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The Effects of Teacher Entry Portals on Student Achievement

Gary T. Henry[1], Kelly M. Purtell[2], Kevin C. Bastian[3], C. Kevin Fortner[4], Charles L. Thompson[3], Shanyce L. Campbell[3], and Kristina M. Patterson[3]

Abstract

The current teacher workforce is younger, less experienced, more likely to turnover, and more diverse in preparation experiences than the workforce of two decades ago. Research shows that inexperienced teachers are less effective, but we know little about the effectiveness of teachers with different types of preparation. In this study, we classify North Carolina public school teachers into *portals*—fixed and mutually exclusive categories that capture teachers' formal preparation and qualifications upon first entering the profession—and estimate the adjusted average test score gains of students taught by teachers from each portal. Compared with undergraduate-prepared teachers from in-state public universities, (a) out-of-state undergraduate-prepared teachers are less effective in elementary grades and high school, (b) alternative entry teachers are less effective in high school, and (c) Teach For America corps members are more effective in STEM subjects and secondary grades.

Keywords

teacher research, quantitative research, HLM (Hierarchical Linear Modeling), educational policy

Currently, the teacher workforce is younger, less experienced, more likely to turnover, and more diverse in terms of their preparation experiences than it was two decades ago (Arnold, Choy, & Bobbitt, 1993; Feistritzer, 2011; Ingersoll & Merrill, 2010). While researchers have charted these changes in the teacher workforce, our knowledge about the relationship of teachers with these characteristics and their effectiveness is very uneven. For example, a large body of literature has estimated the relationship between experience and effectiveness, as measured by value-added models, and provides reasonably consistent findings that effectiveness increases for teachers' first 3 to 5 years but returns to experience diminish after that (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2006; Clotfelter, Ladd, & Vigdor, 2007, 2010; Hanushek, 1997; Harris & Sass, 2011; Henry, Bastian, & Fortner, 2011; Henry, Fortner, & Bastian, 2012; Rockoff, 2004). However, we know very little about the effectiveness of teachers based on the preparation they have received before beginning to teach. Current cohorts of teachers begin their careers with very different levels of preparation in the content they are expected to teach and how to teach it (Feistritzer, 2011; National Commission on Teaching and America's Future, 2009). Several studies have reported on the effectiveness of one particular group of beginning teachers, Teach For America (TFA) corps members (Boyd et al., 2006; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Decker, Mayer, & Glazerman, 2006; Henry, Bastian, & Smith, 2012; Henry et al., in press; Kane, Rockoff, & Staiger, 2008; Raymond, Fletcher, & Luque, 2001; Xu, Hannaway, & Taylor, 2011) but few studies provide evidence about the effects of other teachers with diverse preparation. Limited available research led the National Research Council (NRC) to declare the relationship between teacher preparation and teacher effectiveness an open question (NRC, 2010).

Background: The Diversity of Teacher Preparation Experiences

While the NRC documented 130 alternative pathways into teaching, a few general categories, which we label "portals" throughout this study, tend to dominate. Prior to the period of large-scale experimentation with teacher preparation requirements, the traditional or dominant model of preparation was

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receiving an undergraduate degree in education, which included instruction on content and pedagogy, and obtaining a teaching license within the state where the preparation program was located. After a period of exerting control over the preparation of teachers by setting standards for in-state teacher preparation programs, state legislatures and boards of education began to change their licensing policies in an effort to fill shortages and in hopes of improving students' performance. One of the earliest ways that states expanded the teaching pool was by establishing reciprocal licensing agreements with other states. These agreements allow teachers who completed their teacher preparation in one state to become certified in another with a minimum of effort. Although reciprocity agreements have been enacted for many years and exist in all states, they vary by both state of entry and exit, often change, and frequently contain additional requirements that teachers must meet to gain certification in a new state. Many states rely on teachers trained out-of-state to staff their public schools. For example, in 2004-2005, 12 states reported that more than 40% of the teachers to whom they granted initial certification were from another state; only four states reported that less than 10% of their teachers came from out-of-state (Coggshall & Sexton, 2008).

In addition to these reciprocity agreements, states have also created alternative pathways that allow individuals who did not attend traditional, accredited university-based preparation programs to enter the profession. These alternative entry programs first started in the 1980s as a way to reduce schools' reliance on teachers with emergency certification (Neumann, 1994); states later saw these alternative entry programs as ways to bring professionals from fields requiring strong subject matter knowledge into the classroom, diversify the teaching workforce, introduce greater competition for traditional teacher preparation programs, and perhaps, improve student achievement (Shen, 1997). Although there is substantial diversity in alternative entry programs—both within and across states—states have generally moved away from granting alternative entry to teachers with limited qualifications to developing programs that provide different ways for teachers to receive preparation (NRC, 2010). By the late 1990s, most alternative entry programs (a) were designed for individuals who had already earned a bachelor's degree in another field and (b) required coursework in education and fieldwork experience (Feistritzer, 2005). A hallmark that defines alternative entry programs is that at least some of the required training on how to teach occurs after the individuals have entered the classroom.

As states made these changes to their certification requirements, specialized alternative entry programs have also developed. These programs provide their own training and often operate across states. Perhaps the most visible of these programs, TFA, recruits academically competitive undergraduate students (most of whom are not in teacher education programs) to commit to teaching in a high poverty school for 2 years. Prior to beginning teaching, TFA corps members attend a 5-week summer preparation program, and throughout corps members' teaching commitments, TFA provides mentoring and professional development. Another specialized alternative entry route is the Visiting International Faculty (VIF) program, which brings teachers from a variety of countries to teach in U.S. schools for at least 2 years (VIF, 2013). Finally, there is the licensure-only path, which blends traditional and alternative routes by offering individuals with 4-year degrees a course of study that they can follow under the auspices of a traditional preparation program to become fully certified prior to beginning teaching.

Because of this proliferation of new routes in to the profession, teachers now enter the classroom with a wide range of preparation experiences. Furthermore, the criteria used to select teacher candidates into preparatory programs vary both across states and across alternative routes. As a result, new teachers exhibit a wide range of skills, abilities, and other important characteristics (Boyd et al., 2006; Hoy & Spero, 2005).

To better understand how these differences are related to teacher effectiveness, researchers have used value-added modeling to examine whether teacher preparation routes influence student achievement gains. Here, two valuable bodies of research have emerged. The first focuses on understanding how broad differences in teachers' preparation or certification type predict student achievement gains (e.g., Clotfelter et al., 2007; Goldhaber & Brewer, 2000; Kane et al., 2008). This work provides important information about the teacher workforce, but as detailed in the section below, is currently limited by the measures available to define teacher preparation categories. The second body of research focuses on the effectiveness of teachers prepared at different teacher preparation programs operating within a state (e.g., Gansle, Noell, & Burns, 2012; Henry et al., 2011; Plecki, Elfers, & Nakamura, 2012). While these studies have precisely defined teacher preparation categories, they only examine teachers from in-state traditional preparation programs, and therefore, exclude a large proportion of new teachers.

In the present study, we address the limitations of these earlier studies by using administrative data sources to identify the precise preparation that qualified every North Carolina public school teacher to enter the classroom. Specifically, we classify teachers into *portals*—fixed and mutually exclusive categories that capture a teacher's formal preparation and qualifications upon first entering the teaching profession. Our classification scheme includes 11 distinctly defined portals, which include 8 categories of traditional teacher preparation and 3 categories of alternative entry preparation.[1]

The primary goal of this study is to examine whether teachers from some portals are more effective, as measured by student achievement gains, than teachers who entered from other portals. Because there is reason to hypothesize that teachers with different types of preparation may produce larger (or smaller) student achievement gains in some grades and subjects than others, we separately assess the impact of teacher portals at the elementary, middle, and high school levels on student test scores in reading, mathematics, science, and (in high school only) social studies.

