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Teacher Qualifications and First Grade Achievement: A Multilevel Analysis

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Teacher Qualifications and First-Grade Achievement: A Multilevel Analysis[1]

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1. Introduction

Although many federal, state, and local education policies promote high-quality teaching to enhance student achievement, questions persist about what constitutes quality teaching. One piece of this puzzle involves identifying specific teacher characteristics that predict effectiveness, particularly in terms of improved student achievement. This is a fundamental issue inherent to policy discussions about which qualities and qualifications to promote in aspiring teachers, whom to recruit and hire, what factors to base pay schedules on, and how to distribute teachers across different types of schools and classrooms to achieve equity and adequacy in educational outcomes.

A number of researchers have argued that teacher quality is a powerful predictor of student performance. Darling-Hammond (1996, 2000) concludes that the effects of well-prepared teachers on student achievement can outweigh student background factors including poverty, language background, and minority status. Further, she contends that measures of teacher quality are more strongly related to student achievement than other kinds of investments, including reduced class sizes, overall spending on education, and teacher salaries. Using a very different conception of teacher quality, Rivkin, Hanushek, and Kain (1998) draw similar

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conclusions regarding the importance of teacher quality.[2] They conclude from their analysis of 400,000 students in 3,000 schools that while school quality is an important determinant of student achievement, the most important predictor is teacher quality. Hanushek (1992) estimates that the difference between having a good teacher and having a bad teacher can exceed one grade-level equivalent in annual achievement growth. Likewise, Sanders (1998) and Sanders and Rivers (1996) argue that the single most important factor affecting student achievement is teachers, and the effects of teachers on student achievement are both additive and cumulative. Further, they contend that lower achieving students are the most likely to benefit from increases in teacher effectiveness. Taken together, these multiple sources of evidence – however different in nature – all imply that quality teachers are a critical determinant of student achievement. In the current policy climate of standards-based reform, these findings make a strong case for gaining a better understanding of what really accounts for these effects.

Of particular interest is the impact of policy-relevant teacher qualifications such as degree level, certification, and content-specific expertise. Existing research provides some direction regarding the impact of attributes of secondary school teachers. While quasi-experimental studies have been plagued historically by inconclusive findings regarding the impact of teacher degree at the secondary level (e.g., Summers & Wolfe 1975, 1977; Harnish, 1987; Ehrenberg & Brewer, 1994;[3] Monk, 1994), more recent studies that have attended to the subject area in which the advanced degree was earned have been relatively consistent in their findings of a positive effect of teacher degree on high school student achievement.

[2] Rivkin, Hanushek, and Kain (1998) identify teachers as a major determinant of student performance, but do not describe teacher quality in terms of specific qualifications and characteristics. They show strong, systematic differences in expected achievement gains related to different teachers using a variance-components model. In contrast, Darling-Hammond (1996, 2000) equates teacher quality with specific qualifications.

[3] This study did find that black students assigned to teachers holding a masters degree outperformed their counterparts assigned to teachers without the advanced degree.

Goldhaber and Brewer (1997b, 2000) draw on nationally-representative data provided in NELS:88 to estimate the impact of teachers' holding masters degrees on high school students' mathematics achievement. These studies demonstrate the importance of the subject area in which the degree was awarded. The researchers found that student achievement gains in mathematics were positively associated with those assigned to teachers who earned their masters degree in mathematics, controlling for student and teacher characteristics. No effect was evident in cases where the teachers had no advanced degree or where the degree was earned in a subject other than mathematics.

Goldhaber and Brewer (1998) further confirm the importance of subject-specific information about teacher preparation in their analysis of NELS:88 data to address questions about when to reward teacher degrees. Their findings suggest that general measures of teacher degree level are not related to high school student achievement in math, science, English, or history. However, in math and science, subject-specific degrees earned were found to have a positive impact on student test scores in those subjects. This was the case for both bachelor's as well as master's degrees. Further, teachers holding both a bachelor's and a master' s degree in the subject area taught were the most effective.

Rowan, Chiang and Miller's (1997) analysis of the NELS:88 dataset further documents the importance of the subject matter of teachers' degrees. The model tested in this study includes a variable indicating whether the teacher had majored in mathematics in undergraduate and/or graduate school. While the researchers did not distinguish the level of the degree earned, the subject-specific degree variable was a positive predictor of 10th grade student achievement in all specifications of the model tested.

While fewer in number, studies of high school teacher certification parallel those of degree level, with positive effects limited to subject-specific credentials. Goldhaber and Brewer's (1997a) analysis of NELS:88 data revealed that students assigned to teachers who were certified in mathematics, or had earned a bachelor's or master's degree in mathematics had higher test scores than those assigned to teachers who lacked these subject-specific credentials, controlling for other student and teacher characteristics. In contrast, they found that the mathematics scores of students assigned to teachers with master's degrees or certification in subjects other than mathematics were no different than scores of students assigned to teachers with fewer qualifications, further underlining the importance of subject-specific credentials.

While a clear picture is beginning to emerge regarding the effect of teacher degrees and certification at the high school level, the evidence at the elementary level remains mixed and inconclusive. The existing evidence of a positive effect of teacher degree level on elementary student achievement (Ferguson & Ladd, 1996) is overshadowed by the many studies that find either no discernable effect (Link & Ratledge, 1979; Murnane & Phillips, 1981), or even a negative effect (Murnane, 1975; Eberts & Stone, 1984; Kiesling, 1984; Rowan, Correnti, & Miller, 2002) of teachers' holding master's degrees on elementary student achievement. Strikingly little research has been conducted on the impact of teacher certification on the performance of elementary students, and that which has been studied reveals no discernable effect (Rowan, Correnti, & Miller, 2002).

While most studies estimating the effect of teacher qualifications have focused on the characteristics of the student's current teacher, several efforts have been made to understand whether the qualifications of the full school faculty might have a contextual effect on student achievement. One argument supporting this notion of school-level effects of teacher qualifications is that teachers learn from one another, so any negative effect associated with having a low quality teacher might be reduced if there are other teachers who are supportive, more knowledgeable and more skilled. A second theory is that students interact with and learn from teachers other than those to whom they are directly assigned. This is more likely to occur at the secondary level where students are exposed to a variety of teachers through extracurricular activities, but may also occur at the elementary level if schools assign students to multiple teachers or to different teachers for different subjects.

