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Public School Performance: Examining the Relationship between Teacher Training Program and School Achievement

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Few would argue the importance of providing today's youth with a solid educational foundation, yet the United States ranks as low as 25th educationally among 34 OECD developed nations[1]. Many researchers have studied the various factors affecting student performance in the K-12 educational system, but mixed, ambiguous, or conflicting results have led to a general sense of uncertainty regarding who to hold accountable. The research has tended to focus on teacher effectiveness or school funding. While those are among a wealth of valid inputs to examine, this study attempted to determine the viability of examining the effect of teacher training programs on student achievement.

This study utilized data spanning eight years, from 2001-2008, and representing every public kindergarten through 12th grade school in Kentucky. The data were analyzed using two approaches: fixed-effects estimation and between-effects estimation. The findings indicated that there *is* a relationship between teacher training program and school achievement but that the relationship varies depending on the program and on the specific research question being investigated. Overall, the findings suggested that this exploratory research has potential to inform such decision as how to best train teachers and whether to hold their training programs accountable for the performance of their students. Further analysis on the student level (rather than the school level) is recommended in order to better determine the efficacy of this research approach before expanding the investigation to a statewide or national level. Future investigations into this relationship could be improved with the addition of a broader range of individual student and teacher characteristics.

[1] OECD – The Organization for Economic Cooperation and Development (http://www.oecd.org)

INTRODUCTION

In this seemingly endless economic crisis, America has been keeping its eye on every last dollar. Even so, President Obama feels so strongly about the importance of effective teacher training programs (TTPs) that he has earmarked $185 million for stronger TTP evaluation standards. In an announcement on his website, the President calls for a shift to “performance-based teacher education,” and has said,

> If students are expected to achieve 21st-century learning standards, we can expect no less from their teachers. Yet teachers’ access to knowledge through preparation and professional development is more haphazard in the United States than in most other industrialized countries. Preparation programs range from excellent to extremely weak, and state regulatory systems are uneven across the country.

This BarackObama.com document goes on to point out that TTP accreditation is optional in most states, leaving no guarantee of quality across programs. The President and Vice President call for colleges of education to track their graduates’ contributions to student learning, requiring TTPs to provide concrete evidence “of teacher performance and outcomes in student learning (Obama for America, 2011).”

The $185 million requested for 2012 would fund a grant program for states that agree to track the performance of their TTPs. The money would also go toward increasing licensure and certification standards and holding the most ineffective TTPs accountable for their results or lack thereof (Office of Management and Budget, 2011). By putting a dollar amount on the need for more effective training programs, the

President and his administration have effectively brought to light the need to target teaching disparities at the source – through teacher training programs.

In Kentucky, all TTPs are required to undergo state accreditation through the Education Professional Standards Board, but there is no required national standard. Of the 28 Kentucky teacher training programs, just 15 have *elected* to undergo accreditation by the National Council for Accreditation of Teacher Education (NCATE), the national teacher preparation standards board ("Accreditation Status," 2010).[2] NCATE-accredited programs meet a consistent set of standards and requirements across the nation, signifying comparable levels of TTP quality between states, at least for those programs which elect to submit to this national certification.

Barack Obama recognizes the fact that despite leading the world economically, the United States ranked just 17th in math and 25th in science of the 34 OECD developed nations (Armario, 2010). He has chosen to approach this problem in a way not often used before. There has long been a heated debate over which factors impact student outcomes in the public school system. The merits of many variables have been argued, including high quality teaching, high levels of funding, and school choice, just to name a few. However, although many researchers have studied the impact of teachers themselves, very little empirical research has been conducted regarding the impact that teacher training programs have on achievement through the work of the teachers they educate. It stands to reason that the training institutions should have some influence over school achievement, however indirect it may prove to be. This study sought to address that research gap, to treat teacher training programs as an input to school

[2] See Table A1 in the Appendix for a full list of the accreditation status of all Kentucky TTPs.

achievement, and to use Kentucky TTPs in an exploratory endeavor to determine whether it is feasible to identify a TTP's impact on the performance of schools.

Operational Definitions

Teacher Training Program – For the purposes of this study, a teacher training program refers to the colleges of education that train students to become teachers. Alternative routes to teacher certification, such as Teach for America, emergency certifications, or field-based programs, are not be included in the teacher training programs definition for this research effort.

Schools – The term "schools" refers to all the public elementary, middle, and high schools in Kentucky. This should be clearly differentiated from teacher training programs, which are college and university, not primary school, programs.

School Achievement – School achievement is essentially another term for "school performance." In this study, achievement is measured by student test scores, or more specifically, the student academic index scores, standardized across grade levels and years. As with all other factors in this analysis, achievement is measured on the school level, not the individual student level.

