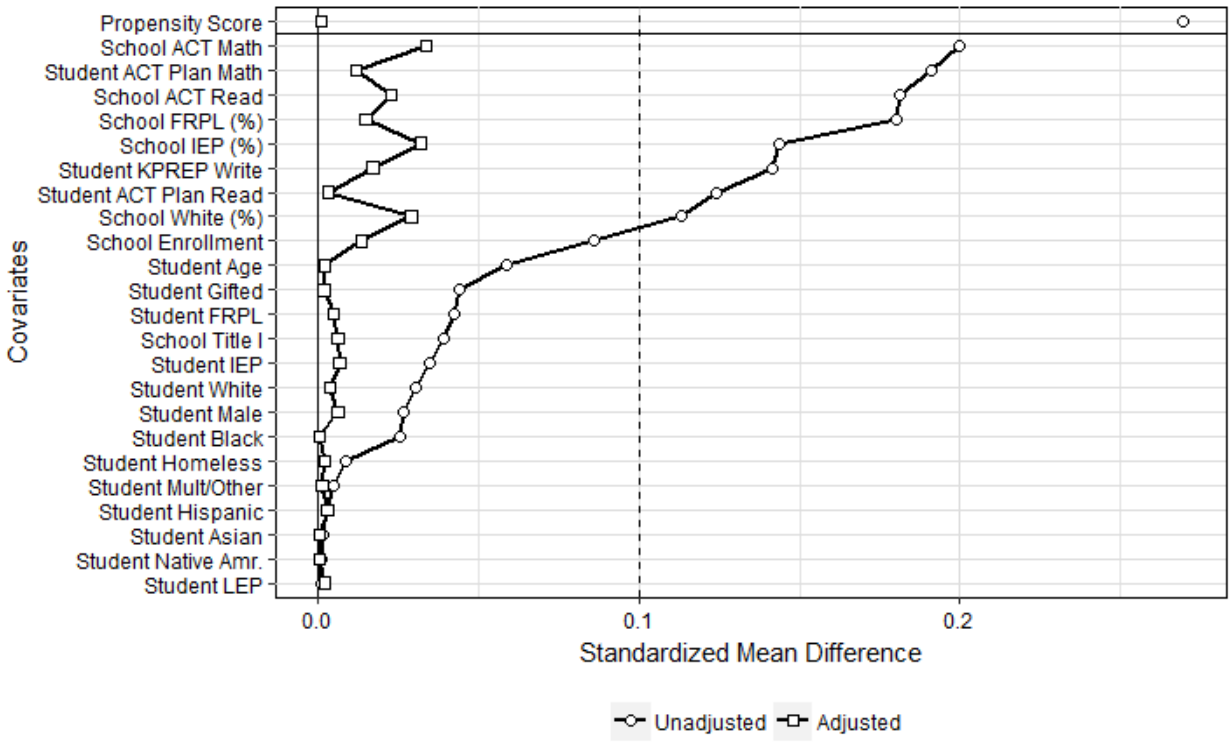

Figure 4. Plot of Standardized Difference of Means for 18 Covariates, Before and After Matching

In addition to plotting standardized difference in means for match groups, I also compared group means of covariates for treatment and control groups before and after matching. Tables 15, 16, 17, and 18 present the group mean characteristics of covariates before and after matching. Prior to matching, 15 of the 18 variables (83.3 percent) were significantly different between the treatment and control groups. No covariates had significantly different group means following matching, which, if present, would indicate bias between the two groups (Stuart, 2010). However, it is important to note that small amounts of bias may be present in places where the matched observations were not perfectly balanced (Stuart, 2010). For example, the school average for the ACT mathematics test was slightly higher for students in traditionally certified teachers' classrooms (M = 19.10, SD = 1.5) than those in alternatively certified teachers' classrooms (M = 19.05, SD = 1.5). I detected similar differences in the school average for the ACT reading test—traditionally certified teacher group (M = 19.44, SD = 1.7) and alternatively certified teacher group (M = 19.40, SD = 1.7). Stuart (2010) further noted, however, that biases introduced through lack of balance were largely a concern when standardized mean differences were greater than 0.5. The standardized mean differences for school ACT mathematics (0.034) and reading (0.023) were both below the 0.5 threshold, therefore reducing concerns of bias. Taken together, these findings further suggest that the study's matching process was able to match students in the treatment group to similar student in the control group.

Table 15.
Balance Diagnostics for Categorical Covariates, Before Matching

	Traditionally Certified Teachers (n = 27,697)		Alternatively Certified Teachers (n = 2,847)		Standardized Mean Difference
	Number	Percent	Number	Percent	
Gender					0.05
Female	13,874	50.1	1,351	47.5	
Male	13,823	49.9	1,496	52.5	
Race/Ethnicity					0.10
African American/Black	2,453	8.9	324	11.4	
Asian American	411	1.5	38	1.3	
Hispanic	901	3.3	100	3.5	
Native American	46	0.2	2	0.1	
White	23,378	84.4	2,317	81.4	
Multiple/other	508	1.8	66	2.3	
Eligible for free or reduced price lunch	11,092	40.0	1,261	44.3	0.09
Special education status	1,917	6.9	296	10.4	0.12
Limited English proficient	191	0.7	17	0.6	0.01
Gifted	6,730	24.3	566	19.9	0.11
Homeless	387	1.4	64	2.2	0.06

Notes. Includes grade 11 students who took the ACT reading test during the state testing window for academic year 2013-2014. Estimates of standardized mean difference were calculated using the difference in means of a variable across treatment and control groups, divided by the standard deviation in the treated group (Stuart, Lee, & Leacy, 2013; Austin, 2011).

Table 16.
Balance Diagnostics for Continuous Covariates, Before Matching

	Traditionally Certified Teachers (n = 27,697)		Alternatively Certified Teachers (n = 2,847)		Standardized Mean Difference
	Mean	Std. Dev.	Mean	Std. Dev.	
Student age (years)	17.4	0.6	17.5	0.6	0.06
ACT Plan Math	0.0	1.0	-0.2	1.0	0.19
ACT Plan Read	0.0	1.0	-0.1	1.0	0.12
KPREP Writing	0.0	1.0	-0.1	1.0	0.14
School Title One (%)	0.3	0.5	0.3	0.5	0.09
School enrollment	1111.8	472.2	1074.7	434.1	0.08
School free or reduced price lunch (%)	0.5	0.2	0.5	0.2	0.18
School minority (%)	0.2	0.2	0.2	0.2	0.11
School special education (%)	0.1	0.0	0.1	0.0	0.15
School average on ACT Math	19.4	1.5	19.1	1.5	0.20
School average on ACT Read	19.7	1.7	19.4	1.7	0.18

Notes. Includes grade 11 students who took the ACT reading test during the state testing window for academic year 2013-2014. Estimates of standardized mean difference were calculated using the difference in means of a variable across treatment and control groups, divided by the standard deviation in the treated group (Stuart, Lee, & Leacy, 2013; Austin, 2011).

Table 17.
Balance Diagnostics for Categorical Covariates, After Matching

	Traditionally Certified Teachers (n = 2,847)		Alternatively Certified Teachers (n = 2,847)		Standardized Mean Difference
	Number	Percent	Number	Percent	
Gender					0.01
Female	1,334	46.9	1,351	47.5	
Male	1,513	53.1	1,496	52.5	
Race/Ethnicity					0.02
African American/Black	325	11.4	324	11.4	
Asian American	37	1.3	38	1.3	
Hispanic	108	3.8	100	3.5	
Native American	1	0.0	2	0.1	
White	2,307	81.0	2,317	81.4	
Multiple/other	69	2.4	66	2.3	
Eligible for free or reduced price lunch	1,248	43.8	1,261	44.3	0.01
Special education status	315	11.1	296	10.4	0.02
Limited English proficient	23	0.8	17	0.6	0.03
Gifted	571	20.1	566	19.9	0.00
Homeless	70	2.5	64	2.2	0.01

Notes: Includes grade 11 students who took the ACT reading test during the state testing window for academic year 2013-2014. Estimates of standardized mean difference were calculated using the difference in means of a variable across treatment and control groups, divided by the standard deviation in the treated group (Stuart, Lee, & Leacy, 2013; Austin, 2011).

Table 18.
Balance Diagnostics for Continuous Covariates, After Matching

	Traditionally Certified Teachers (n = 2,847)		Alternatively Certified Teachers (n = 2,847)		Standardized Mean Difference
	Mean	Std. Dev.	Mean	Std. Dev.	
Student age (years)	17.5	0.6	17.5	0.6	0.00
ACT Plan Math	-0.2	1.0	-0.2	1.0	0.01
ACT Plan Read	-0.1	1.0	-0.1	1.0	0.00
KPREP Writing	-0.1	1.0	-0.1	1.0	0.02
School Title One (%)	0.3	0.5	0.3	0.5	0.01
School enrollment	1080.4	466.1	1074.7	434.1	0.01
School free or reduced price lunch (%)	0.5	0.2	0.5	0.2	0.02
School minority (%)	0.2	0.2	0.2	0.2	0.03
School special education (%)	0.1	0.0	0.1	0.0	0.03
School average on ACT Math	19.1	1.5	19.1	1.5	0.03
School average on ACT Read	19.4	1.7	19.4	1.7	0.02

Notes. Includes grade 11 students who took the ACT reading test during the state testing window for academic year 2013-2014. Estimates of standardized mean difference were calculated using the difference in means of a variable across treatment and control groups, divided by the standard deviation in the treated group (Stuart, Lee, & Leacy, 2013; Austin, 2011).

Teacher Effect Estimates

After creating a matched sample using propensity score matching, I investigated the effects classroom teachers who received their certification using different alternative certification pathways teacher certification pathways in Kentucky have on high school student achievement in mathematics and readings as measured by the ACT test scores compared to their traditionally certified peers. I estimated average treatment effects on the treated using multiple regression modeling. The use of multiple regression to estimate average treatment effects after matching enabled me to mitigate the likelihood of any omitted variable bias that may be left over after matching (Leite, 2017; Rosenbaum & Rubin, 1983). I estimated separate regression models for student ACT mathematics and reading test scores on teacher certification type and a set of student-level covariates. Covariates included in the model were student age, gender, race/ethnicity, free and/or reduced price lunch eligibility, special education status, limited English proficiency status, gifted program indicator, homeless indicator, and standardized prior achievement scores on the ACT Plan mathematics and reading tests as well as the KPREP on-demand writing test. See Chapter 3 for a complete model specification. For clarity, I have excluded regression coefficients for the covariates from the results tables in this chapter. However, I have provided full tables reporting all estimated coefficients in Appendix E.

Effects of Alternatively Certified Teachers on Student Achievement. First, I estimated the effects of teacher certification type on ACT mathematics and reading test scores (Tables 19 and 20). As reported in Table 19, alternatively certified classroom teachers positively affected ACT mathematics test scores. The null model, which estimated treatment effects without covariate adjustment, found alternatively certified teachers to positively affect student achievement in mathematics ($\beta = 0.191$, $p < 0.05$). This represented an increase of 0.04 standard

deviations (SD) from the mean mathematics score for students in the treatment group. I found estimates for models two and three to be similar to those reported in model one after holding constant student characteristics and prior achievement ($\beta = 0.181$, $p < 0.05$ and $\beta = 0.161$, $p < 0.01$, respectively). However, I found the third model explained the largest amount of the variance in student achievement ($R^2 = 0.67$, $F(16, 4629) = 733.350$, $p < 0.001$). The consistency in these results across the three models suggests that alternatively certified teachers positively impact students' mathematics achievement.

The effects of alternative certified teachers on ACT reading test scores were sensitive to different model specifications (Table 20). Results of null model were not statistically significant. However, the second model showed alternatively certified teachers to positively influence students achievement in reading ($\beta = 0.222$, $p < 0.05$). In terms of standard deviations, students in alternatively certified teachers' classrooms scored on average 0.037 SD higher on the ACT reading test than their peers in traditionally certified teachers' classrooms. I found similar results for the third model ($\beta = 0.223$, $p < 0.01$). Model three also explained 65 percent of the variation in ACT reading test scores ($R^2 = 0.65$, $F(16, 5139) = 651.943$, $p < 0.001$). The findings from models two and three suggest alternatively certified teachers have a positive influence on student achievement in reading when controlling for student-level factors.

Table 19.
Effects of Alternatively Certified Teachers on Mathematics Achievement, Grade 11

	ACT Mathematics (scale score)		
Coefficients	(1)	(2)	(3)
Treatment	0.191* (0.115)	0.181* (0.097)	0.161** (0.066)
Constant	18.856*** (0.081)	29.731*** (1.511)	24.008*** (1.029)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.0005	0.292	0.674

Notes. Includes grade 11 students enrolled in a mathematics course and who took the ACT mathematics test during the state testing window in 2013-2014 (n=4,646). Standard errors are in parentheses. Treatment variable was a binary indicator whether a student was assigned to an alternative certified teacher. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Table 20.
Effects of Alternatively Certified Teachers on Reading Achievement, Grade 11

	ACT Reading (scale score)		
Coefficients	(1)	(2)	(3)
Treatment	0.240 (0.153)	0.222* (0.133)	0.223** (0.091)
Constant	19.258*** (0.108)	32.912*** (2.062)	24.776** (1.422)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.0004	0.253	0.647

Notes. Includes grade 11 students enrolled in a reading course and who took the ACT reading test during the state testing window in 2013-2014 (n=5,156). Standard errors are in parentheses. Treatment variable was a binary indicator whether a student was assigned to an alternative certified teacher. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Effects of Alternatively Certified Teacher Experience on Student Achievement. As part of the regression models, I included teacher experience to determine whether experience was related to the achievement of students who are taught by alternatively certified teachers (Tables 21 and 22). As reported in Table 21, the null models showed teaching experience to positively influence ACT mathematics scores ($\beta = 0.079$, $p < 0.001$). This represents an increase of 0.017 SD in mathematics achievement for each year of classroom experience. Alternatively certified teachers were also found to positively affect student mathematics achievement when controlling for experience ($\beta = 0.557$, $p < 0.01$). The interaction of certification type and experience was not statistically significant. Moreover, the null model explained a relatively small amount (16 percent) of the variation in ACT mathematics test scores ($R^2 = 0.16$, $F(3, 4642) = 29.920$, $p < 0.001$), indicating that additional unobserved factors are contributing to the variation in ACT mathematics test scores.

Findings from model two, which included additional covariates for student characteristics, were similar to results of the null model with alternatively certified teachers and experience both positively influencing mathematics achievement ($\beta = 0.325$, $p < 0.05$ and $\beta = 0.045$, $p < 0.001$, respectively). While the second model explained more variation than the null model ($R^2 = 0.30$, $F(15, 4630) = 160.680$, $p < 0.001$), the third model, which included prior student achievement in the model, explained the largest amount of variation in the outcome measure ($R^2 = 0.68$, $F(18, 4627) = 654.290$, $p < 0.001$). The model three coefficients indicating that students enrolled in an alternatively certified teachers' classrooms ($\beta = 0.182$, $p < 0.05$) and experience ($\beta = 0.018$, $p < 0.01$) also showed positive effects. Together, these findings suggest that alternatively certified teachers have greater influence on student mathematics achievement as they gain classroom teaching experience. This finding is similar to those in previous studies

examining the effects of teaching experience on student mathematics achievement (e.g., Clotfelter et al., 2010; Ladd, 2009; Rockoff et al., 2011; Sass, 2011).

Table 22 reports results from the regression models used to estimate the effects of teacher certification and years of experience on ACT reading test scores. Findings from the null model show experience to positively affect student achievement in reading ($\beta = 0.084$, $p < 0.001$). Alternatively certified teachers were also found to positively influence reading achievement ($\beta = 0.608$, $p < 0.05$); however, alternative certification effects were not found to be significant in models two or three. Teacher experience was the only significant coefficient in the second model ($\beta = 0.041$, $p < 0.001$). This represents an increase of 0.007 SD from the mean reading score for the two groups. Model coefficients in the third model were inconclusive. Notably, the results presented in Table 12 indicate that other unobserved factors are influencing students' achievement on the ACT reading test. Taken together, these results are inconclusive whether alternatively certified teachers have a greater effect on students' reading achievement as they gain experience in the classroom.

Table 21.
Effects of Classroom Teaching Experience on Mathematics Achievement, Grade 11

	ACT Mathematics (scale score)		
Coefficients	(1)	(2)	(3)
Treatment	0.557** (0.190)	0.325* (0.161)	0.182* (0.110)
Experience (years)	0.079*** (0.011)	0.045*** (0.009)	0.018** (0.006)
Treatment * Experience	0.015 (0.020)	0.019 (0.017)	0.014 (0.011)
Constant	17.968*** (0.145)	29.437*** (1.510)	23.963*** (1.031)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.016	0.298	0.675

Notes. Includes grade 11 students enrolled in a mathematics course and who took the ACT mathematics test during the state testing window in 2013-2014 (n=4,646). Standard errors are in parentheses. Treatment variable was a binary indicator whether a student was assigned to an alternative certified teacher. Teacher classroom experience was measured in years. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Table 22.
Effects of Classroom Teaching Experience on Reading Achievement, Grade 11

	ACT Reading (scale score)		
Coefficients	(1)	(2)	(3)
Treatment	0.608* (0.253)	0.305 (0.220)	0.166 (0.152)
Experience (years)	0.084*** (0.014)	0.041*** (0.012)	0.005 (0.009)
Treatment * Experience	0.018 (0.026)	0.025 (0.023)	0.014 (0.016)
Constant	18.322*** (0.193)	32.549*** (2.065)	24.717*** (1.426)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.010	0.256	0.648

Notes. Includes grade 11 students enrolled in a reading course and who took the ACT reading test during the state testing window in 2013-2014 (n=5,156). Standard errors are in parentheses. Treatment variable was a binary indicator whether a student was assigned to an alternative certified teacher. Teacher classroom experience was measured in years. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Effects of Alternatively Certified Teachers' Pathway on Student Achievement. I estimated teacher effects for each of the eight alternative teacher certification pathways in Kentucky on student achievement in mathematics and reading (Tables 23 and 24). As reported in Table 23, alternately certified teachers impacted student mathematics performance differently depending on the pathway they used to secure alternative certification. Results from the null model showed classroom teachers who received certification from an alternative teacher certification pathway for adjunct instructors teaching at a post-secondary institution (Option 5) and a pathway for veterans of the Armed Forces (Option 6) positively influenced student achievement in mathematics ($\beta = 3.979$, $p < 0.001$ and $\beta = 1.489$, $p < 0.01$, respectively). I found similar results for teachers with alternative certifications for adjunct instructors and veterans of the Armed Forces when covariates for student characteristics were added to the model ($\beta = 2.414$, $p < 0.001$ and $\beta = 0.829$, $p < 0.05$, respectively). Results from the third model, which included covariates for prior student achievement, also showed Armed Forces veterans to positively affect mathematics achievement ($\beta = 0.470$, $p < 0.05$). Additional, model three also showed positive effects for classroom teachers who received alternative certification through a college or university program ($\beta = 0.140$, $p < 0.05$).

Results also suggest that alternatively certified teachers had, at times, a negative impact on students' mathematics achievement. For example, alternatively certified teachers who received their certification from the pathway designated for the Teach For America program (Option 8) negatively impacted student achievement in mathematics ($\beta = -2.470$, $p < 0.001$, for the null model). I found similar results for Teach For America teachers in models two and three ($\beta = -1.516$, $p < 0.01$ and $\beta = -0.782$, $p < 0.05$, respectively).

Next, I examined teacher effects for Kentucky's eight alternative teacher certification pathways on student achievement in reading (Table 24). Again, teacher effects varied by alternative certification pathway with results from the null model showing alternatively certified teachers from the pathways for adjunct instructors (Option 4) and Armed Forces veterans (Option 5) positively affected reaching achievement ($\beta = 4.166$, $p < 0.001$ and $\beta = 2.185$, $p < 0.001$, respectively). In addition, teachers receiving their certification from the local district alternative certification pathway (Option 2) also positively impacted reading achievement in the null model ($\beta = 2.058$, $p < 0.05$). For model two, classroom teachers with alternative certifications for adjunct instructors and veterans of the Armed Forces positively influence student achievement in reading ($\beta = 2.297$, $p < 0.01$ and $\beta = 1.496$, $p < 0.01$, respectively). Alternatively certified teachers from a university-based program (Option 6) were the only group found to positively affect reading achievement in the third model ($\beta = 0.200$, $p < 0.05$).

Additionally, I found alternatively certified teachers who received a one-year provisional teaching certificate (Option 7) and Teach For America teachers (Option 8) to have a small negative effect on student achievement in reading. Specifically, alternatively certified teachers with provisional teaching certification and Teach For America teachers negatively affected reading achievement in the null model ($\beta = -4.266$, $p < 0.05$ and $\beta = -2.157$, $p < 0.05$, respectively). Only teachers with provisional alternative teaching certification were found to have negative effects in model two ($\beta = -5.256$, $p < 0.05$). Together, these findings further support the conclusion that classroom teachers differ in their impact—positive or negative—on student achievement in reading and mathematics by their alternative certification pathway.

Table 23.
Effects of Kentucky Alterative Teacher Certification Pathways on Mathematics Achievement, Grade 11

	ACT Mathematics (scale-score)		
Coefficients	(1)	(2)	(3)
Option 1: Exceptional Work Experience	0.493 (0.315)	0.345 (0.266)	0.281 (0.181)
Option 2: Local District Program	0.991 (0.747)	-0.160 (0.632)	0.374 (0.430)
Option 3: College Faculty	0.445 (0.556)	0.159 (0.470)	0.181 (0.320)
Option 4: Adjunct Instructor	3.979*** (0.658)	2.414*** (0.559)	0.572 (0.381)
Option 5: Armed Forces Veterans	1.489** (0.466)	0.829* (0.395)	0.470* (0.269)
Option 6: University-Based Program	0.078 (0.121)	0.138 (0.102)	0.140* (0.069)
Option 7: Institute Alternative Route	-2.262 (1.938)	-2.620 (1.640)	-0.391 (1.116)
Option 8: Teach For America	-2.470*** (0.644)	-1.516** (0.545)	-0.782* (0.371)
Constant	18.862*** (0.081)	29.575*** (1.510)	23.975*** (1.031)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.012	0.296	0.675

Notes. Includes grade 11 students enrolled in a mathematics course and who took the ACT mathematics test during the state testing window in 2013-2014 (n=4,646). Standard errors are in parentheses. Options 1-8 were separate binary variables indicating whether a student was assigned to an alternative certified teacher who entered the profession through one of the eight alternative pathways, as designated by EPSB. Teacher classroom experience was measured in years. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Table 24.
Effects of Kentucky Alternative Teacher Certification Pathways on Reading Achievement, Grade 11

	ACT Reading (scale score)		
Coefficients	**(1)**	**(2)**	**(3)**
Option 1: Exceptional Work Experience	0.454 (0.419)	0.191 (0.363)	0.091 (0.250)
Option 2: Local District Program	2.058* (0.994)	0.654 (0.863)	0.517 (0.595)
Option 3: College Faculty	0.589 (0.740)	0.325 (0.642)	0.417 (0.442)
Option 4: Adjunct Instructor	4.166*** (0.875)	2.297** (0.764)	0.676 (0.527)
Option 5: Armed Forces Veterans	2.185*** (0.620)	1.496** (0.540)	0.522 (0.372)
Option 6: University-Based Program	0.087 (0.160)	0.155 (0.139)	0.200* (0.096)
Option 7: Institute Alternative Route	-4.266* (2.579)	-5.256* (2.240)	-2.279 (1.543)
Option 8: Teach For America	-2.157* (0.856)	-1.011 (0.745)	0.311 (0.513)
Constant	19.266*** (0.108)	32.622*** (2.063)	24.698*** (1.424)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.009	0.256	0.648

Notes. Includes grade 11 students enrolled in a reading course and who took the ACT reading test during the state testing window in 2013-2014 (n=5,156). Standard errors are in parentheses. Options 1-8 were separate binary variables indicating whether a student was assigned to an alternative certified teacher who entered the profession through one of the eight alternative pathways, as designated by EPSB. Teacher classroom experience was measured in years. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Effects of Alternatively Certified Teachers' Pathway and Experience on Student Achievement. Lastly, I included teaching experience in the models estimating teacher effects for each of eight alternative teacher certification pathways in Kentucky on mathematics and reading achievement (Tables 25 and 26). I found teaching experience to positively influence ACT mathematics scores ($\beta = 0.079$, $p < 0.001$) in the null model (Table 25). I detected similar effects for teacher experience with the additional covariates for student characteristics and prior student achievement ($\beta = 0.044$, $p < 0.001$ and $\beta = 0.017$, $p < 0.01$, respectively). Results also indicated that the impact of alternatively certified teachers on student achievement in mathematics varied by alternative certification pathway. Specifically, teachers who received their certification from a university-based alternative certification program (Option 6) positively impacted students' ACT scores in mathematics ($\beta = 0.653$, $p < 0.01$, null model; $\beta = 0.330$, $p < 0.05$, model two). Teachers who received certification through a pathway for veterans of the Armed Services (Option 5) negatively impacted mathematics achievement ($\beta = -3.123$, $p < 0.05$, null model; $\beta = -3.191$, $p < 0.05$, model two). This finding is particularly significant given earlier findings (see Table 23) that showed the same group having a positive impact on student mathematics achievement. This suggests that classroom experience plays a significant role in determining teachers' effectiveness in the classroom, as measured by student achievement gains.

Additionally, and perhaps most significantly, I found that the interaction effects between alternative certification pathway and experience varied across different certification pathways. This suggests that experience and the alternative certification pathway selected may bear significantly on the teacher's ability to impact student achievement. Specifically, the null model showed the effects of teachers who received certification through three alternative certification pathways—the local district pathway (Option 2), the pathway for adjunct instructors (Option 4),

and the pathway for Armed Service veterans (Option 5)—and their respective interaction with years of classroom experience were positive ($\beta = 1.567$, $p < 0.01$, $\beta = 0.444$, $p < 0.001$, $\beta = 0.417$, $p < 0.05$, respectively). Positive effects were consistent when additional covariates were added for teachers with certification from the pathway for adjunct instructors ($\beta = 0.341$, $p < 0.01$, model two; $\beta = 0.233$, $p < 0.01$, model three) and the pathway for veterans of the Armed Services ($\beta = 0.363$, $p < 0.01$), model two; $\beta = 0.190$, $p < 0.05$, model three). Overall, these findings suggest a dependent relationship between alternative certification pathway and experience for teachers receiving certification from alternative pathways designated for university adjunct instructors (Option 4) and Armed Service veterans (Option 5). This has important implications for the retention of alternatively certified teachers as their influence on student achievement appears to increase over time.

I also estimated teacher effects for alternative certification pathways with the addition of teaching experience on ACT reading tests (Table 26). I found teaching experience to positively influence students' reading achievement in models one and two ($\beta = 0.084$, $p < 0.001$, $\beta = 0.041$, $p < 0.001$, respectively). Additionally, I found the effects of alternative certification pathways to have little impact on student ACT reading test scores. I detected significant effects for alternatively certified teachers from a local district program (Option 2) and a university-based alternative certification program (Option 6) in the null model ($\beta = -7.352$, $p < 0.05$ and $\beta = 0.616$, $p < 0.05$, respectively). However, model coefficients for both pathways were not significant when additional covariates were added to the model. Finally, I detected one significant interaction—the interaction between alternatively certified teachers from a local district program (Option 2) and experience was positive ($\beta = 2.380$, $p < 0.01$). Again, this result was not consistent across models. However, in general, the findings suggest a dependent relationship

between the teachers' alternative certification pathway and classroom experience was inconclusive.

In summary, results from the multiple regression models indicate alternatively certified teachers positively influence student achievement in mathematics and reading. Teacher experience positively influenced student achievement in mathematics. However, the results were inconclusive for reading. In estimating teacher effects for each of the eight alternative teacher certification pathways, results showed the positive and negative effects of classroom teachers on student achievement in mathematics and reading differed by their alternative certification pathway. Additionally, I detected a dependent relationship between alternative certification pathway and experience for teachers receiving certification from alternative pathways designated for university adjunct instructors (Option 5) and Armed Service veterans (Option 6). Collectively, these findings suggest: (1) alternatively certified teachers have a positive effect on student achievement in mathematics and reading; (2) the alternative certification pathway matters in determining teacher effectiveness in the classroom; and, (3) classroom experience plus alternative certification indicates that greater attention to the retention of alternatively certified teachers is needed as their influence on student achievement appears to increase over time.

Table 25.

Effects of Kentucky Alternative Teacher Certification Pathways and Experience on Mathematics Achievement, Grade 11

	ACT Mathematics (scale score)		
Coefficients	(1)	(2)	(3)
Option 1: Exceptional Work Experience	0.197	0.111	0.568
	(0.919)	(0.781)	(0.533)
Option 2: Local District Program	-5.035*	-1.572	1.596
	(2.456)	(2.088)	(1.425)
Option 3: College Faculty	-0.544	-2.351	-0.930
	(1.721)	(1.460)	(0.996)
Option 4: Adjunct Instructor	-1.057	-1.430	-2.041*
	(1.636)	(1.387)	(0.947)
Option 5: Armed Forces Veterans	-3.123*	-3.191*	-1.628
	(1.890)	(1.604)	(1.094)
Option 6: University-Based Program	0.635**	0.330*	0.119
	(0.220)	(0.187)	(0.128)
Option 7: Institute Alternative Route	-1.760	-2.325	-0.276
	(1.922)	(1.632)	(1.114)
Option 8: Teach For America	-2.006	-0.397	-0.581
	(2.421)	(2.055)	(1.402)
Experience (years)	0.079***	0.044***	0.017**
	(0.011)	(0.009)	(0.006)
Option 1 * Experience	-0.008	-0.0001	-0.022
	(0.052)	(0.044)	(0.030)
Option 2 * Experience	1.567**	0.415	-0.259
	(0.556)	(0.473)	(0.323)
Option 3 * Experience	0.051	0.164*	0.073
	(0.113)	(0.096)	(0.065)
Option 4 * Experience	0.444***	0.341**	0.233**
	(0.132)	(0.112)	(0.077)
Option 5 * Experience	0.417*	0.363**	0.190*
	(0.165)	(0.140)	(0.095)
Option 6 * Experience	0.003	0.032	0.036*
	(0.036)	(0.030)	(0.021)
Option 7 * Experience	-	-	-
Option 8 * Experience	0.176	-0.406	-0.021
	(1.375)	(1.168)	(0.797)
Constant	17.966***	29.137***	23.789***
	(0.144)	(1.508)	(1.031)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.029	0.304	0.676

Notes. Includes grade 11 students enrolled in a mathematics course and who took the ACT mathematics test during the state testing window in 2013-2014 (n=4,646). Standard errors are in parentheses. Options 1-8 were separate binary variables indicating whether a student was assigned to an alternative certified teacher who entered the profession through one of the eight alternative pathways, as designated by EPSB. Teacher classroom experience was measured in years. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test. Models were unable to estimate coefficients for the interaction between Option 7 and experience due to lack of variation.