In the following section, we summarize prior research on the effectiveness of teacher preparation categories and teacher preparation coding schemes. We then detail our process for classifying teachers into portals and describe the data, sample, and methods used for this research. Next, we present the results regarding teacher portal effectiveness, and finally, we discuss the implications of our work for research, teacher preparation, and policy.

Teacher Preparation Research and Classification Schemes: The Issues

Beginning with the Coleman Report, decades of research on the effects of school-based inputs definitively show that (a) teachers are the school resource explaining the most variation in student achievement and (b) there is substantial variation in teacher effectiveness (Aaronson, Barrow, & Sander, 2007; Coleman et al., 1966; Nye, Konstantopoulos, & Hedges, 2004). To explain this variation, many researchers have asked whether a teacher's type of preparation or certification status predicts students' test score growth. Here, quantitative studies have sparked debates between those who support traditional teacher preparation and certification and those who stress the need for alternative entry programs to meet the demand for teachers, particularly in high-need subjects/schools; increase diversity in the teacher workforce; and attract more able men and women into teaching (Darling-Hammond, Berry, & Thoreson, 2001; Gordon, Kane, & Staiger, 2006; Shen, 1997).

Overall, this body of teacher preparation/certification research has generated two broad findings. First, traditionally prepared or regularly certified teachers appear more effective in the early stages of their careers (Boyd et al., 2006; Clotfelter et al., 2007, 2010; Kane et al., 2008). These returns to traditional preparation/regular certification are generally small and dissipate with teaching experience, however, such that the efficacy of the credential as a signal of teacher quality is limited (Boyd et al., 2006; Clotfelter et al., 2010). Second, there is more variation in teacher effectiveness within preparation/certification categories than between them, which has been taken to mean that variables other than preparation may have greater effects on a teacher's classroom success (Boyd, Goldhaber, Lankford, & Wyckoff, 2007; Henry et al., in press; Kane et al., 2008).

Despite these findings, a recent NRC report asserts that the question of the effectiveness of teachers with different qualifications at entry into the profession remains unsettled (NRC, 2010). In large measure, this openness is attributable to the conceptual and operational challenges of classifying teachers into preparation categories. Specifically, there are three main classification issues: First, researchers need to establish consistent definitions for their teacher categories. This makes it difficult for researchers to rely on national data, where definitions may vary across states, or on teacher self-reports. Second, researchers need to distinguish between teacher classification variables that change over time (e.g., certification status for a particular grade/subject) and classification variables that are fixed at entry into the profession (e.g., preparation type). This distinction is essential because through additional coursework and passing licensure exams, two teachers with very different pre-service preparation experiences—one traditionally prepared and one alternatively prepared—can hold the same certification status after just a few years of experience. Thus, studies that classify teachers according to a time-varying certification status may mask effectiveness differences between teachers with different forms of initial preparation. Finally, researchers need to account for the great variety of credentials that qualify individuals to teach by creating more fine-grained classifications—moving beyond two broad categories of traditionally and alternatively prepared. As better data have become available and research has advanced, researchers have employed classification schemes more attuned to these challenges.

Teacher Preparation Research and Classification Schemes: Empirical Studies

In a path-breaking study, Goldhaber and Brewer (2000) relied on self-reports of a national sample of instructors to classify teachers into five certification categories—standard, probationary, emergency, private, and noncertified. Although this was one of the first studies to make finer-grained distinctions between teachers, two classification issues challenge the interpretation of their findings.[2] First, the definitions for each self-reported certification type may have varied within the study sample due to differences in certification requirements across states. Second, teachers' self-reports were used to indicate their certification status for a particular subject/grade at the time of the survey, not the type of preparation that they received prior to entering the profession (Goldhaber & Brewer, 2000).

More recent work by Clotfelter and colleagues in North Carolina elementary and high schools classified teachers into three categories according to the status of their teaching license—regular, lateral entry, or other (Clotfelter et al., 2007, 2010). This scheme improved on work by Goldhaber and Brewer (2000) by employing administrative data (ensuring a consistent definition of teacher categories) and including an indicator for teachers whose licensure status had changed from lateral entry to regular during the study period. However, these studies still did not distinguish among the types of preparation that teachers held prior to becoming a teacher of record nor account for the diversity in entry credentials with more fine-grained categories.

Finally, two studies in New York City used state and district-level administrative data to further advance the classification of teacher preparation/certification. The classification scheme used by Boyd and colleagues (2006) divided teachers into six categories—college recommended, individual evaluation, New York City Teaching Fellows, TFA, temporary licensure, and other. Kane and colleagues included five groups—standard, New York City Teaching Fellows, TFA, international, and uncertified. Importantly, each of these studies treated teacher preparation/certification as a fixed characteristic based on a teacher's initial status upon first being hired in New York State (Boyd et al., 2006) or New York City (Kane et al., 2008). Despite this improvement, a finer-grained classification scheme could better account for the considerable heterogeneity in teachers' preparatory experiences, particularly within the broad categories of college recommended and standard certification.

In addition to these studies of broad preparation/certification pathways, a parallel body of research has focused on the effectiveness—the student achievement gains produced by program graduates—of individual teacher preparation programs within a state. In these studies, the effectiveness of beginning teachers from a specific teacher preparation program operating in the state is compared with the effectiveness of another group of teachers in the state. These comparison groups vary across studies—some have used veteran teachers as the reference category (Gansle et al., 2012; Osborne et al., 2012), others have used out-of-state prepared teachers (Goldhaber & Liddle, 2012; Plecki et al., 2012), and finally, some have used all other novice teachers (Gansle et al., 2012; Henry et al., 2011; Tennessee Higher Education Commission, 2012). While these studies report significant differences in the average effectiveness of graduates from certain teacher preparation programs, findings indicate that there is much more variation in effectiveness within preparation programs than between programs (Goldhaber & Liddle, 2012). For example, a study in Washington State found that only 2 of 13 teacher preparation programs produced student achievement gains that were significantly different from those produced by veteran teachers (the comparison group) in reading; no preparation programs had significant effects in mathematics (Plecki et al., 2012). Similarly, results from Louisiana show a large degree of overlap in program effectiveness, with even the statistically significant program differences being small in magnitude (Gansle et al., 2012).

With state and federal initiatives such as Race to the Top encouraging the evaluation of teacher preparation, these studies of university-based training programs will likely increase. Because this work only focuses on a subset of beginning teachers within a state, however, a need remains to examine the effectiveness of *all* sources of teacher preparation. Therefore, the goals of this study are to classify all early-career teachers into a preparation portal and to estimate the effects of these preparation portals on student achievement gains. In the next section, we describe our preparation portals and detail how they address the classification challenges presented above.

Classifying Teachers into Portals

In response to both the strengths and shortcomings of previous classification schemes, we created 11 preparation categories, which we refer to as portals, that are a fixed and exclusive characteristic that captures the qualifications of teachers as they first enter the profession. To classify teachers into portals, four fundamental questions structured our work. First, was the teacher fully qualified—that is, had she met all requirements for state licensure—when she became a teacher of record for the first time? Second, if so, was her qualification to teach based on a set of education-related courses taken in the process of earning an undergraduate/graduate degree or through a program that terminated in a licensure/certificate only? Third, what was the highest level of degree—undergraduate or graduate—that she held when first entering a classroom as a teacher of record? Finally, if fully qualified and degree holding, from what type of institution—one of the public institutions of higher education within the state, a private college or university within the state, or an out-of-state university—did she earn the degree?

