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The Importance of Teacher Credentials for Early Achievement – *A Replication of Croninger et al. (2007) Econ. Edu. Rev.*

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Abstract

Many educational reforms in the United States incorporated teacher qualifications into their design to better the quality of public education. However, research remains mixed as to whether teacher quality impacts student achievement. This study aimed to replicate a study prior to recent teacher education reforms to understand what differences exist, if any, in the relationships between teacher qualifications and elementary student achievement. A federal data source was used to examine school-, teacher-, and student-level variables on first grade reading and mathematics achievement. Results indicate that few school- and student-level variables relate to reading and mathematics achievement, yet no teacher-level predictors related to first grade achievement. The paper concludes with a discussion on similar studies and limitations.

Keywords: replication; ECLS-K; teacher certification; teacher qualifications

Introduction

Educational stakeholders disagree on the best path to education reform. One argument revolves around the issue of teacher "quality": teacher education, experience, instructional practices, certification type, degree level, etc. A damning report by Darling-Hammond (2000) states, "that measures of teacher preparation and certification are by far the strongest correlates of student achievement in reading and mathematics, both before and after controlling for student poverty and language status" (p.1). Using the data collected in the Early Childhood Longitudinal Study (ECLS) during 1998-1999, Croninger, Rice, Rathbun, and Nishio (2007) found certain teacher qualifications such as degree type and teaching experience positively impacted reading and math achievement for first grade students in the United States. Schools that emphasized more advanced college coursework in their teachers had higher achievement in both reading and math, but certification status was not associated with higher student scores. However, many educational reforms in the United States (No Child Left Behind, Race to the Top, and Common Core, to name the largest endeavors) have been implemented since Darling-Hammond's decree and the Croninger et al. (2007) study. Our study will use more recent data from the ECLS to replicate the Croninger et al. (2007) study and examine the relevance of teacher credentials in the current educational climate. We will first document major US educational reform policies since the data collected in the Croninger et al. (2007) study and then review teacher credential research and its established complexities.

No child left behind (2001)

Since the turn of the century, the United States education system has existed under an era of "high stakes," or test-based, accountability to help eliminate the achievement gap (Gulamhussein, 2013; Linn, 2005). The No Child Left Behind Act of 2001 (NCLB) included a reform to make sure all students had a "highly qualified" teacher in their classrooms, or a teacher with a bachelor's degree and state certification in the assigned teaching area along with demonstrated knowledge in this area (Spellings, 2005). While NCLB was intended to strengthen the quality of teacher preparation, it reduced the level of teacher quality (Baines, 2010). Smith and Gorard (2007) found that NCLB changed teacher education by promoting content area focus over teaching skills, creating vast differences in teacher training, certification, and oversight. However, not all research concludes that this era of accountability has negatively impacted the teacher credential landscape. Multiple policy reforms, including NCLB, have worked together to create an increase in the "level and distribution of teacher qualifications" (Deangelis et al., 2010). Nonetheless, the change in presidents resulted in new reforms with different foci.

Race to the top (2009)

President Barack Obama's efforts to increase teacher quality included the Race to the Top (RttT), which was meant to improve teacher effectiveness by recruiting quality teachers, developing current teachers' knowledge and skills, identifying a teacher's weaknesses and rewarding successes (Duncan, 2009). This reform opened alternative certification pathways (Stern, 2013) and gave school districts more latitude in dismissal of individual teachers by linking student achievement to teacher evaluations (DeNisco, 2014). Improvement plans for struggling teachers differed by districts, but RttT streamlined and standardized these procedures (DeNisco, 2014). While RttT and NCLB legislation mandated more reliable and valid teacher evaluations, many states varied in implementation and evaluation (Herlihy et al., 2014), making claims about accountability difficult.

Common core (2010/2016)

Another educational reform, the Common Core State Standards (CCSS), aimed to provide high standards to make sure students were college and career ready upon graduation (U.S. Department of Education). These standards, released in 2010, would align with high quality assessments and could be altered to meet the needs of individual states (Common Core State Standards Initiative, 2016); however, like NCLB and RttT, the CCSS did not resolve issues regarding accountability of teacher quality. For example, in Lovette's (2013) review of the requirements for secondary licensure in reading, the author concluded that state certification requirements varied widely. Teachers also did not perceive these reforms as positive. In a study by Murphy and Torff (2016), the simultaneous effect of reforms in standards and assessment appeared to reduce the efficacy of teachers and placed teachers in an "unfair" position (p.23). In sum, many reforms attempted to increase teacher quality but evidence on their impact is mixed and unclear.