*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Table 26.
Effects of Kentucky Alternative Teacher Certification Pathways and Experience on Reading Achievement, Grade 11

	ACT Reading (scale score)		
Coefficients	(1)	(2)	(3)
Option 1: Exceptional Work Experience	-0.521	-1.154	-0.510
	(1.228)	(1.070)	(0.739)
Option 2: Local District Program	-7.352*	-2.648	1.104
	(3.280)	(2.861)	(1.975)
Option 3: College Faculty	0.468	-1.345	-0.505
	(2.298)	(1.901)	(1.312)
Option 4: Adjunct Instructor	1.924	1.345	-0.505
	(2.184)	(1.901)	(1.312)
Option 5: Armed Forces Veterans	-1.663	-1.710*	-0.124
	(2.524)	(2.198)	(1.516)
Option 6: University-Based Program	0.616*	0.245	0.061
	(0.294)	(0.256)	(0.177)
Option 7: Institute Alternative Route	-3.732	-4.989*	-2.241
	(2.567)	(2.236)	(1.544)
Option 8: Teach For America	-0.077	1.419	1.551
	(3.232)	(2.816)	(1.943)
Experience (years)	0.084***	0.041***	0.005
	(0.014)	(0.012)	(0.008)
Option 1 * Experience	0.031	0.067	0.035
	(0.052)	(0.044)	(0.042)
Option 2 * Experience	2.380**	0.858	-0.129
	(0.743)	(0.648)	(0.447)
Option 3 * Experience	-0.010	0.108	-0.002
	(0.150)	(0.131)	(0.090)
Option 4 * Experience	0.198	0.086	0.106
	(0.177)	(0.154)	(0.106)
Option 5 * Experience	0.348	0.290	0.059
	(0.220)	(0.192)	(0.132)
Option 6 * Experience	0.019	0.050	0.044
	(0.048)	(0.042)	(0.029)
Option 7 * Experience	-	-	-
Option 8 * Experience	-0.749	-1.197	-0.700
	(1.837)	(1.600)	(1.104)
Constant	18.314***	32.356***	24.763***
	(0.192)	(2.066)	(1.429)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.019	0.26	0.648

Notes. Includes grade 11 students enrolled in a reading course and who took the ACT reading test during the state testing window in 2013-2014 (n=5,156). Standard errors are in parentheses. Options 1-8 were separate binary variables indicating whether a student was assigned to an alternative certified teacher who entered the profession through one of the eight alternative pathways, as designated by EPSB. Teacher classroom experience was measured in years. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test. Models were unable to estimate coefficients for the interaction between Option 7 and experience due to lack of variation.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Chapter 5: Discussion and Conclusion

This quantitative research study examined the effects of teacher certification pathway on high school student achievement in the Commonwealth of Kentucky using data obtained from the Kentucky Center for Education and Workforce Statistics (KCEWS). In particular, I investigated how classroom teachers who secured their teacher certification using one of the Commonwealth's eight certification pathways influence high school student achievement in mathematics and reading as measured by the ACT. Prior to the data analysis, I conducted a descriptive analysis of the Kentucky's alternatively certified teacher population to provide information that articulates the policy context within the Commonwealth and thus contextualize my analytic results. I begin my discussion with a summary of my findings from the descriptive analysis.

Kentucky's Alternatively Certified Teacher Population

In my analysis of Kentucky's alternatively certified teacher population, I found the number of alternatively certified teachers employed in the Commonwealth's public schools has increased at a stable rate from 2008-2009 to 2013-2014. This finding is consistent with recent national research documenting trends in teacher preparation and credentialing that was conducted during the same time period (U.S. Department of Education, 2013). Comparatively, Kentucky's alternatively certified teacher population, as a percentage of total teaching workforce, is on par with the alternatively certified teacher population in Indiana, Maine, New Jersey, Ohio, South Carolina, and Vermont (U.S. Department of Education, 2013). Unlike, other states, however, I found that the majority (88.7 percent) of alternatively certified teachers received their certification from a university-based alternative certification program (Option 6). This suggests that most alternatively certified teachers in Kentucky are receiving similar training

and support as Education Professional Standards Board (EPSB) requires all university-based programs to be in accordance with state accreditation standards, as defined by KAR 165.010 (2011). I also found the number of alternative certified teachers in university-based programs increased by 82.9 percent from 1,149 teachers in 2008-2009 to 2,102 in 2013-2014. The increase in number of teachers trained through university-based alternative teacher certification programs explains the overall rising trends in alternatively certified teachers in the Commonwealth and suggests the continuing dominance of Kentucky's university-based teacher preparation institutions. Unlike other alternative teaching certification pathways in Kentucky, university-based alternative teacher certification does not require teaching candidates to possess an official offer of employment from a local school district at the time of application (Education Professional Standards Board, 2018e). This makes it one of the least restrictive alternative teacher certification pathways in the Commonwealth. In addition, classroom teachers who receive certification through a university-based alternative certification program are not required to teach at the same school or within the same district during their program (Education Professional Standards Board, 2018e). While further research is needed, these findings suggest that Kentucky's university-based teacher preparation programs play an important role in the production of alternatively certified teachers. This stands in contrast to other states and thus makes Kentucky a particularly intriguing policy context for further research.

Previous research has suggested that alternatively certified teachers are often older, with fewer years of experience, fewer advanced degrees, and more likely to identify as a member of racial or ethnic minority than traditionally certified teachers (Constantine et al., 2009; Marinell & Johnson, 2014; Sass, 2011). Consistent with patterns in previous research, I found the majority of alternatively certified teachers (70.2 percent) were 39 years old or younger, whereas most

traditionally certified teachers (57.7 percent) were between ages 32 and 49. I noted that vast majority of alternatively certified teachers had 0-9 years of classroom experience (89.1 percent). I also found fewer alternatively certified teachers with a master's degree (16.1 percent) than traditionally certified teachers (43.4 percent). Finally, I noted that a greater percentage of alternative certified teachers in Kentucky identified as being a racial or ethnic minority (14.0 percent) compared with the teacher workforce as a whole. These findings parallel other studies of alternatively certified teachers (Constantine et al., 2009; Marinell & Johnson, 2014; Sass, 2011). Furthermore, advocates for alternative certification policy have long argued that additional pathways to teaching open the profession to a diversity of teacher backgrounds (Feistritzer, 2011). This study adds to the growing literature showing the potential for alternative teacher certification to support diversification of the teaching profession (e.g., Constantine et al., 2009; Marinell & Johnson, 2014). Further, this study elevates questions about the potential impact that the rising number of alternatively certified teachers may have on Kentucky's relatively high rates of teacher retention (Lochmiller et al., 2016). Research has consistently indicated that alternatively certified teachers have higher rates of attrition than traditionally certified teachers (Boyd et al., 2012; Redding & Smith, 2016; Ronfeldt, Loeb, & Wyckoff, 2013). Johnson, Kraft, and Papay (2014) noted that alternatively certified teachers are more likely to work in schools with high proportions of low-income and minority student where unfavorable working condition are likely to be more prevalent. Both hypotheses clearly point to areas of future research, particularly qualitative research examining the work experiences of alternatively certified teachers in Kentucky.

Different Certifications, Different Outcomes

At its core, this study sought to examine the effects that classroom teachers who received their certification using an alternative teacher certification pathway in Kentucky have on high school student achievement in mathematics and readings as measured by the ACT test scores compared to their traditionally certified peers. Overall, I found that alternatively certified teachers positively impact student achievement in ACT mathematics and reading performance. Alternatively certified teachers' effects on student achievement were most consistent across models in mathematics with effect sizes ranging between 0.161 and 0.557 scale scores. I found the effects of alternatively certified teachers on student achievement in reading to be, on average, larger (0.222 to 0.608 scale scores) than mathematics; however, the significance of effect sizes varied as I added different student- and teacher-level covariates to the model. While the difference in effectiveness between alternatively certified teachers and their traditionally certified peers is small, the difference is meaningful. Conservative estimates, as derived from empirical benchmarks from Bloom, Hill, Black, and Lipsey (2008), show that the difference is equivalent to about 2.3 months of mathematics instruction and 1.8 months of reading instruction in grade 11. Together, these findings suggest that alternative teacher certification programs in Kentucky have produced teachers that are as effective, or even more effective, than traditionally certified teachers. From a policy perspective, it may thus behoove the Commonwealth to consider policies that foster learning between traditional and alternative teacher preparation programs as one approach to improving the quality of the education workforce as a whole. The unique fact that Kentucky's universities prepare the largest number of alternatively certified teachers makes such an arrangement appealing.

While alternatively certified teachers contribute to student achievement, it is important to note that teacher certification alone explains a relatively small amount of the variation in student achievement scores. Thus, the reader would be mistaken to think that alternative teacher preparation programs are an effective replacement for traditional teacher preparation programs. Indeed, models that included covariates for student characteristics and prior achievement explained more variation in ACT test scores. These findings are consistent with the literature that suggests that teacher certification is less predictive of students' achievement on standardized tests than other student-level factors (e.g., Boyd et al., 2012; Rockoff et al., 2011). Given this, policymakers and school leaders should look to alternative teacher certification as one of many policies they can leverage to recruit and prepare high-quality teachers to meet demands that are unique to their schools' student populations. Indeed, in specific circumstances, alternative certification might be an important aspect of the Commonwealth's overall human capital management strategy.

What was most striking about my results was the extent to which teaching experience was attributed to positive student achievement outcomes. Within my models, I included a covariate for teacher experience to determine whether experience was related to achievement of students who were taught by alternatively certified teachers. I found teachers' experience to positively affect student achievement in mathematics (0.018 to 0.079 scale scores), whereas results in reading were inconclusive. There is general consensus in the research literature that teachers' experience impact student achievement most during their early years of teaching (e.g., Clotfelter et al., 2006, 2007, 2010; Ladd, 2009; Sass, 2011). Most likely, these positive effects taper slightly as teachers progress through their careers (Winters, 2011); however, further research is needed to test this hypothesis. In addition, I found that adding teacher experience to

the model did not change teacher effect estimates in mathematics, which signifies the robustness of the teacher effects estimates. Moreover, these findings suggest that alternatively certified teachers have greater influence on student mathematics achievement as they gain classroom teaching experience. While the results in reading were inconclusive, these findings again point to the importance of teacher retention as being a significant focus for policy action.

Alternative Certification Pathway Matters

Additionally, I determined that the nature of the certification pathway an alternatively certified teacher completed had, in some cases, a significant effect on the achievement of students. Surprisingly, I found positive and negative effects of classroom teachers on student achievement in mathematics and reading differed by the teachers' alternative certification pathway. Specifically, I found classroom teachers from three alternative certification pathways—the pathway for adjunct instructors (Option 4), the pathway for veterans for the Armed Forces (Option 5), and the pathway designated for university-based alternative certification programs (Option 6)—to positively impact student achievement in mathematics and reading. Of these three pathways, I found alternative teachers from the pathway for adjunct instructors to have the largest effects in mathematics (2.414 to 3.979 scale scores) and reading (2.297 to 4.116 scales scores). While well-beyond the scope of this study, further research in this area is not only intriguing but needed. Indeed, economists and policy scholars have not substantially investigated the relative effectiveness of certification pathways within a state licensure framework. Rather, most studies have treated alternative certification as being a monolithic enterprise.

The absence of research in this area is particularly concerning as I determined that some of the pathways offered in the Commonwealth negatively impacted student achievement. Specifically, I detected negative effects for alternatively certified teachers who received a one-

year provisional teaching certificate (Option 7) and Teach For America teachers (Option 8). My findings for Teacher For America teachers were the most consistent across models with effect sizes ranging from -0.782 to -2.470 scale scores in mathematics and -4.266 to -5.256 scale scores in reading. While these findings contradict some studies examining the effects of Teacher For America teacher on student achievement (e.g., Clark et al., 2013; Decker et al., 2004; Glazerman, et al., 2006; Xu et al., 2011), it is important to note that Teach For America was in its third year of operation in 2013-14. The relatively inexperienced cohort of Teacher For America teachers may have contributed to these results.

In general, my findings show that classroom teachers from different alternative certification pathways are not the same with respect to their influence in students' mathematics and reading achievement. This suggests that a teacher's alternative certification pathway matters in determining teacher effectiveness in the classroom. Moreover, my findings showing a positive impact of teachers from university-based alternative teacher certification programs points to the importance of an accredited college or university program in preparing and training classroom teachers. These findings provide evidence that contradicts claims that university-based alternative certification programs are inadequate in their preparation of teaching candidates (Darling-Hammond et al., 2005; Humphrey & Wechsler, 2007; Ravich, 2013; Suell & Piotrowski, 2006). There is a compelling need for future research that explores program offerings in university-based alternative teacher certification programs in Kentucky. At present, these findings have the potential to inform policymaker's thinking about the efficacy of various certification pathways, their potential to contribute to the Commonwealth's overall goal of improved student achievement, and the guidance provided at an institutional level to help candidates select the most beneficial pathway. Such thinking demonstrates a shift towards a

human capital management perspective (Odde, 2011) for hiring, placing, developing, and retaining highly qualified teachers in school districts.

I also included teaching experience in the models estimating teacher effects for each of eight alternative teacher certification pathways in Kentucky on mathematics and reading achievement. My results showed positive effects of teachers who received certification through two alternative certification pathways—the pathways for adjunct instructors (Option 4) and Armed Service veterans (Option 5)—and their respective interaction with years of classroom experience. These findings suggest a dependent relationship between these alternative certification pathways and experience for teachers receiving certification from these pathways. Moreover, they imply that retention is an important factor for alternatively certified teachers who were previously either an adjunct instructor in higher education or a member of the Armed Services. Redding and Smith (2016) posited that alternative teacher certification programs with higher admission standards, increased content proficiency, and more classroom supervision may lead to less turnover for alternatively certified teachers. Other scholars have recommended improving working conditions and administrative support for schools in which alternatively certified teachers are employed (Grissom, 2011; Johnson, Kraft, & Papay, 2012; Kraft & Papay, 2014; Ladd, 2011; Ronfeldt et al., 2013). Nonetheless, policymakers and education leaders in Kentucky should consider these recommendations as a means to retain alternatively certified teachers in the Commonwealth that have been shown to increase their impact on student achievement gains as they gain more experience in the classroom.

Implications for Policy

The findings have important implications for policies related to teacher preparation and the practice of school leaders. Notably, findings from my study revealed alternatively certified

teachers who received their certification from an accredited university-based alternative teacher certification program tend to outperform other alternatively certified teachers in the Commonwealth. In fact, alternatively certified teachers trained through a university-based program were the only alternatively certified teachers to show a positive impact in both mathematics and reading when controlling for teacher experience. While there is a great deal of variation in program offerings between Kentucky's eight alternative teacher certification pathways, the teacher preparation coursework provided by university-based programs is one feature that clearly differentiates it from the other alternative certification pathways in the Commonwealth. This distinction lies in the fact that university-based teacher preparation coursework is continually assessed for quality during the school's accreditation process. Coursework for other alternative teacher certification programs do not have the same requirements (Education Professional Standards Board, 2018d). In their study of alternative teacher certification programs across the county, Humphrey, Wechsler, and Hough (2008) found teacher preparation coursework to be a key contributor to alternatively certified teachers' sense of efficacy and professional growth. Specifically, the authors found effective alternative teacher certification programs provided carefully constructed coursework that was tailored to teaching candidates' backgrounds and the challenges they faced in their schools. While findings from this study do not offer insight into what university-based alternative teacher certification programs in Kentucky offered, they do have clear implications for the ways in which the Commonwealth certifies alternative certification program providers, establishes expectations for program delivery, and evaluates programs during regular program accreditation cycles. Indeed, one of the primary policy considerations that this study raises is how policymakers and education leaders

evaluate the relative quality of alternative certification programs in the Commonwealth and use this information to develop more uniformly effective approaches to alternative certification.

Somewhat relatedly, the findings also call upon policymakers to consider how state resource streams allow Kentucky's alternative teacher certification programs to adapt their training and support to the individual needs of teachers. Findings from my study showed alternatively certified teachers in Kentucky to be a highly diverse group, particularly in age and race/ethnicity. Moreover, I found alternatively certified teachers in the Commonwealth were likely to teach in schools with large populations of low-income and minority students. Alternative teacher certification programs could increase their capacity to draw upon the backgrounds and experiences of teacher candidates in the development of teacher preparation programs. Research has demonstrated the value of leveraging teaching candidates' backgrounds and experiences to engage with students and interact with parents in urban schools (L. Anderson & Stillman, 2013). Supporting the individual needs of teaching candidates is particularly import during their first years of teaching as they struggle with feelings of incompetence and struggle to meet the demands of classroom teaching (Darling-Hammond, 2005). This study is thus particularly important regarding ways in which the Commonwealth allocates resources to support novice teachers who complete alternative certification programs. The research raises important questions about the degree to which the Commonwealth's current investment level is supporting these needs adequately given the differences I observed in outcomes.

Implications for School Leaders

Beyond policy considerations, this study also has implications for leadership practice, particularly at the district level where most strategic human capital decisions are made. There has been growing interest in the extent to which leaders make effective human capital decisions in

their schools and districts (Milanowski et al., 2011; Odden, 2011). Hiring effective teachers is arguably the most important task of school leaders (e.g., DeArmond & Goldberg, 2005; Harris et al., 2010), and school principals are often tasked with this responsibility. Research suggests that principals rely on interviews, experience, credentials, recommendations, and teacher screening tools to make human capital decisions (Engel & Finch, 2015; Harris et al., 2010; Liu & Johnson, 2006). Whether a teacher's certification was obtained traditionally or by means of an alternative certification pathway was found to be less important in the hiring process (Bourke, 2012). The mixed findings in the alternative teacher certification literature may be explaining the hesitation of principals to leverage information relating to a teachers' certification pathway.

Findings from my study clearly indicate that alternatively certified teachers in Kentucky differ in their impact on student achievement by the alternative certification pathway in which they were trained. Moreover, the fact that alternatively certified teachers from university-based alternative certification programs outperformed their peers from other pathways emphasizes the importance of the coursework and training alternatively certified teachers received. Alternatively certified teachers from programs with rigorous coursework, comprehensive support before and during teaching, mentorship opportunities, and high performance standards should be given preference during the hiring process, all things being equal. A central concern for educational leaders is thus how they become more discerning consumers within an increasingly diverse teacher labor market.

Limitations

The limitations of this study stemmed from decisions relating to the study's research design, sample, and data used in the analysis. First, and foremost, this study was not an experimental research study with students assigned randomly to their teachers' classrooms and

thus causality cannot be fully inferred from the study's results. The ideal experiment for measuring alternatively certified teachers' effects on student achievement would be to recruit a sizable number of schools with alternatively and traditionally certified teachers and randomly assign some students to teachers from alternative pathways. The remaining students would be assigned to teachers from traditional preparation programs. The experiment would compare achievement across classrooms and schools over time and would mitigate the unbiased effects of alternatively certified teachers on student achievement. Given the absence of this ideal experiment, I chose to examine the study's research questions using the quasi-experimental technique of propensity score matching.

A key limitation to propensity score matching is its inability to account for potential bias stemming from unobservable covariates (Guo & Fraser, 2015; Rosenbaum & Rubin, 1983). Therefore, it was impossible to know whether the assumption of ignorable treatment assignment has been met (Rosenbaum & Rubin, 1983). Guo and Fraser (2015) recommended that studies employing propensity score matching methods include all available (observable) covariates in the model used to estimate the propensity scores. Another limitation unique to propensity score matching is its inability to handle missing data (Guo & Fraser, 2015). Since I elected to delete observations with missing values in this study, an additional limitation was introduced—specifically, potential bias that may be introduced to the study if the observations with missing values differ in some way from those with no missing values (i.e., they were not missing completely at random) (Schlomer, Bauman, & Card, 2010).

Another important limitation to this study related to the decision to examine the effects of teachers on student achievement at the high school level. High school teachers tend to have comparatively larger classroom sizes and less instructional time than elementary and middle

school teachers (Hanushek, 1999; Rice, 1999). This limits the amount of interaction teachers have with their students. Moreover, high school courses often differ in number of credit hours assigned to the courses (Emerson & English, 2016). Variation in credit hours make it difficult to make comparisons across schools (Emerson & English, 2016). Further, Bloom, Hill, Black, and Lipsey (2008) found in their analysis of achievement effect sizes across seven nationally-normed achievement tests that students show the largest annual gains in the early elementary grades, followed by gradually declining gains in later grades. For students in grades 10-11, the mean effect size gains were 0.14 in mathematics and 0.19 in reading (Bloom et al., 2008). While I conducted a power analysis as a way to confirm an appropriate amount of power given the sample size constraints, there remained some concern that the study was underpowered given the size of the study's sample.

The use of school performance measures to assess student learning was another limitation of the study. Standardized assessments are often critiqued over concerns of measurement error and whether their use captures students' true achievement in the classroom (Lockwood & McCaffrey, 2014). For example, measurement error in test questions, random events or influences on students in testing situations, students' familiarity with the test, and subjectivity in grading open-ended questions, are some of the factors that can cause measured achievement scores to differ from students' true knowledge. It was impossible to know which, if any, factor influenced student achievement scores in the study. Moreover, this study relied solely on student scores from standardized assessments to measure teachers' effectiveness in the classroom. Together these issues have the potential to limit the validity of findings in the study (Lockwood & McCaffrey, 2014).

Further, this study was limited by the quality of the data collected and made available by KCEWS. Studies using secondary data are limited by the variables present in the dataset and assume they are constructed with accuracy and without bias (Chetty et al., 2014). There also exists the potential for bias to be introduced to studies examining secondary data through data processing (Chetty et al., 2014). For example, my decision to retain teacher records associated with the greatest number of full-time equivalent (FTE) hours as a means to identify teachers' primary teaching role may have misclassified some teachers. Additionally, administrative datasets—like those analyzed in my study—often lack important information on the school and classroom environments (Figlio, Karbownik, & Salvanes, 2015). Therefore, this study was limited in the information on the conditions in which teachers interact with their students.

Lastly, this study focused on teacher certification policies in Kentucky. A considerable amount of variation exists in state laws defining traditional and alternative teacher pathways (Feistritzer, 2011; Preston, 2017). This study focused on the policies that are unique to the Commonwealth of Kentucky. Interpretations of findings from this study are limited to teachers entering the profession through Kentucky's traditional and alternative certification policies, as defined by Kentucky Revised Statute (KRS) 161.028 (2004) and KRS 161.048 (2010), respectively.

In closing, while these limitations each bear noting and should be addressed through future research, they do not take away from or mitigate the value of the findings I derived. In fact, even with these limitations noted, the findings of the study are compelling and offer policymakers and educational leaders important insights about the relative effectiveness of alternative certification pathways.

Directions for Future Research

My study points to several directions for future research that would help to further deepen our understanding of alternative teacher certification. First, it would be useful to expand the study to include alternatively certified teachers working in elementary and middle schools. Policymakers and education leaders within Kentucky would benefit greatly with a more comprehensive understanding of alternative teacher certification policy within the Commonwealth. A reexamination of the impact of alternatively certified teachers on student achievement in earlier grades would also be particularly interesting considering that average yearly gains in mathematics and reading tend to be larger during students' elementary and middle school years (Bloom et al., 2008).

This study also raises questions about attrition rates for alternatively certified teachers in Kentucky. Research studies have generally found alternatively certified teachers to have higher attrition rates than traditionally certified teachers (Boyd et al., 2012; Glazerman et al., 2006; Kane et al., 2008; Redding & Smith, 2016; Xu et al., 2011), however, they are typically limited to a particular city, state, or certification program. Given that policymakers and education leaders throughout Kentucky have identified teacher shortages as an area of concern for the Commonwealth (Kentucky Department of Education, 2018a), and the extent to which schools and districts are leveraging alternatively certified teachers to fill teaching vacancies (Seiler et al., 2012), it would be of interest to the Commonwealth to learn about attrition rates for alternatively certified teachers. Future research might investigate whether attrition rates for alternatively certified teachers vary based on personal and professional characteristics as well as their alternative certification pathway.

In addition, findings from my study raise additional questions about the backgrounds of alternatively certified teachers. Research evidence suggests that alternatively certified teachers are a diverse group that come with a wide range of prior work experience and skills (Hart, 2010; Johnson, 2004; Morton et al., 2006; Tigchelaar et al., 2008; Wilkins & Comber, 2015). In particular, Marinell (2011) found alternatively certified teachers in Boston to possess a range of practical skills that teachers were able to successfully transfer to a classroom setting. For my study, data limitations prohibited opportunities to analyze the backgrounds of alternatively certified teachers in Kentucky and identify skills that may, potentially, be associated with student achievement gains. Future research might want to examine employment histories or conduct interviews of alternatively certified teachers as a way to gain greater insight into the skills they bring to the classroom.

Lastly, future research may want to explore the curriculum content and structural components of alternative teacher certification programs in Kentucky. This area of research is particularly important given findings from this study that showed alternatively certified teachers to vary in their impact on student achievement by the alternative certification pathway in which they were trained. Harrison and Sass (2011) leveraged transcript data to investigate different forms of teacher preparation programs in Florida. Transcript data provide information on the specific coursework teacher candidates take as part of an alternative teacher certification program and can provide greater insight into the curriculum of their program. These data could also be linked to student achievement data to see if any associations exist between features of alternative teacher certification program coursework and achievement in the classroom. Additionally, other data sources such as course syllabus review, university classroom

observations, and interviews with both faculty and teacher candidates can be investigates with the goal of program improvement to better foster effective teachers.

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Appendix A: Data Use Memorandum of Understanding

MEMORANDUM OF UNDERSTANDING BETWEEN
Indian University **and**
THE KENTUCKY CENTER FOR EDUCATION AND WORKFORCE STATISTICS
ON BEHALF OF

THE KENTUCKY DEPARTMENT OF EDUCATION
AND THE EDUCATION PROFESSIONAL STANDARDS BOARD
TO AUTHORIZE THE RELEASE AND USE OF CONFIDENTIAL DATA
FOR STUDIES

*** *** *** *** *** *** *** *** *** *** *** *** ***

THIS AGREEMENT is made and entered into by and between the Kentucky Center for Education and Workforce Statistics ("KCEWS") on behalf of the Commonwealth of Kentucky's Department of Education ("KDE"), and The Education Professional Standards Board ("EPSB"), and Indiana University collectively the "parties" and establishes the procedures relating to an exchange of information between the parties.

WHEREAS, KCEWS, KDE , and EPSB, are public agencies organized under KRS 151B.131, KRS 156.010, KRS 164.011, KRS 161.028 respectively and their duties include conducting research to identify or develop the best education practices to be used in public schools, postsecondary institutions, training providers and other education and training providers of the Commonwealth of Kentucky;

WHEREAS, Indiana University ("Researcher" or "Contractor") is an entity performing data analysis, or conducting studies, is an eligible entity with a "need to know" the free and reduced price lunch eligibility data of students under a state-level education program;

WHEREAS, various elements of the data maintained by KCEWS on behalf of the agencies are protected by the Privacy Act of 1974, 5 U.S.C. 552a; the Kentucky Family Education Rights and Privacy Act, KRS 160.700 et seq.; the Family Education Rights Privacy Act, 20 U.S.C. 1232(g); the Richard B. Russell National School Lunch Act, 42 U.S.C. 1751 et seq.; the Child Nutrition Act of 1966, 42 U.S.C. 1771 et seq.; the Personal Information Security and Breach Investigation Procedures and Practices Act, KRS 61.931 et seq.; and the Kentucky Open Records Act, KRS 61.820 et seq.;

NOW THEREFORE, KCEWS and the Researcher hereby mutually agree as follows:

Section 1. Identification of the Researcher as an Organization to which KCEWS can Disclose Confidential Data under the FERPA Studies Exception and under 7 C.F.R. 245.6 (f).

A. KCEWS and the Researcher hereby agree that the Researcher is an organization to whom KCEWS can disclose, upon written request, personally identifiable information from an education record of a student, as defined in 34 CFR 99.3, under the "studies exception" of FERPA, 34 C.F.R. 99.31 (a)(6), because the disclosure is to conduct studies for, or on behalf of,

KCEWS to: develop, validate, or administer predictive tests; administer student aid programs; or improve instruction.

B. KCEWS, on behalf of KDE, and the Researcher hereby agree that, if free or reduced price lunch eligibility data (i.e., free or reduced price lunch eligibility data which is the student poverty indicator for most education programs) is to be released to the Researcher, then shall identify the Researcher as a contractor acting in the place of KCEWS; shall ensure that the Researcher has demonstrated that the research is on behalf of KCEWS, under a federal or state-level education program or a state health program; shall ensure that the research includes a "need to know" this data as required by 7 C.F.R. 245.6 (f); and shall ensure that the data will only be disclosed to the Researcher upon written request utilizing the U.S. Department of Agriculture prototype request and confidentiality agreement. The completed USDA Prototype Agreement shall be attached in Exhibit A and incorporated into this agreement as if set forth fully herein and Center's agreement that the Researcher meets the requirements for disclosure set forth in 7 C.F.R. 245.6 (f) and that the Researcher has demonstrated a "need to know" shall be evidenced by KCEWS's agreement to enter the USDA Prototype Agreement.

Section 2. Acknowledgment of Release of Confidential Data under the FERPA Studies Exception and under 7 C.F.R. 245.6 (f), Requirements for Release of Confidential Data to the Researcher, Identification of Confidential Data to be Released to the Researcher and Description of Use of Data by the Researcher.

A. KCEWS shall disclose to the Researcher, upon written request, confidential, personally identifiable information from an education record of a student, as defined in 34 C.F.R. 99.3, under the "studies exception" of FERPA, 34 C.F.R. 99.31 (a)(6), when the disclosure is to conduct studies for, or on behalf of, KCEWS to: develop, validate, or administer predictive tests; administer student aid programs; or improve instruction. The confidential data including student and non-student information to be disclosed is described in a document attached to this agreement as Exhibit A. The Researcher shall use personally identifiable information from education records and other records in order to perform the studies described in Exhibit A. The description of the studies, as included in Exhibit A, shall include purpose and scope of the studies, the duration of the studies, specific description of the methodology of disclosure and an explanation as to the need for confidential data to perform these studies. The Researcher shall notify KCEWS and KCEWS shall provide written consent, if approved, of any changes to the list of disclosed data necessary for the studies or any changes to the scope, purpose or duration of the studies themselves. Any agreed upon changes to the data disclosed or to the studies shall be reduced to writing and included in Exhibit A to this agreement.

B. If free or reduced price lunch eligibility data (i.e., free or reduced price lunch eligibility data which is the student poverty indicator for most education programs) is to be released to the Researcher, then KCEWS shall disclose this data to the Researcher, upon written request utilizing the U.S. Department of Agriculture prototype request and confidentiality agreement, and upon KCEWS agreeing that the Researcher has demonstrated that disclosure is allowed by 7 C.F.R. 245.6. A description of any data protected by 7 C.F.R 245.6 which is to be disclosed under this agreement shall be included in Exhibit A. Any agreed upon changes to the data disclosed or to the studies shall be reduced to writing and included in Exhibit A to this agreement.

Section 3. The Researcher and the Authorized Users' Obligations.

A. The Researcher shall not share these confidential data with anyone, except those employees of the Researcher and the Researcher's subcontractors, ("Authorized Users") that are directly involved and have a legitimate interest under FERPA or a "need to know" (as defined in 7 C.F.R. 245.6 in the case of disclosure of free or reduced price lunch eligibility data which is the student poverty indicator for education programs), in the performance of the studies according to the terms of this agreement or any overarching agreement between KCEWS and the Researcher in which the Researcher agrees to perform these studies on KCEWS's behalf ("Master Agreement").

B. The Researcher shall require all Authorized Users to comply with FERPA and other applicable state and federal student and non-student privacy laws. The Researcher shall require and maintain confidentiality agreements or KCEWS's Nondisclosure Statement(s) with each Authorized User of confidential data. If a confidentiality agreement with each Authorized User is used, which is different from KCEWS's Nondisclosure Statement(s), then the terms of the Researcher's confidentiality agreements shall contain, at a minimum, the terms and conditions of this agreement and a copy of the current Researcher's confidentiality agreement or KCEWS's Nondisclosure Statement(s), as appropriate, shall be attached to this agreement as Exhibit B.

C. The Researcher shall protect confidential data in a manner that does not permit personal identification of students and their parents, and non-students by anyone except those bound by this agreement and KCEWS. The Researcher shall store all confidential data on secure data servers using current industry best practices. The Researcher shall notify KCEWS as soon as practicable if the Researcher learns of any security breach to the server containing the confidential data or of any disclosure of confidential data to anyone other than the Researcher's Authorized Users or KCEWS officials authorized to receive confidential data. The Researcher shall cooperate and take all reasonable means prescribed by KCEWS to secure any breaches as soon as practicable.