With these questions as a guide, we created 11 mutually exclusive and fixed categories that pinpointed the portal through which an individual entered the teaching profession. A full listing of our 11 portal categories is as follows: in-state public undergraduate prepared, in-state public graduate degree prepared, in-state private undergraduate prepared, in-state private graduate degree prepared, out-of-state undergraduate prepared, out-of-state graduate degree prepared, in-state public licensure only, out-of-state licensure only, TFA, VIF, and alternative entry (other; see Table 1 for definitions of each portal).[3]

To categorize North Carolina public school teachers into one of these portals, we relied on administrative data from four sources. First, we used institutional data from the University of North Carolina General Administration (UNCGA), covering each of the state's 15 public universities, to identify in-state public prepared teachers at the undergraduate, graduate, and licensure-only level. Second, TFA provided us with data identifying their corps members in North Carolina. Third, the VIF program supplied identifiers for their teachers in the state. We chose to use this available information to establish separate portals for TFA and VIF, rather than include them in the alternative entry portal, because a primary goal of the portals is to create finer-grained classifications to better account for the variety in teacher preparatory experiences. Fourth, we utilized teacher education, licensure audit, and certified salary files from the North Carolina Department of Public Instruction (NCDPI). From

Table 1. Teacher Portal Definitions.

Teacher Portal	Definition
In-state public undergraduate prepared	A North Carolina public school teacher who completed the requirements for initial licensure at a UNC system institution before beginning teaching by earning (a) a bachelor's degree in education or (b) a bachelor's degree in another major while concurrently completing the necessary education-related coursework.
In-state public graduate degree prepared	A North Carolina public school teacher who earned a graduate degree from a UNC system institution and qualified for an initial license before beginning teaching.
In-state private undergraduate prepared	A North Carolina public school teacher who completed the requirements for initial licensure at a private (independent) institution in North Carolina before beginning teaching by earning (a) a bachelor's degree in education or (b) a bachelor's degree in another major while concurrently completing the necessary education-related coursework.
In-state private graduate degree prepared	A North Carolina public school teacher who earned a graduate degree from a private (independent) North Carolina institution and qualified for an initial license before beginning teaching.
Out-of-state undergraduate prepared	A North Carolina public school teacher who completed the requirements for initial licensure at an out-of-state institution before beginning teaching by earning (a) a bachelor's degree in education or (b) a bachelor's degree in another major while concurrently completing the necessary education-related coursework.
Out-of-state graduate degree prepared	A North Carolina public school teacher who earned a graduate degree at an out-of-state institution and qualified for an initial license before beginning teaching.
In-state public licensure only	A North Carolina public school teacher who, after earning a bachelor's degree at any public or private institution in the state, separately completes the education-related requirements for teacher licensure in a licensure/certificate program at a UNC system institution before beginning teaching.
Out-of-state licensure only	A North Carolina public school teacher who, after earning a bachelor's degree at any public or private institution in the state, separately completes the education-related requirements for teacher licensure in a licensure/certificate program at an out-of-state institution before beginning teaching.
Teach For America	A North Carolina public school teacher who entered teaching in North Carolina through the Teach For America program.
Visiting International Faculty	A North Carolina public school teacher who entered teaching in North Carolina through the Visiting International Faculty program.
Alternative entry	A North Carolina public school teacher who entered the profession prior to completing requirements for initial licensure (Teach For America corps members excluded)
Unclassifiable	A North Carolina public school teacher who cannot be classified into one of the portals above on the basis of available administrative data.

these data sets, we employed several key pieces of information to classify teachers into portals, including the year an individual began teaching; the basis for an individual's license when she started teaching; an individual's undergraduate and, when applicable, graduate degree graduation year; degree type (undergraduate or graduate); and degree origin (in-state public institution, in-state private institution, or an out-of-state institution). If an individual earned multiple degrees prior to becoming a teacher of record, we categorized her according to the degree most proximate to beginning teaching. Putting all these variables together, we categorized approximately 94% of North Carolina public school teachers into a unique portal.

When data were not sufficient to classify teachers into 1 of the first 11 portals described in Table 1, we placed individuals into an "unclassifiable" portal. This generally happened in three situations: (a) a teacher did not have a college graduation year in the data, (b) a teacher's highest degree earned prior to entering teaching was less than a bachelor's degree, or (c) administrative data recorded the person as a classroom teacher more than 1 year prior to her graduation year.[4] We retained this group as a portal in the analyses so that the student sample would not be biased by omitting these teachers.

In Figure 1, we display the portal classifications for the 100,616 teachers employed in North Carolina public schools in the 2009-2010 school year. In total, the in-state public university system—undergraduate, graduate, and licensure-only programs—supplied 35,632 teachers (slightly more than 35% of the workforce). Private colleges and universities in North Carolina supplied 12,850 teachers, or nearly 13% of the workforce, while nearly 30% of North Carolina's public school teachers (29,457) received teacher preparation in another state.[5] Over 15,000 teachers—more than 15% of the workforce—began teaching before completing the state's requirements for licensure. We categorized many of these

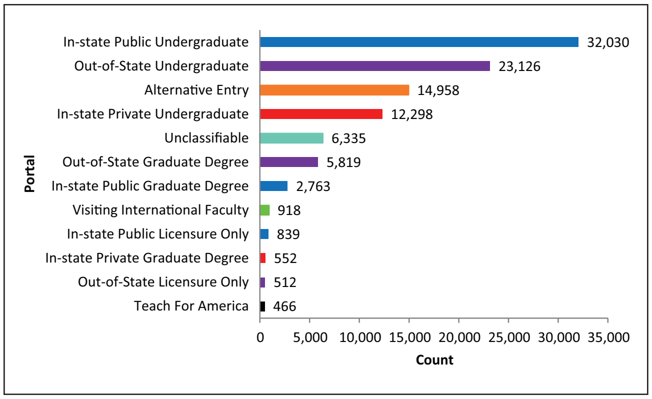

Figure 1. The distribution of teachers by portal in 2009-2010.
Note. In the 2009-2010 school year, there were 100,616 unique individuals paid as teachers (at least one pay period) in North Carolina public schools. This chart details how many unique teachers entered the profession through each portal.

teachers into the alternative entry portal and a small number into the TFA portal (TFA is the smallest portal, representing less than 0.50% of the state workforce). Finally, too little information was available to classify 6,335 teachers (unclassifiable). Clearly, North Carolina has a great diversity in how its teachers were prepared, with nearly half the state's teachers coming from out-of-state or beginning teaching before completing all licensure requirements. In the next section, we describe the study sample, data, and analytic approach used for our value-added analyses.

Method

Study Sample

The analysis data sets for our value-added models span the 2005-2006 through the 2009-2010 school years and are limited to tested-grade/subject teachers with less than 5 years teaching experience. We restrict our sample to these teachers for two reasons. First, research evidence indicates that the effects of teacher preparation decay over time, meaning that teachers are most likely to display measurable and relevant preparation influences early in their careers (Goldhaber & Liddle, 2012). Second, early career teachers now comprise approximately one quarter of the teacher workforce—both nationally and in North Carolina—and thus are a population of interest for states considering policy mechanisms to improve the quality of their teacher workforce (Ingersoll & Merrill, 2010).