LITERATURE REVIEW

As previously stated, there has been a great deal of research into the relationship between school inputs, such as spending, and outputs, including student test scores,

with a major emergence of the field with the United States Department of Education's 1966 report *Equality of Educational Opportunity,* one of the largest studies on educational equality in history and the first recorded appearance of the debate over school effects. As research grew and adapted from there, more specific and thorough analyses began to appear. The field soon took on a somewhat different empirical approach with the appearance of educational production functions (an application of an economic concept to the educational research field) (Hanushek, 1979). Controversy has arisen with the literature, as the future of American public education has always been a hot-button issue. The empirically-demonstrated relationship between school inputs and outputs has often been in stark opposition to public expectations and opinion. These apparent discrepancies will be discussed in the next sections.

Educational Research Background

After the 1966 Coleman Report first examined the field of education through an analytical lens, Eric Hanushek took up the cause, continuing to pave the way for this new field of research with his 1979 review of educational production function research. Hanushek's review brought to light both the weaknesses and the potential in the existing research. For the first time the relationship between school resources and achievement was thoroughly examined through a meta-analysis of various studies, summarized by Hanushek. As economists began to delve into the education policy arena, their statistical research and the relationships they defined became known as educational production functions, building upon the existing theory and methods of

input-output-analyses. This led to a change in the way results of even existing studies were interpreted (Hanushek, 1979).

The Relationship between School Inputs and Student Achievement

There is a widespread public perception that school resources, such as teacher quality, funding, and class size can increase student achievement. Despite this belief, the research has shown that often very little correlation exists between these categories of variables. The Coleman Report, the largest undertaking of its kind at the time, began the debate that still rages today by finding that school funding in particular contributes little to student achievement (Coleman, 1966). To the contrary, most impact on student academic success appears to stem from factors *outside* the school environment and of the control of the public realm, such as cultural and family life, socioeconomic status, and the influence of genetic makeup. One book on this topic has even found a significant impact of such seemingly unrelated factors as vision and hearing problems, nutrition, low birth weight, student mobility, and parental cigarette and alcohol use (Rothstein, 2004).

The Debate over Teacher Quality and Effects

There has long been a focus on teachers as one of the most important inputs to attain enhanced student achievement outcomes. Methods of addressing the belief in better teachers as a solution have included merit pay systems, specialized training, changes to institutional recruitment policies, and various forms of continuing education. Teachers are also the costliest school resource, with their salaries accounting for the

largest portion of public education budgets (Wayne, 2003). There is a wealth of literature to support or refute each of these proposed solutions, so it is difficult to synthesize any one reliable method to address the teacher quality issue.

Debate still rages over how much impact teachers actually have on student outcomes, with some arguing that teacher effects are insignificant. The majority seems to claim that effects are dependent on the situation or upon student characteristics (Nye, 2004; Porter, 2004; Wayne, 2003). One study found that teacher effects were much larger in accounting for student outcomes in schools with lower socioeconomic status than those with average or higher socioeconomic status. The study also found that, across all schools, teacher effects were larger than overall school effects, indicating that a child's teacher may play a larger role in his or her success in any given school than the school itself (Nye, 2004).

The literature arguing that teachers *do* have an impact on student achievement typically offers suggestions for increasing teacher quality. One review of the topic compiled various existing studies and found strong support for increasing teacher certification and qualification requirements, such that a math teaching candidate would have to have a stronger background in mathematics coursework than is currently required, for example. The authors also propose increasing pay accordingly in order to better attract the better qualified teaching candidates (Wayne, 2003). However, Hanushek and Rivkin found that salary increases alone are costly and ineffective and instead argue for certification changes and stronger links between student success and teacher career advancement and pay, or what is more commonly known as a merit pay system (2007).

Teacher Training Program Effects

Despite the wealth of research on teacher impacts on student outcomes, there is still little research about teacher training program efficacy. A University of North Carolina study examined the effect of teachers trained through North Carolina public TTPs versus those trained out of state or within state in private or independent programs. These researchers found that a teacher trained by NC public schools yields slightly better learning outcomes in elementary and high school students (but not in middle school) than does a teacher educated elsewhere. They defined better learning outcomes as measured in terms of additional days of schooling equivalent above the average, a measured constructed for the purposes of this study (Henry, 2011).

RESEARCH DESIGN

Due to the complex nature of a widely-based, school-level empirical analysis, there was a great deal of consideration regarding which type of model to use. Ultimately, a combination of two estimation models was chosen to allow for the reader's interpretation of the results.

Data

Data from two primary sources were used in this analysis. School level data were collected from every public elementary, middle, and high school in the state of Kentucky as provided by the Kentucky Department of Education. For much of the data, values

were obtained directly from schools and digitized in the absence of any previously recorded database. Additional data were collected from the Common Core Database from the National Center for Education Statistics.[3] Together, the data represent 1,279 schools, for a total of 10,250 observations spanning an eight-year period, from 2001-2008. The data were separated by school type: elementary, middle, and high (see Table 1 for summary statistics), in order to identify differences in the effects of each variable among school levels by TTP.