One study of secondary mathematics and science teachers' subject matter preparation on the performance gains of their pupils in these subjects sought to sort out these multi-level effects. Monk and King (1994) used hierarchical linear models to analyze data from the Longitudinal Study of American Youth (LSAY), a nationally representative panel survey including a base-year sample of almost 3,000 students from 51 randomly selected public high schools. The researchers hypothesized that the effects of teacher preparation are likely to exist at multiple levels within schools. They took account for this by distinguishing between the teachers that a student was assigned to in the classroom and the other teachers that contributed to education schoolwide. Their findings suggest that it is the cumulative effect of the set of teachers that a student has had over time, rather than the subject matter preparation of the entire faculty in the school, that affects student mathematics and science achievement. No similar studies of multilevel effects associated with teacher qualifications could be found for elementary education.

In an effort to address these gaps in the literature, this study draws on national data from the recent Early Childhood Longitudinal Study (ECLS) to analyze the relationship between elementary school teacher qualifications and student achievement. The analysis parallels the work of researchers who have studied the relationship between teacher qualifications and student achievement at the high school level (most notably, the work of Goldhaber & Brewer, 1997a, 1997b, 1998, 2000). In doing so, the study provides much needed empirical evidence about teacher quality at the elementary school level.

2. Empirical model

Because the effects of teacher qualifications on student achievement are nested within schools, we use hierarchical linear modeling in our analysis. We use a three-level random intercept model to examine the effects of first-grade teacher qualifications on children's first-grade achievement. The model partitions variance in the outcome Y_{ijk} into three components: variance between students taught by specific first-grade teachers (level 1), variance between teachers within elementary schools (level 2), and variance between schools (level 3). At level 1, we model the early learning of child i taught by teacher j in school k as a function of a vector of student and family characteristics (a_{pijk}) and random student error (e_{ijk}):

$$Y_{ijk} = \pi_{0jk} + \pi_{pjk}a_{pijk} + e_{ijk},$$

where

Y_{ijk} is the achievement of student i taught by teacher j in school k;

π_{0jk} is the average achievement of students taught by teacher j in school k;

a_{pijk} is the vector of p = 1, …, p student characteristics;

π_{pjk} are the level-1 coefficients that measure the effects of individual student characteristics on individual student achievement; and

e_{ijk} is the random error or unique effect of student ijk on achievement.

We measure first-grade achievement (Y_{ijk}) using one of two cognitive assessments (reading or mathematics) administered to children at the end of the first grade. Variables that tap the characteristics of students and their families include minority status, gender, number of parents in the household, socioeconomic status, and prior achievement at the end of kindergarten (either reading or mathematics, depending on the outcome). We also include a measure of the amount of time that elapsed between the assessment of cognitive development at the end of kindergarten and the end of the first grade in the level-1 model to control for differences in developmental opportunity.

At level 2, we model the average achievement of students taught by teacher j in school k as a function of a vector of teacher and classroom characteristics (X_{qjk}) and random teacher error (r_{0jk}):

$$\pi_{0jk} = \beta_{00k} + \beta_{0qk}X_{qjk} + r_{0jk},$$

where

π_{0jk} is the average achievement of students taught by teacher j in school k;

β_{00k} is the average achievement of students taught across teachers in school k;

X_{qjk} is the vector of q = 1, …, q teacher characteristics and classroom characteristics;

β_{0qk} are the level-2 coefficients that measure the effects of teacher and classroom characteristics on average student achievement within schools; and

r_{0jk} is the random error or unique effect of teacher jk on achievement.

The level-2 model includes a series of teacher characteristics often associated with teacher quality, such as teacher certification status, degree attainment, degree program, subject-specific coursework in reading or mathematics, and years of first-grade teaching experience. Because the effects of these characteristics on the achievement of students taught by teachers may be confounded by other characteristics of teachers and their classrooms, we also include teachers' age and class size as controls at evel-2 of our models.

At level 3, we model the average achievement of teachers in school k as a function of a vector of school characteristics (W_{sk}) and random school error (u_{00k}):

$$\beta_{00k} = \gamma_{000} + \gamma_{00s}W_{sk} + u_{00k},$$

where

β_{00k} is the average achievement of students taught by teachers in school k;

γ_{000} is the average achievement of students across schools;

W_{sk} is a vector of s = 1, …, s school characteristics;

γ_{00s} are level-3 coefficients that measure the effects of school characteristics on average achievement of students in schools; and

u_{00k} is the random error or unique effect of school k on achievement.

The level-3 model examines potential contextual effects associated with teacher qualifications and school composition on average first-grade achievement in schools. Among the contextual effects that we consider are the percentage of certified teachers, percentage of teachers with advanced degrees, percentage of teachers with elementary education degrees, average years of experience teaching first grade, average ratio of coursework in reading or mathematics, minority enrollment, and average socioeconomic status of students enrolled in the school.

Our models allow the intercept for first-grade achievement to vary randomly between teachers within schools (r_{0j}) and between schools (u_{00k}). All level-1 and level-2 variables are grand-mean centered. The level-1 intercept (π_{0jk}), therefore, is the average achievement of students with average student characteristics and family backgrounds taught by teacher j in school k, whereas the level-2 intercept (β_{00k}) is the average achievement of teachers with average teacher qualifications and classroom characteristics in school k. Because the average sample of students per teacher (n = 4 students) and the average sample of teachers per school (n = 3 teachers) are relatively small, we do not include random effects for specific student characteristics or teacher qualifications in models (a topic that we will return to later).

3. Data

Data for this study come from the Early Childhood Longitudinal Study, Kindergarten Class of 1998–1999 (ECLS-K), sponsored by the U.S. Department of Education' s National Center for Education Statistics (NCES).[4] ECLS-K is a longitudinal study that includes a wide range of family, school, classroom, and individual variables related to children's development and achievement in school. In the base year of the study (1998-1999), ECLS-K collected data from a nationally representative sample of about 23,000 kindergartners attending nearly 1,300 public and private schools. ECLS-K conducted follow-up assessments and surveys with these children in 2000,[5] when children were first graders, and in 2002,[6] when children were third graders. The longitudinal design for the study specifies additional data collection in 2004, when children will be fifth graders. We use data from the base year and first-grade follow-up in our analyses.