D. The Researcher shall not redisclose KCEWS's confidential data to any other party without the prior consent of the parent or eligible student, or non-student except as allowed by applicable federal and state law.

E. The Researcher certifies that it has the capacity to restrict access to confidential data solely to Authorized Users and to ensure that the confidential data is accessed only for the purposes described in this agreement. A copy of the Researcher's data security policies and procedures is attached to this agreement as Exhibit C.

F. The Researcher shall destroy all confidential data within forty-five (45) days after it is no longer needed to perform the studies described in this agreement, upon KCEWS's request or upon termination of this agreement, whichever occurs first unless agreed otherwise in writing. The Researcher's description of the method(s) which will be used to destroy all confidential data shall be attached to this agreement as Exhibit D. The Researcher shall provide written verification of the data destruction to KCEWS within forty-five (45) days after the data is destroyed by completing Exhibit F.

G. The Researcher shall permit KCEWS, at KCEWS's cost and upon written reasonable request, to audit the Researcher to confirm that the Researcher is complying with the data security policies and procedures in Exhibit C and/or that the Researcher has destroyed the data as verified.

H. The Researcher shall collect and use these confidential data only for the purposes and related to the activities outlined in this agreement or in any Master Agreement.

I. The Researcher shall obtain prior written approval from KCEWS before accessing confidential data for activities beyond the scope specified in this agreement or in a Master Agreement; and, any access beyond the scope of this agreement or a Master Agreement shall be consistent with federal and state law requirements. Any confidential data collected by the Researcher under activities approved by KCEWS under this section, which are not regularly collected within the scope of this agreement but are consistent with the activities described in this agreement, shall be subject to the terms and conditions of this agreement.

J. If the Researcher becomes legally compelled to disclose any confidential data (whether by judicial or administrative order, applicable law, rule or regulation, or otherwise), then the Researcher shall use all reasonable efforts to provide KCEWS with prior notice before disclosure so that KCEWS may seek a protective order or other appropriate remedy to prevent the disclosure or to ensure KCEWS's compliance with the confidentiality requirements of federal or state law; provided, however, that the Researcher will use all reasonable efforts to maintain the confidentiality of confidential data. If a protective order or other remedy is not obtained prior to the deadline by which any legally compelled disclosure is required, the Researcher will only disclose that portion of confidential data that the Researcher is legally required to disclose.

K. The Researcher shall abide by and be bound by the requirements of the U.S. Department of Education, Family Policy Compliance Office's Guidance for Reasonable Methods and WrittenAgreements issued pursuant to the requirements of the Family Educational Rights and PrivacyAct ("Guidance"). The Guidance is available by clicking the following hyperlink, http://www2.ed.gov/policy/gen/guid/fpco/pdf/reasonablemtd_agreement.pdf and made a part of this agreement as if stated fully herein.

L. The Researcher shall also, if the data shared by KCEWS includes data protected by 7 C.F.R. 245.6 (i.e., free or reduced price lunch eligibility data which is the student poverty indicator for most education programs), abide by the restrictions of disclosure and confidentiality requirements contained in 7 C.F.R. 245.6 (f) applicable to KCEWS on behalf of KDE.

Section 4. Disclosure of Data not an Endorsement of the Studies.

KCEWS is not required to agree with or endorse the conclusions or results of the studies. At least five days prior to Researcher's public disclosure of conclusions or results of the studies, the Researcher shall proide a copy of conclusions, results or product(s) resulting from the study (e.g., article, report, book, etc.) to the KCEWS Executive Director. No later than 45 days following the end date of the studies, the Researcher shall provide their conclusions, results or product(s) of the studies.

Section 5. Transfer Protocol.

KCEWS and the Researcher shall work cooperatively to determine the proper medium and method for the transfer of confidential data between each other. The Researcher shall confirm the transfer of confidential data and notify KCEWS as soon as practicable of any discrepancies between the actual data transferred and the data described in this agreement. The same protocol shall apply to any transfer of confidential data from the Researcher to KCEWS.

Section 6. Breach of Data Confidentiality.

The Researcher acknowledges that the breach of this agreement or its part may result in irreparable and continuing damage to KCEWS for which money damages may not provide adequate relief. In the event of a breach or threatened breach of this agreement by the Researcher, KCEWS, in addition to any other rights and remedies available to KCEWS at law or in equity, may be entitled to preliminary and permanent injunctions to enjoin and restrain the breach or threatened breach. If the United States Department of Education's Family Policy Compliance Office determines that the Researcher has violated paragraph 34 C.F.R. 99.31(a)(6)(iii)(B), KCEWS may not allow the Researcher access to personally identifiable information from education records for at least five (5) years. If the Researcher breaches the confidentiality requirements of 7 C.F.R. 245.6 relative to any confidential free or reduced price lunch eligibility data, then the Researcher shall be responsible for any consequences or penalties which result from such breach.

Section 7. Amendment and Assignability.

The terms and conditions of this agreement may only be amended by mutual written consent of both KCEWS, on the behalf of the KDE, and the Researcher and the Researcher shall not assign its respective rights or obligations under this agreement without the prior written consent of KCEWS. The rights and obligations of each party under this agreement shall inure to the benefit of and shall be binding upon that party and its respective successors and assigns.

Section 8. Choice of Law and Forum.

All questions as to the execution, validity, interpretation, and performance of this agreement shall be governed by the laws of the Commonwealth of Kentucky. The selected forum to hear any causes of action arising from this agreement, or any actions thereunder, is the Franklin Circuit Court, Frankfort, Kentucky.

Section *9. Waiver.*

The failure by one party to require performance of any provision shall not affect that party's right to require performance at any time thereafter, nor shall a waiver of any breach or default of this agreement *constitute a waiver of any subsequent breach or default or a waiver of the provision itself. No modification, amendment, waiver or release of any provision of this agreement or of any right, obligation, claim or cause of action arising from this agreement shall be valid or binding for any purpose unless in writing and duly executed by the party against whom they are asserted.*

Section 10. *Severability.*

Any provision of this agreement that is declared invalid by a court of competent jurisdiction or by operation of law, shall not affect the validity or enforceability of any other provision of this agreement.

Section 11. Authority to Enter the Agreement.

KCEWS and the Researcher represent and warrant, by the signatures of their duly appointed representatives, that they are legally entitled to enter into this agreement.

Section 12. Data Custodians.

The individuals who are the designated data custodians for the Researcher with respect to this agreement are listed with their contact information in Exhibit E.

Section 13. Termination.

Either party may cancel this agreement at any time for cause or may cancel without cause on thirty (30) days written notice.

Section 14. Cost of Services.

KCEWS may charge a fee for the assembly and delivery of the data or analyses being requested.

Section 15. Effective Date and Term of the Agreement.

This confidential data release and use agreement will become effective once the KDE, the EPSB, KCEWS, and the Researcher have each signed it and it shall remain in effect until terminated or cancelled by one of the parties pursuant to the terms herein.

APPROVED:

Kate Shirley Akers Date
Executive Director
Kentucky Center for Education and Workforce Statistics

Bethany Allen 4/20/16
Research Entity's Authorized Agent Date
Agent's Title Director, Grant Services
Agent's Name (Typed) Bethany N Wilcox
Research Entity's Name Indiana University

Stephen Pruitt Date
Commissioner
Kentucky Department of Education

James Adams Date
Executive Director
Kentucky Education Professional Standards Board

Memorandum of Understanding (MOU)

Description of Exhibits

To authorize the release and use of confidential data under the FERPA Studies Exception

Exhibits referenced in the Memorandum of Understanding must be completed and incorporated into the final MOU. Exhibits include:

- Exhibit A: Specifics of data being requested.
  - Section I - the initial data request that describes the study and data being requested.
  - Section II - required if requesting Free and Reduced Lunch information.
- Exhibit B: Researcher Confidentiality Agreements (one for each data custodian)
- Exhibit C: Researcher data security policy.
- Exhibit D: Data destruction plan at completion of study.
- Exhibit E: Identification of data custodians.
- Exhibit F: Researcher's Certificate of Data Destruction

Please refer to The U.S. Department of Education, Family Policy Compliance Office's Guidance for Reasonable Methods and Written Agreements for additional information on requirements for data sharing under the Family Educational Rights and Privacy Act (FERPA). Linked here.

Exhibit A:

Contact Information

Research Entity Legal Name Indiana University—Bloomington

Primary Data Custodian Name Chad R. Lochmiller, Ph.D. Phone [redacted]

Email [redacted]

Secondary Data Custodian Name Aaron J. Butler, MBA Phone [redacted]

Email [redacted]

Section I- to be completed by all requestors:

Purpose, Scope and Duration *Use of data received under this MOU is limited to purpose and scope defined.*

Completely describe the purpose and scope of the study.	Indiana University School of Education (IUSoE) is requesting student- and teacher-level data from the Kentucky Center for Education and Workforce Statistics (KCEWS) for a study that will examine the effectiveness of second-career teachers in the Kentucky public education system. The study explores the relationships between teacher characteristics, prior work experiences, and classroom effectiveness as measured by an increase in student achievement on state mandated achievement measures using a random-effects approach. Research questions: 1. What are the characteristic differences between second-career teachers and first-career teachers in Kentucky? 2. Do second-career teachers and first-career teachers generate the same increases in student achievement, as measured by state mandated achievement tests? 3. How are second-careeer teachers' prior work experiences (i.e., years of experience, type of experience, and postsecondary degree and relevance to instructional area) associated with student achievement? IUSoE requests data for ***all Kentucky students enrolled in a public school*** in the 2008/09, 2009/10, 2010/11, 2011/12, 2012/13, 2013/14, and 2014/15 academic year in 3rd through 12th grade. This information includes institutional-, student-, and course-level data as well as all available assessment data. IUSoE requests data for ***every public school teacher and administrator (e.g., principal, assistant principal, superintendent, etc.) employed in the Kentucky public education system*** in the 2008/09, 2009/10, 2010/11, 2011/12, 2012/13, and 2014/15 academic year. This information includes teacher- and administration-level demographic information, licensure and certification information, and information pertaining to their teaching and administration assignment.

	In addition, IUSoE requests that KCEWS provide a unique identifier for each student and teacher that allows IUSoE to (1) link student and teacher records across years of data; and (2) link students to their teachers.
Please describe how the results will be used.	The results will be used as part of a doctoral dissertation in Education Policy Studies at Indiana University and in research that will contribute to generalized knowledge by furthering the state's understanding of teacher labor markets. The results may be useful in informing state and district policymakers decisions about current state policies and programs designed to attract and retain teachers with prior work experience.

Duration of Study: **Start Date:** April 1, 2016 **End Date:** March 31, 2018

Data Being Requested

*A detailed list of elements is included below

P-12 Data		Postsecondary and Adult Ed Data		Teacher Data	
X	Demographics		Demographics	X	Demographics
X	Enrollments		Financial Aid	X	Credential Permissins
X	Assessments		Enrollments	X	Assessments
X	Courses		Readiness	X	Degrees/Majors
X	Free & Reduced		Degree	X	Educator Credentials
X	Transcript		Course Enrollment	X	Credentials
X	Behavior		Readiness Follow-Up	X	Credential Category
X	Gifted		Cohort	X	National Board
	Preschool		Institution		Internship Committee
X	Special Education		Aerin Data	X	Internship
X	Limited English Proficiency			X	Student Teaching
X	Title 1			X	Educator
	Health			X	Educator College Program
X	School Info	KHEAA			
X	District Info		Demographics		
	KEDS		Disbursements		
			KEES Earned		

Years included in Study: ☐ 2015-16 ☒ 2014-15 ☒ 2013-14 ☒ 2012-13

☒ 2011-12 ☒ 2010-11 ☒ 2009-10 ☒ 2008-09 ☐ Other_____

Specific Data Elements Requested:

Section II- Complete if free or reduced -price lunch eligibility data is required for confidential records.

Prototype Agreement:
Disclosure of Free and Reduced Price Information

A. Purpose and Scope

The Kentucky Center for Education and Workforce Statistics (KCEWS) on behalf of the Kentucky Department of Education (KDE), and Indiana University acknowledge and agree that children's free and reduced price meal and free milk eligibility information obtained under provisions of Richard B. Russell National School Lunch Act (42 USC 1751 et. seq.) (NSLA) or Child Nutrition Act of 1966 (42 USC 1771 et. seq.) (CNA) and the regulations implementing these Acts is confidential information. This Agreement is intended to ensure that any information disclosed by KCEWS to the Indiana University about children eligible for free and reduced price meals or free milk will be used only for purposes specified in this Agreement and that KCEWS and Indiana University recognize that there are penalties for unauthorized disclosures of this eligibility information.

B. **Authority**

Section 9(b)(6)(A) of the NSLA (42 USC 1758(b)(6)(A)) authorizes the limited disclosure of children's free and reduced price meal or free milk eligibility information to specific programs or individuals, without prior parent/guardian consent. Except that, the parent/guardian must be provided the opportunity to decline to share eligibility information prior to the disclosure for identifying children eligible for benefits under or enrolling children in the State Medicaid Program and the State children's health insurance program. Additionally, the statute specifies that for any disclosures not authorized by the statute, the consent of children's parents/guardians must be obtained prior to the disclosure.

The requesting agency certifies that it is currently authorized to administer the following program(s) and that information requested will only be used by the program(s) indicated.

Check all that Apply	Program	Information Authorized
☐	*Medicaid* or the *State children's health insurance program (SCHIP),* administered by a State or local agency authorized under titles XIX or XXI of the Social Security Act. Specify Program:_____	All eligibility information unless parents elect not to have information disclosed.
☐	*State health program* other than Medicaid/SCHIP, administered by a State agency or local education agency. Specify Program: _____	Eligibility status only; consent not required
☐	*Federal health program* other than Medicaid/SCHIP Specify Program: _____	No eligibility information unless parental consent is obtained.
☐	*Local health program* Specify Program: _____	No eligibility information unless parental consent is obtained.
☐	*Child Nutrition Program* under the National School Lunch Act or Child Nutrition Act Specify Program: _____	All eligibility information; consent not required.
☐	*Federal education program* Specify Program: _____	Eligibility status only; consent not required.

☒	*State education program* administered by a State agency or local education agency Specify Program: Indiana University School of Education	Eligibility status only; consent not required.

Note: Section 9(b(6)(A) specifies that certain programs may receive children's eligibility status only, without parental consent. Parental consent must be obtained to disclose any additional eligibility information. Section 9(b)(6)(D)(ii) specifies that for State Medicaid or SCHIP, parents must be notified and given opportunity to elect not to have information disclosed. Social security numbers may only be disclosed if households are given notice of the disclosure and the uses to be made of their social security numbers as required by Sec. 7 of the Privacy Act.

C. Responsibilities

Kentucky Center for Education and Workforce Statistics, on behalf of the Kentucky Department of Education will:
When required, secure parents/guardians consent prior to any disclosure not authorized by the National School Lunch Act or any regulations under that Act, unless prior consent is secured by the receiving agency and made available to the determining agency;

For State Medicaid and SCHIP notify parents/guardians of potential disclosures and provide opportunity for parents/guardians to elect not to have information disclosed;

Disclose eligibility information only to persons directly connected to the administration or enforcement of programs authorized access under the National School Lunch Act or regulations under the Act or to programs or services for which parents/guardians gave consent.

Indiana University will:

Ensure that only persons designated as data custodians and listed on Exhibit E who are directly connected with the administration or enforcement of the Indiana University and whose job responsibilities require use of the eligibility information will have access to children's eligibility information.

Use children's free and reduced price eligibility information for the following specific purpose(s):

Describe:

The information will be used to disaggregate results by eligibility status. For example, this data will be used ot make research statements, such as: "31 percent of free or reduced price eligible students were taught by teachers with prior work experience in the 2010-11 academic year." References to individual students or their free/reduced price lunch eligibility will not by made.

Inform all persons that have access to children's free and reduced price meal eligibility information that the information is confidential, that children's eligibility information must only be used for purposes specified above, and the penalties for unauthorized disclosures.

Protect the confidentiality of children's free and reduced price meal or free milk eligibility information as follows:

The data received from KCEWS will contain no identifying information. All results will be presented in aggregate form. Individual students and their eligibility state will not by disclosed.

Specifically describe how the information will be protected from unauthorized uses and further disclosures.

The data received from KCEWS will contain no identifying information. Information obtained from KCEWS will be stored on a secure, internal server. Only research team members will have direct access to the data provided by KCEWS. Information reported from the study will be reported in aggregate form so that individual students are not identifiable.

D. Effective Date

This agreement shall be effective during the dates of duration for the study.

E. Penalties

Any person who publishes, divulges, discloses, or makes known in any manner, or to any extent not authorized by Federal law (Section 9(b)(6)(C) of the National School Lunch Act; 42 USC 1758(b)(6)(C)) or regulation, any information about a child's eligibility for free and reduced price meals or free milk shall be fined not more than a $1,000 or imprisonment of not more than 1 year or both.

F. Signatures

The parties acknowledge that children's free and reduced price meal and free milk eligibility information may be used only for the specific purposes stated above; that unauthorized use of free and reduced price meal and free milk information or further disclosure to other persons or programs is prohibited and a violation of Federal law which may result in civil and criminal penalties.

Requesting Agency/Program Administrator

Typed or Printed Name: Bethany N. Wuensch

Title: Director, Grant Services
Office of Research Administration Phone: [redacted]

Signature: Bethany Wuensch

Date: 4/20/16

Determining Agency Administrator

Typed or Printed Name: Stephen Pruitt

Title: Commissioner Phone [redacted]

Signature: _____

Date: _____

**Any attachments will become part of this agreement.*

Exhibit B:

KENTUCKY CENTER FOR EDUCATION AND WORKFORCE STATISTICS
CONTRACTOR'S EMPLOYEE OR CONTRACTOR NONDISCLOSURE STATEMENT

Contractor Indiana University

Contractor's employee or contractor name Chad R. Lochmiller Title Assistant Professor

Address [redacted] Telephone [redacted]

I understand that the performance of my duties as an employee or contractor, of a contractor for the Kentucky Center for Education and Workforce Statistics (KCEWS), may involve a need to access and review confidential information (information designated as confidential by FERPA, NSLA, CNA, KRS 61.931 (6), or other federal or state law); and, that I am required to maintain the confidentiality of this information and prevent any redisclosure prohibited under the law as stated below. By signing this document I agree to the following:

- I will not permit access to confidential information to persons not authorized by KCEWS and its contractor.
- I will maintain the confidentiality of the data or information
- I will not access data of persons related or known to me for personal reasons.
- I will not reveal any individually identifiable information furnished, acquired, retrieved or assembled by me or others for any purpose other than statistical purposes specified in KCEWS survey, project, or proposed research.
- I will report, immediately and within twenty-four (24) hours, any known reasonablu believed instances of missing data, data that has been inappropriately shared, or data taken off site
    - To KCEWS, the contractor, my immediate supervisor and
    - To the Division of HR if I am a KCEWS employee or
    - To the KCEWS office for whom I perform work under the contract if I am a KCEWS contractor or an employee of a KCEWS contractor
- I understand that procedures must be in place for monitoring and protecting confidential information.
- I understand and acknowledge that FERPA-protected information obtained under provisions of Family Education Rights and Privacy Act of 1974 (FERPA), as a KCEWS contractor's employee or contractor of KCEWS, is confidential information.
- I understand that FERPA protects informationin students' education records that are maintained by an educational agency or institiution or by a party acting for the agency or institution, and includes, but is not limited to the student's name, the name of the student's parent or other family members, the address of the student or student's family, a personal identifier, such as the student's social security number, student number, or biometric record, other indirect identifiers, such as the student's date of birth, place of birth, and mother's maiden name, and other information that, alone or in combination, is linked or linkable to a specific student that would allow a reasonable person in the school community, who does not have personal knowledge of the relevant circumstances, to identify the student with reasonable certainty.
- I understand that any unauthorized disclosure of confidential information is illegal as provided in the FERPA and in the implementing of federal regulations found in 34 CFR, Part 99. The penalty for unlawful disclosure is a fine of not more than $250,000.00 (under 18 U.S.C. 3571) or imprisonment for not more than five years (under 18 U.S.C. 3559), or both.

- I understand and acknowledge that children's free and reduced price meal and free milk eligibility information or information from the family's application for eligibility, obtained under the provisions of the Richard B. Russell National School Lunch Act (42 U.S.C 1751 et seq)(NSLA) or Child Nutrition Act of 1966 (42 U.S.C. 1771 et seq.)(CNA) and the regulations implementing these Acts, is confidential information.
- I understand that any unauthorized disclosure of confidential free and reduced price lunch information or information from an application for this benefit is illegal as provided in the Richard B. Russell National School Lunch Act (42 U.S.C. 1751 et seq)(NSLA) or Child Nutrition Act of 1966 (42 U.S.C. 1771 et seq.)(CNA) and the regulations implementing these Acts, specifically 7 C.F.R. 245.6. The penalty for unlawful disclosure is a fine of not more than $1,000.00 (under 7 C.F.R. 245.6) or imprisonment for up to one year (under 7 C.F.R. 245.6), or both.
- I understand that KRS 61.931 also defines "personal information" to include an individual's first name or first initial and last name; personal mark; or unique biometric or genetic print or image, in combiniation with one (1) or more of the following data elements:
    - An account number, credit card number, or debit card number that , in combination with any required secruriy code, access code, or password, would permit access to an account;
    - A Social Security number;
    - A taxpayer identification number that incorporates a Social Security number;
    - A driver's license number, state identification card number, or other individual identification number issued by any agency;
    - A passport number or other identification number issued by the United States government; or
    - Individually identifiable health information as defined in 45 C.F.R sec. 160.103, except for education records covered by the Family Educational Rights and Privacy Act, as amended, 20 U.S.C. sec. 1232g.
- I understand that other federal and state privacy laws protect confidential data not otherwise detailed above and I acknowldedge my duty to maintain confidentiality of that data as well.
- I understand that any personal characteristics, that could make the person's identity traceable, including membership in a group such as ethnicity or program area, are protected.
- In addition, I understand that any data sets or output reports that I may generate using confidential data are to be protected. I will not distribute to any unauthorized person any data sets or reports that I have access to or may generate using confidential data. I understand that I am responsible for any computer transactions performed as a result of access authorized by use of sign-on/password(s).

Claud R Lilmick — 5/6/16

Contractor's employee or contractor signature — Date

Bethany Wuensch — 4/20/16

Contractor's authorized agent signature — Date

Bethany N. Wuensch
Director, Grant Services
Office of Research Administration

Contractor's authorized agent name (typed)

KENTUCKY CENTER FOR EDUCATION AND WORKFORCE STATISTICS
CONTRACTOR'S EMPLOYEE OR CONTRACTOR NONDISCLOSURE STATEMENT

Contractor Indiana University

Contractor's employee or contractor name Aaron J. Butler Title Doctoral Candadite

Address [redacted] Telephone [redacted]

I understand that the performance of my duties as an employee or contractor, of a contractor for the Kentucky Center for Education and Workforce Statistics (KCEWS), may involve a need to access and review confidential information (information designated as confidential by FERPA, NSLA, CNA, KRS 61.931 (6), or other federal or state law); and, that I am required to maintain the confidentiality of this information and prevent any redisclosure prohibited under the law as stated below. By signing this document I agree to the following:

- I will not permit access to confidential information to persons not authorized by KCEWS and its contractor.
- I will maintain the confidentiality of the data or information
- I will not access data of persons related or known to me for personal reasons.
- I will not reveal any individually identifiable information furnished, acquired, retrieved or assembled by me or others for any purpose other than statistical purposes specified in KCEWS survey, project, or proposed research.
- I will report, immediately and within twenty-four (24) hours, any known reasonablu believed instances of missing data, data that has been inappropriately shared, or data taken off site
    - To KCEWS, the contractor, my immediate supervisor and
    - To the Division of HR if I am a KCEWS employee or
    - To the KCEWS office for whom I perform work under the contract if I am a KCEWS contractor or an employee of a KCEWS contractor
- I understand that procedures must be in place for monitoring and protecting confidential information.
- I understand and acknowledge that FERPA-protected information obtained under provisions of Family Education Rights and Privacy Act of 1974 (FERPA), as a KCEWS contractor's employee or contractor of KCEWS, is confidential information.
- I understand that FERPA protects informationin students' education records that are maintained by an educational agency or instituition or by a party acting for the agency or institution, and includes, but is not limited to the student's name, the name of the student's parent or other family members, the address of the student or student's family, a personal identifier, such as the student's social security number, student number, or biometric record, other indirect identifiers, such as the student's date of birth, place of birth, and mother's maiden name, and other information that, alone or in combination, is linked or linkable to a specific student that would allow a reasonable person in the school community, who does not have personal knowledge of the relevant circumstances, to identify the student with reasonable certainty.
- I understand that any unauthorized disclosure of confidential information is illegal as provided in the FERPA and in the implementing of federal regulations found in 34 CFR, Part 99. The penalty for unlawful disclosure is a fine of not more than $250,000.00 (under 18 U.S.C. 3571) or imprisonment for not more than five years (under 18 U.S.C. 3559), or both.
- I understand and acknowledge that children's free and reduced price meal and free milk eligibility information or information from the family's application for eligibility, obtained under the provisions of the Richard B. Russell

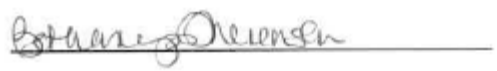
National School Lunch Act (42 U.S.C 1751 et seq)(NSLA) or Child Nutrition Act of 1966 (42 U.S.C. 1771 et seq.)(CNA) and the regulations implementing these Acts, is confidential information.

- I understand that any unauthorized disclosure of confidential free and reduced price lunch information or information from an application for this benefit is illegal as provided in the Richard B. Russell National School Lunch Act (42 U.S.C. 1751 et seq)(NSLA) or Child Nutrition Act of 1966 (42 U.S.C. 1771 et seq.)(CNA) and the regulations implementing these Acts, specifically 7 C.F.R. 245.6. The penalty for unlawful disclosure is a fine of not more than $1,000.00 (under 7 C.F.R. 245.6) or imprisonment for up to one year (under 7 C.F.R. 245.6), or both.
- I understand that KRS 61.931 also defines "personal information" to include an individual's first name or first initial and last name; personal mark; or unique biometric or genetic print or image, in combiniation with one (1) or more of the following data elements:
    - An account number, credit card number, or debit card number that , in combination with any required secruriy code, access code, or password, would permit access to an account;
    - A Social Security number;
    - A taxpayer identification number that incorporates a Social Security number;
    - A driver's license number, state identification card number, or other individual identification number issued by any agency;
    - A passport number or other identification number issued by the United States government; or
    - Individually identifiable health information as defined in 45 C.F.R sec. 160.103, except for education records covered by the Family Educational Rights and Privacy Act, as amended, 20 U.S.C. sec. 1232g.
- I understand that other federal and state privacy laws protect confidential data not otherwise detailed above and I acknowldedge my duty to maintain confidentiality of that data as well.
- I understand that any personal characteristics, that could make the person's identity traceable, including membership in a group such as ethnicity or program area, are protected.
- In addition, I understand that any data sets or output reports that I may generate using confidential data are to be protected. I will not distribute to any unauthorized person any data sets or reports that I have access to or may generate using confidential data. I understand that I am responsible for any computer transactions performed as a result of access authorized by use of sign-on/password(s).

Contractor's employee or contractor signature

4/6/16

Date



Contractor's authorized agent signature

4/20/16

Date

Bethany N. Wuensch
Director, Grant Services
Office of Research Administration

Contractor's authorized agent name (typed)

KENTUCKY CENTER FOR EDUCATION AND WORKFORCE STATISTICS
CONTRACTOR'S EMPLOYEE OR CONTRACTOR NONDISCLOSURE STATEMENT

Contractor Indiana University

Contractor's employee or contractor name Gary M. Crow Title Executive Associate Dean and Professor

Address [redacted] Telephone [redacted]

I understand that the performance of my duties as an employee or contractor, of a contractor for the Kentucky Center for Education and Workforce Statistics (KCEWS), may involve a need to access and review confidential information (information designated as confidential by FERPA, NSLA, CNA, KRS 61.931 (6), or other federal or state law); and, that I am required to maintain the confidentiality of this information and prevent any redisclosure prohibited under the law as stated below. By signing this document I agree to the following:

- I will not permit access to confidential information to persons not authorized by KCEWS and its contractor.
- I will maintain the confidentiality of the data or information
- I will not access data of persons related or known to me for personal reasons.
- I will not reveal any individually identifiable information furnished, acquired, retrieved or assembled by me or others for any purpose other than statistical purposes specified in KCEWS survey, project, or proposed research.
- I will report, immediately and within twenty-four (24) hours, any known reasonablu believed instances of missing data, data that has been inappropriately shared, or data taken off site
    - To KCEWS, the contractor, my immediate supervisor and
    - To the Division of HR if I am a KCEWS employee or
    - To the KCEWS office for whom I perform work under the contract if I am a KCEWS contractor or an employee of a KCEWS contractor
- I understand that procedures must be in place for monitoring and protecting confidential information.
- I understand and acknowledge that FERPA-protected information obtained under provisions of Family Education Rights and Privacy Act of 1974 (FERPA), as a KCEWS contractor's employee or contractor of KCEWS, is confidential information.
- I understand that FERPA protects informationin students' education records that are maintained by an educational agency or instituition or by a party acting for the agency or institution, and includes, but is not limited to the student's name, the name of the student's parent or other family members, the address of the student or student's family, a personal identifier, such as the student's social security number, student number, or biometric record, other indirect identifiers, such as the student's date of birth, place of birth, and mother's maiden name, and other information that, alone or in combination, is linked or linkable to a specific student that would allow a reasonable person in the school community, who does not have personal knowledge of the relevant circumstances, to identify the student with reasonable certainty.
- I understand that any unauthorized disclosure of confidential information is illegal as provided in the FERPA and in the implementing of federal regulations found in 34 CFR, Part 99. The penalty for unlawful disclosure is a fine of not more than $250,000.00 (under 18 U.S.C. 3571) or imprisonment for not more than five years (under 18 U.S.C. 3559), or both.
- I understand and acknowledge that children's free and reduced price meal and free milk eligibility information or information from the family's application for eligibility, obtained under the provisions of the Richard B. Russell

National School Lunch Act (42 U.S.C 1751 et seq)(NSLA) or Child Nutrition Act of 1966 (42 U.S.C. 1771 et seq.)(CNA) and the regulations implementing these Acts, is confidential information.

- I understand that any unauthorized disclosure of confidential free and reduced price lunch information or information from an application for this benefit is illegal as provided in the Richard B. Russell National School Lunch Act (42 U.S.C. 1751 et seq)(NSLA) or Child Nutrition Act of 1966 (42 U.S.C. 1771 et seq.)(CNA) and the regulations implementing these Acts, specifically 7 C.F.R. 245.6. The penalty for unlawful disclosure is a fine of not more than $1,000.00 (under 7 C.F.R. 245.6) or imprisonment for up to one year (under 7 C.F.R. 245.6), or both.
- I understand that KRS 61.931 also defines "personal information" to include an individual's first name or first initial and last name; personal mark; or unique biometric or genetic print or image, in combiniation with one (1) or more of the following data elements:
    - An account number, credit card number, or debit card number that , in combination with any required secruriy code, access code, or password, would permit access to an account;
    - A Social Security number;
    - A taxpayer identification number that incorporates a Social Security number;
    - A driver's license number, state identification card number, or other individual identification number issued by any agency;
    - A passport number or other identification number issued by the United States government; or
    - Individually identifiable health information as defined in 45 C.F.R sec. 160.103, except for education records covered by the Family Educational Rights and Privacy Act, as amended, 20 U.S.C. sec. 1232g.
- I understand that other federal and state privacy laws protect confidential data not otherwise detailed above and I acknowldedge my duty to maintain confidentiality of that data as well.
- I understand that any personal characteristics, that could make the person's identity traceable, including membership in a group such as ethnicity or program area, are protected.
- In addition, I understand that any data sets or output reports that I may generate using confidential data are to be protected. I will not distribute to any unauthorized person any data sets or reports that I have access to or may generate using confidential data. I understand that I am responsible for any computer transactions performed as a result of access authorized by use of sign-on/password(s).