The dependent variable being analyzed was student academic index scores, which was the measure of school achievement for this study. The index scores were standardized across time and grade-level. As mentioned earlier, the dependent variable, as with all other variables, was recorded at the school-level, and should ultimately be interpreted as school achievement.

Each model included the same 23 independent variables. Teacher training programs, the variables of interest, were measured as the percentage of teachers at a given school in a given year who graduated from each TTP. TTPs included in the study represented twelve of the largest programs in Kentucky, six of which were private, and six public. The sample included both NCATE-accredited and non NCATE-accredited programs. Many additional variables were included as controls in the model, including student demographic information, school, and teacher characteristics.

[3] This dataset was originally compiled by Dr. Eugenia Toma and her team for investigational analysis of the Appalachian Math Science Partnership for the National Science Foundation.

Table 1: Variable Descriptions

Variable	Description
TTP1-12	teacher training programs
Index Score	student academic index score
Lagged Index Score	student academic index score for the year prior to the current year
Free/Reduced Lunch	percent of students in school on free/reduced price lunch (poverty)
Ethnicity Black	percent of black students in school
Ethnicity Hispanic	percent of Hispanic students in school
Ethnicity Asian	percent of Asian students in school
Master's	percent of teachers in school with a Master's degree
Student:Computer	student to computer ratio
Enrollment	total school enrollment
Experience	average years experience of all teachers in school; in years
Spending	spending per student; in dollars
Student:Teacher	student to teacher ratio
Appalachian	certified Appalachian region, measure of rurality

Student demographic variables included ethnicity (percent of black, Hispanic, and Asian students) and poverty (percentage of students receiving free/reduced price lunch). School characteristics consisted of the student to computer ratio to gauge access to technology, total enrollment as a measure of school size, spending per

student, and the student to teacher ratio. Teacher-related variables included average years of experience and the percentage of teachers with a Master's degree.

A student academic index score with a one-year lag was also created as an independent variable to capture the prior effects of the control variables on school achievement. The lagged score effectively separated influences on the index score from year to year, capturing and accounting for the effects of all previous inputs, including each of the control variables mentioned above. This essentially enabled achievement to be attributed specifically to the teacher for the current year alone, which was in-turn attributed to the specific program that trained that teacher.[4]

The between-effects model included one additional control variable not found in the fixed-effects estimation. Kentucky is divided into 15 Area Development Districts, some of which are designated to be in the Appalachian region. An Appalachian dummy (yes or no) variable was introduced to control for whether or not a school was in one of these regions.

[4] A complete listing of variables with accompanying descriptions can be found in Table 1.

Table 2: Descriptive Statistics

	Elementary School					Middle School					High School				
Measure[AB]	n[C]	Mean	StDev[D]	Min	Max	n	Mean	StDev	Min	Max	n	Mean	StDev	Min	Max
Index	5626	80	13.82	36	125	2481	73	13	33	122	1788	71	10	39	110
TTP 1[E]	5904	11	21.50	0	100	2535	12	20	0	91	1811	12	20	0	93
TTP 2	5904	14	18.16	0	98	2535	13	16	0	91	1811	12	14	0	79
TTP 3	5904	9	11.29	0	67	2535	8	10	0	57	1811	10	9	0	46
TTP 4	5904	15	23.64	0	100	2535	13	23	0	100	1811	13	20	0	87
TTP 5	5904	2	8.81	0	85	2535	3	11	0	78	1811	2	7	0	75
TTP 6	5904	1	2.93	0	50	2535	1	3	0	36	1811	2	4	0	100
TTP 7	5904	1	3.47	0	45	2535	1	2	0	19	1811	1	3	0	19
TTP 8	5904	7	19.10	0	100	2535	8	19	0	96	1811	9	19	0	94
TTP 9	5904	2	7.07	0	75	2535	2	8	0	75	1811	3	7	0	73
TTP 10	5904	5	11.63	0	63	2535	4	10	0	56	1811	4	9	0	47
TTP 11	5904	2	6.37	0	85	2535	3	8	0	79	1811	1	4	0	47
TTP 12	5904	2	10.47	0	88	2535	3	12	0	88	1811	2	9	0	68
Lagged Index Score	5686	77	13.53	33	125	2457	77	14	36	125	1751	76	14	40	121
Free/Reduced Lunch	5717	57	22.05	0	100	2389	54	21	0	100	1790	41	18	0	99
Ethnicity Black	5799	9	14.64	0	85	2494	7	12	0	58	1802	8	13	0	100
Ethnicity Hispanic	5799	2	3.49	0	55	2494	1	2	0	26	1802	1	1	0	16
Ethnicity Asian	5799	1	1.51	0	27	2494	1	1	0	11	1802	1	1	0	14
Student:Computer	5748	5	7.87	1	451	2484	5	10	0	451	1792	4	5	1	100
Enrollment	5800	406	163.63	69	1170	2495	514	236	53	1577	1802	785	414	72	2126
Experience	5768	12	2.67	1	26	2462	12	3	0	26	1767	12	2	0	20
Spending	5767	5218	2484.60	0	14775	2485	4634	2209	0	14775	1795	4734	2222	0	14295
Student:Teacher	5799	15	2.83	6	123	2495	16	6	9	273	1802	17	7	5	305
Master's	5791	67	28.76	0	100	2492	67	29	0	100	1799	67	28	0	100
Appalachian	5579	0.23	0.45	0	1	2485	0.34	0.48	0	1	1796	0.28	0.45	0	1