For our analyses, we separate the data into 10 grade-level/subject combinations: three models for End-of-Grade exams in elementary grades (3-5)—mathematics, reading, and fifth-grade science; three models for End-of-Grade exams in middle grades (6-8)—mathematics, reading, and eighth-grade science; and four models for End-of-Course exams in high school grades (9-12)—mathematics (Algebra 1, Algebra 2, and geometry), English 1, science (biology, physical science, chemistry, and physics), and social studies (U.S. history and civics/economics). In elementary grades, student test score data are available for all 5 years (2005-2006 through 2009-2010) for mathematics and reading and from 2008-2009 through 2009-2010 for fifth-grade science.[6] In middle grades, student test score data are available for all 5 years for mathematics and reading and from 2007-2008 through 2009-2010 for the eighth-grade science exam. Finally, End-of-Course test score data at the high school level are available for all 5 years for mathematics, English 1, and social studies models. Due to test piloting, there are no student test score data for the high school science exams in 2006-2007; North Carolina also terminated the chemistry and physics End-of-Course exams after the 2008-2009 school year.

In total, across all elementary, middle, and high school models, we analyzed 2,679,204 test scores, 1,616,578 unique students, and 29,934 unique teachers with less than 5 years of experience. Table 2 displays descriptive information, by portal, at the elementary grades, middle grades, and high school levels, for the types of classrooms and schools in which our sample of teachers worked.

Dependent Variables and Covariates

The dependent variable for these value-added analyses is students' test score performance on the North Carolina End-of-Grade or End-of-Course exams. To remove any secular trends, we standardized all End-of-Grade exams within subject, grade, and year and all End-of-Course exams within subject and year. how? individually? In addition, we include year fixed effects in our value-added models. Standardized mathematics and reading scores from the previous grade, or from eighth grade for high school students, serve as prior achievement covariates in these value-added models. The focal variables in these analyses are a set of teacher preparation indicators, comparing 10 different teacher portals to the reference group of in-state public undergraduate-prepared teachers. As listed in Table 3, we also include a rich set of student, classroom/teacher, and school covariates in the value-added models to aid in isolating the impact of the teacher portals on student achievement gains. Specifically, (a) the student covariates adjust for time invariant and time-varying characteristics of students that have been significantly associated with achievement gains in previous work; (b) classroom/teacher variables account for items of classroom structure (e.g., class size, variation in prior achievement, curriculum level) and teacher credentials (e.g., teaching out-of-field, experience) that may influence teaching practices and may be imbalanced across the portals; and (c) school covariates adjust for variations in school enrollment, resources, and culture that may be imbalanced across the portals and may affect teachers' choices to work at the school and teachers' performance while employed there (see Appendix Table A1 for a brief definition of each covariate). Finally, for each year of data in our analyses, we performed a series of checks on our dependent variables and covariates—examining data against both reports issued by the NCDPI and data from previous years—to ensure missing data were minimized and did not occur in systematic patterns.

Table 2. Classroom and School Descriptives 2005-2006 Through 2009-2010.

Teacher Portal	Elementary school tested grades				Middle school tested subjects				High school tested subjects			
	Class average	Class FRPL	Class minority	School pass rate	Class average	Class FRPL	Class minority	School pass rate	Class average	Class FRPL	Class minority	School pass rate
In-state public undergraduate	−0.131	52.89	46.20	61.13	−0.215	46.58	44.56	62.20	−0.044	37.13	45.53	71.07
In-state public graduate	−0.124	49.71	46.91	64.59	−0.069	43.95	41.88	63.48	0.089	30.72	45.14	72.33
In-state private undergraduate	−0.083	51.40	39.92	62.76	−0.192	46.12	39.15	63.01	−0.051	35.41	45.62	70.92
In-state private graduate	0.019	48.62	46.09	67.31	−0.179	42.47	47.51	62.62	0.067	29.96	53.63	70.01
Out-of-state undergraduate	−0.122	51.51	53.07	61.03	−0.167	44.24	46.72	63.47	−0.072	36.33	49.43	69.80
Out-of-state graduate	−0.087	47.35	49.43	63.79	−0.132	43.36	48.15	63.63	0.003	34.08	48.52	71.15
In-state public licensure only	−0.073	51.38	47.23	62.33	−0.029	43.74	43.79	63.48	−0.011	34.46	44.30	69.19
Out-of-state licensure only	−0.277	52.43	48.08	61.35	−0.372	54.40	52.81	57.33	0.101	32.88	38.90	72.77
Teach For America	−0.453	72.66	83.32	47.55	−0.619	66.58	78.36	46.56	−0.518	58.73	82.01	56.59
Visiting International Faculty	−0.309	60.42	68.67	53.71	−0.454	54.01	58.03	51.69	−0.356	44.94	62.34	63.29
Alternative entry	−0.469	52.60	50.52	56.79	−0.451	51.70	53.16	55.14	−0.208	41.11	53.82	65.16

Note. This table displays descriptive information, by portal, for the classrooms and schools in which our sample of tested-grade/subject teachers work. Class average refers to the standardized prior test performance of students. Class FRPL displays the percentage of classroom students qualifying for subsidized lunches and class minority indicates the percentage of minority students. School pass rate shows the percentage of standardized exams passed at a school. FRPL = free and reduced-price lunch.

Table 3. Covariates Used in Value-Added Analyses.

Student covariates	Classroom/teacher covariates	School covariates
1. Prior achievement scores (std.)	1. Number of students	1. School size
2. Peer ability	2. Heterogeneity of prior achievement within the classroom	2. School size squared
3. Structural mobility	3. Advanced curriculum (middle school and high school only)	3. Total per-pupil expenditures
4. Between-year mobility	4. Remedial curriculum (middle school and high school only)	4. Average teacher salary supplement
5. Within-year mobility	5. Teaching out-of-field	5. Short-term suspension rate
6. Underage for grade	6. Single-year teacher experience indicators	6. Violent acts rate
7. Overage for grade	7. Teacher portals	7. Racial/ethnic composition
8. Giftedness		8. Concentration of poverty
9. Disability		
10. Poverty status		
11. Race/ethnicity		
12. Gender		
13. Currently limited English proficient		
14. Was limited English proficient		
15. Year effects		
16. Subject indicators (high school only)		

Analysis Plan

The main goal of this study is to generate unbiased estimates of the effectiveness of teachers entering through each of the identified portals. To fulfill this objective, a convincing strategy to identify the causal effects of these groups of teachers should credibly remove the confounding effect of variables that influence student performance that may not be balanced across the types of students, classrooms, and schools in which individuals from different portals teach. Therefore, taking advantage of the rich set of covariates (Table 3), our main estimation strategy is a three level—student, classroom, and school—hierarchical linear model using the proc mixed procedure, with the restricted maximum likelihood estimator, in SAS 9.3 (SAS Institute, Inc., 2011). This approach allows us to control for the nested structure of schooling data—students nested within classrooms, classrooms nested within schools—and estimate adjusted standard errors for correct inference. Because one portal must serve as the reference group, we designated the largest and most policy-relevant portal, in-state public undergraduate-prepared teachers, as the reference category. Controlling for the rich set of covariates described, model coefficients provide estimates of the adjusted-average differences in student achievement gains between teachers trained in traditional in-state public undergraduate programs and those in the specified portal. Here, it is important to clarify that the value-added estimates for teacher portals represent a combination of selection into training portals—both the characteristics preferred by training portals and the characteristics of individuals choosing among possible portals—and the teacher training received in a portal. While a separate estimate of training effects would be valuable, it is this combined selection and training effect that is of interest for state legislatures, school districts, and school administrators.[7] Overall, the equation used to estimate teacher portal effects is as follows:

$$Y_{ijst} = \gamma_0 + \gamma Y_{it-n} + \gamma_x X_{ijs} + \beta_2 \text{Portal}_2 + \ldots + \beta_{12} \text{Portal}_{12} + \beta_z Z_{js} + \delta_w W_s + \mu_i + \varepsilon_j + \tau_s,$$

where Y_{ijst} is the test score for student i, in classroom j, in school s, at time t; γ_0 represents the model intercept value for the reference student; $\beta_2 \ldots \beta_{12}$ estimate the average effect of the 11 portals in reference to in-state public undergraduate-prepared teachers; portal$_2$ … portal$_{12}$ are indicator variables that equal 1 if the teacher entered teaching through that portal and 0 if not; Y_{it-n} represents prior test score(s) for student i; X_{ijs}, Z_{js}, and W_s represent a set of student, classroom/teacher, and school covariates, respectively; γ_x, β_z, and δ_w estimate the average effect of the student, classroom/teacher, and school covariates, respectively; and μ_i, ε_j, and τ_s are disturbance terms representing unexplained variation at the student, classroom, and school levels, respectively.