Gary M. Crow — 4-12-16

Contractor's employee or contractor signature — Date

Bethany Wuensch — 4/20/16

Contractor's authorized agent signature — Date

Bethany N. Wuensch
Director, Grant Services
Office of Research Administration

Contractor's authorized agent name (typed)

KENTUCKY CENTER FOR EDUCATION AND WORKFORCE STATISTICS
CONTRACTOR'S EMPLOYEE OR CONTRACTOR NONDISCLOSURE STATEMENT

Contractor Indiana University

Contractor's employee or contractor name Thomas J. Sugimoto Title Research Associate
Address [redacted] Telephone [redacted]

I understand that the performance of my duties as an employee or contractor, of a contractor for the Kentucky Center for Education and Workforce Statistics (KCEWS), may involve a need to access and review confidential information (information designated as confidential by FERPA, NSLA, CNA, KRS 61.931 (6), or other federal or state law); and, that I am required to maintain the confidentiality of this information and prevent any redisclosure prohibited under the law as stated below. By signing this document I agree to the following:

- I will not permit access to confidential information to persons not authorized by KCEWS and its contractor.
- I will maintain the confidentiality of the data or information
- I will not access data of persons related or known to me for personal reasons.
- I will not reveal any individually identifiable information furnished, acquired, retrieved or assembled by me or others for any purpose other than statistical purposes specified in KCEWS survey, project, or proposed research.
- I will report, immediately and within twenty-four (24) hours, any known reasonablu believed instances of missing data, data that has been inappropriately shared, or data taken off site
    - To KCEWS, the contractor, my immediate supervisor and
    - To the Division of HR if I am a KCEWS employee or
    - To the KCEWS office for whom I perform work under the contract if I am a KCEWS contractor or an employee of a KCEWS contractor
- I understand that procedures must be in place for monitoring and protecting confidential information.
- I understand and acknowledge that FERPA-protected information obtained under provisions of Family Education Rights and Privacy Act of 1974 (FERPA), as a KCEWS contractor's employee or contractor of KCEWS, is confidential information.
- I understand that FERPA protects informationin students' education records that are maintained by an educational agency or institiution or by a party acting for the agency or institution, and includes, but is not limited to the student's name, the name of the student's parent or other family members, the address of the student or student's family, a personal identifier, such as the student's social security number, student number, or biometric record, other indirect identifiers, such as the student's date of birth, place of birth, and mother's maiden name, and other information that, alone or in combination, is linked or linkable to a specific student that would allow a reasonable person in the school community, who does not have personal knowledge of the relevant circumstances, to identify the student with reasonable certainty.
- I understand that any unauthorized disclosure of confidential information is illegal as provided in the FERPA and in the implementing of federal regulations found in 34 CFR, Part 99. The penalty for unlawful disclosure is a fine of not more than $250,000.00 (under 18 U.S.C. 3571) or imprisonment for not more than five years (under 18 U.S.C. 3559), or both.
- I understand and acknowledge that children's free and reduced price meal and free milk eligibility information or information from the family's application for eligibility, obtained under the provisions of the Richard B. Russell National School Lunch Act (42 U.S.C 1751 et seq)(NSLA) or Child Nutrition Act of 1966 (42 U.S.C. 1771 et seq.)(CNA) and the regulations implementing these Acts, is confidential information.

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- I understand that KRS 61.931 also defines "personal information" to include an individual's first name or first initial and last name; personal mark; or unique biometric or genetic print or image, in combiniation with one (1) or more of the following data elements:
    - An account number, credit card number, or debit card number that , in combination with any required secruriy code, access code, or password, would permit access to an account;
    - A Social Security number;
    - A taxpayer identification number that incorporates a Social Security number;
    - A driver's license number, state identification card number, or other individual identification number issued by any agency;
    - A passport number or other identification number issued by the United States government; or
    - Individually identifiable health information as defined in 45 C.F.R sec. 160.103, except for education records covered by the Family Educational Rights and Privacy Act, as amended, 20 U.S.C. sec. 1232g.
- I understand that other federal and state privacy laws protect confidential data not otherwise detailed above and I acknowldedge my duty to maintain confidentiality of that data as well.
- I understand that any personal characteristics, that could make the person's identity traceable, including membership in a group such as ethnicity or program area, are protected.
- In addition, I understand that any data sets or output reports that I may generate using confidential data are to be protected. I will not distribute to any unauthorized person any data sets or reports that I have access to or may generate using confidential data. I understand that I am responsible for any computer transactions performed as a result of access authorized by use of sign-on/password(s).

Contractor's employee or contractor signature — Date: 4/7/16

Contractor's authorized agent signature — Date: 4/20/16

Bethany N. Wuensch
Director, Grant Services
Office of Research Administration

Contractor's authorized agent name (typed)

Exhibit C: Please describe the measures you take to ensure the protection of confidential data released to you. If you have a policy, please attach or copy/paste here as Exhibit C. (Include information on the requested delivery method, how we should deliver the data to you , if you have a secure ftp/dropbox site, etc.)

See attached policy and standard operating procedures from Indiana University's Office of Research Assurance regarding Data Management. A copy of the university's policies and procedures regarding the protection of research data can be obtained online:
http://policies.iu.edu/policies/categories/research/IU-Research-Policies/Research_with_Human_Subjects.shtml

Exhibit D: Please describe the methods Researcher will use to irrevocably destroy all confidential data at the completion of the study. This includes but is not limited to paper, electronic, magnetic or other media as well as any internal hard drive of a printer or copier that must be irrevocably sanitized when disposed of or sent to surplus. Please specify the date and means of destruction for all forms of media that are applicable. If you have a policy that describes the methods you will use to destroy all confidential data, it can be attached as Exhibit D. Researcher's Certificate of Destruction (Exhibit F) is required for certification that any forms of personal or confidential data have been irrevocably destroyed, wiped or sanitized.

Indiana University policy requires that departments choose and correctly deploy a tool that performs at lease a 1-pass wipe of the disk when deleting electronically stored data. The university requires that departments use either DBAN or Mac OX X's Disk Utility. If the storage device is inoperable or cannot be wiped using one of these tools, then the remaining options include degaussing and drive destruction. The university recommends against degaussing and instead encourages departments to use the IUB/IUPUI Surplus Data Destruction Service. For the present project, all information will be destroyed by March 31, 2017. Additional information pertaining to the university's policies regarding secure data destruction can be found online: https://protect.iu.edu/online-safety/protect-data/sensitive-data/guidelines.html

Exhibit E: In alphabetical order by last name, provide the contact information for those persons designated as data custodians. This should include anyone with access to confidential data. A designated primary and secondary data custodian are required and a minimum of four is requested. Attach if more space is needed. Each data custodian should also have signed non-disclosure agreement labeled as Exhibit B.

Primary Data Custodian:

Last Name, First Name: Lochmiller, Chad
Phone: [redacted]
Email:
Employer: Indiana University

Secondary Data Custodian:

Last Name, First Name: Butler, Aaron
Phone: [redacted]
Email:
Employer: Indiana University

All Other Data Custodians

Last Name, First Name: Crow, Gary
Phone: [redacted]
Email:
Employer: Indiana University

Last Name, First Name: Sugimoto, Thomas
Phone: [redacted]
Email:
Employer: Indiana University

Last Name, First Name: _____
Phone: _____
Email: _____
Employer: _____

Last Name, First Name: _____
Phone: _____
Email: _____
Employer: _____

All Other Data Custodians (Continued)

Last Name, First Name: _____
Phone: _____
Email: _____
Employer: _____

Last Name, First Name: _____
Phone: _____
Email: _____
Employer: _____

Last Name, First Name: _____
Phone: _____
Email: _____
Employer: _____

Last Name, First Name: _____
Phone: _____
Email: _____
Employer: _____

Last Name, First Name: _____
Phone: _____
Email: _____
Employer: _____

Last Name, First Name: _____
Phone: _____
Email: _____
Employer: _____

Last Name, First Name: _____
Phone: _____
Email: _____
Employer: _____

Exhibit F: RESEARCHER'S CERTIFICATE OF DATA DESTRUCTION

The Researcher shall irreversibly destroy all copies of all confidential and otherwise personally identifiable data regardless of format (e.g. paper, electronic) within forty-five (45) days after it is no longer needed to perform the studies described in this agreement, upon KCEWS's request or upon termination of this agreement, whichever occurs first unless agreed otherwise in writing. Using this form, the Researcher shall provide written verification of the data destruction to the KCEWS within forty-five (45) days after the data is destroyed. Scan the signed Certificate of Data Destruction and return it to [redacted]

If the Researcher uses a contractor for data destruction services, a certificate of destruction from the contractor is also required. Please submit the contractor's certificate of destruction with this signed Certificate of Data Destruction.

Research Entity's Name Indiana University

MOU No. **Click here to enter text.** (If you do not know your MOU identification number, contact KCEWS at by email a[redacted]

In accord with the provisions of the Memorandum of Understanding (MOU) between the Kentucky Center for Education and Workforce Statistics on behalf of the Kentucky Department of Education and the ("Researcher" or "Contractor"), the confidential and otherwise personally identifiable data were destroyed as required in Section N according to the methods described in Exhibit D of the MOU.

Date submitted: **Click here to enter a date.**

Scheduled date of destruction (per MOU): **Click here to enter a date.**

Actual destruction date: **Click here to enter a date.**

Description of records disposed of:

Media type	Method of Destruction	Comments
Click here to enter text.	Click here to enter text.	Click here to enter text.
Click here to enter text.	Click here to enter text.	Click here to enter text.
Click here to enter text.	Click here to enter text.	Click here to enter text.
Click here to enter text.	Click here to enter text.	Click here to enter text.

I hereby certify that all confidential and otherwise personally identifiable data described above have been destroyed in the manner indicated.

_____

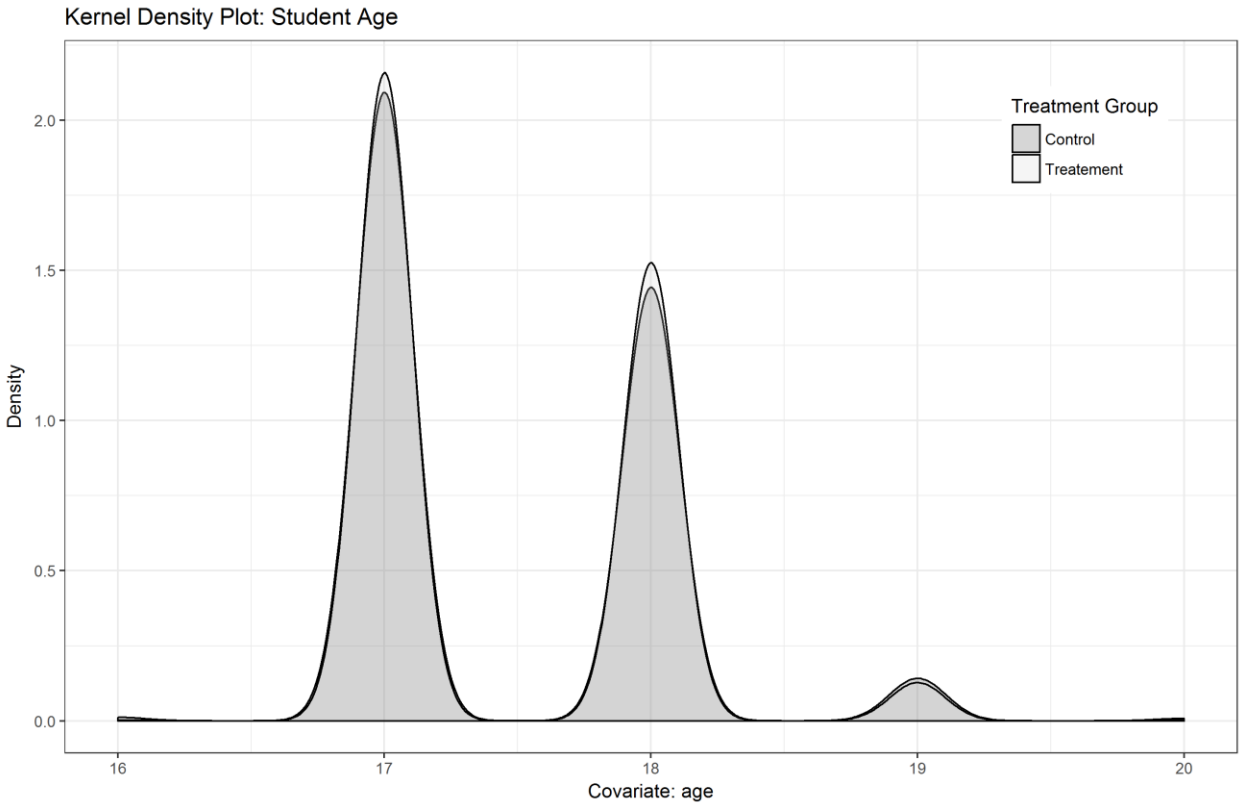
Research Entity's Authorized Agent Signature / Date

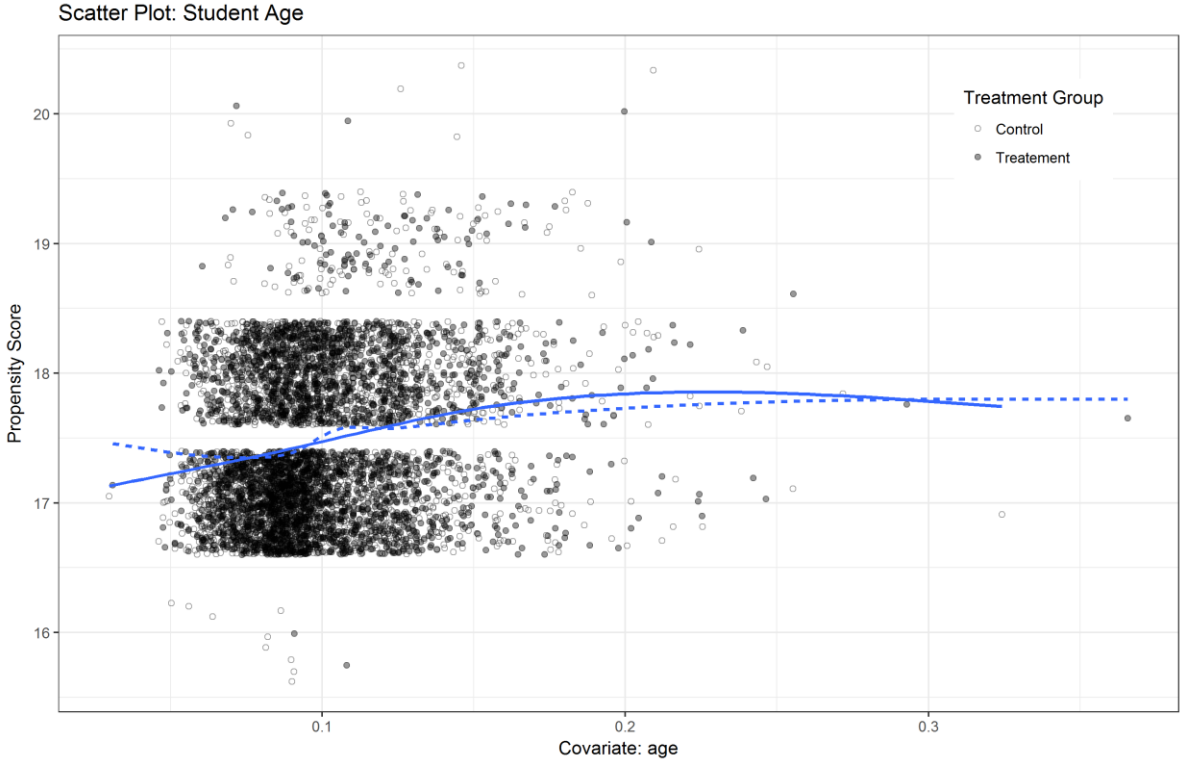
Agent's Name (Typed) **Click here to enter text.** Agent's Title **Click here to enter text.**

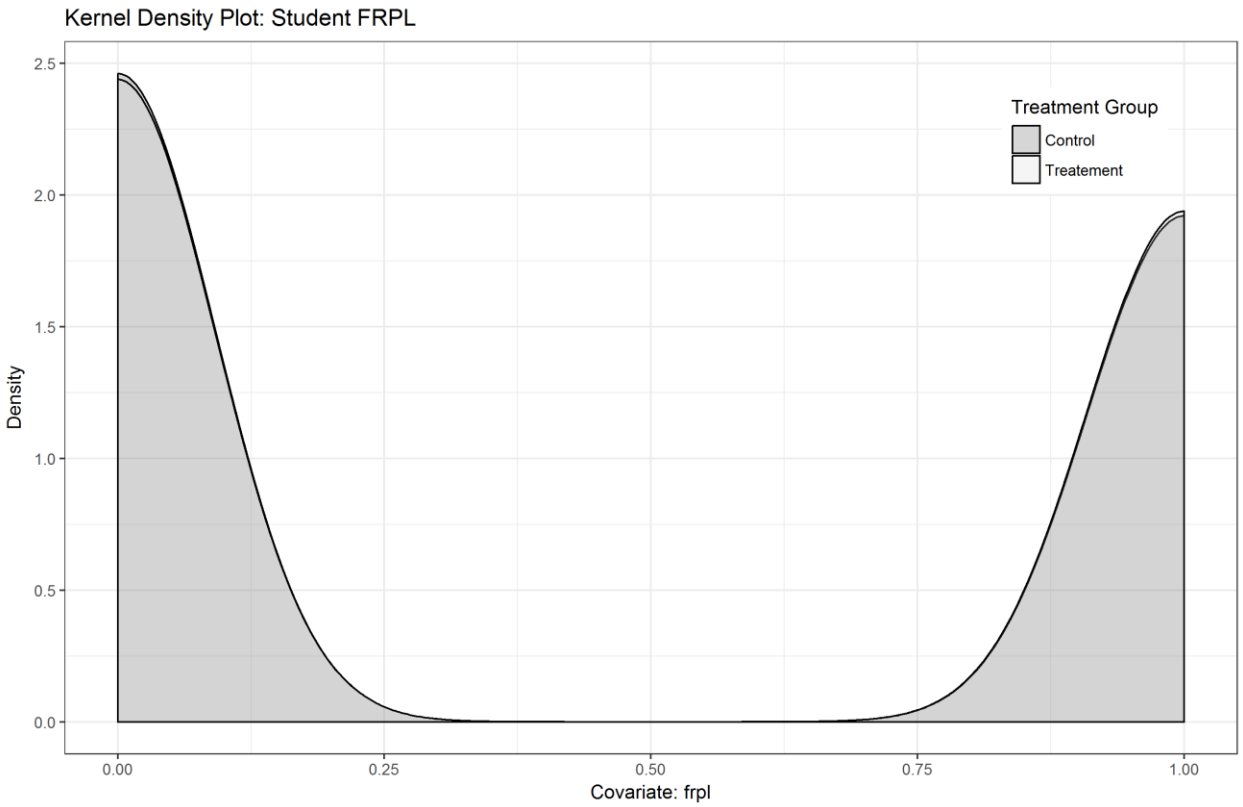
Appendix B: Code Used for Matching

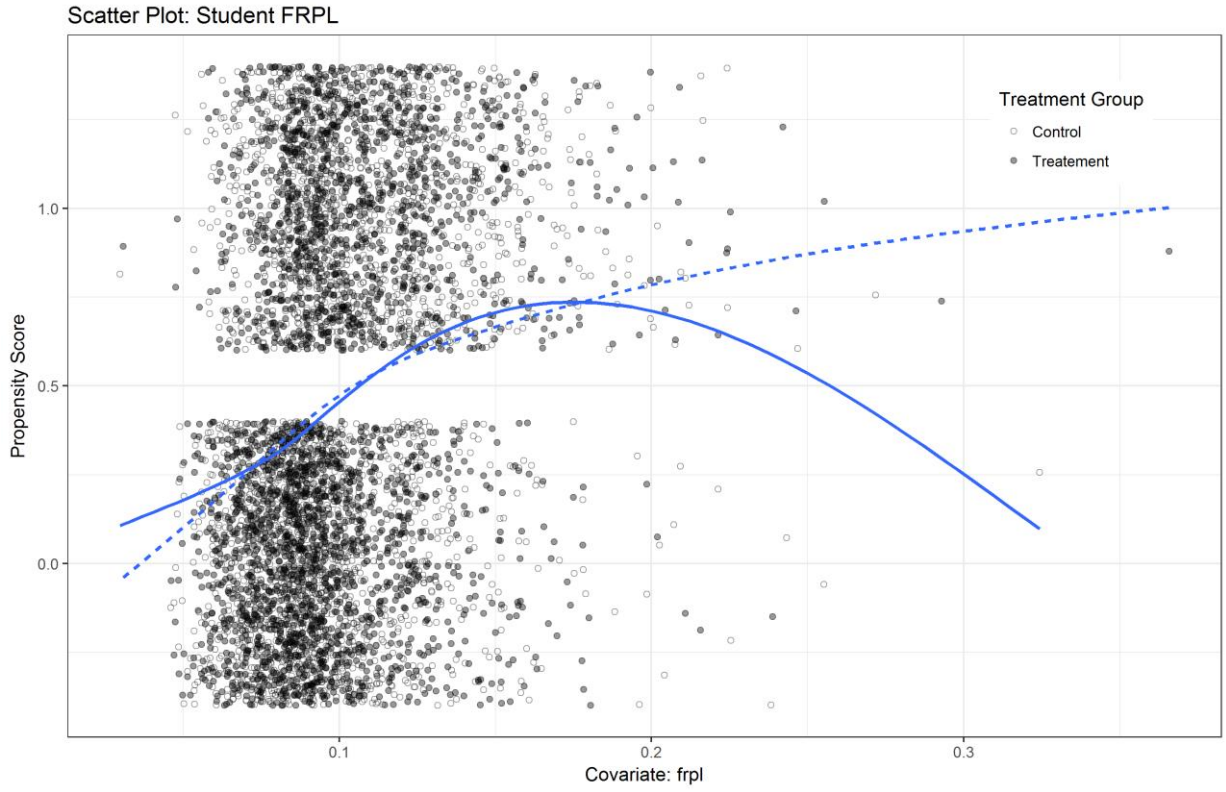
```
# file:          matching.R
# purpose:       estimate propensity scores and match students


# load data
df  ← readRDS("data/processed/for_analysis.rds")

# subset data
df_math ← dplyr::filter(df, subject == "math")
df_read  ← dplyr::filter(df, subject == "read")

# matching function
fun_match ← function(dta           = df_math,
                     setSubject = "math",
                     setRatio    = 1,
                     setCaliper = 0) {

   # matching formula
   myFormula ← treatment ~  age + factor(male) + factor(race) + factor(frpl) +
      factor(iep) + factor(lep) + factor(gifted) + factor(homeless) +
      plan_ma_z + plan_rd_z + kprep_wr_z + factor(title_one) + enroll +
      white_pct + frpl_pct + iep_pct + act_math_mean + act_read_mean

   # match data
   myMatch ← MatchIt::matchit(
      formula = myFormula,
      data      = dta,
      method  = "nearest",
      distance = "logit",
      ratio      = setRatio,
      caliper   = setCaliper
   )

   # create matched dataframe
   matchedData ← MatchIt::match.data(myMatch)
   return(matchedData)

}

matched_math ← fun_match(df_math, "math")
matched_read  ← fun_match(df_read, "read")
```

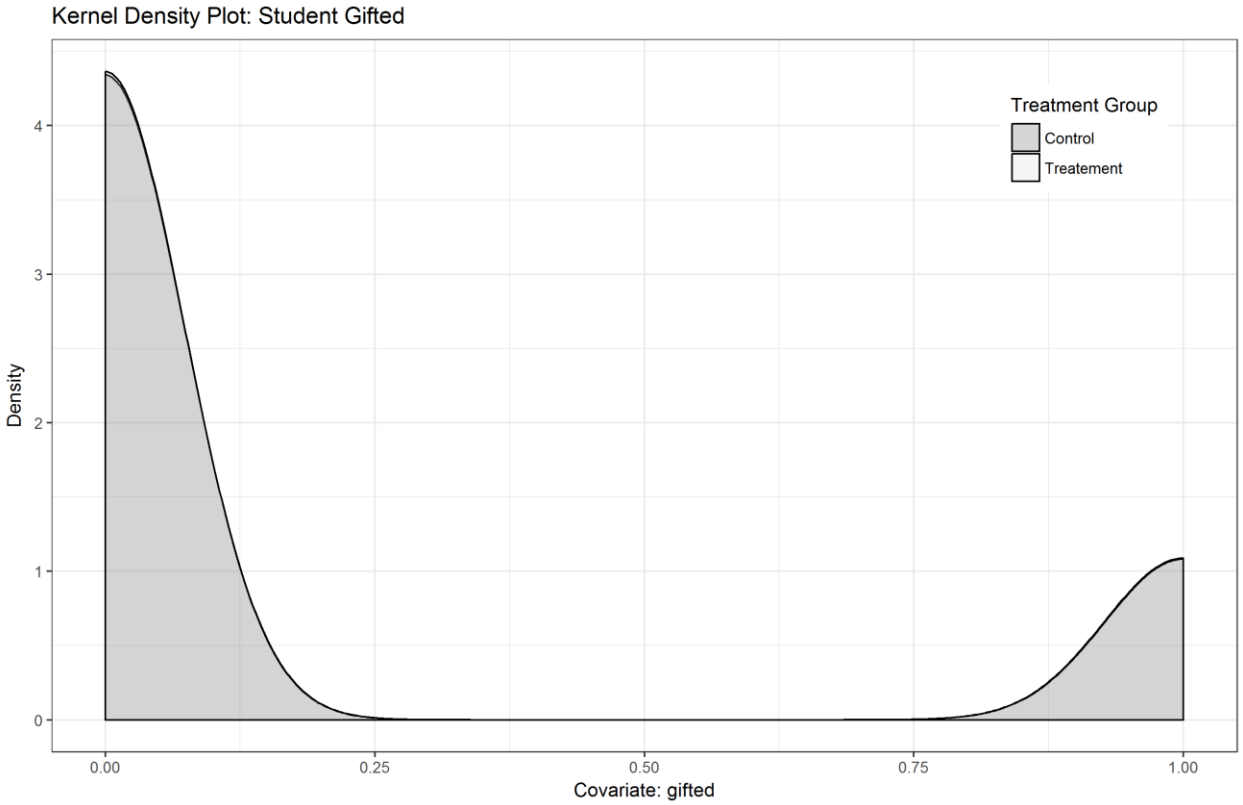
Appendix C: Covariate Balance Plots

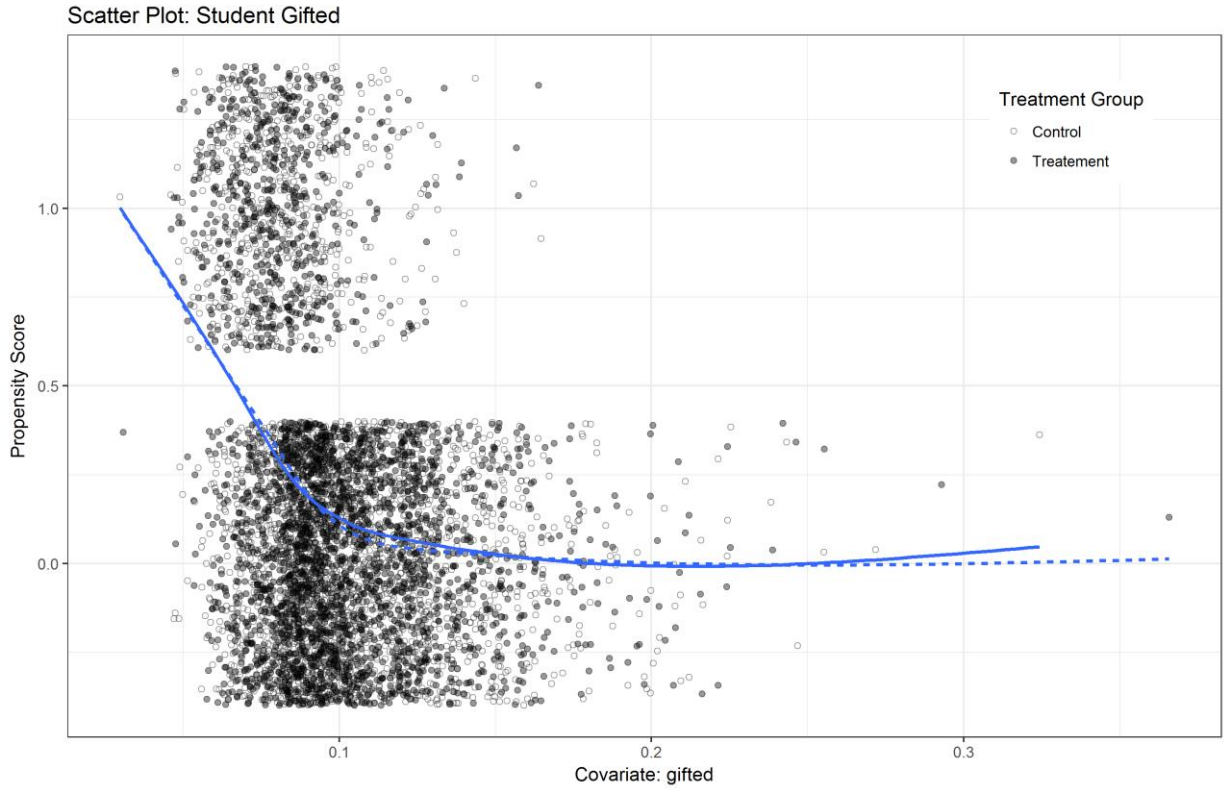


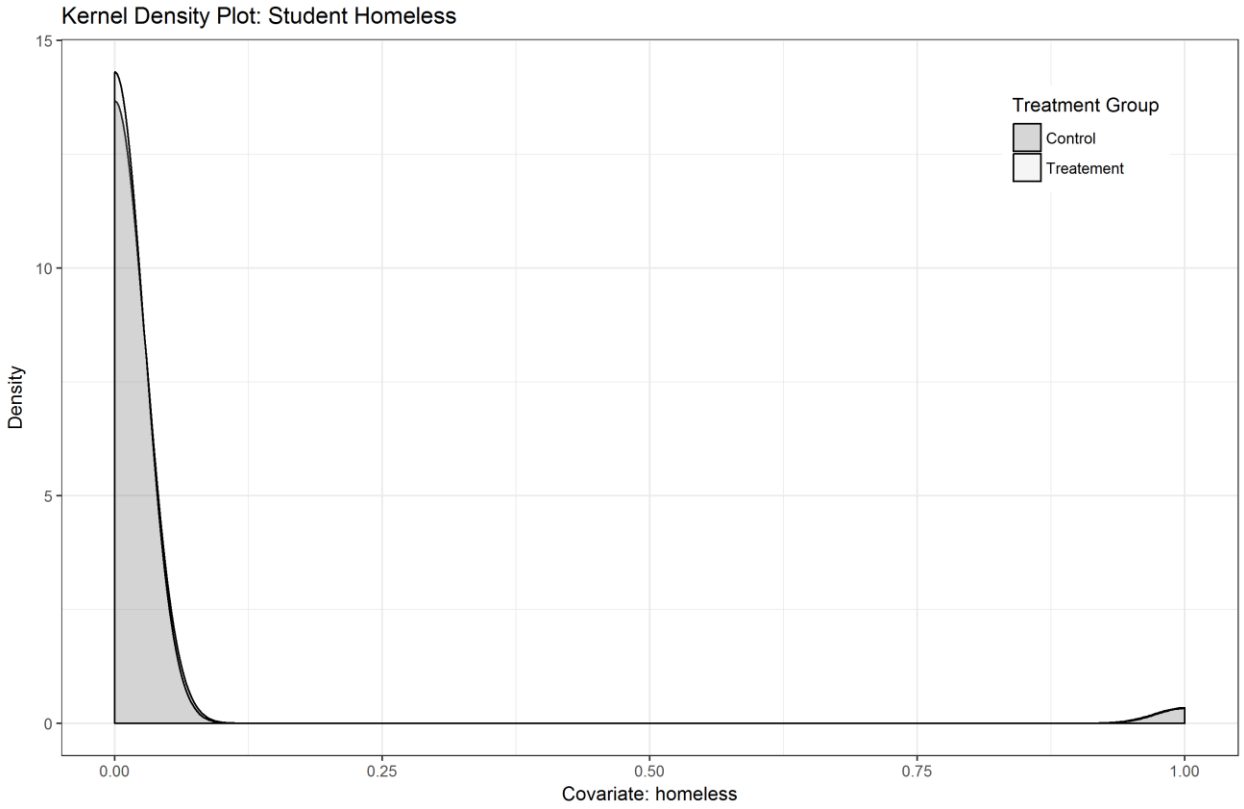


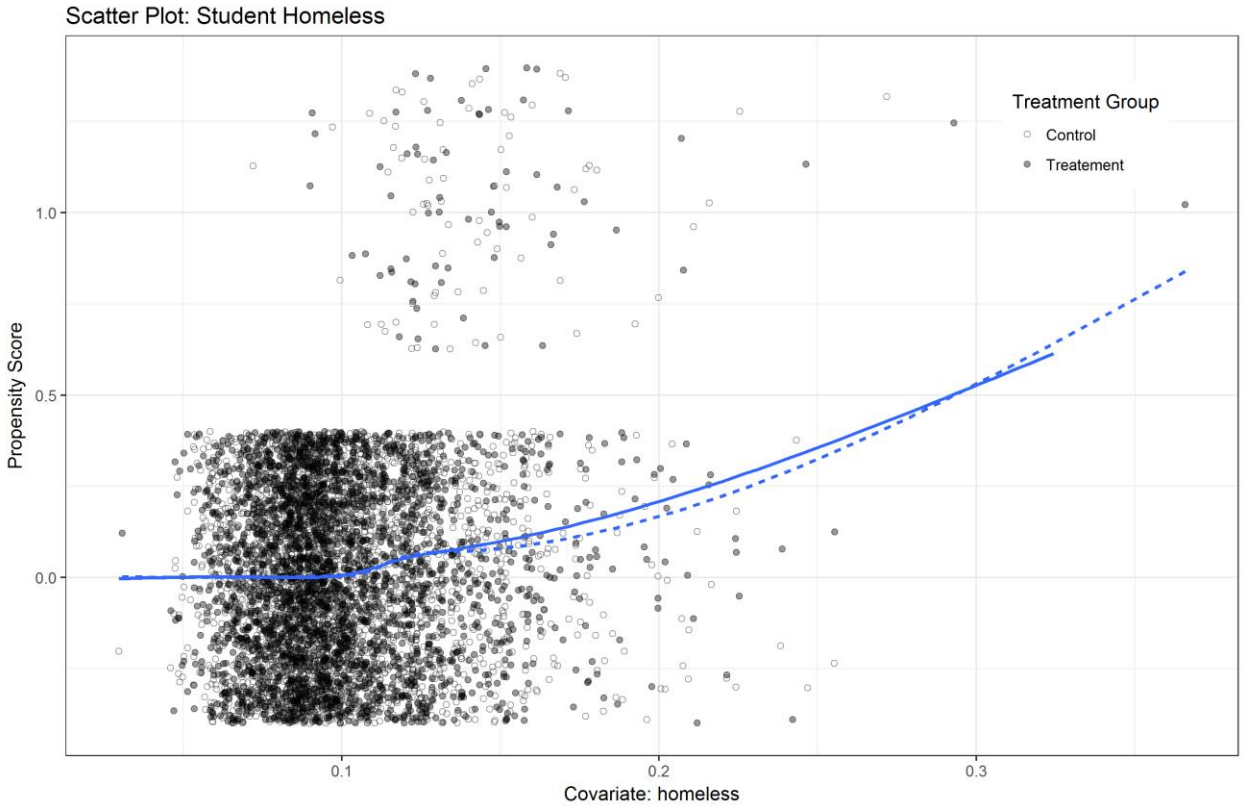

Kernel Density Plot: Student FRPL
Treatment Group
Control
Treatement
Density
Covariate: frpl
0.0
0.5
1.0
1.5
2.0
2.5
0.00
0.25
0.50
0.75
1.00