[A] See Table A1 in Appendix A for a complete listing of all variables and their accompanying descriptions
[B] Out of a possible total of 100% unless otherwise noted in Table A1.
[C] n refers to the number of observations.
[D] StDev refers to standard deviation.
[E] TTP refers to teacher training program.
Sources: Kentucky Department of Education; National Center for Education Statistics' Common Core Database

Research Model

This study was designed to account for the effects of individual teacher training programs on school achievement by separating those effects from all others, including teacher-specific effects, such as experience and pay. By accounting for so many variables related to schools, teachers, and students through the aforementioned variables, the potential random error was reduced, and more of the TTP effect was isolated. Because the data were in panel form, or multiple observations of several variables over a period of time, time-trend regression was necessary.

Two methods of time-trend estimation were used to address the two research questions: fixed-effects estimation and between-effects estimation. The fixed-effects regression model focused on examining the changes in the characteristics of each individual school over time, such as the level of poverty or the ratio of students to teachers. By focusing on the changes over time for each school, it was possibly to determine whether those changes had an effect on achievement. The comparison was, therefore, an assessment of whether a change *within* a particular school was associated with increases or decreases in the student scores in that same school over time. This is called a “fixed-effects” model because it controls for all the characteristics of a school that do not change over time, such as distance from the locations of each TTP, but that do vary substantially between schools and could otherwise reduce the ability to isolate the effects of the variables of interest. This approach does a somewhat better job at controlling for lingering bias than does the between-effects model, but each model answers a different research question in this analysis.

The between-effects regression model differed from the fixed-effects regression in that it estimated how differences between schools, such as the poverty level or ratio of teachers to students, affected student scores for all schools. In this case, the model estimated the effect of average school characteristics, including relative number of teachers from each teacher training program, on average student index. By comparing these differences in characteristics *between* schools it was possible to identify what average school characteristics were associated with higher or lower student scores. A limitation of this approach was that there may have been other factors, such as the distance from the school to the TTP that might affect the results but which were not possible to incorporate into the model, but the fixed-effects regression addressed this limitation.

For both estimation models, the student academic index score was regressed on the aforementioned demographic controls: student, teacher, and school characteristics, and the variables of interest. To reiterate, the variables of interest were the percentage allocation of teachers from the twelve largest teacher training programs in Kentucky, leaving the remaining 18 Kentucky programs as well as the out of state programs as the omitted base category.

Research Question 1: Do schools that change the percentage of teachers from a given teacher training program experience a change in school achievement outcomes?

The primary regression model included a fixed effect of school along with an indicator representing all other omitted factors, including the immeasurable individual school environments. The estimation allowed general heteroscedasticity (robust estimation), or differences in variation among the variables. It also allowed for correlations within schools (clustering). A fixed effects model takes into account all traits that are unique and varying over time, which is anything that is not completely intrinsic to each individual school. This model is illustrated by Equation 1:

$$Y_{it} = A + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \alpha_i + \varepsilon_{it}$$

where Y denotes the achievement of students at school *i* recorded in year *t*. $X_{1\text{-}12}$ represent the TTPs, the variables of interest in this analysis. Again, the TTP variables are measured as the percentage of teachers in a school who received their degree from a given TTP in a given year. $X_{13\text{-}23}$ illustrate the demographic control variables, or school-level characteristics of students, teachers, and individual schools. Finally, ε denotes the random error in the model. Unique to this model is α_i, the unobserved individual school effect, such as each unique school environment, for example.

Research Question 2: On average, is there a relationship between the percentage of teachers at a school who were trained in a particular teacher training program and the performance of the students at that same school?