A unique characteristic of the ECLS-K dataset is that it provides information about children's early learning, individual and family characteristics, and the qualifications of children' s teachers. Children completed individually-administered cognitive assessments about academically-related skills and content areas during the spring of their kindergarten and first-grade years. At the same time, ECLS-K collected data from children's parents, their teachers, and the administrators of participating schools about a comprehensive set of developmental and education-related matters. Although other datasets provide more extensive information about the professional qualifications of elementary school teachers (e.g., the NCES School and Staffing Survey), ECLS-K is the only dataset to include a nationally representative, longitudinal sample

[4] We use data from the March 2002 Longitudinal kindergarten-first grade public use child file and electronic codebook (NCES 2002-148).

[5] ECLS-K also collected data from a sub-sample of children in the fall of 1999; these data, however, are not used in this analysis.

of elementary school children with cognitive assessment data that can be linked to their individual teachers.

The ECLS-K data that we use in our analysis fall into four broad categories: measures of achievement, measures of individual teacher qualifications, measures of the qualifications of teachers employed by schools, and measures of student, teacher, and school characteristics that we employ as controls in our analyses.

Achievement. Our dependent variables are IRT-scale scores for cognitive assessments in reading and mathematics administered to children at the end of their first-grade year. The reading assessment measures basic skills in print familiarity, beginning and ending sounds; vocabulary; and comprehension (e.g., listening comprehension, words in context); the mathematics assessment measures skills in conceptual knowledge, procedural knowledge, and problem solving. To control for prior learning, we include the IRT-scale scores for the comparable assessment administered to children at the end of their kindergarten year in level-1 models. Because the lag time between administrations varied for children, we also include the number of days that elapsed between the kindergarten and first-grade assessments in our analyses. We standardized the assessment measures and the measure of elapsed time.[7]

Teacher qualifications. ECLS-K provides a range of information about the qualifications of children' s first-grade teachers, including highest degree attained, degree type, certification status, coursework related to teaching, and the number of years that teachers have taught different grades. We were especially interested in developing a set of variables that would parallel variables used in studies that examined the effects of teacher qualifications on achievement at the secondary level (see Goldhaber & Brewer 1996, 1998, 2000). Consistent

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[6] The data for the third-grade assessment of children have not been released yet.
[7] See the Appendix for a full description of all variables used in this analysis.

with these studies we constructed an indicator of teachers' certification status (regular or alternative v. none, temporary, provisional, emergency or probational) and two indicator variables of teachers' experience (beginning teachers with zero through two years of experience teaching first grade and more veteran teachers with five or more years of experience teaching first grade).

These studies also emphasize the importance of using subject-specific rather than general degree variables in models that estimate the effects of teacher qualifications on student achievement. Unlike secondary school teachers, though, elementary school teachers are less likely to possess subject-specific degrees. Although professional organizations, such as the National Council of Teaching of Mathematics (NCTM) and the International Reading Association (IRA), have pressed for subject-specific coursework for elementary school teachers, subject-specific degrees are relatively rare at the elementary level; more common are degrees that prepare teachers to work with different grades of children (e.g., early childhood education v. elementary education). Nonetheless, teachers often have some discretion in the courses that they take, and it is possible that teachers "unofficially specialize" in specific subject areas as part of their degree programs.

To examine these possibilities, we develop three measures related to teachers' degrees: one general measure and two more fine-grained measures that tap either curricular content or relative specialization in coursework. We constructed an indicator variable for whether teachers hold an advanced degree in any area of study (MA or higher) as a general measure of educational attainment. As a more refined measure of degree program, we developed an indicator variable of whether teachers have a degree in elementary education.[8] The ECLS-K survey also asks

[8] Because elementary education degrees are the modal degree for elementary school teachers, including teachers in the ECLS-K sample, we focus on elementary education rather than other degree programs.

teachers about the number of courses that they took in specific subject areas as part of their degree programs. We used this information to construct a continuous measure of the ratio of subject-specific coursework (reading or mathematics) to total coursework (reading, mathematics, and science) reported by teachers. When these three variables are included in the model it allows us to observe the value of having an "in-field" degree or "unofficial specialization" (i.e., a degree in elementary education or a higher ratio of coursework in one subject area compared to others) over and above any effects of possessing an advanced degree.

We also aggregate teacher qualification measures to the school level to investigate the possible contextual effects of teacher qualifications on first-grade achievement. We created three indicator variables for schools with high percentages of certified teachers (more than 93 percent, the mean at the teacher level), high percentages of teachers with elementary education degrees (more than 83 percent), and high percentages of teachers with advanced degrees (more than 38 percent). We use standardized continuous measures of the average reading course ratio, average mathematics course ratio, and average years first-grade teaching experience to tap these aspects of teacher qualifications as school characteristics.

Related control measures. We control for various characteristics of students, teachers, and schools that might serve as alternative explanations for the effects of teachers' qualifications on first-grade achievement. In addition to prior achievement and the elapsed time between assessments, we consider indicators for student's gender (female v. male) and minority status (minority v. non-minority), and we include a continuous measure of a student's family's socioeconomic status (SES). Because teacher qualifications may be related to teacher' s age, we also consider the effects of teacher's age (in years) at level 2 of models. At level 3, we include two measures of student composition: a continuous measure of average socioeconomic status of students and an indicator variable for high-minority enrollment (50 percent or more minority enrollment). In our analysis, we standardized the measure of children's socioeconomic status, teacher's age, and school's average socioeconomic status.

We used a series of filters to derive our analytic sample from the full 1998-1999 kindergarten cohort that participated in the first-grade assessments and attended a public elementary school during the 1999-2000 school year. First, we restricted the sample to non-special education students and students who had data for teachers who said that they had primary responsibility for students' learning in reading and mathematics. Next, we restricted the sample to students that had no missing data for assessment variables and teachers that had no or minimal missing data for teacher qualification variables. Lastly, we restricted the sample to teachers with data about at least two of their students and elementary schools with data about at least two of their teachers. Our final analytic sample consists of 5,167 students taught by 1,342 teachers nested in 453 elementary schools (roughly 44 percent of the original cohort). There is an average of four students per teacher and three teachers per school in the sample.