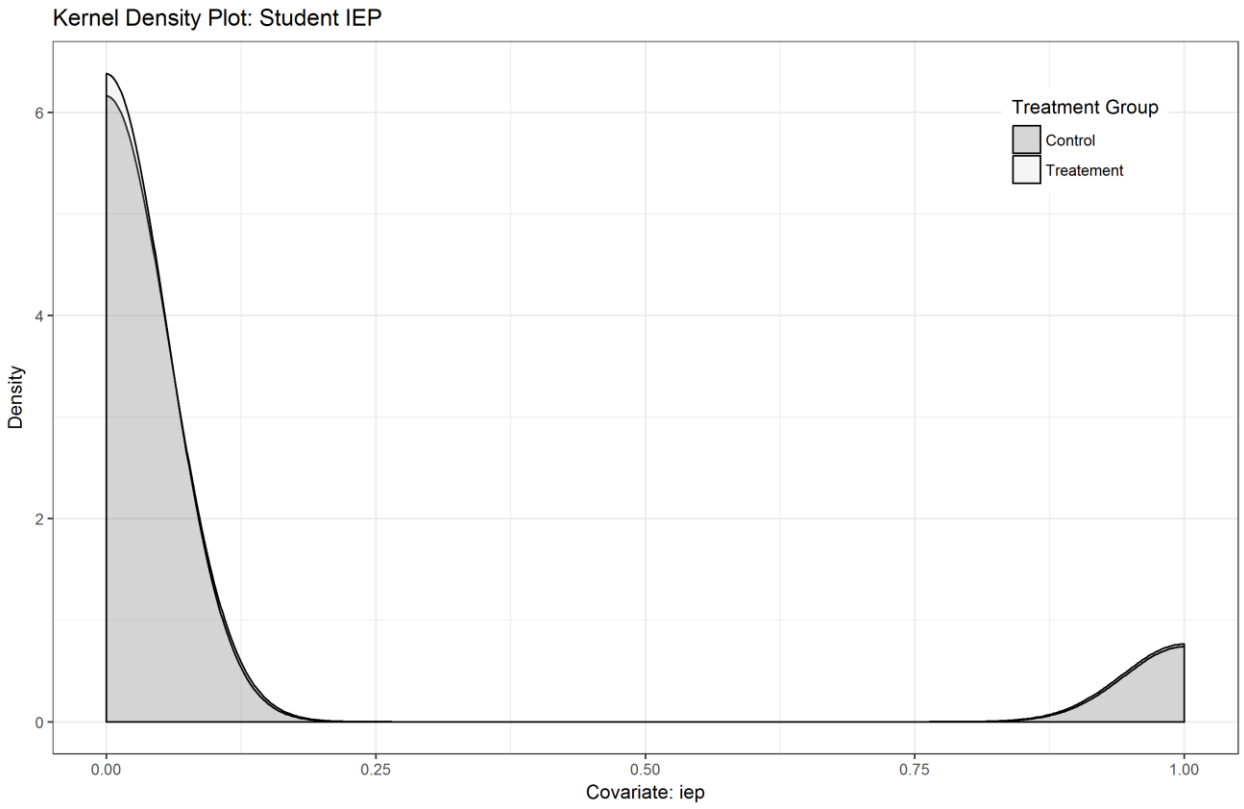

Scatter Plot: Student FRPL
Treatment Group
Control
Treatement
Propensity Score
Covariate: frpl
0.0
0.5
1.0
0.1
0.2
0.3

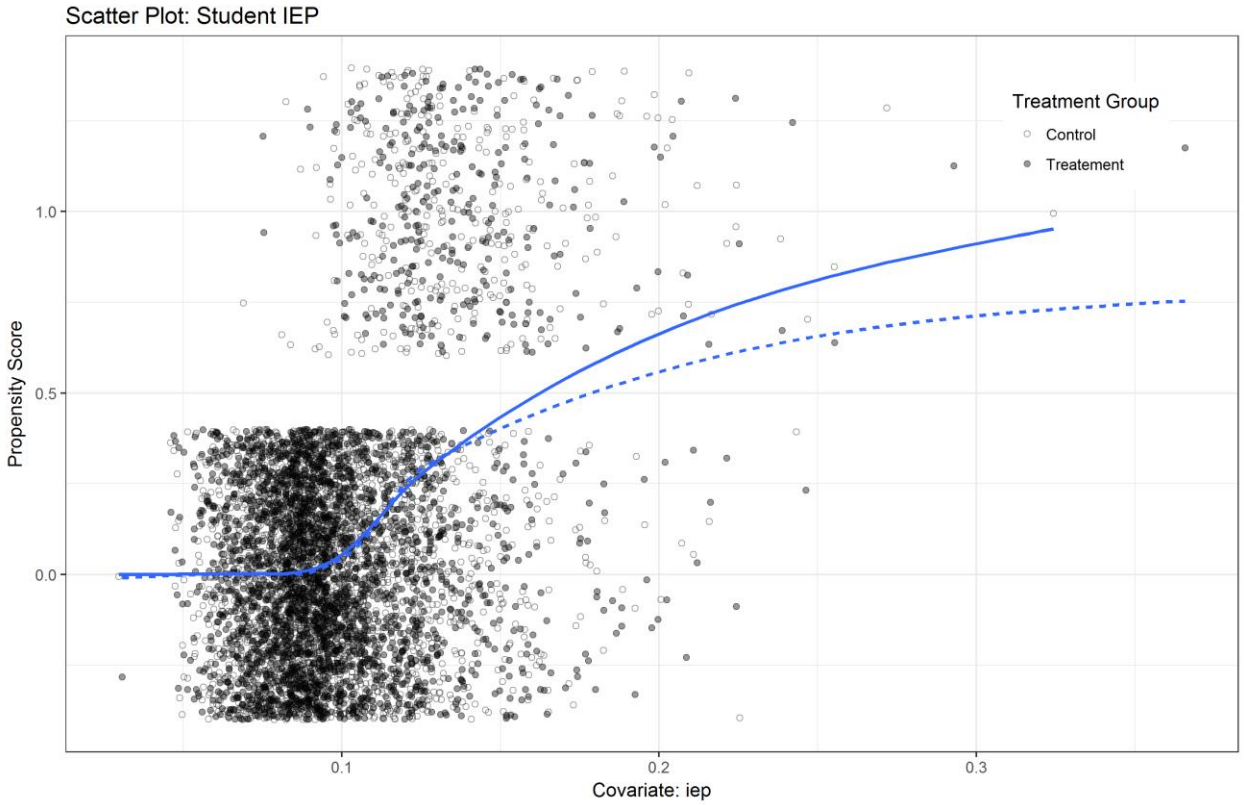

Kernel Density Plot: Student Gifted
Treatment Group
Control
Treatement
Density
0
1
2
3
4
0.00
0.25
0.50
0.75
1.00
Covariate: gifted

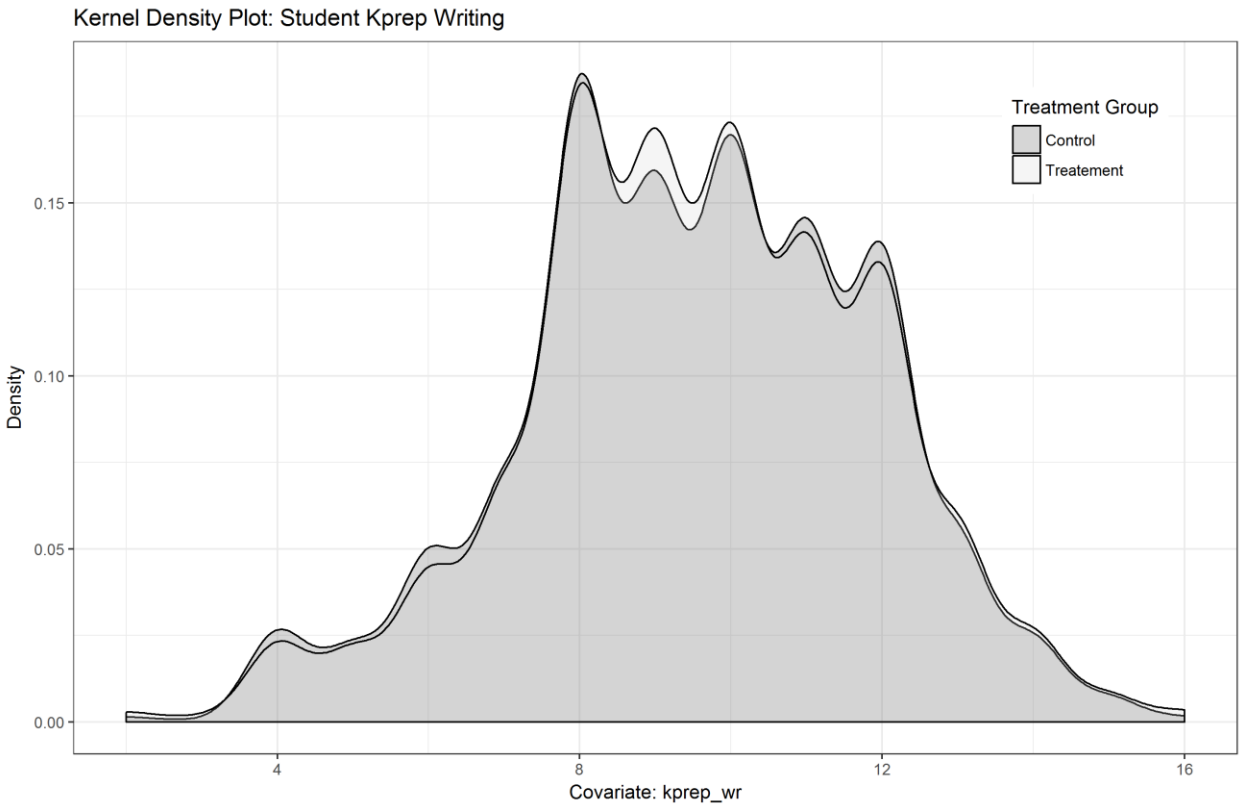

Scatter Plot: Student Gifted
Treatment Group
Control
Treatement
Propensity Score
0.0
0.5
1.0
0.1
0.2
0.3
Covariate: gifted

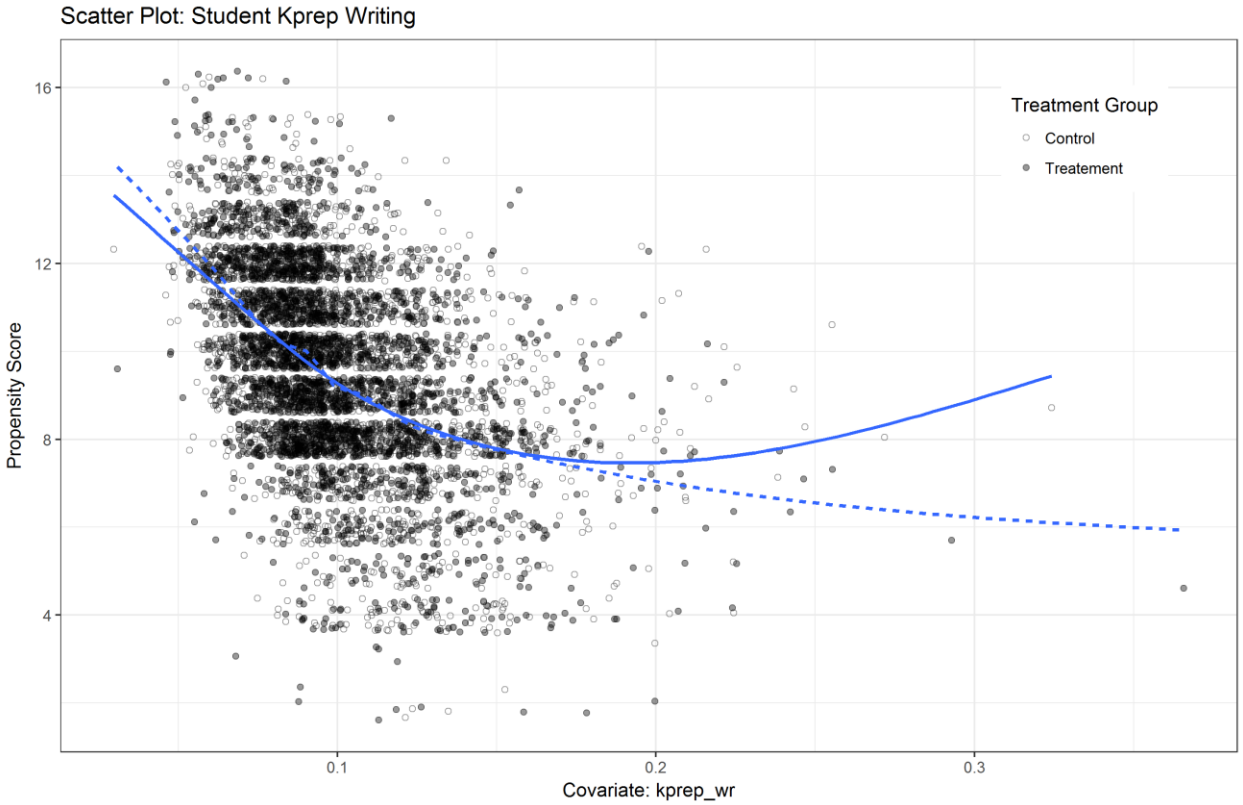

Kernel Density Plot: Student Homeless
Treatment Group
Control
Treatement
Density
15
10
5
0
0.00
0.25
0.50
0.75
1.00
Covariate: homeless

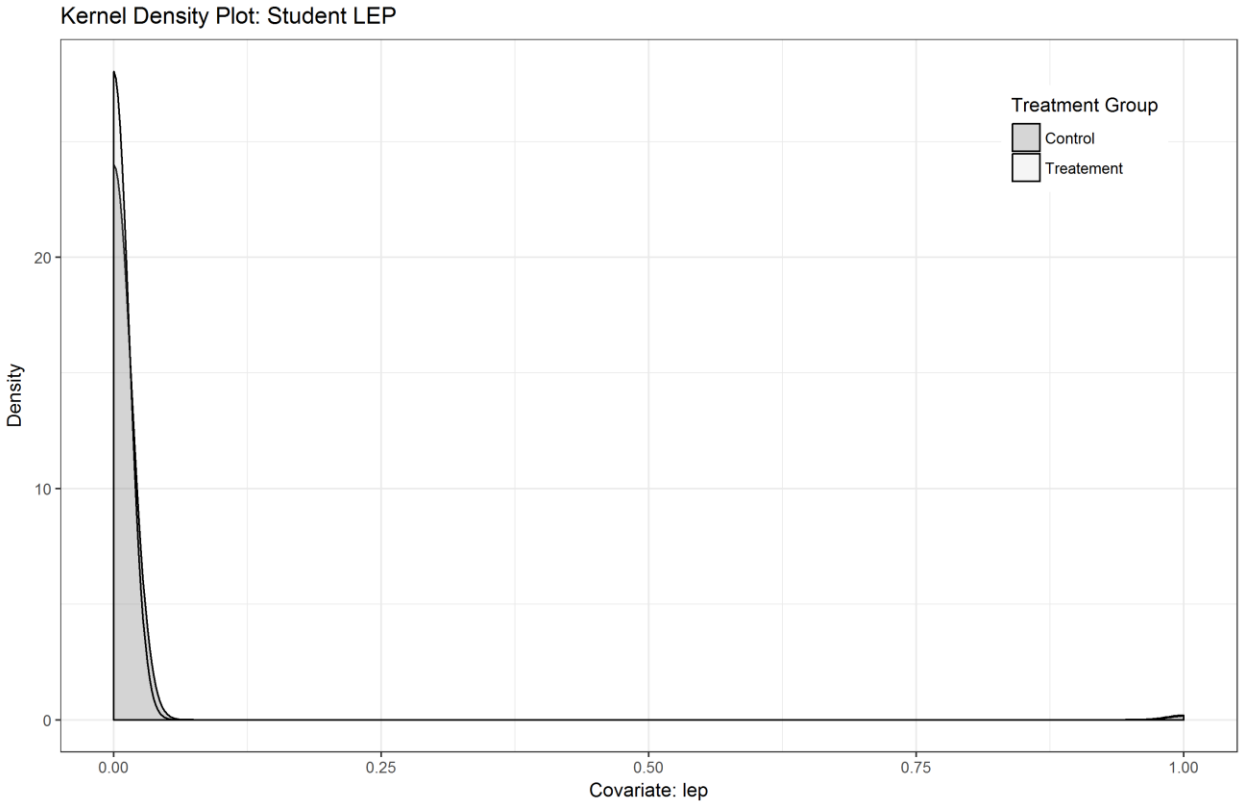

Scatter Plot: Student Homeless
Treatment Group
Control
Treatement
Propensity Score
1.0
0.5
0.0
0.1
0.2
0.3
Covariate: homeless

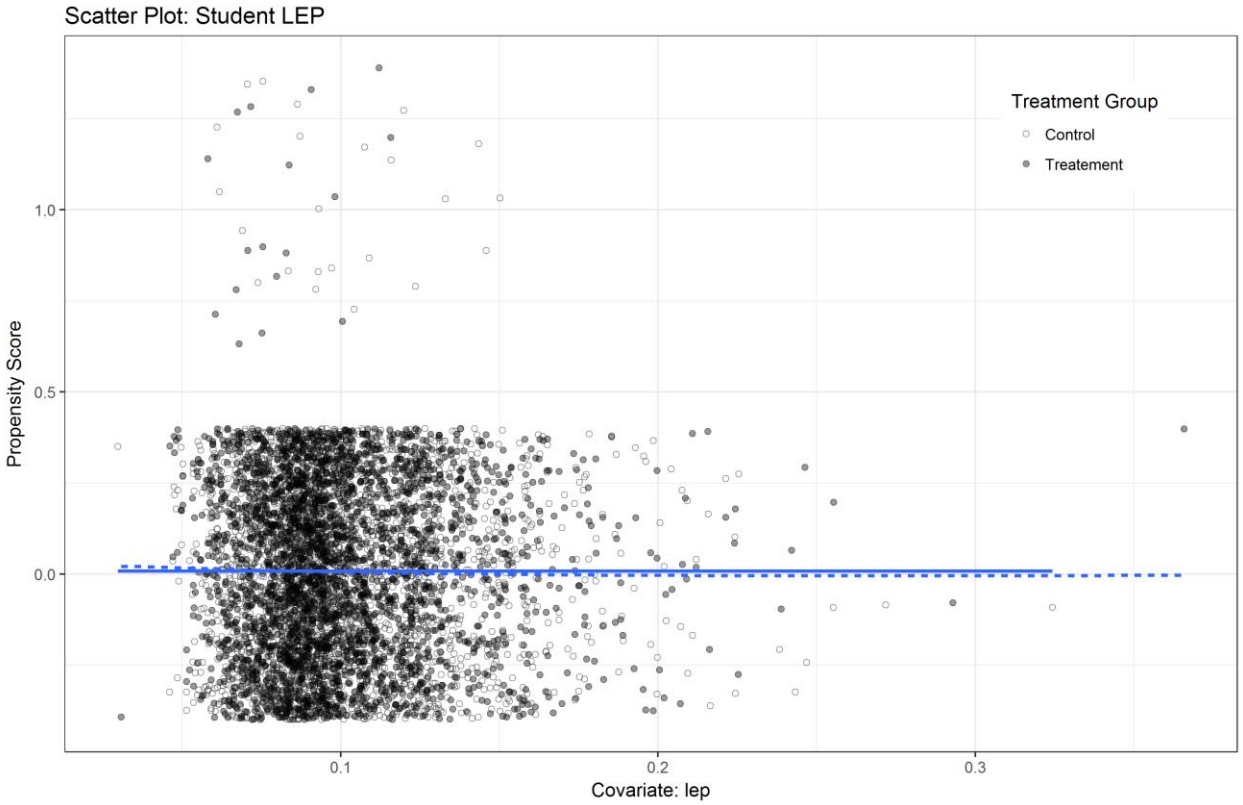

Kernel Density Plot: Student IEP
Treatment Group
Control
Treatement
Density
0
2
4
6
0.00
0.25
0.50
0.75
1.00
Covariate: iep


Scatter Plot: Student IEP
Treatment Group
Control
Treatement
Propensity Score
0.0
0.5
1.0
0.1
0.2
0.3
Covariate: iep

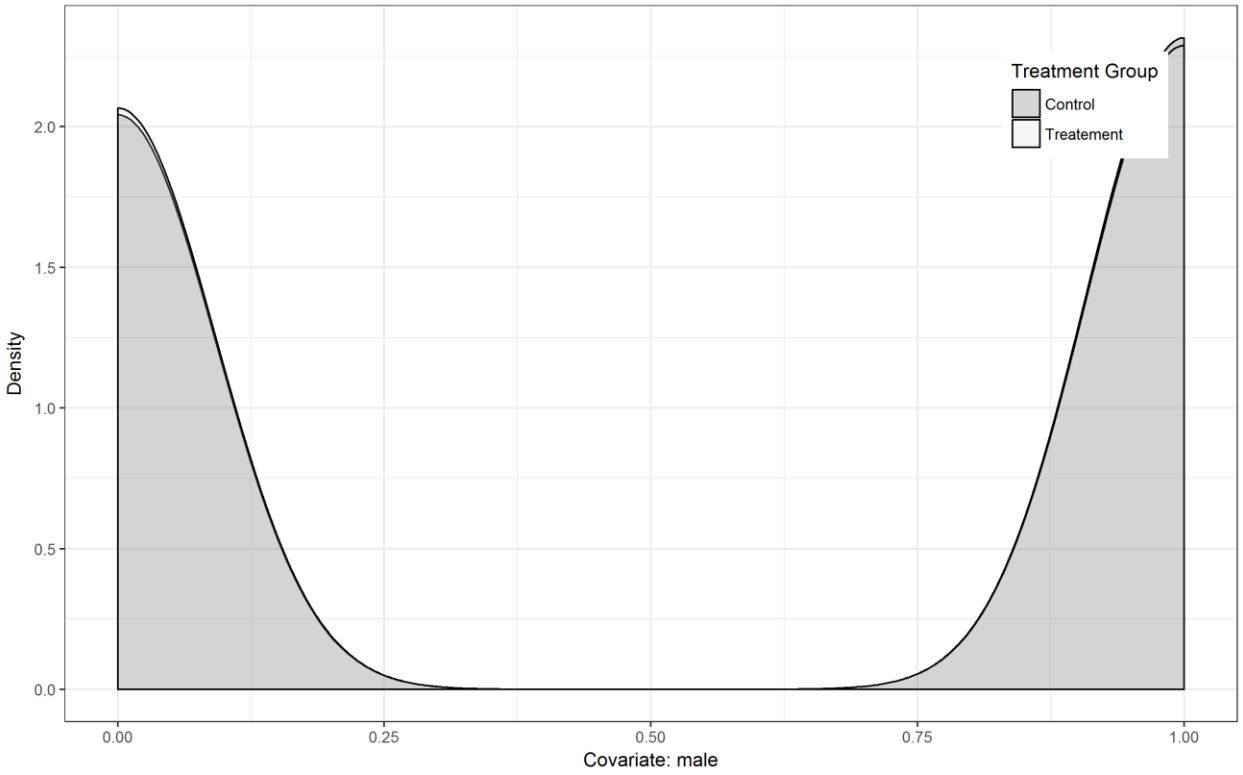

Kernel Density Plot: Student Kprep Writing
Treatment Group
Control
Treatement
Density
0.15
0.10
0.05
0.00
4
8
12
16
Covariate: kprep_wr


Scatter Plot: Student Kprep Writing
Treatment Group
Control
Treatement
Propensity Score
16
12
8
4
0.1
0.2
0.3
Covariate: kprep_wr

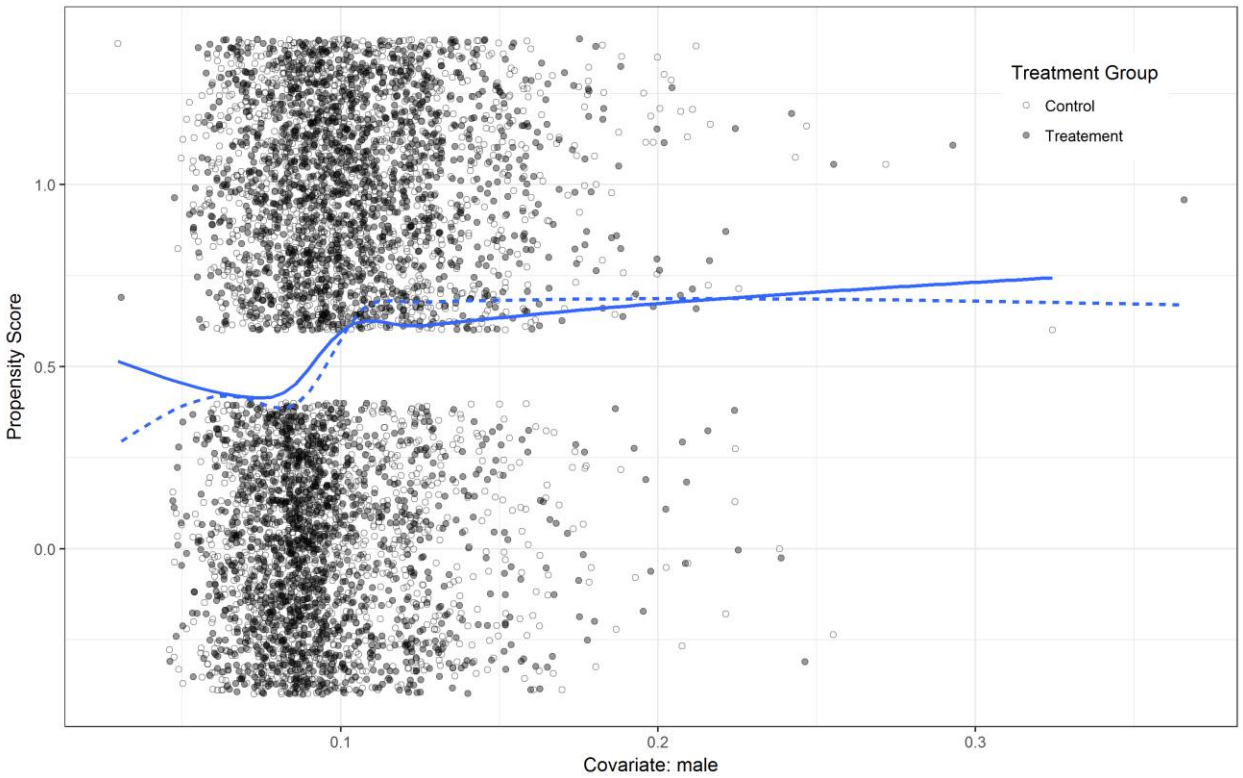

Kernel Density Plot: Student LEP
Treatment Group
Control
Treatement
Density
20
10
0
0.00
0.25
0.50
0.75
1.00
Covariate: lep