Because many of the explanatory variables from this data set varied insignificantly over the eight year period, their effect was pulled into the effect of the individual school environment. To recover these masked effects, the between-effects estimator was used as the primary model in this analysis. Through this approach, it was possible to isolate the estimated effects of those explanatory variables, even though they remained relatively constant over time. The model, structurally similar to that of Equation 1, is show by Equation 2:

$$Y_{it} = A + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \varepsilon_{it}$$

where, again, Y_{it} denotes the academic index scores of school *i* recorded in year *t*, and the 'X's represent all the same variables as in Equation 1. The random error term in the model is expressed through ε_{it}.

ANALYSIS AND FINDINGS

Based on the results presented in Tables 3 and 4, several TTPs showed a significant effect on student academic index scores, though many more proved significant in the between-effects analysis than in the fixed-effects model. The results

also varied a great deal across school types, with different TTPs yielding significant outcomes in elementary, middle, and high school.

Fixed-Effects Findings

The fixed-effects analysis (Table 4) let to a much different set of results than the between-effects model, at least in one aspect. Most notably, far fewer TTPs had a significant effect, net of all other factors. In only one situation does any program show a significant effect in more than one school type, and even in that case, it is across only two of the three types. This model did, however, exhibit the same school-type trend seen with the first estimation. Four TTPs were significant in elementary schools, two were significant in middle schools, and just one was significant in high schools. The same mixture of positive and negative effects was seen, and again, in the case where a TTP was significant across multiple school types, the effect was in the same direction.

The explanatory variable results shared similarities with the outcomes of the first model, chiefly that the lagged student academic achievement index score was consistently significant and positive across all three school types. However, the differences in the outcomes of the two models are quite notable in that ethnicity did not appear to be nearly as significant or to show very much effect with this second model. This is possibly attributable to the fact that ethnic compositions in schools tend to vary little over time, leaving their effects to be pulled into the overall fixed-effect of the schools themselves. Also unlike between-effects, spending showed a significant positive effect, though the effect size was negligible. Perhaps the most interesting difference between the estimations is the significant *positive* effect of poverty in this second case. This could be attributed to the fact that the more impoverished schools

had a larger achievement gap to make up in comparison with other schools. With the larger achievement gap, some of the more superficial changes that had already been implemented in the wealthier schools may have helped to close the gap, lending to the appearance of greater progress in the short-run.

The very fact that so few TTPs showed any significant impact on school outcomes is significant in and of itself. One would hope that *all* teacher education programs would have a significant positive impact on the achievement of the students educated by the teachers they graduate. A nonsignificant result in either case indicates that the TTP provides nothing above and beyond any other characteristic of the students, teachers, or schools, despite the fact that education among programs likely varies greatly, given that a consistent national accreditation standard is not a requirement for TTPs in Kentucky.

Table 4: Fixed-Effect Regression Output

	Estimated Coefficients (*t*-Statistics)					
Independent Variables	**Elementary**		**Middle**		**High**	
TTP 1	0.03	(0.81)	0.00	(0.03)	-0.08	(-1.36)
TTP 2	-0.01	(-0.30)	-0.07	(-1.34)	0.00	(-0.08)
TTP 3	0.01	(0.19)	-0.13	(-2.44)*	-0.04	(-0.90)
TTP 4	0.05	(1.37)	0.00	(0.08)	0.02	(0.30)
TTP 5	0.17	(1.65)**	-0.09	(-1.23)	0.10	(0.92)
TTP 6	0.11	(1.08)	0.01	(0.09)	-0.02	(-0.13)
TTP 7	-0.13	(-1.36)	-0.05	(-0.46)	0.04	(0.32)
TTP 8	0.11	(2.20)*	-0.01	(-0.20)	-0.03	(-0.52)
TTP 9	-0.06	(-0.74)	-0.01	(-0.14)	0.06	(0.74)
TTP 10	0.04	(0.69)	0.05	(0.62)	-0.11	(-1.54)**
TTP 11	0.36	(3.91)*	-0.03	(-0.26)	0.15	(1.36)
TTP 12[A]	-0.19	(-2.09)*	-0.30	(-3.07)*	-0.08	(-0.76)
Lagged Index Score	0.52	(27.69)*	0.55	(25.1)*	0.33	(13.95)*
Free/Reduced Lunch	0.03	(2.25)*	0.08	(3.66)*	0.05	(2.07)*
Ethnicity Black	-0.13	(-2.84)*	-0.19	(-1.44)	-0.03	(-1.36)
Ethnicity Hispanic	0.24	(3.66)*	-0.01	(-0.09)	0.28	(1.64)**
Ethnicity Asian	0.05	(0.38)	0.50	(1.55)*	-0.15	(-0.45)
Student:Computer	-0.02	(-1.71)**	-0.01	(-1.23)	0.04	(2.52)*
Enrollment	0.00	(-0.24)	0.00	(1.27)	0.00	(0.51)
Experience	0.04	(0.54)	0.02	(0.31)	-0.12	(-1.42)
Spending	0.00	(13.68)*	0.00	(7.61)*	0.00	(3.82)*
Student:Teacher	-0.13	(-2.39)*	0.00	(0.07)	-0.02	(-4.88)*
Master's	0.05	(4.51)*	0.06	(4.36)*	0.06	(3.92)*