The students in our sample have higher levels of kindergarten and first-grade achievement for all of the cognitive assessments, with differences in achievement ranging from .11 SD to .15 SD (compared to the full public elementary school sample). Students in the analytic sample also had less time between testing (-.13 SD) and tended to be from more economically advantaged families (.10 SD). There are also fewer minority children (35 percent v. 44 percent) in the final sample but no difference in the proportion of female students. There are also fewer teachers with graduate degrees (38 percent v. 40 percent) in the final sample compared to the full analytic sample. All other differences in demographics and teacher qualifications are minimal. See Table 1 for descriptive statistics for all variables used in the analysis.

Table 1 about here

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4. Findings

Fully unconditional models. Table 2 provides estimates for random effects, intraclass correlations, and the reliability of level-1 (π_{0j}) and level-2 intercepts (β_{00k}) based on a fully unconditional model for each outcome. The first column provides estimates for first-grade reading achievement; the second column provides estimates for first-grade mathematics achievement. Estimates for each outcome are virtually identical, suggesting that the variance composition is roughly the same for reading and mathematics achievement in our analytic sample of students, teachers, and schools.

Most of the variance in student achievement occurs between students taught by individual teachers, not a surprising finding given the decomposition of variance in achievement reported in our studies (see, for example, Rivkin, Hanushek, & Kain, 1998). Roughly three-quarters of the variance in student achievement is associated with student characteristics, whereas one-quarter of the variance is associated with the characteristics of teachers and schools. The intraclass correlation for teachers is approximately 0.07 for reading and mathematics achievement, whereas the intraclass correlation for schools is roughly 0.017 (0.18 for reading achievement and 0.16 for mathematics achievement). In other words, roughly seven percent of the variance in student achievement occurs between teachers within schools and 17 percent of the variance in student achievement occurs between schools.

These variance components, r_0 at the teacher level and u_{00} at the school level, are significantly different form zero ($p < .000$). Reliability estimates for teacher and school intercepts are modest but sufficient for multilevel modeling, roughly .025 for average achievement within teachers (π_{0j}) and 0.61 for average achievement within schools (β_{00k}). When student's prior achievement is entered into the model (not shown here) all three variance components shrink dramatically but remain significantly different from zero. The variance components associated with teachers and schools are roughly equal after controlling for differences between teachers and schools in student' s prior achievement, suggesting that the potential effects of teacher and school characteristics on student achievement within our sample are roughly equal.[9]

Table 2 about here

Student-level models. Table 3 presents the three-level, fully conditional models for first-grade reading and mathematics achievement. The first column presents the results for reading achievement, while the second column presents results for mathematics achievement. The lower panel of coefficients represents the effects of student characteristics, the middle panel represents the effects of teacher characteristics, and the upper panel represents the effects of school characteristics. Using the random effects reported in Table 2 as a baseline, the reading achievement model accounts for roughly 57 percent of the variance in individual student achievement, whereas the mathematics achievement model accounts for roughly 58 percent.

[9] The reliability estimate for the teacher intercept (λ = 0.25 to 0.26) is roughly one third of the reliability estimate for the school intercept (λ = 0.64 to 0.61), indicating that the teacher variance component is probably under-estimated compared to the school-level variance component based on the fully unconditional models. Other studies

Most of the explanatory power of these models, though, is attributable to student’ s prior achievement, as well as differences between teachers within schools and between schools in what student’ s cognitive development prior to entering the first grade. Because the dependent variable is standardized, coefficients can be interpreted as effect sizes (or the percentage change in SD units for each outcome).

Table 3 about here

Prior achievement has the strongest effect on how much children learn in reading and mathematics. The effect of prior achievement is roughly 0.69 SD for reading and 0.70 SD for mathematics. All other effects are relatively small compared to prior achievement, with no statistically significant effect greater than 0.09 SD. The more time that elapsed between the kindergarten and first-grade cognitive assessments, the greater the gains in first-grade IRT-scale scores. In other words, the more time children had to learn, the more they learned in reading and mathematics. A time lag difference of one SD is equal to an increase of approximately 0.06 SD on the first-grade reading assessment and 0.05 SD on the first-grade mathematics assessment.

Students from more advantaged households have greater cognitive gains than students from less advantaged households in reading and mathematics by the end of the first grade (the difference being roughly 0.06 SD in reading and 0.08 SD in mathematics for students who differ by one SD on socioeconomic status). Female students have greater gains than male students in reading (0.05 SD) but lesser gains than male students in mathematics (-0.05 SD). There is no difference between minority and non-minority students in reading achievement, after controlling

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report large variance components for teachers, more comparable to those that we report here for schools. See Scheerens & Bosker, 1997.

for prior achievement, but minority students fall behind their non-minority peers by -0.09 SD in mathematics by the end of their first-grade year. The achievement gains of students from single-parent households are equivalent to those for students from two-parent households, all else being equal.

Teacher-level models. After controlling for differences between teachers in the characteristics of students that they teach, especially student's prior learning, we discovered only modest effects of teacher qualifications on student's reading achievement and no effects on student's mathematics achievement. Certification status, advanced degrees, and reading and mathematics course ratios have no effects on students' achievement. Students taught by teachers with an elementary education degree, however, gain more in reading (0.08 SD) than students taught by teachers with a different type of degree (e.g., early childhood education), and students taught by beginning teachers (0-2 years) have lower levels of reading gains (-0.06 SD) than students taught by teachers with more experience. Students taught by veteran teachers with more than five or more years of experience, though, have no advantage over students taught by teachers with more than two but less than five years of experience. Among the control variables that we include in the models, teacher's age has no effect but students in larger classrooms have lower gains than students in smaller classrooms in reading and mathematics. The achievement difference is about –0.02 SD between students in classes that differ in size by one SD.