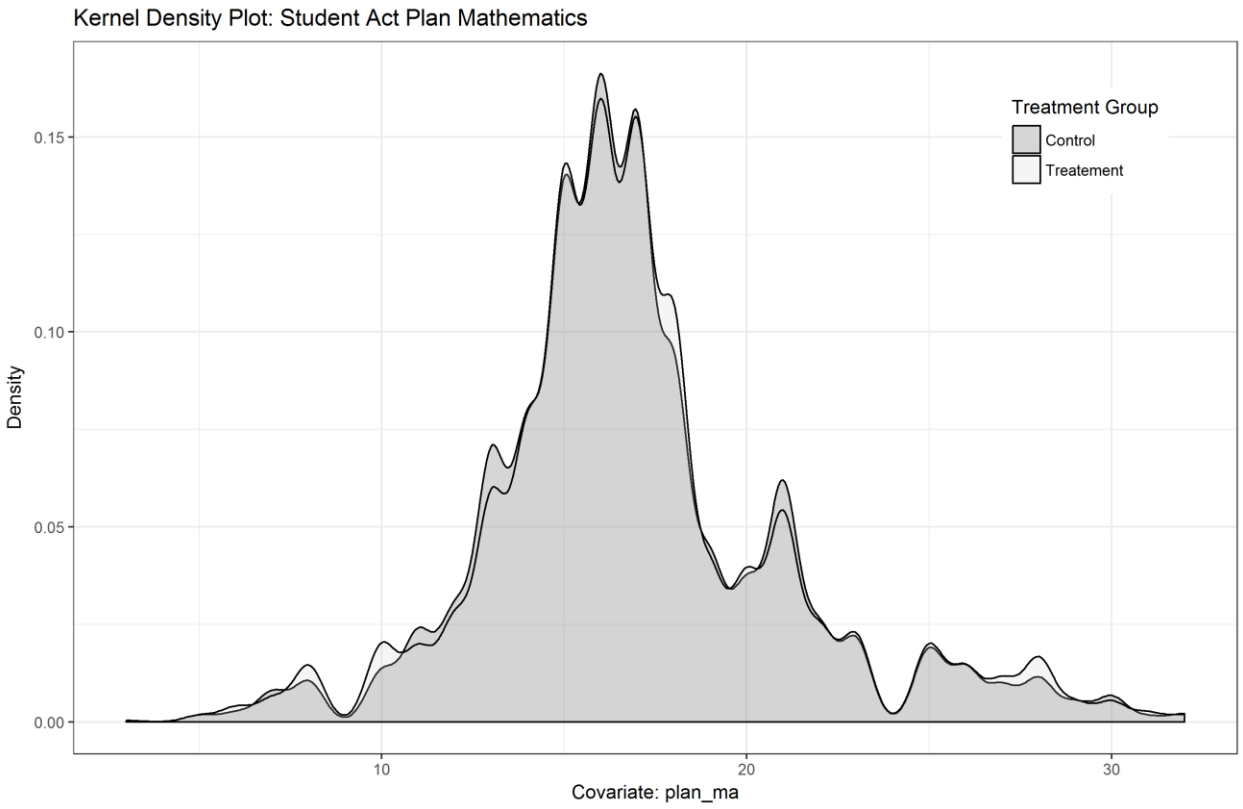

Scatter Plot: Student LEP
Treatment Group
Control
Treatement
Propensity Score
1.0
0.5
0.0
0.1
0.2
0.3
Covariate: lep

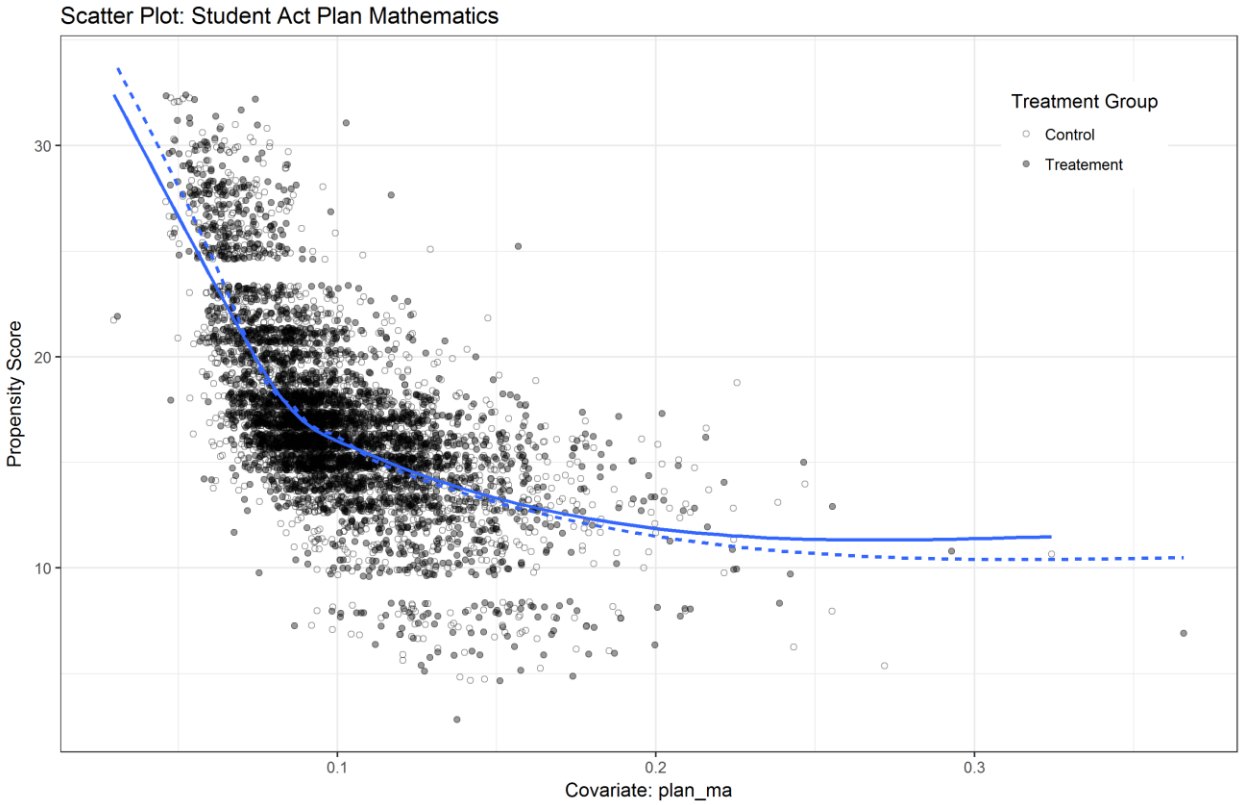
Kernel Density Plot: Student Male

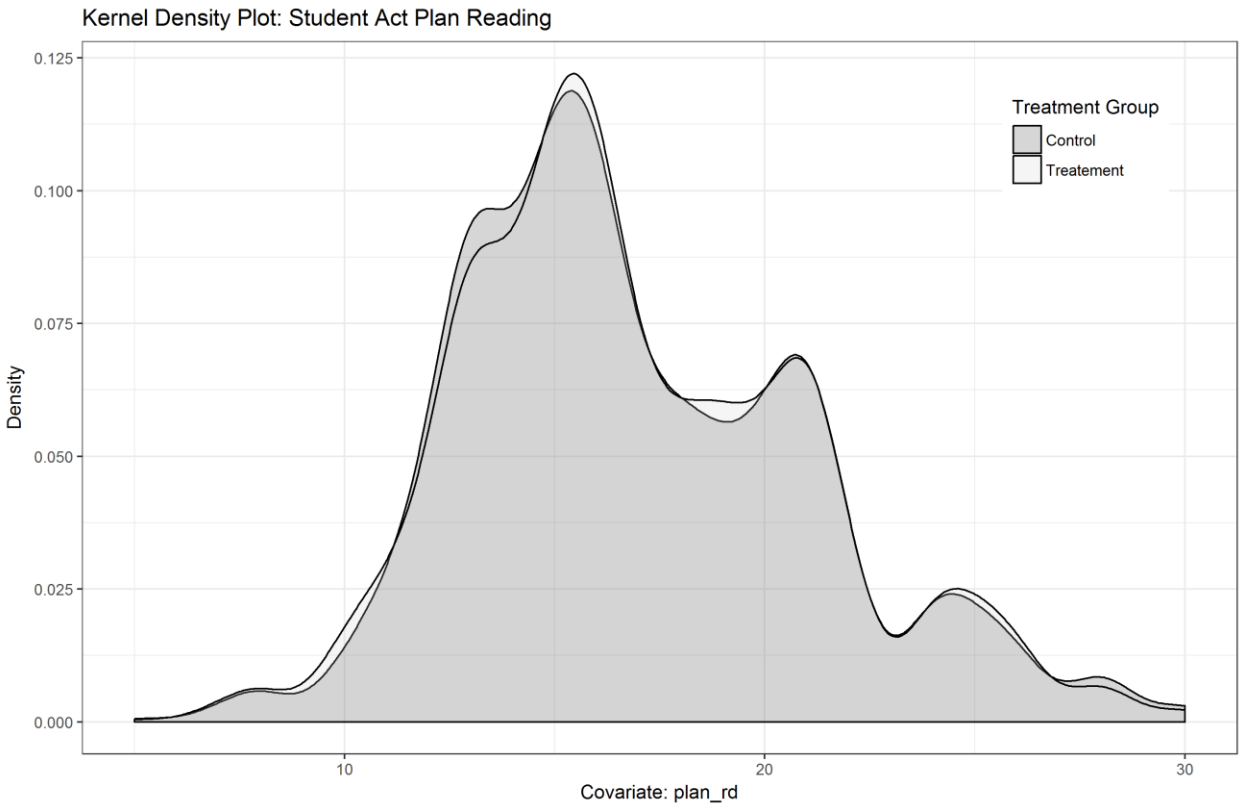


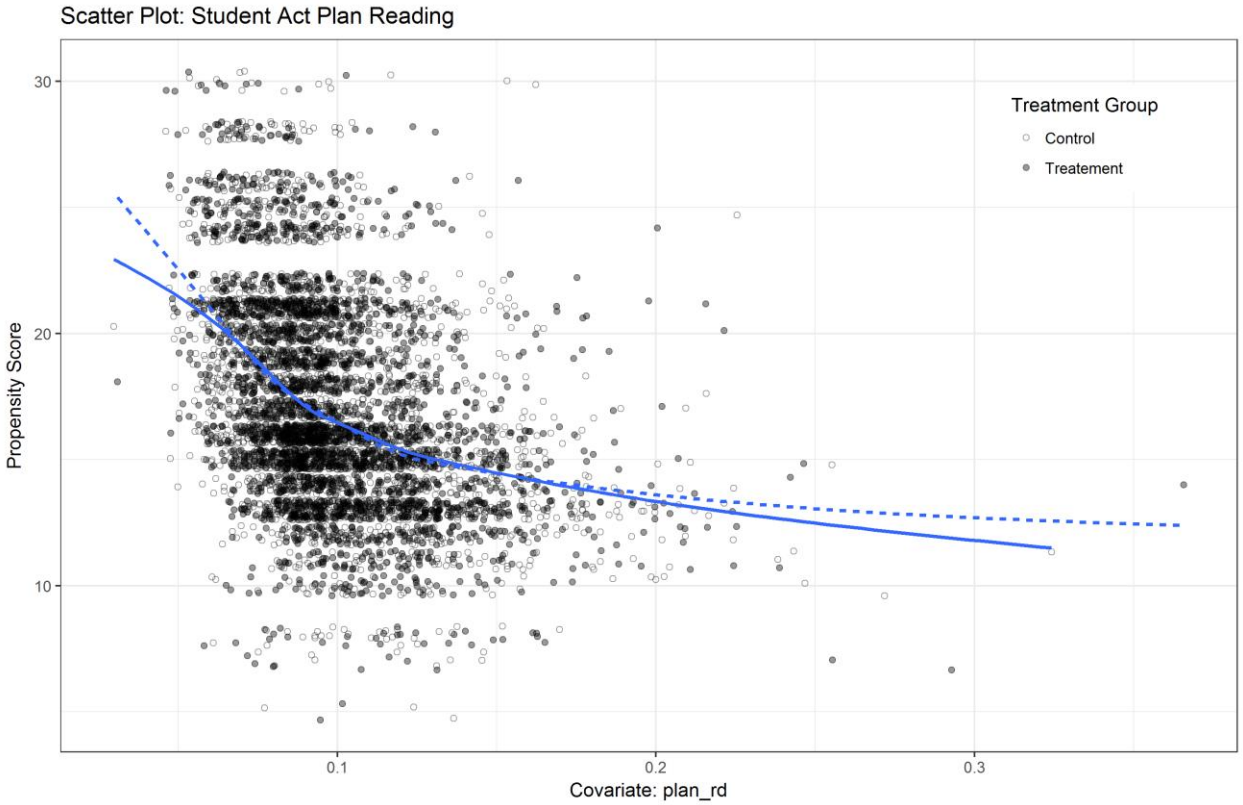
Scatter Plot: Student Male

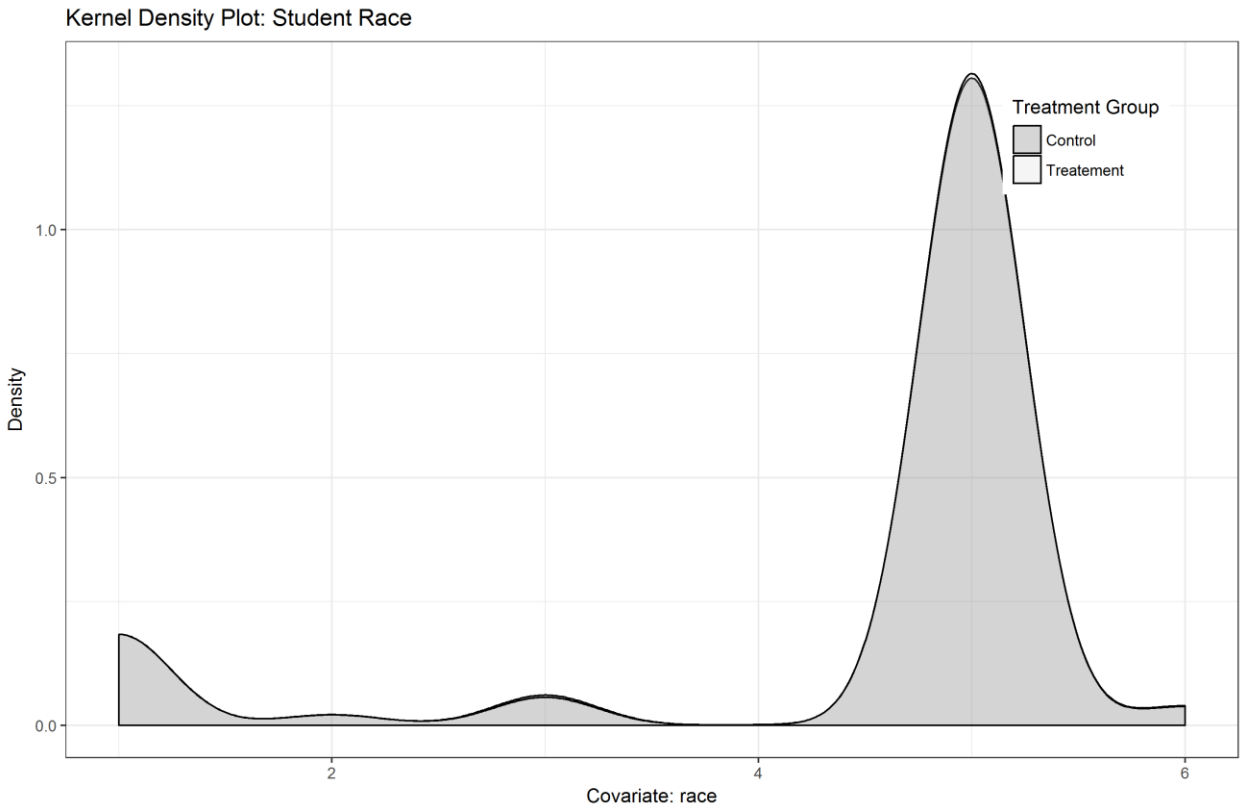


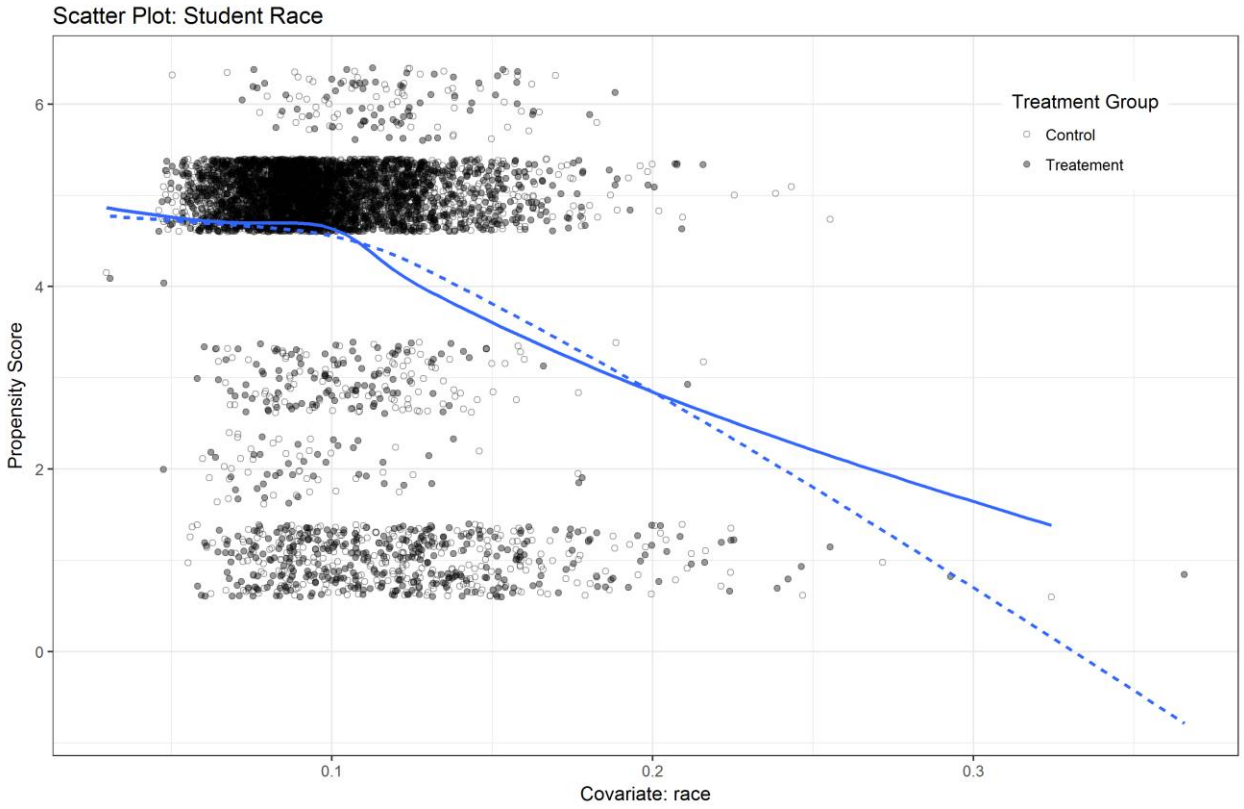

Kernel Density Plot: Student Act Plan Mathematics
Treatment Group
Control
Treatement
Density
0.15
0.10
0.05
0.00
10
20
30
Covariate: plan_ma

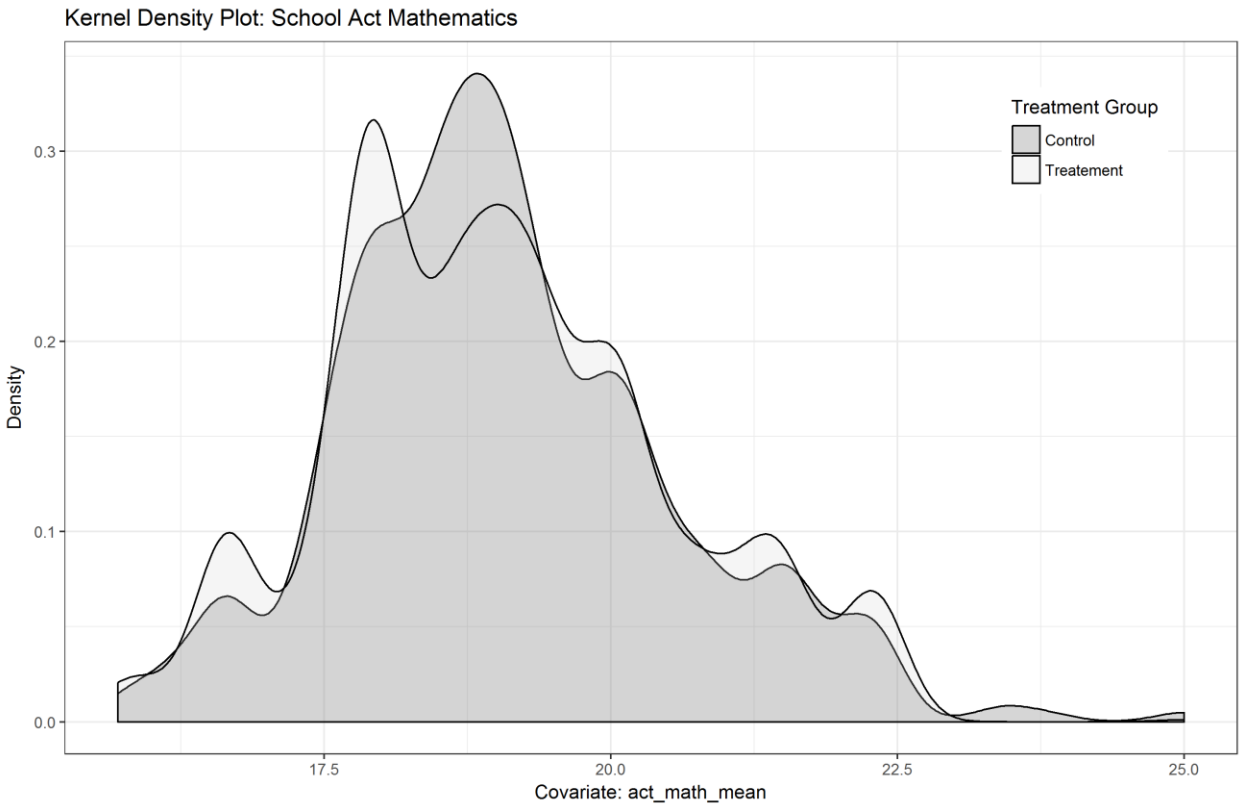

Scatter Plot: Student Act Plan Mathematics
Treatment Group
Control
Treatement
Propensity Score
30
20
10
0.1
0.2
0.3
Covariate: plan_ma

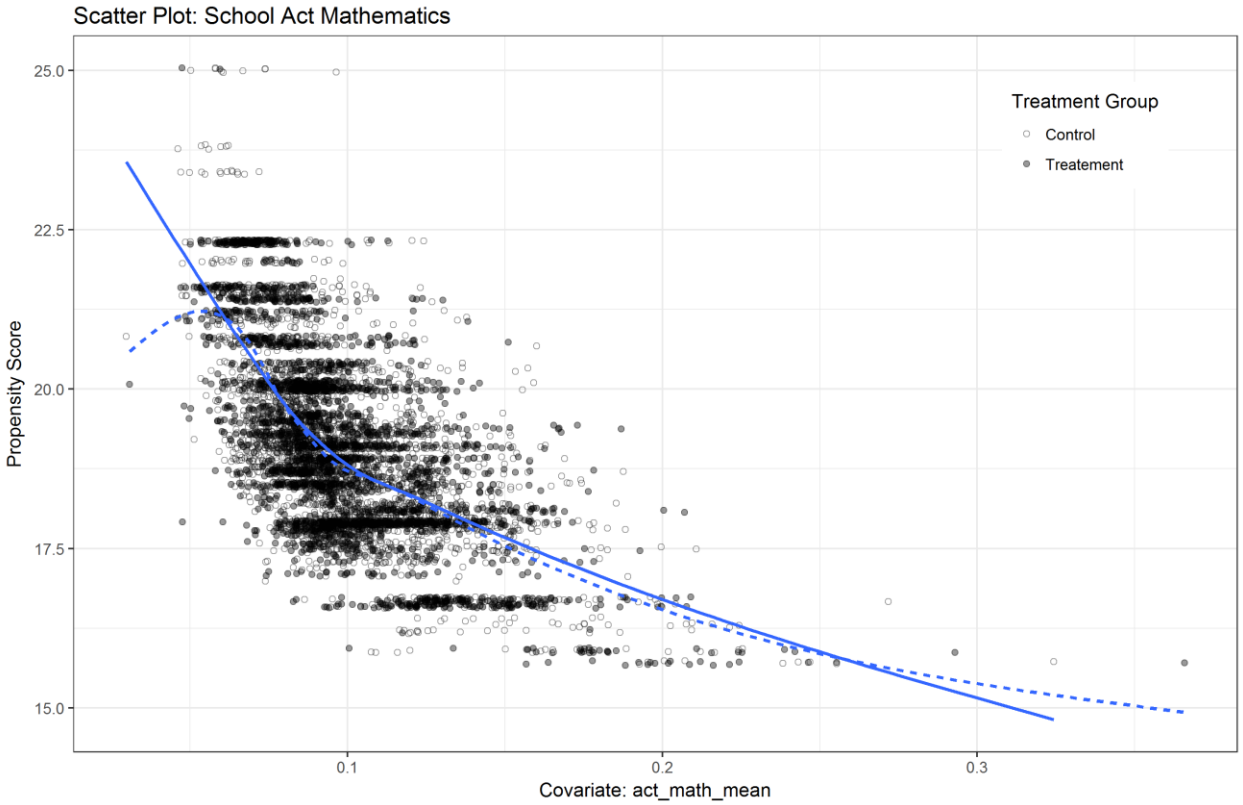

Kernel Density Plot: Student Act Plan Reading
Treatment Group
Control
Treatement
Density
0.125
0.100
0.075
0.050
0.025
0.000
10
20
30
Covariate: plan_rd

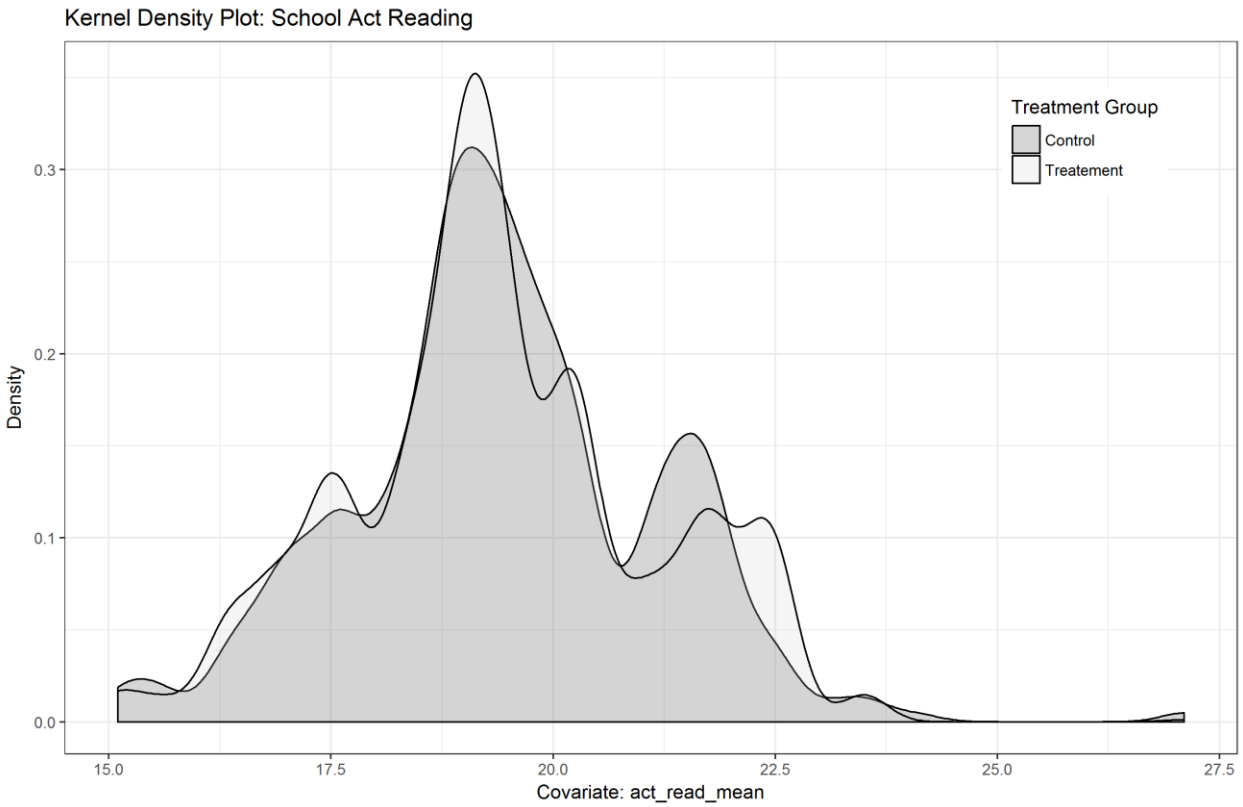

Scatter Plot: Student Act Plan Reading
Treatment Group
Control
Treatement
Propensity Score
30
20
10
0.1
0.2
0.3
Covariate: plan_rd

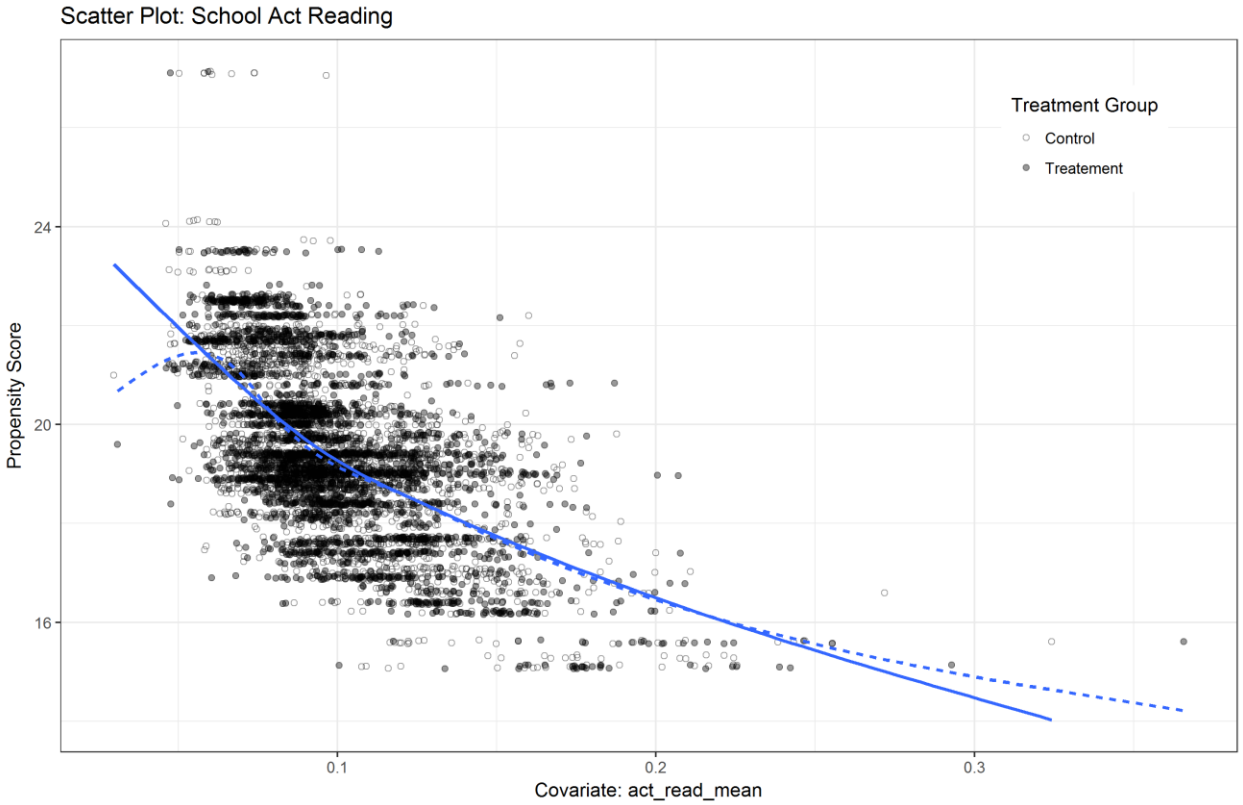

Kernel Density Plot: Student Race
Treatment Group
Control
Treatement
Density
1.0
0.5
0.0
2
4
6
Covariate: race