* significant at the α .05 confidence level
** significant at the α .1 confidence level
[A] TTP significant across two school types

Between-Effects Findings

The between-effects regression analysis (Table 3) showed significant effects of many TTPs, but there is a marked drop in the occurrence of significant effects from one school type to the next: eight for elementary school, seven for middle school, and just four in high school. Just as interesting, however, is the fact that which TTPs are significant varies from one school type to the next. In only one case is the same TTP significant across all three school types. The same TTP is significant across two of the three types in five of the twelve cases, with high school tending to be case in which they are not significant. Where a TTP is significant across school types, the directionality is consistent, so a program having a significant positive impact in elementary school also had a positive impact in other school types.

Across all three school types, several explanatory variables had a statistically significant impact on school achievement. The lagged index score was as expected, with a higher score in the past yielding higher current outcomes, regardless of grade in school. Poverty, as measured by the percent of students receiving free or reduced-price lunch, had a negative effect on achievement, which is consistent with expectations. Ethnicity varied, with black students tending to have consistently poorer outcomes than their peers and Asian students demonstrating consistently positive outcomes. Spending per student and student to computer ratio, two controls used to measure school wealth, were nonsignificant across all school types, indicating than financial inputs do not necessarily impact student achievement outputs as strongly as several of the other control factors.

Table 3: Between-Effects Regression Output

	Estimated Coefficients (*t*-Statistics)					
Independent Variables	**Elementary**		**Middle**		**High**	
TTP 1[B]	0.02	(1.04)	-0.07	(-2.58)*	-0.08	(-2.41)*
TTP 2	0.03	(1.57)**	-0.01	(-0.22)	-0.02	(-0.52)
TTP 3	0.00	(0.06)	0.00	(0.04)	-0.09	(-1.59)**
TTP 4[B]	0.05	(3.11)*	0.05	(2.35)*	-0.03	(-0.98)
TTP 5[B]	-0.12	(-3.06)*	-0.09	(-2.09)*	-0.03	(-0.51)
TTP 6	-0.07	(-0.69)	-0.27	(-1.88)**	-0.06	(-0.48)
TTP 7	-0.13	(-1.47)**	0.04	(0.24)	-0.06	(-0.33)
TTP 8[B]	0.05	(2.76)*	0.04	(1.57)**	-0.01	(-0.45)
TTP 9	0.01	(0.29)	0.03	(0.7)	-0.10	(-1.79)**
TTP 10[A]	-0.07	(-1.73)**	-0.09	(-1.87)**	-0.14	(-2.37)*
TTP 11	-0.13	(-2.56)*	0.02	(0.41)	-0.07	(-0.71)
TTP 12[B]	0.08	(2.54)*	0.07	(2.00)*	0.03	(0.57)
Lagged Index Score	0.15	(5.60)*	0.28	(7.45)*	0.13	(3.38)*
Free/Reduced Lunch	-0.27	(-11.86)*	-0.23	(-7.59)*	-0.34	(-9.44)*
Ethnicity Black	-0.10	(-3.29)*	-0.18	(-3.95)*	-0.09	(-1.92)**
Ethnicity Hispanic	-0.05	(-0.47)	-0.43	(-1.95)*	-0.13	(-0.39)
Ethnicity Asian	0.86	(3.72)*	1.95	(4.20)*	2.99	(7.27)*
Student:Computer	-0.05	(-0.73)	-0.07	(-0.82)	0.20	(1.16)
Enrollment	-0.01	(-2.91)*	0.00	(-0.81)	0.00	(-1.86)**
Experience	-0.36	(-2.29)*	0.14	(0.62)	0.14	(0.48)
Spending	0.00	(0.56)	0.00	(0.84)	0.00	(1.35)
Student:Teacher	0.11	(0.62)	0.02	(0.13)	0.09	(0.68)
Master's	0.35	(7.06)*	0.15	(2.28)*	0.06	(0.74)
Appalachian	2.89	(2.31)*	3.04	(1.81)**	3.57	(2.15)*

* significant at the α .05 confidence level
** significant at the α .1 confidence level
[A] TTP significant across all school types
[B] TTP significant across two school types

The Appalachian region control variable yielded a somewhat surprising outcome, with positive effects across all three school types. It was expected that these rural schools would have a lower achievement level than their more urban counterparts, which was supported by simple difference in means testing.[5] However, the fact Appalachian status actually added something above and beyond the average after controlling for many other factors indicates that even though Appalachian schools have other characteristics that have negative impacts on student achievement, Appalachian schools displayed an ability to rise above those negatives to some degree. Net of all those negative factors, they do better than other areas.