While we consider this hierarchical linear model to be the most appropriate specification for *statewide* value-added comparisons between in-state public undergraduate-prepared teachers and their peers in the 10 other portals, two factors suggest that results from school fixed effect models—limiting effectiveness comparisons to teachers working in the same schools—will enhance our knowledge of teacher portal effects. First, previous research indicates that teachers are nonrandomly assigned to students, both between and within schools, and that school characteristics, such as principal leadership and teacher collaboration, influence teacher effectiveness (Branch, Hanushek, & Rivkin, 2012; Kennedy, 2010; Lankford, Loeb, & Wyckoff, 2002; Rothstein, 2010). To the extent that these factors disproportionately affect teachers from a certain portal (e.g., teachers from a particular portal are frequently assigned to students with a greater propensity for achievement gains or concentrated in schools with high-quality principal leadership) *and* are uncontrolled for by our rich set of covariates, a school fixed effect will mitigate these sources of bias. Second, we prefer portal effectiveness estimates relative to the statewide population of teachers, but teachers from certain portals, especially those portals that are smaller in size, only work in a sample of schools. For instance, TFA places corps members into approximately 12 (out of 115) school districts in North Carolina. One implication of this distribution of teachers is that the comparative effectiveness of a portal could differ depending on the reference group—in-state public undergraduates statewide or those teaching in the same school environments. Therefore, we employ school fixed effects to isolate portal effectiveness within particular school settings. Specifically, the school fixed effects models include a dichotomous indicator for each school in the analysis, thereby limiting effectiveness comparisons between in-state public undergraduates and their peers in the 10 other portals, to those teachers working in the same schools (see Appendix C for the school fixed effects estimation equation). Results from the school fixed effects provide an important check on the robustness of the coefficients from the hierarchical linear models.

Findings

In total, across elementary, middle, and high schools, each of the 10 other portals was compared with the in-state public undergraduate portal on 10 different standardized test outcome measures (three in elementary school, three in middle grades, and four in high school). This created 100 possible comparisons (10 test outcomes and 10 portals in reference to in-state public undergraduates). In cases when a portal had fewer than 10 teachers teaching the grade or subject associated with the test, the coefficient is not reported (marked "NR" in the results table). Therefore, in Table 4, we report on 84 effectiveness comparisons and provide unique student, classroom, and school-year counts; we provide unique teacher counts from these models in Table 5.

Before examining the effects of teacher portals on student achievement gains, we want to make note that intraclass correlations (ICCs) from the null hierarchical linear models indicate that a three-level model was necessary because of the significant variance shared within both classrooms and schools (see Appendix B). In addition, we note that although a full discussion is beyond the scope of this article, the direction and significance of coefficients for our covariates was consistent with expectations. At the student level, prior student achievement was by far the strongest predictor of current year achievement, although many other variables also had a statistically significant relationship with student performance. Results for teacher covariates indicated substantial returns to experience—on average, more experienced teachers (in reference to 1st year teachers) generated significantly larger student achievement gains.

The Effects of Teacher Portals on Student Achievement

In-state public undergraduate prepared. In-state public undergraduate-prepared teachers are the reference group for this analysis and therefore, the grade-subject-portal comparisons in which they are significantly different are represented in Table 4 by the 24 coefficients that appear with asterisks. However, the signs are reversed for the in-state public undergraduate portal. That is, the positive coefficients indicate that *the comparison portal defining that row outperformed* the in-state public undergraduate portal teachers and the negative coefficients indicate that *the in-state public undergraduate-prepared teachers outperformed* the comparison portal defining the row. The in-state public undergraduate-prepared teachers outperformed in-state private undergraduate-prepared teachers in fifth-grade science, middle grades and high school math; out-of-state prepared undergraduate teachers in reading, math and science in

how to do it? Default by HLM?

Table 4. Teacher Portal Effectiveness.

	Elementary grades			Middle grades			High school			
Teacher portal	Math	Reading	Fifth-grade science	Math	Reading	Eighth-grade science	Math	English I	Science	Social studies
In-state public graduate degree	0.018 (0.014)	0.002 (0.010)	NR	−0.013 (0.026)	−0.017 (0.011)	NR	0.049* (0.023)	0.008 (0.010)	0.050 (0.037)	−0.013 (0.019)
In-state private undergraduate	−0.000 (0.006)	−0.004 (0.004)	−0.040* (0.016)	−0.024* (0.011)	0.009 (0.007)	−0.103 (0.054)	−0.036* (0.015)	0.011 (0.009)	−0.020 (0.037)	−0.022 (0.017)
In-state private graduate degree	−0.045 (0.029)	−0.044 (0.022)	NR	NR	−0.033 (0.029)	NR	0.030 (0.028)	0.028 (0.016)	0.207** (0.053)	0.004 (0.027)
Out-of-state undergraduate	−0.020** (0.004)	−0.012** (0.003)	−0.037** (0.014)	0.001 (0.007)	−0.005 (0.004)	−0.022 (0.023)	−0.034** (0.012)	−0.010 (0.008)	−0.033 (0.024)	−0.044** (0.015)
Out-of-state graduate degree	−0.011 (0.007)	−0.007 (0.006)	−0.025 (0.023)	−0.004 (0.014)	0.008 (0.007)	0.002 (0.032)	−0.034 (0.023)	0.024 (0.013)	−0.015 (0.028)	−0.029 (0.021)
In-state public licensure only	0.013 (0.015)	0.013 (0.011)	NR	−0.006 (0.022)	−0.017 (0.010)	NR	NR	0.004 (0.013)	−0.037 (0.055)	0.002 (0.021)
Out-of-state licensure only	−0.055* (0.027)	−0.053* (0.022)	NR	NR	0.008 (0.033)	NR	NR	NR	NR	NR
Teach For America	0.058** (0.019)	0.026 (0.015)	0.067 (0.046)	0.120** (0.020)	0.019 (0.012)	0.188** (0.043)	0.146** (0.030)	0.051* (0.019)	0.223** (0.040)	0.092* (0.038)
Visiting International Faculty	0.023 (0.014)	0.028** (0.011)	0.042 (0.043)	0.000 (0.015)	0.022 (0.012)	NR	−0.077* (0.033)	−0.017 (0.031)	−0.025 (0.057)	NR
Alternative entry	−0.009 (0.008)	0.003 (0.006)	−0.022 (0.024)	−0.008 (0.006)	0.000 (0.004)	−0.034 (0.021)	−0.034** (0.011)	−0.002 (0.006)	−0.038* (0.018)	−0.031* (0.012)
Observations used	715,173	1,008,363	96,745	432,662	484,381	99,250	357,456	201,827	250,612	307,851
Unique students	353,188	357,581	64,348	311,281	333,832	92,577	232,226	154,197	184,971	220,675
Unique classrooms	39,329	56,260	4,923	24,999	29,041	5,078	22,039	12,751	15,069	18,659
Unique school years	5,913	5,962	1,690	2,415	2,496	931	1,877	1,634	1,431	1,773

Note. All coefficients are in reference to In-state public undergraduate degree prepared teachers. Cells with an "NR" value indicate that the portal had less than 10 teachers in the model. We report standard errors in parentheses.
*$p < .05$. **$p < .01$.