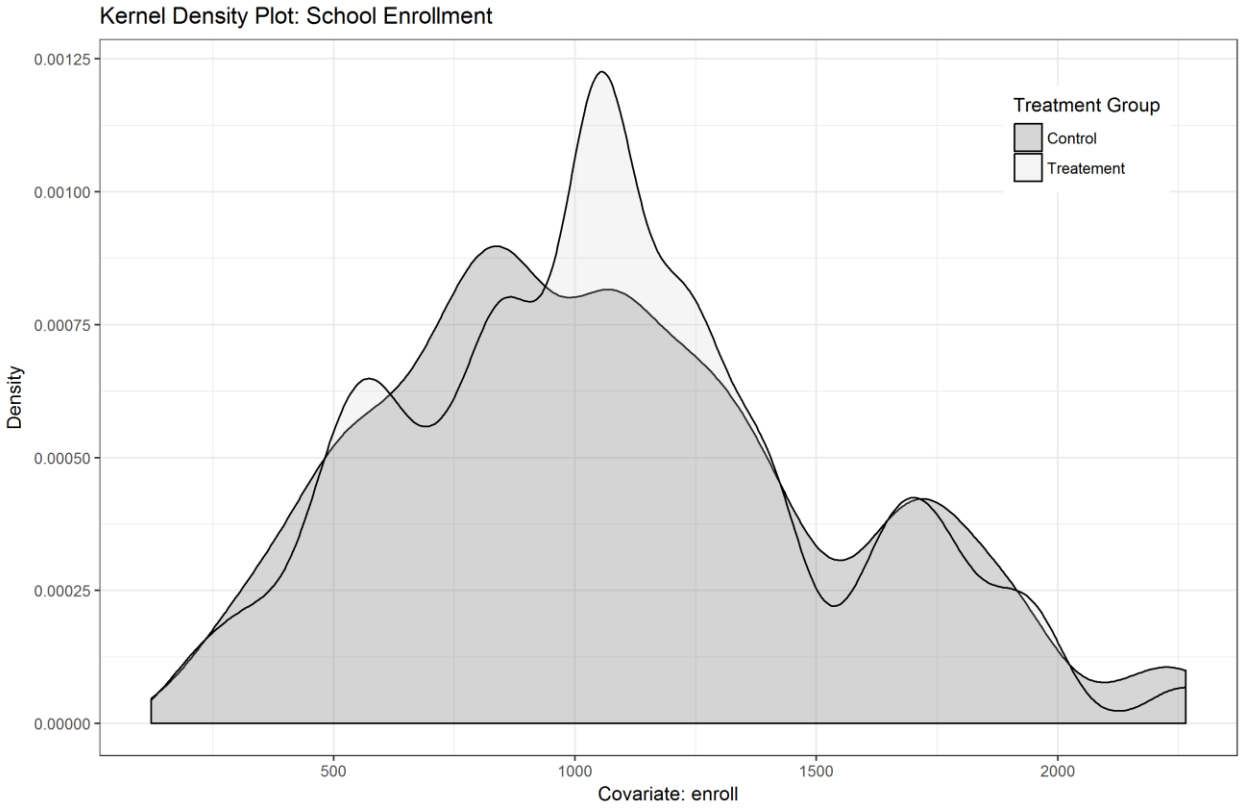

Scatter Plot: Student Race
Treatment Group
Control
Treatement
Propensity Score
6
4
2
0
0.1
0.2
0.3
Covariate: race

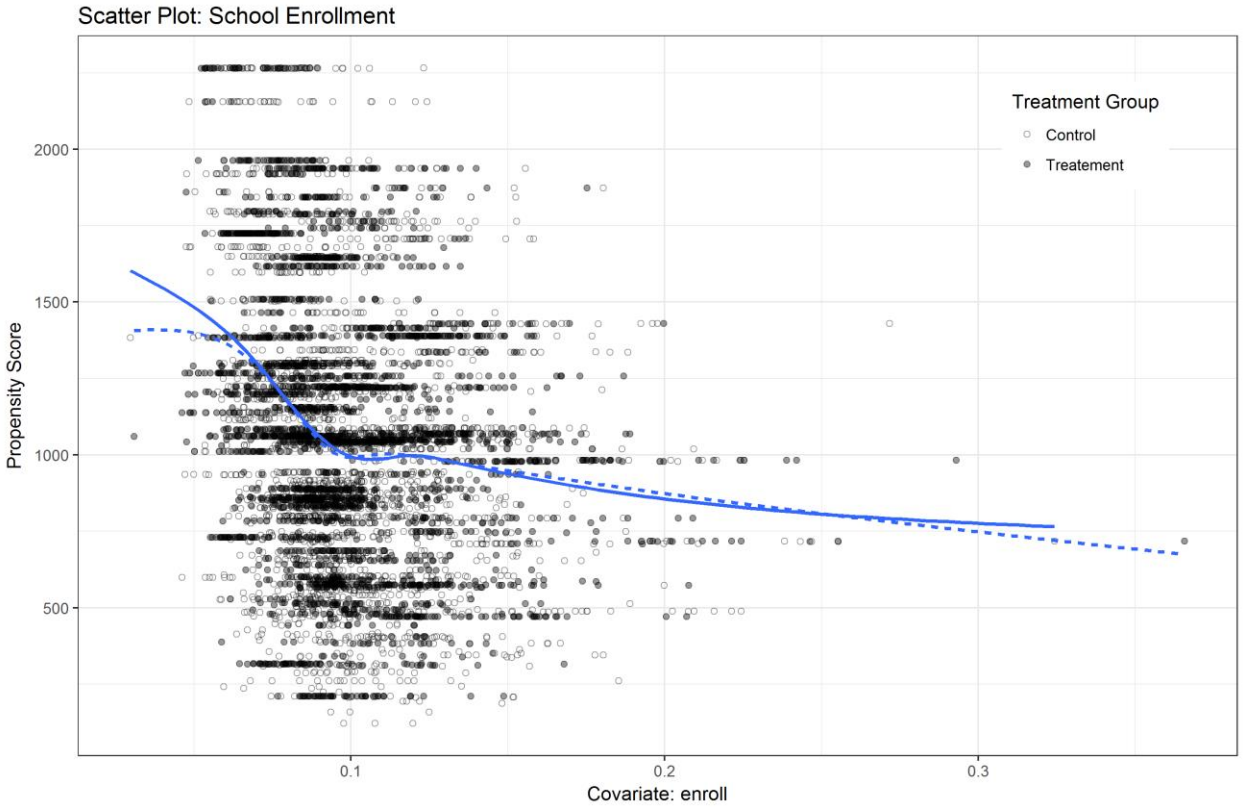

Kernel Density Plot: School Act Mathematics
Treatment Group
Control
Treatement
Density
0.0
0.1
0.2
0.3
17.5
20.0
22.5
25.0
Covariate: act_math_mean

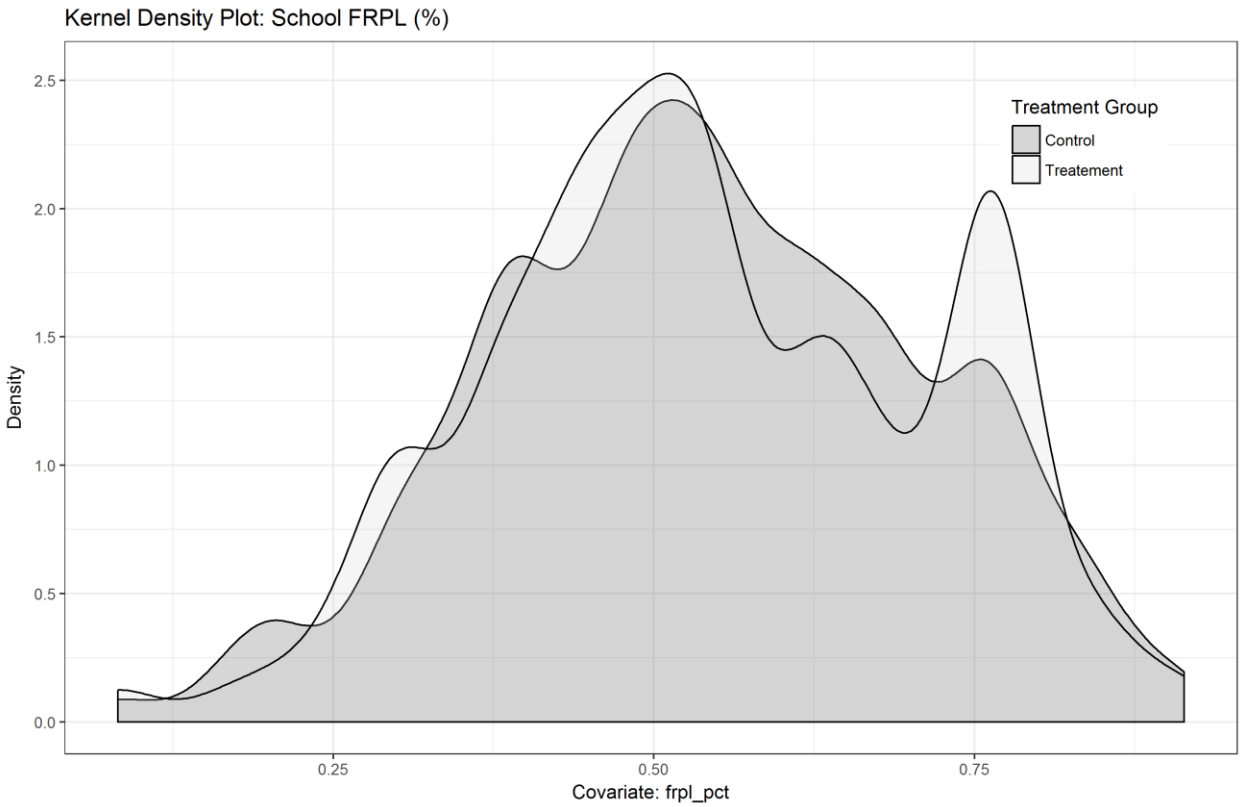

Scatter Plot: School Act Mathematics
Treatment Group
Control
Treatement
Propensity Score
15.0
17.5
20.0
22.5
25.0
0.1
0.2
0.3
Covariate: act_math_mean

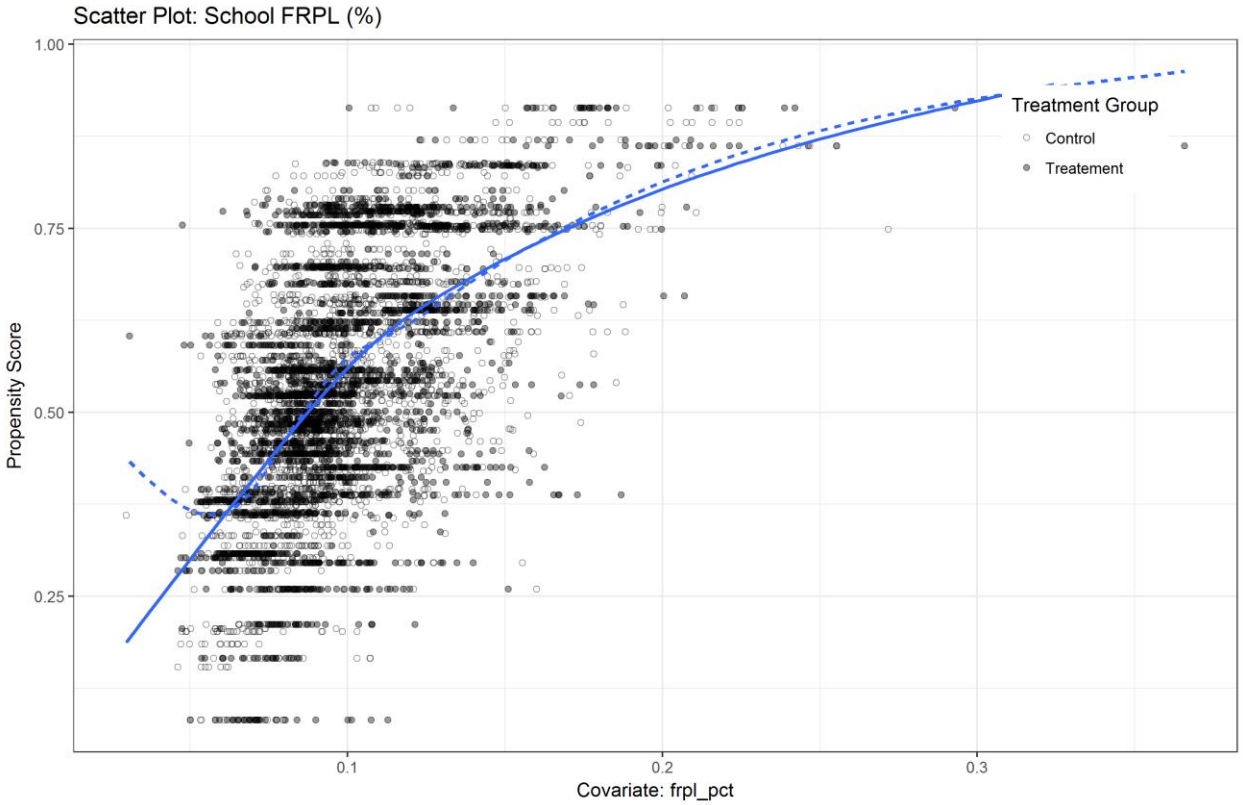

Kernel Density Plot: School Act Reading
Treatment Group
Control
Treatement
Density
0.0
0.1
0.2
0.3
15.0
17.5
20.0
22.5
25.0
27.5
Covariate: act_read_mean

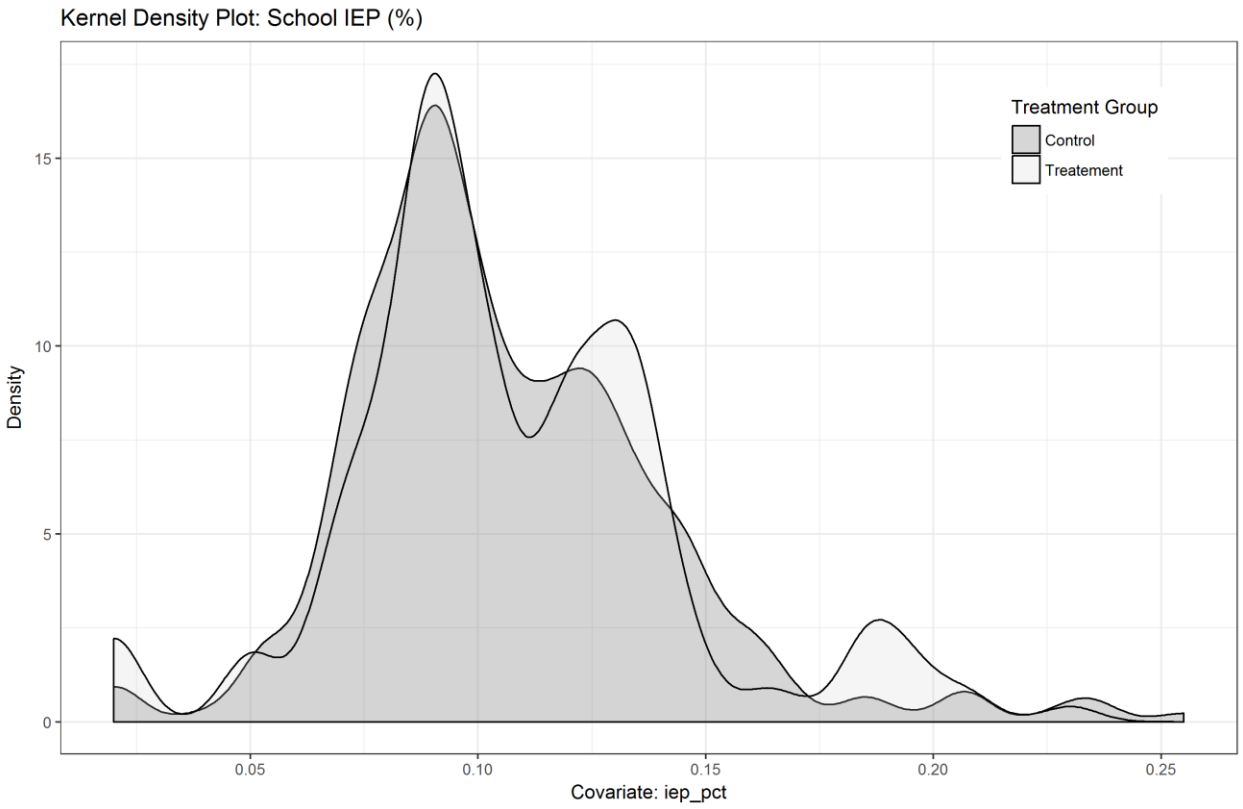

Scatter Plot: School Act Reading
Treatment Group
Control
Treatement
Propensity Score
16
20
24
0.1
0.2
0.3
Covariate: act_read_mean

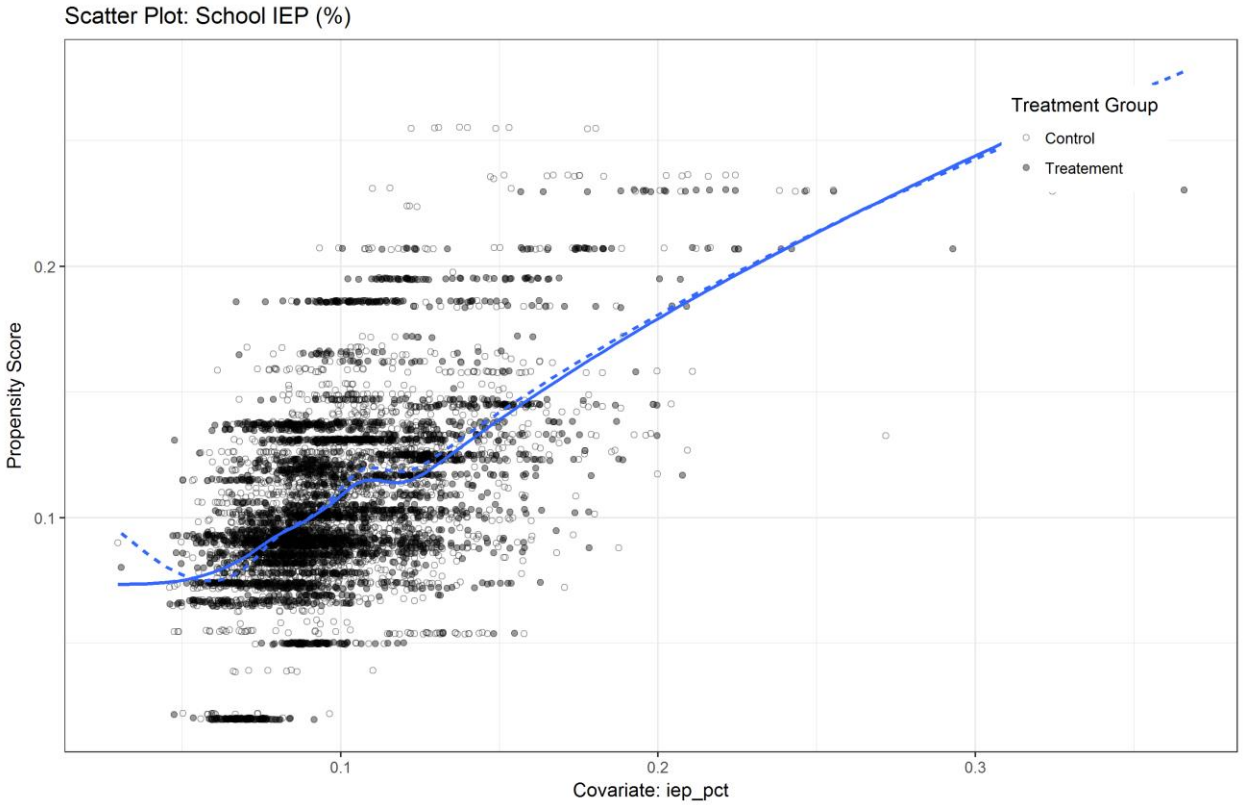

Kernel Density Plot: School Enrollment
Treatment Group
Control
Treatement
Density
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
500
1000
1500
2000
Covariate: enroll

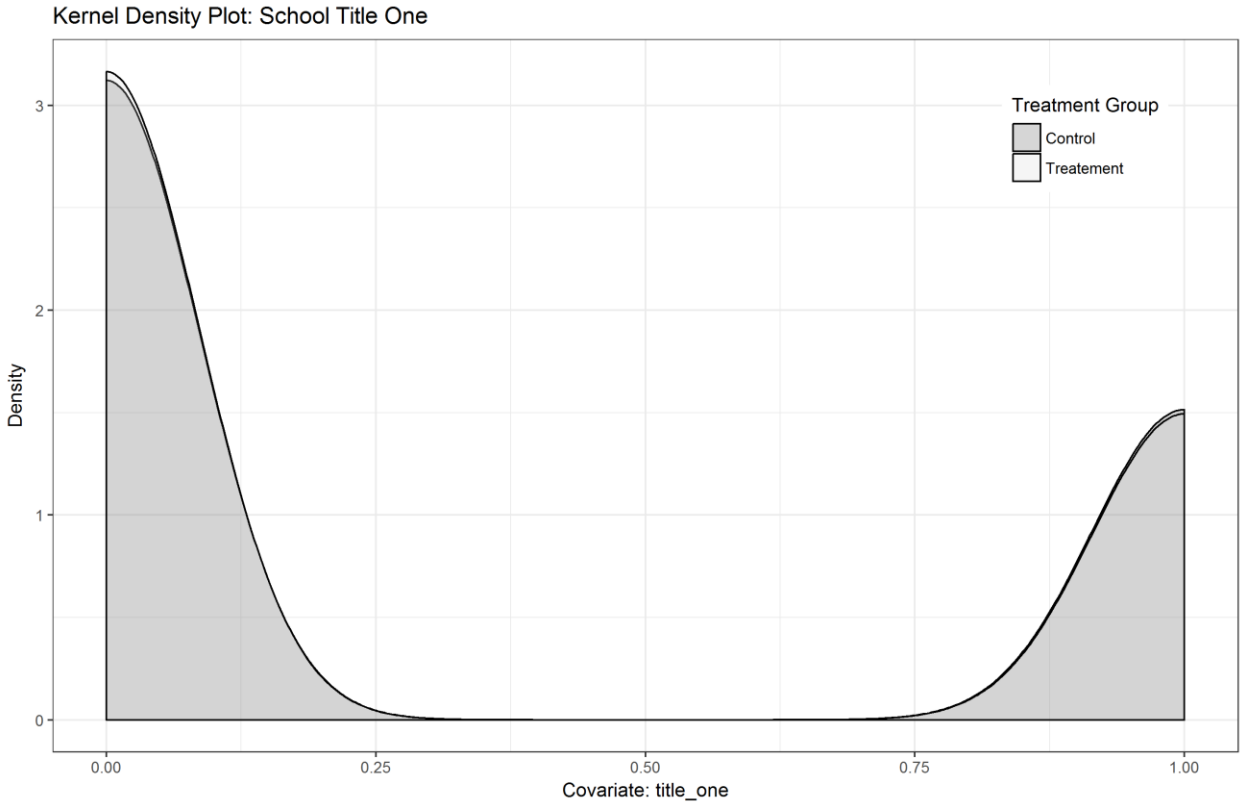

Scatter Plot: School Enrollment
Treatment Group
Control
Treatement
Propensity Score
2000
1500
1000
500
0.1
0.2
0.3
Covariate: enroll

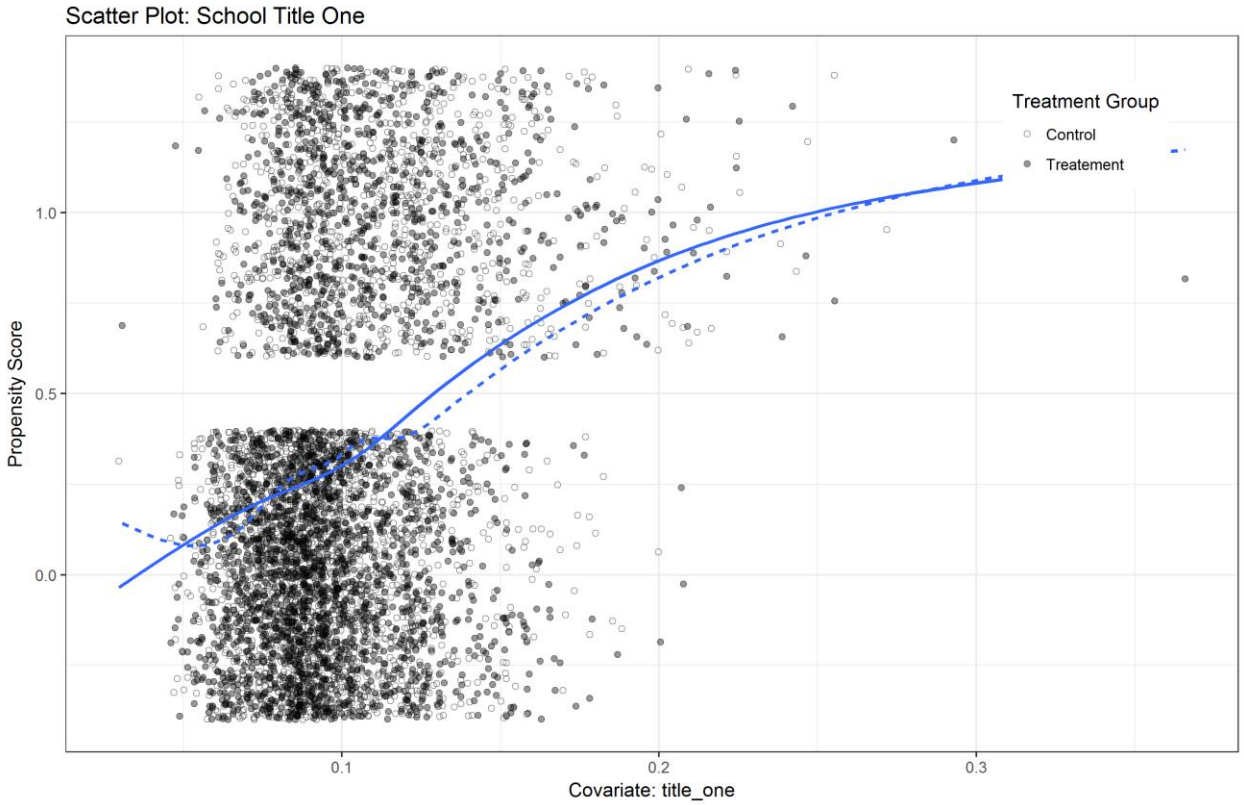

Kernel Density Plot: School FRPL (%)
Treatment Group
Control
Treatement
Density
2.5
2.0
1.5
1.0
0.5
0.0
0.25
0.50
0.75
Covariate: frpl_pct

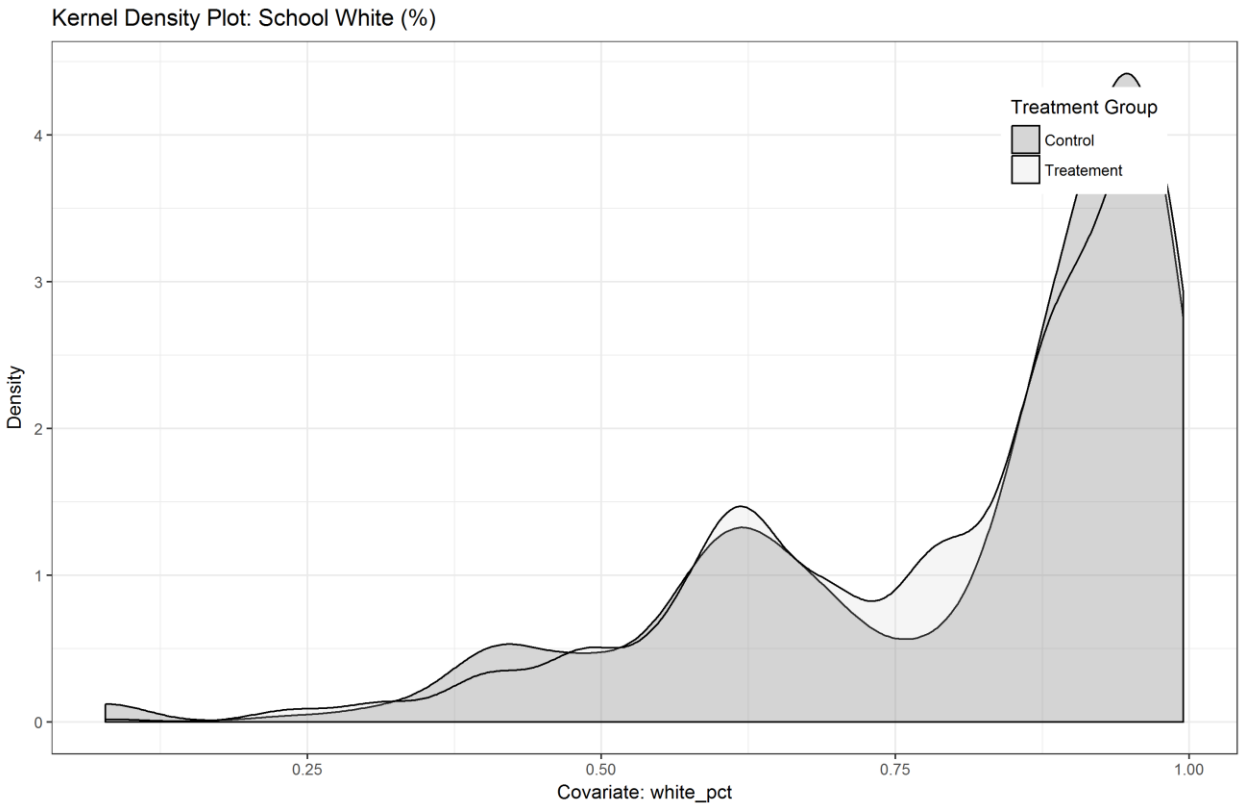

Scatter Plot: School FRPL (%)
Treatment Group
Control
Treatement
Propensity Score
1.00
0.75
0.50
0.25
0.1
0.2
0.3
Covariate: frpl_pct