DISCUSSION

Study Limitations

This analysis was limited in several ways that should be noted. The data set included teachers from every public school in Kentucky, and the TTP set included the larger, more prominent Kentucky programs. However, despite the fact that many teachers were educated in TTPs in bordering states, none of these TTPs were included in the model. Given their proximity (in some cases closer than in-state programs), their contributions to the teaching pool in Kentucky should be taken into account. Furthermore, this study does not control for the fact that teachers self-select into TTPs, so a TTP could potentially appear stronger simply because stronger future-teachers

[5] See Table A2 in the Appendix for results of the t-test.

choose to attend that program, and vice-versa. Until an effective method for controlling for selection bias is determined, these results should be interpreted with the caveat that some of the effect of a given TTP could be attributed not to the quality of the program itself, but rather to the quality of the teachers who choose to be trained by that institution.

Henry (2011) noted that the effect of TTP contribution to student achievement diminishes over time, such that a teacher with more experience will exhibit less of a TTP effect via student achievement. This is not accounted for in any way through this study, leading to a possible overestimation of TTP effects over the progression of time. Controlling for this through some teacher experience limit would yield sounder, more reliable results.

Recommendations

In the future it could be informative to expand this analysis to a statewide scale, including every TTP in Kentucky, both public and private. The validity of the analysis would be improved by obtaining student-level (rather than school-level) data and linking student performance to having been in the classroom of specific teachers. Knowing more about the achievement scores of individual students and the characteristics of individual teachers, such as their ACT/SAT scores and their performance while enrolled in their TTP, could help to better isolate differing average effects of the various teacher training programs by better controlling for variations in individual teacher characteristics. With this more complete, micro-level analysis in Kentucky, a better assessment of the possible relationship between TTP and student achievement could be undertaken to

indicate whether such research would be feasible and advisable on a larger, national scale.

Significant differences were found between TTP associations with school performance for different school types, but at this time there is no sound and reliable empirical explanation for these differences. It would be beneficial to all parties concerned to investigate the reasons behind these differences through further research on the TTPs themselves. Perhaps some have a stronger training focus on one school type or education level as opposed to others. If TTPs were found to have training programs that are particularly effective in preparing teachers to educate students at a particular type of school, it would be important to replicate those methods so that other students in similar schools could benefit from the same successful training approach.

With the proper measures taken to fully develop the data and relevant hypotheses for this research model, it is believed that the results, whatever they indicate, could inform important decisions about how to best go about training teachers to improve the academic performance of their students. Just as there is a major focus on holding teachers and schools accountable for the academic performance of their students, it seems only fair to develop methods to hold TTPs accountable for the success of the methods they employ to train teachers.

CONCLUSION

Based on the results of both the between- and fixed-effects analyses, it is apparent that teacher training programs do indeed have some impact on student achievement, at least measured on the school-level. The degree to which TTPs impact student outcomes is open to interpretation based on the research question and estimation approach. As reported, the between-effects model indicated that many more TTPs had significant impacts on school achievement than did the fixed-effects estimation. By referring back to the research questions, more specific conclusions can be drawn.

Research Question 1: Do schools that change the percentage of teachers from a given teacher training program experience a change in school achievement outcomes??

As the fixed-effects model showed, schools that changed the number of teachers from *certain* TTPS experienced changes in achievement, though those changes were typically relatively small in either direction – positive or negative. It is apparent that increasing the number of teachers from an institution yielded a far subtler effect on school achievement outcomes than simply *having* a large quantity of teachers from a certain program. Interestingly, the significant relationships seemed to diminish across school types, ranging from three significant TTP effects at the elementary level to just one at the high school level.

Research Question 2: On average, is there a relationship between the percentage of teachers at a school who were trained in a particular teacher training program and the performance of the students at that same school?

Through the between-effects estimation, it was shown that many teacher training programs did, in fact, have a significant, measurable relationship with school achievement, as measured through school-level student academic index scores. It appears, however, that this relationship again diminishes across school types and is far less present by high school than in elementary school.

APPENDIX

Table A1: Kentucky Teacher Training Program Accreditation Status

Teacher Training Program	Accreditation Status
Alice Lloyd College	continuing accreditation granted September 2008
Asbury College	continuing NCATE/state accreditation granted January 2008
Bellarmine University	continuing NCATE/state accreditation granted March 2006
Berea College	continuing NCATE/state accreditation granted November 2005
Brescia University	continuing state-only accreditation granted March 2007
Campbellsville University	initial NCATE/state accreditation granted September 2007
Centre College	continuing state-only accreditation granted August 2010
University of the Cumberlands	continuing state-only accreditation granted September 2002
Eastern Kentucky University	continuing NCATE/state accreditation granted June 2003
Georgetown College	initial NCATE/state accreditation granted September 2008
JCPS ACES	continuing state-only accreditation granted June 2003
Kentucky Christian University	continuing state-only accreditation granted September 2004
Kentucky State University	continuing NCATE/state accreditation granted March 2006
Kentucky Wesleyan College	continuing state-only accreditation granted September 2004

Table A1: Kentucky Teacher Training Program Accreditation Status contd.