Table 5. Teacher Portal Counts in Value-Added Analyses.

	Elementary models			Middle grades models			High School models			
Teacher porta	Math	Reading	Fifth-grade science	Math	Reading	Eighth-grade science	Math	English I	Science	Social studies
In-state public undergraduate	2,196	2,600	171	658	779	84	506	382	184	423
In-state public graduate degree	112	150	7	24	61	4	53	79	46	92
In-state private undergraduate	949	1,168	61	158	196	14	129	91	43	118
In-state private graduate degree	23	26	2	6	10	1	23	19	19	31
Out-of-state undergraduate	2,204	2,562	158	606	706	121	293	211	165	271
Out-of-state graduate degree	484	529	34	114	189	34	76	59	79	80
In-state public licensure only	83	91	2	29	42	3	9	24	14	41
Out-of-state licensure only	31	35	0	3	10	1	3	3	9	3
Teach For America	60	65	12	63	92	15	52	38	40	31
Visiting International Faculty	184	193	13	106	54	8	42	14	36	1
Alternative entry	552	682	31	906	1,184	247	642	483	679	378
Unclassifiable	156	191	17	36	60	8	30	17	24	42
Total	7,034	8,292	508	2,709	3,383	540	1,858	1,420	1,338	1,511

Note. This table displays unique counts of teachers included in our value-added models. For a given model, if a teacher portal has less than 10 teachers we do not report the coefficient.

elementary grades, and math and social studies in high school; out-of-state licensure-only teachers in elementary grades math and reading; VIF in high school math; and alternative entry teachers in high school math, science, and social studies. The in-state public undergraduate-prepared teachers were outperformed by in-state graduate prepared teachers in high school math; in-state private graduate degree prepared teachers in high school science; VIF in elementary grades reading; and TFA corps members in elementary, middle grades and high school math, eighth grade and high school science, and high school English 1 and social studies. Overall, the in-state public undergraduate-prepared teachers outperformed other portals in 14 comparisons, were outperformed by them in 10 comparisons, and were no different in 60 comparisons.

In-state public graduate degree prepared. Teachers with a graduate degree from an in-state public university were significantly more effective than in-state public undergraduate-prepared teachers in one comparison—high school mathematics—and no different in seven comparisons. Data were insufficient to provide comparisons for the remaining two models.

In-state private undergraduate prepared. Teachers with undergraduate degrees from in-state private universities were significantly less effective than undergraduate-prepared teachers from in-state public universities in three comparisons—fifth-grade science, middle grades math, and high school math—and no different in the remaining seven comparisons. Undergraduate preparation programs at in-state private universities represent the fourth largest source of teachers in North Carolina, and in total, teachers from this portal with less than 5 years of experience instructed more than 130,000 students in fifth-grade science and middle and high school math during our study period.

In-state private graduate degree prepared. Teachers with graduate degrees from in-state private universities were significantly more effective than in-state public undergraduate-prepared teachers in one comparison—high school science—and no different in six comparisons. Data were insufficient to provide comparisons for the remaining three models.

Out-of-state undergraduate prepared. Teachers with undergraduate degrees from out-of-state universities were significantly less effective than teachers prepared at in-state public universities in five comparisons—elementary grades math and reading, fifth-grade science, high school math, and high school social studies—and no different in the remaining five comparisons. The underperformance of out-of-state prepared undergraduates is particularly important since this portal is the second largest source of teachers in the state and represented nearly 23% of the teacher workforce in the 2009-2010 school year. From 2005-2006 through 2009-2010, the out-of-state prepared undergraduates in our sample taught more than 300,000 students in the grade levels/subjects where they are significantly less effective.

Out-of-state graduate degree prepared. Teachers with graduate degrees from out-of-state universities were no different from teachers with undergraduate degrees from in-state public universities in all 10 comparisons.

In-state public licensure only. Teachers whose preparation was through a licensure/certificate program at an in-state public university were no different from in-state public undergraduate-prepared teachers in seven comparisons. Data were insufficient to provide comparisons for the remaining three models.

Out-of-state licensure only. Consistent with our findings for out-of-state undergraduates, teachers whose preparation was through a licensure/certificate program at an out-of-state university were less effective than in-state public undergraduate-prepared teachers in two comparisons—elementary grades math and reading—and no different in one comparison. Data were insufficient to provide comparisons for the remaining seven models.

TFA. Teachers entering the profession as TFA corps members were more effective than in-state public undergraduates in seven comparisons—elementary grades math, middle grades math and science, and high school math, English I, science, and social studies—and no different in three comparisons. Although TFA corps members comprise a small percentage of the teacher workforce in the state, the magnitude of their effects is large. For example, compared with students taught by in-state public undergraduate-prepared teachers, students taught by a TFA corps member gain approximately the equivalent of 15 and 64 additional days of schooling in elementary and middle grades math, respectively. We are able to calculate these equivalent days of schooling in the elementary and middle grades because the test scores are scaled across years, meaning we can calculate the average yearly gain in a subject. We convert coefficients from standard deviation units to actual scale score points, divide it by the average yearly gains in scale score points, and multiply by 180 (the number of days in a school year) to create the additional days of schooling.

VIF. Teachers entering the profession through the VIF program were more effective than in-state public undergraduate-prepared teachers in one comparison—elementary school reading—less effective in one comparison—high school math—and no different in six comparisons. Data were insufficient to provide comparisons in the remaining two models.

Alternative entry. Teachers entering the profession via alternative entry were less effective than traditionally prepared teachers in three comparisons—high school math, science, and social studies—and no different in the remaining seven comparisons. This suggests that prior to entry into the profession more extensive preparation to teach has a positive impact on student achievement in secondary grades or that teaching while taking required coursework to obtain certification makes these teachers less effective. These results bear greater practical significance given that districts report the most difficulty finding certified teachers for secondary grades science and math courses and alternative entry teachers are the largest source of early-career teachers at the secondary grades level (NCDPI, 2012).

Do Portal Results Differ When Comparing Within Schools?

Overall, the results from the hierarchical linear models with a rich set of covariates were consistent with the school fixed effects estimates. Of the 24 significant findings in Table 4, 22 remain significant and in the same direction in our school fixed effects specification (see the equation in Appendix C). The school fixed effects estimates indicate that the in-state public graduate prepared teachers are not more effective than the in-state public undergraduate-prepared teachers in high school math and TFA corps members are not more effective that in-state undergraduate-prepared teachers in high school social studies. There were nine significant comparisons in the school fixed effects approach that were not significant in our statewide hierarchical linear models, but all of these estimates were in the same direction as those from the preferred models. In addition, in-state undergraduate-prepared teachers outperformed teachers from other portals in the same schools in 18 comparisons and were outperformed by them in 13 comparisons, a similar ratio (1.4) as in the hierarchical linear models. Taken together, this suggests that the covariates used in the hierarchical linear models controlled for differences between school environments.