School-level models. The school-level models control for average teacher qualifications at level 2 and average student characteristics at level 1, so coefficients can be interpreted as contextual effects – that is, as the effect of an organizational characteristic (in this case, the compositional characteristics of employed teachers and enrolled students) that is significantly different from the effects of individual teacher and student characteristics. Contextual effects occur with regularity in multilevel organizational studies, including educational studies (Willms, 1986). Although their interpretation can be difficult, such effects often indicate a unique additive or collective effect of individual characteristics on individual outcomes (Raudenbush & Bryk, 2002).[10]

Although there is no indication of a contextual effect for the percentage of teachers with certification status and elementary education, or of a contextual effect for the average years of teaching experience, students in schools where teachers have a higher ratio of reading courses have higher gains in reading achievement at the end of first grade (0.05 SD), just as students in schools where teachers have a higher ratio of mathematics courses have higher gains in mathematics achievement (0.03 SD). Neither of these teacher qualifications has an effect at the teacher level, yet each has an effect at the school level, suggesting that teachers who "informally specialize" in a subject area may collectively enhance the achievement of students in that subject area schoolwide. Interestingly, there also appears to be an aggregate effect of the percentage of teachers with advanced degrees on mathematics achievement, but the effect is negative! Students in schools where more than one-third of their teachers possess advanced degrees actually learn less mathematics (-0.07 SD) than students in schools where fewer teachers possess these degrees.

We also find contextual effects for student's minority status and student's socioeconomic status. Students in high-socioeconomic schools achieve at higher levels than students in low-socioeconomic status schools, regardless of their own socioeconomic status. The difference in achievement between students in a low-socioeconomic schools (-1 SD) and a high-socioeconomic status schools (+1 SD) is 0.15 SD in reading achievement (2 X 0.075) and 0.09

[10] We also considered the effects of region, urbanicity, and school size. Because these variables did not contribute significantly to the explanatory power of our models, we dropped them from the analysis.

SD in mathematics achievement (2 X 0.043). Students in schools with high-minority enrollments also gain less in reading (-0.09 SD) but not less in mathematics, all else being equal.

5. Conclusions

Our investigation of teacher qualifications and the effects on early learning generate several key findings. First, findings from this study reveal that certain teacher qualifications matter. These findings differ from those that have discovered no discernable effects for specific teacher qualifications at the elementary level (e.g., Link & Ratledge, 1979; Murnane & Phillips, 1981). Our analysis reaffirms findings from other studies that have concluded that more refined measures of teachers' preparation are better predictors of student achievement than are more conventional measures (Rice, 2003). In addition to experience, the two teacher qualifications we found to be associated with significant positive effects on reading achievement are those that capture the emphasis of the coursework taken in preparation for the profession (at the school level) and the specific type of degree earned (elementary education, at the teacher level). In contrast, broader measures like certification status and possession of an advanced degree were not found to be related positively to elementary student achievement in either reading or mathematics. Nonetheless, it is these sorts of measures that are typical of teacher hiring and compensation policies in most states and districts.

These findings are also comparable to those at the high school level that have demonstrated the importance of teachers' subject-specific degrees in mathematics and science (Goldhaber & Brewer, 1997a, 1997b, 1998, 2000). While the more integrated curriculum at the elementary level makes it difficult to model similar subject-specific effects, the significant positive effects we found with respect to a degree in elementary education and intensive coursework in reading and mathematics seem analogous to the subject-specific qualifications that have been found to be significant at the secondary level. An important implication of our findings, though, is that teacher qualifications may influence student achievement through effects associated with individual teacher characteristics or through the effects associated with collective teacher characteristics.

Second, teacher qualifications appear to have the strongest influence on reading achievement, arguably the focus of early elementary education. Teachers who hold elementary education degrees and those who have more than two years of experience teaching first grade are associated with higher student achievement in reading. However, these effects do not hold for mathematics. In fact, no teacher qualifications surface as significant predictors of student mathematics achievement at the teacher level. The only significant effects of teacher qualifications on mathematics achievement are at the school level: the *negative* effect associated with attending an elementary school where more than 38 percent of teachers possess an advanced degree and the *positive* effect associated with a higher ratio of mathematics coursework among teachers. One explanation for the greater effects of teacher qualifications on reading may be the disproportionate amount of time devoted to reading instruction in the first grade. Teachers in the ECLS-K study reported spending 90 minutes or more every day on reading instruction compared to only 30-60 minutes twice a week on mathematics instruction. There may well be stronger effects of teacher qualifications on mathematics achievement in later grades where the curricular and instructional focus is more balanced.

Third, findings from this study reveal the importance of considering not only the individual effects of teacher qualifications but also contextual effects of teacher qualifications. Although many studies have considered the importance of individual teacher qualifications on achievement, far fewer have considered the possible collective effects of hiring highly qualified teachers on average school achievement. While we found some evidence that individual teacher characteristics predict student achievement in reading, the effect of coursework emphasis in reading and mathematics is detectable only at the school level. The implication is that it is the collective effect of this dimension of teacher qualifications that is important (different from the cumulative effect of teacher qualifications detected by Monk & King, 1994). One possible explanation is that teachers with greater collective expertise in specific subject areas may be able to develop stronger curricular programs and provide pedagogical support to less qualified colleagues, boosting subject-specific cognitive gains schoolwide. Regardless, the possible contextual effects of teacher qualifications warrant additional consideration.

More puzzling, however, is the negative effect of schools where a high level of teachers hold advanced degrees on first-grade mathematics achievement. While it is difficult to interpret this finding, it is not without precedent. Rowan, Correnti, and Miller (2002), using *Prospects* data and multilevel methods, found advanced academic preparation in mathematics to be negatively associated with children' s gains in mathematics achievement through the elementary grades. (We found a similar result in a previous paper that analyzed the ECLS-K data using OLS regression. See Croninger, Rice, & Rathbun, 2003.) Although our dataset does not permit us to determine whether teachers are certified in specific subject areas, it is possible that our finding taps a relationship similar to that discovered in the *Prospects* data. If so, these findings may indicate that under some circumstances advanced education is not simply unrelated to quality, it may actually interfere with or diminish the quality of teaching in classrooms. We suggest that such a finding warrants further investigation.

Our findings may represent "lower-bounded" estimates of the effects of teacher qualifications on student achievement. The relatively small sample sizes for students within teachers and teachers within schools limits the statistical power of our analyses, as well as our ability to model more complex relationships (e.g., how teacher qualifications might influence the effects of student SES on achievement or how school characteristics might influence the effects of teacher qualifications on achievement).[11] (See Raudenbush & Bryk, 2002, for a discussion of the implications of sample sizes on statistical power and the specification of more complex models.) Although ECLS-K is one of a few nationally representative datasets with information about early learning, teacher qualifications, and school characteristics, the structure of the data does not permit a definitive examination of the effects of teacher qualifications on first-grade achievement. Larger sample sizes, particularly regarding the number of students per teacher and number of teachers per school, would make it easier to disentangle student, teacher, and school effects, as well examine more complex processes by which teacher qualifications might influence achievement.