Teacher Training Program	Accreditation Status
Lindsey Wilson College	continuing state-only accreditation granted September 2002
Mid-Continent University	initial state-only accreditation granted November 2005
Midway College	continuing state-only accreditation granted May 2009
Morehead State University	continuing NCATE/state accreditation granted September 2004
Murray State University	continuing NCATE/state accreditation granted August 2009
Northern Kentucky University	continuing NCATE/state accreditation granted March 2004
Pikeville College	continuing state-only accreditation granted March 2004
Spalding University	continuing NCATE/state accreditation granted September 2004
St. Catharine College	first state-only accreditation granted May 2010
Thomas More College	continuing state-only accreditation granted September 2004
Transylvania University	continuing NCATE/state accreditation granted January 2008
Union College	state-only accreditation granted August 2010
University of Kentucky	continuing NCATE/state accreditation granted September 2008
University of Louisville	continuing NCATE/state accreditation granted August 2009
Western Kentucky University	continuing NCATE/state accreditation granted January 2005

source: Kentucky Education Professional Standards Board

Table A2: *t* Test Output for Appalachian Region Schools

School Region	Mean Index Score	Standard Deviation
Non-Appalachian	77.53	13.40
Appalachian	74.43	13.99

Mean Difference	3.10
***t* Value**	10.29
Degrees of Freedom	9656

Controlling for no other factors, the mean student academic index score for a non-Appalachian school is 77.53 (standard deviation 13.40) and 74.43 (standard deviation 13.99) for Appalachian schools, a mean difference of 3.10. The *t* value of 10.29 indicates statistical significance at the 99% confidence level.

Table A3: *f* Test Output for Public and Private TTPs for Between & Fixed Effects

		***f* Statistic**		
		Elementary	**Middle**	**High**
Between Effects	Public TTPs	1.95**	2.39*	1.43
	Private TTPs	3.31*	4.12*	2.13*
Fixed Effects	Public TTPs	4.63*	3.55*	2.34**
	Private TTPs	5.69*	3.05*	1.56

* significant at the α .05 confidence level
** significant at the α .1 confidence level

Post-regression *f*-tests were run on each iteration of the two models to ascertain the effect (if any) of public and private TTPs as a unit. For both estimation models, the effects of training programs net of other characteristics of schools are present for elementary and middle schools but are far less present or significant for high schools, but the effects of individual training programs are not equal, and to impose such an assumption in the estimation and testing would bias the results.

REFERENCES

Armario, Christine. (2010). Wake-up Call: U.S. Students Trail Global Leaders. *The Associated Press*. http://www.msnbc.msn.com/id/40544897/ns/us_news-life/#. Accessed 31 March 2011.

Coleman, James S., et al. (1966). *Equality of Educational Opportunity*. Washington: U.S. Government Printing Office.

"Accreditation Status." (2010) Education Professional Standards Board. http://www.kyepsb.net/teacherprep/status.asp. accessed 29 March 2011.

Hanushek, Eric A. (1979). Conceptual and Empirical Issues in the Estimation of Educational Production Functions. *The University of Wisconsin Press: Journals Division* 14 (3): 351-388.

Hanushek, Eric A. (1986). The Economics of Schooling: Production and Efficiency in Public Schools. *Journal of Economic Literature* 24 (3): 1141-1177.

Hanushek, Eric A. and Steven Rivkin. (2007). Pay, Working Conditions, and Teacher Quality. *The Future of Children: Princeton University* 17 (1): 69-86.

Henry, Gary T., et al. (2011). The Impact of Teacher Preparation on Student Learning in North Carolina Public Schools.

Nye, Barbara and Spyros Konstantopoulos. (2004). How Large Are Teacher Effects?. *Educational Evaluation and Policy Analysis: American Educational Research Association* 26 (3): 237-257.

Porter-Magee, Kathleen. (2004). Teacher Quality, Controversy, and NCLB. *The Clearing House* 78 (1): 26-29.

Rothstein, Richard. (2004). Social Class, Student Achievement, and the Black-White Achievement Gap. *Class and Schooling*. Economic Policy Institute: Columbia University: 13-59.

Wayne, Andrew J. and Peter Youngs. (2003). Teacher Characteristics and Student Achievement Gains: A Review. *Review of Educational Research* 73 (1): 89-122.