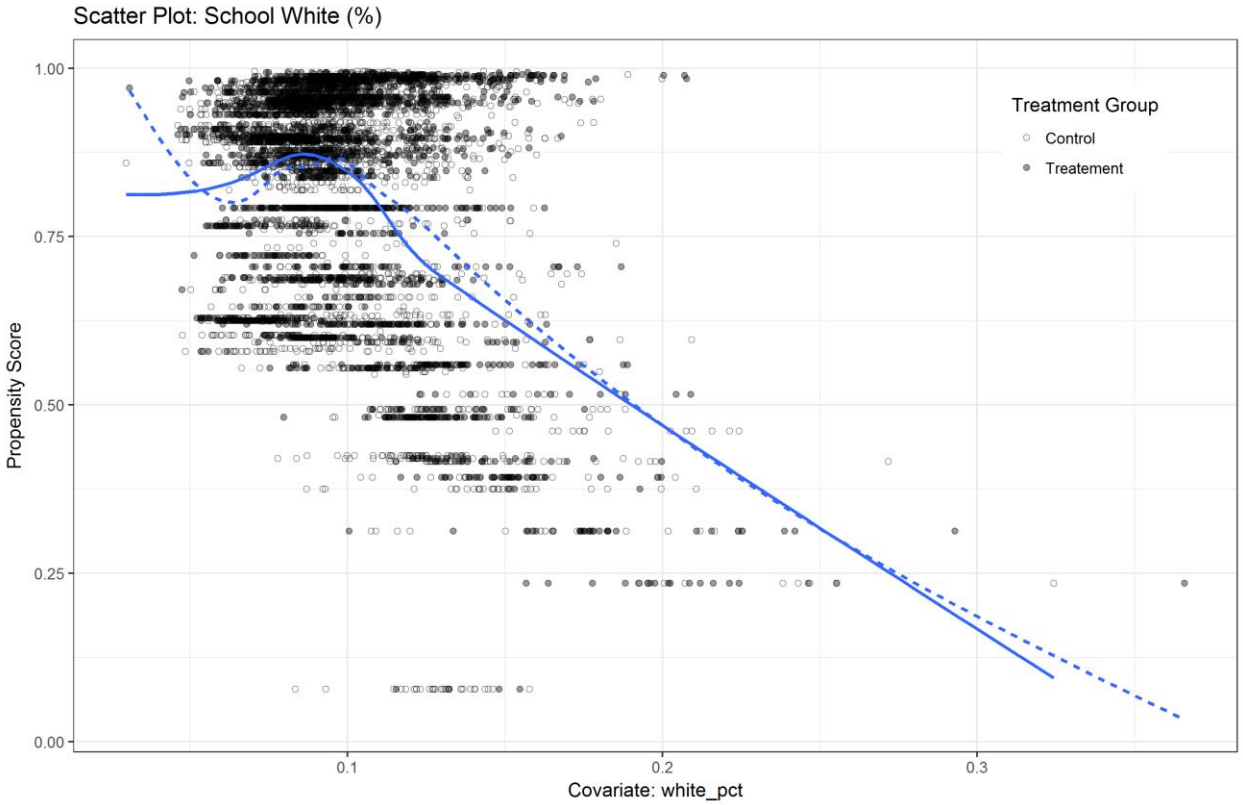

Kernel Density Plot: School IEP (%)
Treatment Group
Control
Treatement
Density
15
10
5
0
0.05
0.10
0.15
0.20
0.25
Covariate: iep_pct


Scatter Plot: School IEP (%)
Treatment Group
Control
Treatement
Propensity Score
0.2
0.1
0.1
0.2
0.3
Covariate: iep_pct


Kernel Density Plot: School Title One
Treatment Group
Control
Treatement
Density
0
1
2
3
0.00
0.25
0.50
0.75
1.00
Covariate: title_one


Scatter Plot: School Title One
Treatment Group
Control
Treatement
Propensity Score
0.0
0.5
1.0
0.1
0.2
0.3
Covariate: title_one


Kernel Density Plot: School White (%)
Treatment Group
Control
Treatement
Density
0
1
2
3
4
0.25
0.50
0.75
1.00
Covariate: white_pct


Scatter Plot: School White (%)
Treatment Group
Control
Treatement
Propensity Score
0.00
0.25
0.50
0.75
1.00
0.1
0.2
0.3
Covariate: white_pct

Appendix D: Propensity Score Model Summary

Logistic Regression Model Coefficients Used to Estimate Propensity Scores

Covariates	***Treatment***
Student age (years)	0.036 (0.36)
Student gender (male)	0.086** (0.041)
Student race (Asian)	0.006 (0.185)
Student race (Hispanic)	0.013 (0.124)
Student race (Native American)	-0.826 (0.727)
Student race (White)	-0.032 (0.075)
Student race (Multiple/Other)	0.172 (0.147)
Student FRPL (yes)	-0.026 (0.045)
Student IEP (yes)	0.223*** (0.074)
Student LEP (yes)	-0.567** (0.266)
Student gifted (yes)	-0.110* (0.056)
Student homeless (yes)	0.314** (0.139)
ACT Plan mathematics (z-score)	-0.114*** (0.030)
ACT Plan reading (z-score)	0.039 (0.028)
KPREP grade 10 writing (z-score)	-0.023 (0.026)
School Title I (yes)	-0.063 (0.050)
School enrollment	-0.0001 (0.0001)
School minority (%)	0.611*** (0.143)

(continued)

Covariates	***Treatment***
School free and/or reduced price lunch (%)	0.235 (0.251)
School special education (%)	1.823*** (0.705)
School average on ACT mathematics (z-score)	-0.121*** (0.037)
School average on ACT reading (z-score)	0.063* (0.033)
Constant	-1.550* (0.875)

Notes. Includes all grade 11 students who (a) attended a public high school in Kentucky during the academic year 2013-2014, (b) had a valid teacher identification number listed on their transcript, (c) completed the ACT test during the state assessment window, and (d) had a valid grade 10 ACT Plan and KPREP writing scores reported in the prior academic year (n=30,544). Standard errors are in parentheses. Treatment variable was a binary indicator whether a student was assigned to an alternatively certified teachers.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Appendix E: Teacher Effects Estimates, Full Tables

Effects of Alternatively Certified Teachers on Mathematics Achievement, Grade 11, Full Table

	ACT Mathematics (scale score)		
Coefficients	(1)	(2)	(3)
Treatment	0.191* (0.115)	0.181* (0.097)	0.161** (0.066)
Gender: Male		0.474*** (0.099)	0.622*** (0.068)
Race: Asian American		2.318*** (0.459)	0.818** (0.313)
Race: Hispanic		0.688* (0.295)	-0.156 (0.201)
Race: Native American		5.520** (2.123)	1.966 (1.442)
Race: White		0.964*** (0.156)	-0.160 (0.108)
Race: Multiple/Other		0.868* (0.347)	-0.006 (0.236)
Age		-0.682*** (0.086)	-0.281*** (0.059)
FRPL: Yes		-1.444*** (0.102)	-0.385*** (0.071)
IEP: Yes		-2.523*** (0.163)	0.372** (0.119)
LEP: Yes		-2.168*** (0.611)	0.014 (0.417)
Gifted: Yes		4.067*** (0.125)	1.003*** (0.093)
Homeless: Yes		-0.839** (0.325)	-0.313 (0.221)
ACT Plan: Math			0.623*** (0.011)
ACT Plan: Reading			0.141*** (0.011)
KPREP Writing			0.236*** (0.019)

(continued)

Constant	18.856*** (0.081)	29.731*** (1.511)	24.008*** (1.029)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.0005	0.292	0.674

Notes. Includes grade 11 students enrolled in a mathematics course and who took the ACT mathematics test during the state testing window in 2013-2014 (n=4,646). Standard errors are in parentheses. Treatment variable was a binary indicator whether a student was assigned to an alternative certified teacher. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Effects of Alternatively Certified Teachers on Reading Achievement, Grade 11, Full Table

	ACT Reading (scale score)		
Coefficients	(1)	(2)	(3)
Treatment	0.240	0.222*	0.223**
	(0.153)	(0.133)	(0.091)
Gender: Female		-0.543***	0.040
		(0.134)	(0.094)
Race: Asian American		2.750***	0.682
		(0.627)	(0.432)
Race: Hispanic		1.483***	0.030
		(0.402)	(0.277)
Race: Native American		2.735	-1.267
		(2.897)	(1.992)
Race: White		1.903***	0.080
		(0.213)	(0.148)
Race: Multiple/Other		1.486**	0.270
		(0.474)	(0.326)
Age		-0.848***	-0.286***
		(0.118)	(0.081)
FRPL: Yes		-1.787***	-0.377***
		(0.139)	(0.098)
IEP: Yes		-2.712***	0.561***
		(0.223)	(0.164)
LEP: Yes		-3.831***	-0.437
		(0.834)	(0.576)
Gifted: Yes		4.869***	0.895***
		(0.171)	(0.129)
Homeless: Yes		-0.958*	-0.432
		(0.443)	(0.305)
ACT Plan: Math			1.338***
			(0.067)
ACT Plan: Reading			2.998***
			(0.063)
KPREP Writing			0.864***
			(0.061)
Constant	19.258***	32.912***	24.776**
	(0.108)	(2.062)	(1.422)

(continued)

Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.0004	0.253	0.647

Notes. Includes grade 11 students enrolled in a reading course and who took the ACT reading test during the state testing window in 2013-2014 (n=5,156). Standard errors are in parentheses. Treatment variable was a binary indicator whether a student was assigned to an alternative certified teachers. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Effects of Classroom Teaching Experience on Mathematics Achievement, Grade 11, Full Table

	ACT Mathematics (scale score)		
Coefficients	(1)	(2)	(3)
Treatment	0.557**	0.325*	0.182*
	(0.190)	(0.161)	(0.110)
Experience (years)	0.079***	0.045***	0.018**
	(0.011)	(0.009)	(0.006)
Treatment * Experience	0.015	0.019	0.014
	(0.020)	(0.017)	(0.011)
Gender: Male		0.467***	0.618***
		(0.098)	(0.068)
Race: Asian American		2.245***	0.790*
		(0.458)	(0.312)
Race: Hispanic		0.646*	-0.173
		(0.294)	(0.200)
Race: Native American		5.407*	1.926
		(2.115)	(1.440)
Race: White		0.927***	-0.169
		(0.156)	(0.107)
Race: Multiple/Other		0.809**	-0.026
		(0.346)	(0.236)
Age		-0.689***	-0.286***
		(0.086)	(0.059)
FRPL: Yes		-1.413***	-0.374***
		(0.102)	(0.071)
IEP: Yes		-2.516***	0.364**
		(0.163)	(0.118)
LEP: Yes		-2.085***	0.042
		(0.609)	(0.416)
Gifted: Yes		4.020***	0.994***
		(0.125)	(0.093)
Homeless: Yes		-0.796*	-0.294
		(0.324)	(0.220)
ACT Plan: Math			2.690***
			(0.049)
ACT Plan: Reading			0.598***
			(0.046)

(continued)

KPREP Writing			0.546*** (0.044)
Constant	17.968*** (0.145)	29.437*** (1.510)	23.963*** (1.031)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.016	0.298	0.675

Notes. Includes grade 11 students enrolled in a mathematics course and who took the ACT mathematics test during the state testing window in 2013-2014 (n=4,646). Standard errors are in parentheses. Treatment variable was a binary indicator whether a student was assigned to an alternative certified teachers. Teacher classroom experience was measured in years. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Effects of Classroom Teaching Experience on Reading Achievement, Grade 11, Full Table

	ACT Reading (scale score)		
Coefficients	(1)	(2)	(3)
Treatment	0.608*	0.305	0.166
	(0.253)	(0.220)	(0.152)
Experience (years)	0.084***	0.041***	0.005
	(0.014)	(0.012)	(0.009)
Treatment * Experience	0.018	0.025	0.014
	(0.026)	(0.023)	(0.016)
Gender: Male		-0.549***	0.039
		(0.134)	(0.094)
Race: Asian American		2.679***	0.668
		(0.626)	(0.432)
Race: Hispanic		1.395***	0.019
		(0.402)	(0.277)
Race: Native American		2.624	-1.289
		(2.892)	(1.992)
Race: White		1.869***	0.078
		(0.213)	(0.149)
Race: Multiple/Other		1.433**	0.266
		(0.473)	(0.326)
Age		-0.855***	-0.289***
		(0.118)	(0.081)
FRPL: Yes		-1.755***	-0.370***
		(0.139)	(0.098)
IEP: Yes		-2.707***	0.555***
		(0.222)	(0.164)
LEP: Yes		-3.752***	-0.426
		(0.833)	(0.576)
Gifted: Yes		4.824***	0.892***
		(0.171)	(0.129)
Homeless: Yes		-0.915*	-0.421
		(0.443)	(0.305)
ACT Plan: Math			1.385***
			(0.067)
ACT Plan: Reading			2.995***
			(0.063)

(continued)

KPREP Writing			0.863*** (0.061)
Constant	18.322*** (0.193)	32.549*** (2.065)	24.717*** (1.426)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.010	0.256	0.648

Notes. Includes grade 11 students enrolled in a reading course and who took the ACT reading test during the state testing window in 2013-2014 (n=5,156). Standard errors are in parentheses. Treatment variable was a binary indicator whether a student was assigned to an alternative certified teachers. Teacher classroom experience was measured in years. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Effects of Kentucky Alterative Teacher Certification Pathways on Mathematics Achievement, Grade 11, Full Table

	ACT Mathematics (scale-score)		
Coefficients	(1)	(2)	(3)
Option 1: Exceptional Work Experience	0.493 (0.315)	0.345 (0.266)	0.281 (0.181)
Option 2: Local District Program	0.991 (0.747)	-0.160 (0.632)	0.374 (0.430)
Option 3: College Faculty	0.445 (0.556)	0.159 (0.470)	0.181 (0.320)
Option 4: Adjunct Instructor	3.979*** (0.658)	2.414*** (0.559)	0.572 (0.381)
Option 5: Armed Forces Veterans	1.489** (0.466)	0.829* (0.395)	0.470* (0.269)
Option 6: University-Based Program	0.078 (0.121)	0.138 (0.102)	0.140* (0.069)
Option 7: Institute Alternative Route	-2.262 (1.938)	-2.620 (1.640)	-0.391 (1.116)
Option 8: Teach For America	-2.470*** (0.644)	-1.516** (0.545)	-0.782* (0.371)
Gender: Male		0.475*** (0.098)	0.624*** (0.068)
Race: Asian American		2.164*** (0.461)	0.804* (0.314)
Race: Hispanic		0.667* (0.294)	-0.160 (0.201)
Race: Native American		5.549** (2.118)	1.988 (1.442)
Race: White		0.986*** (0.156)	-0.141 (0.108)
Race: Multiple/Other		0.849* (0.347)	-0.005 (0.236)
Age		-0.671*** (0.086)	-0.277*** (0.059)
FRPL: Yes		-1.412*** (0.102)	-0.374*** (0.071)
IEP: Yes		-2.505*** (0.163)	-0.377** (0.071)

(continued)

LEP: Yes		-2.153*** (0.610)	-0.001 (0.417)
Gifted: Yes		4.004*** (0.125)	1.000*** (0.093)
Homeless: Yes		-0.827* (0.324)	-0.309 (0.221)
ACT Plan: Math			2.695*** (0.049)
ACT Plan: Reading			0.598*** (0.046)
KPREP Writing			0.547*** (0.044)
Constant	18.862*** (0.081)	29.575*** (1.510)	23.975*** (1.031)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.012	0.296	0.675

Notes. Includes grade 11 students enrolled in a mathematics course and who took the ACT mathematics test during the state testing window in 2013-2014 (n=4,646). Standard errors are in parentheses. Options 1-8 were separate binary variables indicating whether a student was assigned to an alternative certified teacher who entered the profession through one of the eight alternative pathways, as designated by EPSB. Teacher classroom experience was measured in years. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Effects of Kentucky Alternative Teacher Certification Pathways on Reading Achievement, Grade 11, Full Table

	ACT Reading (scale score)		
Coefficients	(1)	(2)	(3)
Option 1: Exceptional Work Experience	0.454 (0.419)	0.191 (0.363)	0.091 (0.250)
Option 2: Local District Program	2.058* (0.994)	0.654 (0.863)	0.517 (0.595)
Option 3: College Faculty	0.589 (0.740)	0.325 (0.642)	0.417 (0.442)
Option 4: Adjunct Instructor	4.166*** (0.875)	2.297** (0.764)	0.676 (0.527)
Option 5: Armed Forces Veterans	2.185*** (0.620)	1.496** (0.540)	0.522 (0.372)
Option 6: University-Based Program	0.087 (0.160)	0.155 (0.139)	0.200* (0.096)
Option 7: Institute Alternative Route	-4.266* (2.579)	-5.256* (2.240)	-2.279 (1.543)
Option 8: Teach For America	-2.157* (0.856)	-1.011 (0.745)	0.311 (0.513)
Gender: Male		-0.093*** (0.023)	0.005 (0.016)
Race: Asian American		0.444*** (0.106)	0.111 (0.073)
Race: Hispanic		0.238*** (0.068)	0.005 (0.047)
Race: Native American		0.470 (0.489)	-0.211 (0.337)
Race: White		0.326*** (0.036)	0.015 (0.025)
Race: Multiple/Other		0.244** (0.080)	0.044 (0.055)
Age		-0.141*** (0.020)	-0.048*** (0.014)
FRPL: Yes		-0.295*** (0.024)	-0.063*** (0.017)
IEP: Yes		-0.454*** (0.038)	0.095*** (0.028)

(continued)

LEP: Yes		0.649*** (0.141)	-0.075 (0.097)
Gifted: Yes		0.818*** (0.029)	0.151*** (0.022)
Homeless: Yes		-0.161* (0.075)	-0.073 (0.052)
ACT Plan: Math			0.234*** (0.011)
ACT Plan: Reading			0.506*** (0.011)
KPREP Writing			0.145*** (0.010)
Constant	19.266*** (0.108)	32.622*** (2.063)	24.698*** (1.424)
Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.009	0.256	0.648

Notes. Includes grade 11 students enrolled in a reading course and who took the ACT reading test during the state testing window in 2013-2014 (n=5,156). Standard errors are in parentheses. Options 1-8 were separate binary variables indicating whether a student was assigned to an alternative certified teacher who entered the profession through one of the eight alternative pathways, as designated by EPSB. Teacher classroom experience was measured in years. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Effects of Kentucky Alternative Teacher Certification Pathways and Experience on Mathematics Achievement, Grade 11, Full Table

	ACT Mathematics (scale score)		
Coefficients	(1)	(2)	(3)
Option 1: Exceptional Work Experience	0.197 (0.919)	0.111 (0.781)	0.568 (0.533)
Option 2: Local District Program	-5.035* (2.456)	-1.572 (2.088)	1.596 (1.425)
Option 3: College Faculty	-0.544 (1.721)	-2.351 (1.460)	-0.930 (0.996)
Option 4: Adjunct Instructor	-1.057 (1.636)	-1.430 (1.387)	-2.041* (0.947)
Option 5: Armed Forces Veterans	-3.123* (1.890)	-3.191* (1.604)	-1.628 (1.094)
Option 6: University-Based Program	0.635** (0.220)	0.330* (0.187)	0.119 (0.128)
Option 7: Institute Alternative Route	-1.760 (1.922)	-2.325 (1.632)	-0.276 (1.114)
Option 8: Teach For America	-2.006 (2.421)	-0.397 (2.055)	-0.581 (1.402)
Experience (years)	0.079*** (0.011)	0.044*** (0.009)	0.017** (0.006)
Option 1 * Experience	-0.008 (0.052)	-0.0001 (0.044)	-0.022 (0.030)
Option 2 * Experience	1.567** (0.556)	0.415 (0.473)	-0.259 (0.323)
Option 3 * Experience	0.051 (0.113)	0.164* (0.096)	0.073 (0.065)
Option 4 * Experience	0.444*** (0.132)	0.341** (0.112)	0.233** (0.077)
Option 5 * Experience	0.417* (0.165)	0.363** (0.140)	0.190* (0.095)
Option 6 * Experience	0.003 (0.036)	0.032 (0.030)	0.036* (0.021)
Option 7 * Experience	-	-	-
Option 8 * Experience	0.176 (1.375)	-0.406 (1.168)	-0.021 (0.797)

(continued)

Gender: Male		0.468*** (0.098)	0.624*** (0.068)
Race: Asian American		2.095*** (0.459)	0.780* (0.313)
Race: Hispanic		0.630* (0.293)	-0.165 (0.200)
Race: Native American		5.359* (2.110)	1.886 (1.439)
Race: White		0.944*** (0.156)	-0.148 (0.108)
Race: Multiple/Other		0.790* (0.346)	-0.013 (0.236)
Age		-0.677*** (0.086)	-0.281*** (0.059)
FRPL: Yes		-1.397*** (0.102)	-0.373*** (0.071)
IEP: Yes		-2.496*** (0.162)	-0.371** (0.118)
LEP: Yes		-2.019*** (0.608)	0.068 (0.416)
Gifted: Yes		3.993*** (0.125)	0.992*** (0.093)
Homeless: Yes		-0.800* (0.323)	-0.301 (0.221)
ACT Plan: Math			2.680*** (0.049)
ACT Plan: Reading			0.594*** (0.046)
KPREP Writing			0.552*** (0.044)
Constant	17.966*** (0.144)	29.137*** (1.508)	23.789*** (1.031)

(continued)

Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.029	0.304	0.676

Notes. Includes grade 11 students enrolled in a mathematics course and who took the ACT mathematics test during the state testing window in 2013-2014 (n=4,646). Standard errors are in parentheses. Options 1-8 were separate binary variables indicating whether a student was assigned to an alternative certified teacher who entered the profession through one of the eight alternative pathways, as designated by EPSB. Teacher classroom experience was measured in years. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

Effects of Kentucky Alternative Teacher Certification Pathways and Experience on Reading Achievement, Grade 11, Full Table

	ACT Reading (scale score)		
Coefficients	(1)	(2)	(3)
Option 1: Exceptional Work Experience	-0.521 (1.228)	-1.154 (1.070)	-0.510 (0.739)
Option 2: Local District Program	-7.352* (3.280)	-2.648 (2.861)	1.104 (1.975)
Option 3: College Faculty	0.468 (2.298)	-1.345 (1.901)	-0.505 (1.312)
Option 4: Adjunct Instructor	1.924 (2.184)	1.345 (1.901)	-0.505 (1.312)
Option 5: Armed Forces Veterans	-1.663 (2.524)	-1.710* (2.198)	-0.124 (1.516)
Option 6: University-Based Program	0.616* (0.294)	0.245 (0.256)	0.061 (0.177)
Option 7: Institute Alternative Route	-3.732 (2.567)	-4.989* (2.236)	-2.241 (1.544)
Option 8: Teach For America	-0.077 (3.232)	1.419 (2.816)	1.551 (1.943)
Experience (years)	0.084*** (0.014)	0.041*** (0.012)	0.005 (0.008)
Option 1 * Experience	0.031 (0.052)	0.067 (0.044)	0.035 (0.042)
Option 2 * Experience	2.380** (0.743)	0.858 (0.648)	-0.129 (0.447)
Option 3 * Experience	-0.010 (0.150)	0.108 (0.131)	-0.002 (0.090)
Option 4 * Experience	0.198 (0.177)	0.086 (0.154)	0.106 (0.106)
Option 5 * Experience	0.348 (0.220)	0.290 (0.192)	0.059 (0.132)
Option 6 * Experience	0.019 (0.048)	0.050 (0.042)	0.044 (0.029)
Option 7 * Experience	-	-	-
Option 8 * Experience	-0.749 (1.837)	-1.197 (1.600)	-0.700 (1.104)

(continued)

Gender: Male		-0.563*** (0.134)	0.029 (0.094)
Race: Asian American		2.563*** (0.628)	0.641 (0.434)
Race: Hispanic		1.363*** (0.402)	0.021 (0.278)
Race: Native American		2.561 (2.890)	-1.341 (1.993)
Race: White		1.883*** (0.214)	0.083 (0.149)
Race: Multiple/Other		1.382** (0.214)	0.258 (0.327)
Age		-0.842*** (0.118)	-0.288*** (0.082)
FRPL: Yes		-1.728*** (0.140)	-0.369*** (0.098)
IEP: Yes		-2.694*** (0.222)	0.547*** (0.164)
LEP: Yes		-3.731*** (0.833)	-0.414 (0.577)
Gifted: Yes		4.793*** (0.171)	0.891*** (0.129)
Homeless: Yes		-0.929* (0.443)	-0.432 (0.306)
ACT Plan: Math			1.380*** (0.067)
ACT Plan: Reading			2.994*** (0.064)
KPREP Writing			0.863*** (0.061)
Constant	18.314*** (0.192)	32.356*** (2.066)	24.763*** (1.429)

(continued)

Controls			
Student characteristics	No	Yes	Yes
Prior achievement	No	No	Yes
R^2	0.019	0.26	0.648

Notes. Includes grade 11 students enrolled in a reading course and who took the ACT reading test during the state testing window in 2013-2014 (n=5,156). Standard errors are in parentheses. Options 1-8 were separate binary variables indicating whether a student was assigned to an alternative certified teacher who entered the profession through one of the eight alternative pathways, as designated by EPSB. Teacher classroom experience was measured in years. Student characteristics controls include age, gender, race/ethnicity, Free and/or Reduced Price Lunch status, special education status, Limited English Proficiency status, gifted status, and homeless status. Prior achievement controls include standardized scores for the grade 10 ACT Plan mathematics test, ACT Plan reading test, and KPREP On-Demand Writing test.
*p < 0.05; **p < 0.01; ***p < 0.001 (2-Tail).

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Curriculum Vitae

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EDUCATION

Ph.D.	Education Policy Studies, Indiana University, 2018 *Dissertation:* Different Pathways, Different Impacts: Examining How Alternative Certification Pathways Influence Student Achievement in Kentucky *Committee:* Chad Lochmiller (chair), Gary Crow, Suzanne Eckes, Dubravka Svetina
M.B.A.	Business Administration, Indiana University, 2011
M.S.	Secondary Education, Pace University, 2006
B.M.	Music Performance, University of British Columbia, 2004

PROFESSIONAL EXPERIENCE

2016-Present	Kentucky Department of Education, Frankfort, KY *Research Analyst, Office of the Commissioner*
2016-Present	Center for Education Policy Research, Cambridge, MA *Strategic Data Fellow*
2016	Center for Survey Research, Bloomington, IN *Research and Data Processing Associate*
2014-2016	Center for Evaluation and Education Policy, Bloomington, IN *Graduate Research Assistant*
2012-2016	Indiana University, Bloomington, IN *Associate Instructor*
2012-2014	Indiana University, Bloomington, IN *Graduate Assistant*
2007-2012	Fort Wayne Philharmonic, Fort Wayne, IN *Director of Education*
2006-2007	Japan Exchange and Teaching Programme, Takaoka, Japan *Assistant Language Teacher*
2006-2007	Association for Japan Exchange and Teaching Programme, Tokyo, Japan *Content Editor*
2004-2006	New York City Department of Education, New York, NY *Teacher, Teach For America Corps Member*

PUBLICATIONS

Peer-Reviewed Journal Articles

Eckes, S., Butler, A. J., & Wilson, N. M. (2015). *Brown v. Board of Education's* 60th anniversary: Still no cause for a celebration. *Education Law Reporter, 311*(1), 1-23.

Butler, A. J., Whiteman, R., & Crow, G. M. (2013). Technology's role in fostering transformational educator mentoring. *International Journal of Mentoring and Coaching, 2*(3), 233-248.

Books

Standlee, P. J., Butler, A., Warren, A., & Lazo, J. (Eds.) (2007). *Planet eigo: Down to earth team teaching*. Tokyo, Japan: National AJET Publications.

Non-Peer Reviewed Journal Articles, Reports, and Technical Reports

Butler, A. J. & Eckes, S. (2014). Segregation in schools: 60 years after *Brown v. Board of Education*. *Principal Leadership, 15*(2), 10-12.

Ruddy, A.-M., Yumarnamto, M., Butler, A., & Owens, C. (2014). Impact evaluation of foreign language and area studied (FLAS) fellowships and programming at Indiana University 2014 grand survey results: Institute for European Studies. Bloomington, IN: Center for Evaluation and Education Policy.

Ruddy, A.-M., Butler, A., Yumarnamto, M., Hiller, S., & Owens, C. (2014). Evaluation of outreach activities and programming at Indiana University 2014 outreach survey results: Center for Latin America and Caribbean Studies. Bloomington, IN: Center for Evaluation and Education Policy.

Ruddy, A.-M., Butler, A., Yumarnamto, M., & Hiller, S. (2014). Impact evaluation of outreach activities and programming at Indiana University 2014 outreach survey results: African Studies Program National Resource Center. Bloomington, IN: Center for Evaluation and Education Policy.

PRESENTATIONS

Competitive Conference Presentations

Nguyen, D., Butler, A. J., & Hunter, P. (2016, April). Developing the leadership capacity and leader efficacy of first-generation college students through involvement in student philanthropy. Paper submitted to the Tobias Leadership Conference, Indianapolis, IN.

Ruddy, A.-M. & Butler, A. J. (2016, March). Becoming a global university: An analysis of institutional policies aimed to internationalize university activities. Paper submitted for the Annual Conference of the Comparative and International Education Society, Vancouver, Canada

Ruddy, A.-M. & Butler, A. J. (2015, March). The ebb and flow of international higher education: Global and local policy perspectives. Paper submitted for the Annual Conference of the Comparative and International Education Society, Washington, D.C.

Butler, A. J. (2014, November). Keeping teachers in schools: An institutional perspective on job embeddedness in education. Paper submitted for the Annual Convention of the University Council for Educational Administration, Washington, D.C.

Whiteman, R. & Butler, A. J. (2013, November). You can't always get what you want: Indiana superintendents' preferences and teacher evaluation system selection. Paper submitted for the Annual Convention of the University Council for Educational Administration, Indianapolis, IN.

Selection of Invited Presentations and Guest Lectures

Butler, A. J., Carlton, J., Spencer, J., Vanderhaar, J., Weeter, C. (2018, June). *Addressing chronic absenteeism in Kentucky.* Presentation given at the AdvancED Kentucky Persistence to Graduation Summit, Lexington, KY.

Butler, A. J. (2018, June). *Chronic absenteeism and accountability.* Round table presentation given at the Strategic Data Project Convening, Boston, MA.

Weeter, C., Butler, A. J. (2017, September). *Chronic absenteeism: Facts and solutions.* Presentation given at the Kentucky Directors of Pupil Personnel Annual Institute, Lexington, KY.

Poquette, H., Butler, A. J. (2017, June). *Optimizing your data.* Presentation given at the Kentucky Center for Performance Excellence Annual Conference, Lexington, KY.

Butler, A. J. (2013, March). *Reflections on Teach For America.* Guest lecture for H340: Education and American Culture, Indiana University, Bloomington, IN.

Butler, A. J. & Cummings, C. T. (2011, November). *Connecting composition and the Fort Wayne Philharmonic to our Local Forth Graders through FAME.* Presentation given at the Indiana Music Educators Association State Convention, Fort Wayne, IN.

Butler, A. J. (2010, April). *Entrepreneurial orientation.* Guest lecture for M590: Strategic Management, Indiana University—Purdue University Fort Wayne, Fort Wayne, IN

Butler, A. J. (2010, April). *Integrating brain-based learning into the Fort Wayne Youth Symphony.* Presentation given at the Middle School High Abilities Conference, West Lafayette, IN.

Butler, A. J., Cummings, C. T., & Gibbons-Brown, K. (2009, November). *Building collaboration to build achievement: Fort Wayne Community Schools, Philharmonic, Ballet, and Museum of Art.* Presentation given at the National Middle School Association, Indianapolis, IN.

Butler, A. J. & Nave III, J. L. (2008, October). *The ins and outs of orchestra management.* Guest lecture for MUS 392: Music and Business, Taylor University, Taylor, IN.

PROFESSIONAL ACTIVITIES & SERVICE

- Assembly Representative, Graduate and Professional Student Organization, Indiana University, 2014-2015
- Event Facilitator, Martha McCarthy Education Law and Policy Institute, 2013-2015
- Selection Committee, Excellence in Mentoring Award, Indiana University, School of Education, 2014
- Reading Coach, Study Connections, Fort Wayne Community Schools, 2009-2012
- Chair, Strategic Directions Committee, Foundation for Arts and Music Education, 2009-2012
- Member, Board of Directors, Foundation for Arts and Music Education, 2008-2012
- Member, Broad Based Planning Committee, Fort Wayne Community Schools, 2008-2012
- Volunteer, Summer Reading Tutor, Learn United, 2009
- Volunteer, Chicago Institute, Teach For America, 2009