Although the results between the statewide and school-specific models were consistent, two portals warrant more information. First, like their out-of-state undergraduate-prepared peers, out-of-state graduate degree holders were significantly less effective in elementary grades and high school math than in-state public undergraduates working in the same schools. This further underscores that teachers imported from other states underperform in North Carolina. Second, when comparing within schools, VIF teachers significantly outperform in-state public undergraduates in middle grades reading and across all elementary grades comparisons. Therefore, in elementary grades, the VIF program represents a high-quality labor source for the schools in which they have been hired.

Discussion

We began this study with two goals: (a) improving upon previous approaches to classify teachers into preparation/certification categories and (b) using our teacher portal classification system to provide more accurate estimates of the effects of teacher preparation. Since portal membership includes both the effects of selection of individuals into specific portals and effects of the course content and training received in those portals, the findings combine both selection and preparation effects of the portal.

Overall, our findings suggest that creating more preparation portals through which teachers enter public school classrooms had mixed effects on student performance. Teachers from out-of-state and alternative portals frequently underperform teachers who were prepared in in-state public undergraduate programs. This suggests that a main argument for lowering barriers to entry—increasing student achievement by supporting the career transitions of individuals with mathematics and science content knowledge—has not materialized. In fact, novice alternative entry teachers significantly underperform in-state public undergraduate-prepared teachers in high school mathematics and science (as well as social studies), precisely where alternative entry teachers had been expected by some to have the greatest positive impacts on student performance.

is it the case? do people with math and science knowledge want to be teachers?

The pattern of underperformance from the general alternative entry portal teachers is quite different than the two particular alternative entry portals that we were able to distinguish in our analysis, TFA and VIF. Our results show that TFA corps members significantly outperform in-state public undergraduates in mathematics and science courses and at the secondary grades level. While the current impact of these findings is limited, since TFA corps members comprise a very small percentage of the state's teacher workforce, the findings do suggest that high standards for the recruitment/selection of alternative entry teachers, coupled with a short but intense preparation prior to beginning to teach, and ongoing coaching and professional development can supply effective teachers. It is unclear how much the supply of these types of teachers can be increased while maintaining the quality, but efforts already underway through Race to the Top and other federal initiatives will test TFA expansion limits.

VIF teachers are traditionally trained in the sense that they have a university degree in education, but it is from another country. Our results show that they are particularly effective in elementary school subjects, especially when compared with other teachers within their own school. Because VIF teachers are fluent in English and their home language, they may be particularly adept at teaching English Language Learners. As the immigrant population in states like North Carolina continues to increase (Fortuny & Chaudry, 2011), school administrators may want to continue to recruit VIF teachers to work in elementary schools, especially those with a high number of English language learners.

The other main policy approach for addressing teacher shortages, granting more reciprocal certification licenses for out-of-state prepared teachers, appears to have adversely impacted student achievement. Teachers prepared in traditional preparation programs out-of-state are less effective than in-state public undergraduates in elementary grades mathematics, science and reading and in high school mathematics and social studies. Other research suggests that this may be due to high turnover rates, presumably due to teachers' preferences to teach in their home states, and a lack of familiarity with the curriculum and culture of the state (Bastian & Henry, 2013).

These findings suggest that the graduates of colleges of education at in-state public universities more frequently

selection issue between in-state and out-of-state teachers?

outperform teachers from other portals than they are outperformed by them, perhaps suggesting that it is not a simple matter to recruit, select, and prepare highly effective teachers in other ways. It is also noteworthy that in-state public licensure-only teachers, who typically have a bachelor's degree in another field but return to an in-state public university to complete a teacher preparation certificate/licensure program, do not perform significantly differently than the traditional in-state public undergraduate-prepared teachers. This may suggest that taking the additional coursework to become a fully certified teacher, while concurrently teaching, may distract alternative entry teachers from their classroom responsibilities. Alternatively, it may be that the licensure-only programs recruit more motivated individuals to invest in the specific human capital necessary to teach prior to entering the classroom.

It is somewhat difficult to interpret these findings for their specific implications for more traditional undergraduate teacher preparation programs. Only in eighth-grade science and English 1 are the in-state-public undergraduate-prepared teachers outperformed consistently, and in each case, there is a single other portal that outperforms them. Evaluations of the effectiveness of the graduates of particular programs, such as those of Gansle and colleagues (2012) and Plecki and colleagues (2012), can help colleges of education identify high-performing preparation programs for more in-depth study. But these results, like our own, only identify where to look to make improvements or for ideas about how to improve. Researchers will need to go deeper into process issues by examining the extent to which variations in programs' preparation requirements—for example, selection criteria, course content, intensity of field experiences—or the timing of those requirements vary systematically with the effectiveness of their program completers when they begin teaching (see Boyd et al., 2006, 2009).

Overall, the primary contribution of the present study is better understanding the effectiveness, as measured by value-added scores, of teachers who have come through multiple portals. The portals used in this study are a more accurate and fine-grained system for classifying the preparation of all K-12 teachers according to differences in university status (public or private), degree level (undergraduate, graduate, or licensure only), preparation location (in-state or out-of-state) and preparation timing (traditional or alternative). Our results show that the traditional preparation programs within a state, while not an unqualified success, are not the sources of teachers who are much less effective than the alternatives. In other words, there is both room for improvement for traditional teacher preparation and a reasonable base from which the improvements could be launched. Furthermore, we find that teacher preparation *matters*. That is, across portals meaningful differences exist in the adjusted-average student achievement gains that teachers produce. Given these results, we encourage further research that (a) applies this or an even more fine-grained portal classification scheme to other states, (b) separates the effects of training received in a portal from the selection into a portal, and (c) examines how variations in teacher preparation practices relate to variations in teacher effectiveness.

Appendix A

Covariates in Value-Added Models

Table A1. Covariate Definitions.

Variable	Definition
Prior achievement scores	A standardized variable for a student's prior End-of-Grade test scores
Peer ability	A standardized variable for the average ability of a student's peers within a classroom
Structural mobility	A dichotomous variable for student mobility necessary due to the grade-level structure of a school
Between-year mobility	A dichotomous variable for student mobility between school years (excluding structural mobility)
Within-year mobility	A dichotomous variable for student mobility within the school year
Underage for grade	A dichotomous variable for a student who is underage for grade
Overage for grade	A dichotomous variable for a student who is overage for grade
Giftedness	A dichotomous variable for a student who receives academically gifted services
Disability	A dichotomous variable for a student who receives disability services
Poverty status	A set of dichotomous variables for a student receiving (a) free school lunches or (b) reduced-price school lunches
Race/ethnicity	A set of dichotomous variables for a student who is (a) Black, (b) Hispanic, (c) Asian, (d) American Indian, or (e) multiracial
Gender	A dichotomous variable for a student who is male
Currently limited English proficient	A dichotomous variable for a student who currently receives limited English proficiency services
Was limited English proficient	A dichotomous variable for a student who used to receive limited English proficiency services
High School subject indicators	A set of dichotomous variables for a student taking (a) algebra 1, (b) algebra 2, (c) geometry, (d) English 1, (e) biology, (f) physical science, (g) chemistry, (h) physics, (i) U.S. history, or (j) civics/economics
Number of students	A continuous variable for the number of students in a classroom
Heterogeneity of prior achievement	A continuous variable which is the standard deviation of prior achievement scores within the classroom
Advanced curriculum	A dichotomous variable for a course labeled as advanced or honors
Remedial curriculum	A dichotomous variable for a course labeled as remedial
Teaching out-of-field	A dichotomous variable for a teacher teaching out-of-field (not licensed at that grade-level or subject-area)
Teacher experience	A set of dichotomous variables for (a) 2nd-year, (b) 3rd-year, (c) 4th-year, or (d) 5th-year teachers (in reference to 1st-year teachers)
Teacher portals	A set of dichotomous variables for the teacher portals
School size	A continuous variable for the number of students enrolled at a school
School size squared	A continuous variable for the squared term of school size
Total per-pupil expenditures	A continuous variable for the dollars spent, per-pupil, at a school
Average teacher salary supplement	A continuous variable for the average salary supplement received by teachers at a school
Short-term suspension rate	A continuous variable (per 100 students) for the number of short-term suspensions at a school
Violent acts rate	A continuous variable (per 1,000 students) for the number of violent acts at a school
Racial/ethnic composition	A set of continuous variables for the percentage of (a) Black, (b) Hispanic, (c) Asian, (d) American Indian, and (e) multiracial students at a school
Concentration of poverty	A continuous variable for the percentage of students qualifying for free or reduce-price school lunches

Appendix B

Intraclass Correlations

Table B1. Intraclass Correlations from Hierarchical Linear Models.