Despite these limitations and cautions, our study provides evidence that specific teacher qualifications matter and raises a number of questions about the effects of teacher qualifications on achievement. Although we found evidence that some teacher qualifications are related to first-grade achievement outcomes, we have not shed any light on the actual processes through which qualifications become transformed into high-quality teaching in the classroom. Do teachers with high qualifications engage in more powerful instructional practices than teachers with low qualifications? Do they have deeper, more principled content knowledge of specific

[11] For example, in an earlier analysis of this dataset using OLS regression we found stronger effects for teacher qualifications, including an interaction between student' s SES and specific teacher qualifications. Unfortunately, the ECLS-K data structure, with only four students on average per teacher, does not permit a meaningful

subject areas, like reading; are they more motivated, committed, and professionally engaged in teaching; or are they better at managing classroom behaviors and school-family relationships than teachers with low qualifications? While certification status, degree type, and experience serve as important proxies for teacher quality, they do not identify the important processes by which these qualifications influence teaching and early learning. If teacher qualifications are related to positive teacher beliefs and practices, it would further reinforce their importance as indicators of quality for policymakers and school decision-makers.

investigation of a cross-level interaction between student SES and teacher qualifications (see Croninger, Rice, & Rathbun, 2003).

6. References

Croninger, R. G., Rice, J. K., & Rathbun, A. (2003 March). Teacher qualifications and early learning: Effects of certification status, degree, and experience on first-grade achievement. Paper presented at the annual meeting of the American Education Finance Association, Orlando, FL.

Darling-Hammond, L. (2000). Teacher quality and student achievement: A review of state policy evidence. *Journal of Education Policy Analysis, 8*(1).

Darling-Hammond, L. (1996). Teacher quality and student achievement: A review of state policy evidence. Unpublished manuscript.

Eberts, R.W. & Stone, J.A. (1984). *Unions and public schools*. Lexington, MA: D.C. Heath and Company.

Ehrenberg, R.G. & Brewer, D.J. (1994). Do school and teacher characteristics matter? Evidence from High School & Beyond. *Economics of Education Review, 13*(1), 1-17.

Ferguson, R.F. & Ladd, H. F. (1996). How and why money matters: An analysis of Alabama schools. In H.F. Ladd (ed.) *Holding schools accountable: Performance-based reform in education* (pp. 265-298). Washington, D.C.: Brookings.

Goldhaber, D.D. & Brewer, D.J. (2000). Does teacher certification matter? High school teacher certification status and student achievement. *Educational Evaluation and Policy Analysis, 22*(2), 129-146.

Goldhaber, D.D. & Brewer, D.J. (1998). When should we reward degrees for teachers? *Phi Delta Kappan, 80*(2), 134-138.

Goldhaber, D.D. & Brewer, D.J. (1997a). Why don't schools and teachers seem to matter? Assessing the impact of unobservables on educational productivity. *The Journal of Human Resources, 32*(3), 505-523.

Goldhaber, D.D. & Brewer, D.J. (1997b). Evaluating the effect of teacher degree level on educational performance. In W.J. Fowler (ed.) *Developments in School Finance, 1996*, Washington, D.C: U.S. Department of Education.

Hanushek, E.A. (1992). The trade-off between child quantity and quality. *Journal of Political Economy, 100*, 84-117.

Harnisch, D.L. (1987). Characteristics associated with effective public high schools. *Journal of Educational Research, 80*, 233-241.

Kiesling, H.J. (1984). Assignment practices and the relationship of instructional time to the reading performance of elementary school children. *Economics of Education Review, 3*(4), 341-350.

Link, C.R & Ratledge, E.C. (1979). Student perceptions, I.Q., and achievement. *Journal of Human Resources, 14*, 98-111.

Monk, D.H. (1994). Subject area preparation of secondary mathematics and science teachers and student achievement. *Economics of Education Review, 13*(2), 125-145.

Monk, D.H. & King, J.K. (1994). Multilevel teacher resource effects on pupil performance in secondary mathematics and science: The case of teacher subject-matter preparation. In R. Ehrenberg (Ed.), *Choices and consequences: Contemporary policy issues in education* (pp.29-58). Ithaca, NY: ILR Press.

Murnane, R.J. (1975). *The impact of school resources on the learning of inner city children*. Cambridge, MA: Ballinger.

Murnane, R.J. & Phillips, B.R. (1981). Learning by doing, vintage and selection: Three pieces of the puzzle relating teaching experience and teaching performance . *Economics of Education Review 1*(4), 453-465.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models. Applications and data analysis methods* (2nd edition). Thousand Oaks, CA: Sage

Rice, J.K. (2003). *Teacher quality: Understanding the effects of teacher attributes*. Washington, D.C.: Economic Policy Institute.

Rivkin, S.G., Hanushek, E.A., & Kain, J.F. (1998). *Teachers, schools, and academic achievement.* National Bureau of Economic Research, Working Paper 6691.

Rowan, B., Correnti, R., & Miller, R.J. (2002). What large-scale, survey research tells us about teacher effects on student achievement: Insights from the Prospects student of elementary schools. *Teachers College Record*.

Rowan, B., Chiang, F., & Miller, R.J. (1997). Using research on employees' performance to study the effects of teachers on students' achievement. *Sociology of Education*, 70 (October), 256-284.

Sanders, W.L. (1998). Value-added assessment. *The School Administrator, 55*(11), 24-32.

Sanders, W.L. & Rivers, J.C. (1996). *Cumulative and residual effects of teachers on future academic achievement.* University of Tennessee Value-Added Research and Assessment Center.

Scheerens, J., & Bosker, R. (1997). *Foundations of educational effectiveness*. New York: Pergamon.

Summers, A.A. & Wolfe, B.L. (1975). Equality of educational opportunity quantified: A production function approach. Philadelphia, PA: Federal Reserve Bank of Philadelphia.

Summers, A.A. & Wolfe, B.L. (1977). Do schools make a difference? *American Economic Review, 67,* 639-652.

Willms, J. D. (1986). Social class and segregation and its relationship to pupils' examination results in Scotland. *American Sociological Review*, *55*, 224-241.

Table 1
Descriptive statistics for students, teachers, and schools (5,167 students, 1,342 teachers, 453 elementary schools)[a]

School variables	M	SD	Min.	Max.
High certification status (> 93%)	0.82	0.39	0.00	1.00
High advanced degrees (> 38%)	0.45	0.50	0.00	1.00
High elem. educ. degrees (> 83%)	0.64	0.48	0.00	1.00
Ave. yrs. experience	0.00	1.00	-2.85	2.28
Ave reading course ratio	0.00	1.00	-2.82	4.48
Ave mathematics course ratio	0.00	1.00	-3.65	5.97
High minority enrollment (50% plus)	0.30	0.45	0.00	1.00
Ave. socioeconomic status	0.00	1.00	-2.53	3.13

Teacher variables	M	SD	Min.	Max.
Certification status (1 = yes)	0.93	0.26	0.00	1.00
Advanced degree (MA plus)	0.38	0.49	0.00	1.00
Elementary ed. degree (1 =yes)	0.83	0.37	0.00	1.00
Experience (0-2 yrs.)	0.29	0.45	0.00	1.00
Experience (5 plus yrs.)	0.50	0.50	0.00	1.00
Reading courses ratio	0.00	1.00	-2.88	4.93
Mathematics courses ratio	0.00	1.00	-3.13	4.67
Teachers age	0.00	1.00	-1.73	2.17
Class size	0.00	1.00	-2.41	4.10

Student variables	M	SD	Min.	Max.
Minority student (1 = yes)	0.35	0.48	0.00	1.00
Female student (1 = yes)	0.50	0.50	0.00	1.00
Single parent household (1 = yes)	0.20	0.40	0.00	1.00
Socioeconomic status	0.00	1.00	-3.92	3.59
Elapsed time between testing	0.00	1.00	-4.25	3.86
Kindergarten reading achievement	0.00	1.00	-2.06	4.97
First-grade reading achievement	0.00	1.00	-3.28	2.56
Kindergarten mathematics achievement	0.00	1.00	-2.51	3.56
First-grade mathematics achievement	0.00	1.00	-4.40	1.92

a We dropped all teachers with fewer than two students and all schools with fewer than two teachers. The resulting analytic sample averages four students per teacher, three teachers per school, and 11 students per school with ranges of two to 13 students, two to seven teachers, and four to 22 students respectively.

Table 2
Random effects, intraclass correlations, and reliability estimates for first-grade reading and mathematic achievement (5,167 students, 1,342 teachers, 453 elementary schools)

	Reading Achievement	Mathematics Achievement
Random effects[a]		
Intercept, β_{00k}		
Between school variance, u_{00}	0.179	0.162
Intercept, π_{0jk}		
Between teacher variance, r_0	0.069	0.073
Between student variance, e	0.757	0.767
Intraclass correlations		
$\tau_{\beta 00} / \tau_{\beta 00} + \tau_{\pi 00} + \sigma^2$		
School and student achievement	0.178	0.162
$\tau_{\pi 00} / \tau_{\beta 00} + \tau_{\pi 00} + \sigma^2$		
Teacher and student achievement	0.069	0.073
Reliability estimates		
Intercept, β_{00k}		
Average teacher achievement within schools	0.640	0.613
Intercept, π_{0jk}		
Average student achievement within teachers	0.249	0.256

a The variance in achievement in reading and the variance in achievement in mathematics between schools (u_{00}) and between teachers (r_0) is significantly different from zero ($p < .000$)

Table 3
Effects of teacher qualifications on first-grade reading and mathematics achievement (5,167 students, 1,342 teachers, 453 elementary schools)[a]

	Reading Achievement	Mathematics Achievement
School-level model		
Average school achievement, γ_{000}	-0.013	-0.003
High certification status (> 93%), γ_{002}	0.031	0.002
High advanced degrees (> 38%), γ_{001}	-0.005	-0.068*
High elem. educ. degrees (> 83%), γ_{003}	0.019	0.019
Ave. yrs. experience, γ_{004}	-0.001	0.020
Ave. reading course ratio, γ_{005}	0.047**	0.019
Ave. mathematics course ratio, γ_{006}	0.025	0.029$^{\sim}$
High minority enrollment (50% plus), γ_{007}	-0.085*	-0.016
Ave. socioeconomic status, γ_{008}	0.075***	0.043**
Teacher-level model		
Certification status, β_{01}	0.004	-0.032
Advanced degree (MA plus), β_{02}	0.004	0.020
Elementary ed. degree, β_{03}	0.078*	0.025
Experience (0-2 yrs.), β_{04}	-0.055$^{\sim}$	-0.024
Experience (5 plus yrs.), β_{05}	0.032	-0.033
Reading course ratio, β_{06}	-0.001	0.004
Mathematics course ratio, β_{07}	-0.013	-0.008
Teachers age, β_{08}	0.009	0.005
Class size, β_{09}	-0.024$^{\sim}$	-0.022$^{\sim}$
Student-level model		
Minority student, π_1	0.006	-0.089***
Female student, π_2	0.046*	-0.046**
Single parent household, π_3	-0.036	0.025
Socioeconomic status, π_4	0.062***	0.078***
Kindergarten achievement, π_5	0.686***	0.700***
Elapsed time between testing, π_6	0.061***	0.050***

*** *p* > .000; ** *p* > .01; * *p* > .05; $^{\sim}$ *p* > .10
a Dependent variables and continuous independent variables are standardized (M = 0, SD = 1). All school-level, student-level and teacher-level variables are grand-mean centered. Conditional random effects for reading achievement are 0.031 (u_{00}), 0.034 (r_0), and 0.363 (e); conditional random effects for mathematics achievement are 0.021 (u_{00}), 0.027 (r_0), and 0.364 (e). The residual variance in achievement in reading and the residual variance in achievement in mathematics between schools (u_{00}) and between teachers (r_0) is significantly different from zero ($p < .000$).