Model	Classroom-level ICC	School-level ICC
Elementary math	0.098	0.239
Elementary reading	0.087	0.287
Fifth-grade science	0.057	0.301
Middle grades math	0.408	0.184
Middle grades reading	0.340	0.185
Eighth-grade science	0.152	0.224
High school math	0.267	0.226
High school English I	0.356	0.188
High school science	0.239	0.200
High school social studies	0.268	0.176

Note. ICC = intraclass correlations.

Appendix C

School Fixed Effects

School fixed effects equation

$$Y_{ijst} = \gamma_0 + \gamma_1 Y_{it-n} + \gamma_x X_{ijs} + \beta_2 Portal_2 + \ldots +$$
$$\beta_{12}\mathrm{Portal}_{12} + \beta_z Z_{js} + \delta_w W_s + \theta_s + \mu_{ijs},$$

where Y_{ijst} is the test score for student i, in classroom j, in school s, at time t; γ_0 is the model y-intercept value; $\beta_2 \ldots \beta_{12}$ estimate the average effect of the 11 portals (including unclassifiable teachers) in reference to in-state public undergraduate-prepared teachers (portal 1); portal$_2$ … portal$_{12}$ are indicator variables that equal 1 if the teacher entered teaching through that portal and 0 if not; Y_{it-n} represents a prior test score(s) for student i; X_{ijs}, Z_{js}, and W_s represent a set of student, classroom/teacher, and school covariates, respectively; γ_x estimates the average effect of the student covariates; β_z estimates the average effect of the classroom/teacher covariates; δ_w estimates the average effect of the school covariates; θ_s is a school fixed effect included to adjust for time-invariant school factors and limit portal effectiveness comparisons within schools; and μ_{ijs} is a disturbance term representing all unexplained variation.

Table C1. Teacher Portal Effectiveness (School Fixed Effects).

Teacher portal	Elementary grades			Middle grades			High school			
	Math	Reading	Fifth-grade science	Math	Reading	Eighth-grade science	Math	English 1	Science	Social studies
In-state public graduate degree	0.017 (0.014)	0.005 (0.010)	NR	−0.013 (0.027)	−0.026* (0.012)	NR	0.042 (0.023)	0.021 (0.011)	0.036 (0.032)	−0.012 (0.018)
In-state private undergraduate	−0.004 (0.005)	−0.003 (0.004)	−0.049** (0.017)	−0.036** (0.011)	0.004 (0.007)	−0.181** (0.055)	−0.036* (0.016)	0.009 (0.009)	−0.003 (0.033)	−0.029 (0.016)
In-state private graduate degree	−0.050 (0.029)	−0.031 (0.021)	NR	NR	−0.007 (0.029)	NR	0.055 (0.033)	0.046** (0.015)	0.194** (0.048)	0.010 (0.026)
Out-of-state undergraduate	−0.020** (0.004)	−0.011** (0.003)	−0.035* (0.015)	−0.003 (0.007)	−0.005 (0.004)	−0.019 (0.024)	−0.035** (0.012)	−0.007 (0.008)	−0.036 (0.022)	−0.051** (0.014)
Out-of-state graduate degree	−0.015* (0.007)	−0.009 (0.006)	−0.026 (0.023)	−0.020 (0.014)	0.007 (0.007)	−0.042 (0.035)	−0.050* (0.024)	0.033* (0.013)	−0.006 (0.025)	−0.036 (0.023)
In-state public licensure only	0.007 (0.014)	0.018 (0.011)	NR	−0.010 (0.022)	−0.013 (0.011)	NR	NR	0.019 (0.016)	−0.056 (0.053)	−0.037 (0.022)
Out-of-state licensure only	−0.082** (0.029)	−0.057** (0.021)	NR	NR	0.011 (0.030)	NR	NR	NR	NR	NR
Teach For America	0.069** (0.020)	0.027 (0.016)	−0.004 (0.051)	0.128** (0.021)	0.020 (0.012)	0.289** (0.058)	0.178** (0.029)	0.088** (0.020)	0.154** (0.048)	0.062 (0.039)
Visiting International Faculty	0.035* (0.014)	0.031** (0.011)	0.092* (0.047)	−0.009 (0.015)	0.029* (0.013)	NR	−0.129** (0.035)	−0.004 (0.031)	−0.055 (0.049)	NR
Alternative Entry	−0.004 (0.008)	0.007 (0.006)	−0.016 (0.027)	−0.011 (0.006)	0.001 (0.004)	−0.032 (0.0230)	−0.036** (0.011)	0.002 (0.006)	−0.036* (0.017)	−0.036** (0.012)
Observations	669,225	943,912	45,626	370,281	412,688	29,155	299,575	146,904	137,735	238,425

Note. All coefficients are in reference to In-state public undergraduate degree prepared teachers working in the same schools. Cells with an "NR" value indicate that the portal had less than 10 teachers in the model. We report standard errors in parentheses below effectiveness estimates. Reported observation counts for school fixed effects models differ from those for hierarchical linear models because some schools (a) only employed in-state public undergraduates or (b) never employed in-state public undergraduates during our study period.
$^{*}p < .05$. $^{**}p < .01$.

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Notes

1. There is one additional category containing individuals who cannot be classified, based on available data, into any of these 11 entry portals.
2. Although Goldhaber and Brewer (2000) had teacher self-report data concerning certification status, the authors made conclusions regarding the efficacy of traditional teacher preparation. Darling-Hammond and colleagues (2001) challenged these conclusions, demonstrating that teachers with different certification statuses (standard and emergency) can have comparable preparation.
3. Licensure/certificate only data provided by the University of North Carolina General Administration allowed us to identify in-state public licensure-only teachers. Comparable data were not available for the private universities in-state, and thus, we were unable to create an in-state private licensure-only portal.
4. Few of these teachers were part of the value-added analysis sample (discussed in the following section) because they had been teaching for more than 5 years and/or were assigned to nontested grades/subjects.
5. The top four states from which North Carolina imports teachers are New York, Pennsylvania, Ohio, and Michigan.
6. Value-added outcomes for third-grade students are available from 2005-2006 through 2008-2009. After the 2008-2009 school year, the North Carolina Department of Public Instruction ceased the mathematics and reading pretests given at the start of third grade.
7. To separate the effects of selection into a portal from the efficacy of training received in a portal, it is necessary to obtain a measure(s) of teacher knowledge or ability prior to entry into a teacher portal. Examples might include SAT/ACT scores or Praxis I exam scores. Unfortunately, these exam scores are only available for a small portion of our sample and we do not estimate such models.

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