7. Appendix: Description of Variables

Dependent Variables (n = 5,167)

Spring kindergarten and first-grade IRT scale scores (reading and mathematics). Children were administered an un-timed, individualized assessment in each subject area using computer adaptive testing. For each assessment, children were asked either to point to items on an easel or respond orally to items administered by a trained assessor. Children completed a routing test in each subject area composed of items asked of all students. Children' s performance on the routing test was used to determine which second-stage test was most appropriate in difficulty. IRT-scale scores were calculated for each subject area based on children' s performance on the routing and second-stage tests. The mathematics two-stage assessment batteries were identical in the kindergarten and first-grade year, whereas the kindergarten and first grade reading batteries were similar, with the exception that the number of reading items was increased in first grade with more difficult vocabulary words and text to eliminate the possibility of ceiling effects.

Reading assessment – measures basic skills (e.g., print familiarity, beginning and ending sounds), vocabulary, and comprehension (e.g., listening comprehension, words in context). We standardized the IRT scale scores for analyses (M = 0, SD = 1). Standardized scores range from –2.06 to 5.97 at the end of kindergarten and from –3.28 to 2.56 at the end of first grade.

Mathematics assessment – measures skills in conceptual knowledge, procedural knowledge, and problem solving. We standardized the IRT scale scores for analyses (M = 0, SD = 1). Standardized scores range from – 2.51 to 3.56 at the end of kindergarten and from –4.40 to 1.92 at the end of first grade.

Student Variables (n = 5,167)

Minority student. An indicator variable coded, 1 = minority, 0 = white, non-Hispanic. Thirty-five percent (35%) of the sample is minority.

Female student. An indicator variable coded, 1 = female, 0 = male. Half of the sample (50%) is female.

Single-parent household. An indicator variable coded, 1 = single parent household, 0 = two-parent household. One-fifth of the sample (20%) is from a single-parent household.

Socioeconomic status. The SES variable is a composite on the ECLS-K data file based on the following variables: mother/female guardian' s education level, father/male guardian's education level, mother/female guardian' s occupation, father/male guardian's occupation, and household income. We standardized the composite for analyses (M = 0, SD = 1). Standardized scores range from -3.92 to 3.59.

Elapsed time between testing. We used the dates for testing at the end of kindergarten and the first grade to create a measure of developmental opportunity or how much time had elapsed between testing. The number of days elapsed ranges from 279 to 438 days between spring kindergarten and spring first grade assessments, with a mean of 365.7 days. We calculated elapsed time by 1) converting the assessment date variables on the data file into numeric date format, 2) subtracting the numeric date value for the spring kindergarten assessment from the date value for the spring first-grade assessment, and 3) dividing the difference by 86400 to determine elapsed time in days. We standardized these values for use in the analysis (M = 0, SD = 1). Standardized values for this variable range from -4.25 to 3.81.

Teacher Qualifications and Control Variables (n = 1,342 teachers)

Certification status. An indicator variable coded, 1 = advanced professional certification, regular certification, or alternative program certification as certified, 0 = probationary or not certified. Ninety-three percent (93%) of the sample is certified.

Advanced degree. An indicator variable coded, 1 = highest degree is a MA or higher in any area of study, 0 = BA or lower degree. Thirty-eight percent (38%) of the sample has an advanced degree.

Elementary education degree. An indicator variable coded, 1 = has an elementary education degree, 0 = does not have an elementary education degree. Eighty-three percent (83%) of the sample has an elementary education degree.

Reading and mathematics course ratios. The ECLS-K data file includes information about teachers' coursework in reading, mathematics, and science. We constructed a ratio of coursework for reading and mathematics by dividing the number of courses taken in each of these subject areas by the total number of courses taken across all three subject areas. We used teachers' degrees to estimate missing values for roughly four percent of the cases. Then we took the natural log of values and standardized the result for use in our analyses (M = 0, SD = 1). Standardized values range from -2.88 to 4.93 for the reading course ratio and from-3.13 to 4.67 for the mathematics course ratio.

Experience (0-2 yrs.) and experience (plus 5 yrs.). Teachers reported an average of 8 years of experience teaching first grade with a range of zero to 30 years of experience. We used this information to create two indicator variables for teachers with less and more experience. We coded teachers with two or fewer years of experiences as having less experience (Yes = 1, Others = 0), while we coded teachers with more than five or more years of experience as having more experience (Yes = 1, Others = 0). Twenty-nine percent (29%) of the teachers has zero to two years of experience, while 50% has five or more years of experience.

Teacher's age. The average age of teachers in the sample is 42 years old with a range of 23 to 65 years old. We use a standardized version of this variable in our analyses (M = 0, SD = 1).

Class size. The average class size reported by teachers is 21 students with a range of 12 to 35 students. We use a standardized version of this variable in our analyses (M = 0, SD = 1).

School Variables (n = 453 schools)

High certification status. We coded schools with a higher percentage of certified teachers than the percentage of certified teachers as having a percentage of certified teachers, coded 1 = greater than 93%, 0 = 93% or less. Eighty-two percent (82%) of the schools has a high percentage of certified teachers.

High advanced degrees. We coded schools with a higher percentage of teachers with advanced degree than the percentage of teachers with advanced degrees as having a high percentage of teachers with advanced degrees, coded 1 = more than 38%, 0 = 38% or less. Forty-five percent (45%) of the schools has a high percentage of teachers with advanced degrees.

High elementary education degrees. We coded schools with a higher percentage of teachers with an elementary education degree than the percentage of teachers with an elementary education degree as having a high percentage of teachers with elementary education degrees, coded, 1 = more than 83%, 0 = 83% or less. Nearly two-thirds (64%) of the sample has a high percentage of teachers with elementary education degrees.

Average years of experience. We aggregated the years of experience that teaches reported to the school level, calculated the natural log of the school means, and standardized the result (M = 0, SD = 1). Standardized values range from -2.85 to 2.28.

Average reading course ratio. We aggregated the reading course ratio to the school level, calculated the natural log of the school means, and standardized the result (M = 0, SD = 1). Standardized values range from -2.88 to 4.93.

Average mathematics course ratio. We aggregated the reading course ratio to the school level and standardized the school means (M = 0, SD = 1). Standardized values range from -3.65 to 5.97.

High minority enrollment. An indicator variable coded, 1 = 50% or more minority enrollment, 0 = less than 50%. Nearly one-third of the sample (30%) has high minority enrollment.

Average socioeconomic status. We aggregated student's socioeconomic status to the school level and standardized the school means (M = 0, SD = 1). Standardized values range from -2.53 to 3.13.