Teachers' qualifications

The research on teacher qualifications' impact on student achievement appears mixed given some important research considerations. First, what qualifies as a "qualification" depends on the study; some consider certification, degree type, and years in the classroom while others examine professional development enrollment, self-esteem, or classroom practices. Secondly, impacts on student outcomes depend on the age of the student, subject area, the level of school, and what "achievement" really means. Another consideration is that credential programs and assessments vary by state. For example, in a review of teacher preparation programs, Howell et al. (2016) found that middle grade preparation (ranging from 4th-9th grades), only half of the programs had no explicit teacher preparation and credentialing for middle level students but that this varied dramatically between state and region. Finally, there is a large lack of causal designs within the teaching qualifications research. It is difficult to randomly assign teachers to different credential programs given this might require them to significantly alter their lives by enrolling in a different university or moving to new cities or states. Many studies are also not able to randomly assign students to teachers given the logistics associated with location and scheduling. These discrepancies make it impossible to compare across studies and dictate the impact of qualifications on student achievement.

When examining the relationship between teacher qualifications and student achievement, results differ based on key model variables. Older studies have not found positive relationships between teacher quality and student test scores. For pre-kindergarten students, academic gains do not appear to be related to the characteristics of the child or the teaching program (Howes et al., 2008). McDonald, Son, Hindman, and Morrison (2005) found that teachers with more formal education showed more warmth to their students, yet their students had lower reading scores. Similarly, Palardy and Rumberger (2008) found that the "highly qualified teacher" label from NCLB did not raise student achievement for students in first grade. In fact, teacher qualification contributed less to test score variance than instructional practices.

Additionally, the NCLB indicators of teacher effectiveness did not appear to raise achievement for at-risk or non-risk students in first grade (Phillips, 2010). In an international study of 25 countries, Luschei and Chudgar (2011) argued that background of both the teacher and student did not impact the achievement in math or science for fourth graders and cited the need for more research on improving teacher quality through other measures besides education or experience.

These studies directly contrast more recent work from the United States. Using national data from 2004, Curry et al. (2018) found that students were more likely to have higher reading scores if their teachers had been prepared in a traditional teacher certification program, earned a degree, and had a National Board qualification (additional certification that requires years of work). So, for lower elementary grades, teacher background would appear to have little to no effect on standardized test scores, but in a full review of the research since 2003, researchers from the Learning Policy Institute found that a teacher's years of experience positively related to increases in students' standardized test scores (Kini & Podolsky, 2016). These findings were consistent across grade and subject although not all states were represented in the research (Kini & Podolsky, 2016). In sum, more research must be done to clarify which teacher quality variables may (or may not) relate to student achievement.

No studies were found that made comparisons between achievement prior to and after reforms, indicating the need for additional, more current research. This study serves to fill this gap by replicating an older study that includes important school-, teacher- and student-level variables. One study examined how school, teacher, and student characteristics contribute to math and reading achievement in first grade. Croninger et al. (2007) used 1998-1999 data from the Early Childhood Longitudinal Study-Kindergarten (ECLS-K), a nationally representative sample collected from the National Center of Education Statistics. Results from their study indicated that only two teacher characteristics- degree type and school average number of teachers with reading courses- had an effect on reading scores. There were no teacher characteristics that had an effect on math scores except for the school average of having more teachers with advanced degrees. However, many teacher qualification policies have been implemented since this study and replication is needed to determine if the same claims can be made given the sweeping reforms around teaching quality.

Purpose

As Bogard, Traylor, and Takanishi (2008), state, "Characterizing teachers' training experiences prior to entering the classroom is vital" (p. 3). Accordingly, the purpose of this study is to examine the relationship between the "era of accountability" reforms- specifically those that address teacher qualifications- and student achievement. Considering the reforms on teacher quality that have been implemented since 2002, we ask the question: What changes have occurred in the relationships between elementary school teacher qualifications and student achievement since the implementation of "era of accountability" reforms? To do so, we will replicate the Croninger et al. (2007) study using data since these reforms and compare the coefficients.

Methods

The sample used in this study comes from the Early Childhood Longitudinal Study-Kindergarten (ECLS-K) class of 2011. The ECLS, sponsored by the United States' National Center for Education Statistics (NCES) beginning in 1998, includes data from a nationally representative sample of students, teachers, and schools. Additional information about the study along with data products can be found at https://nces.ed.gov/ecls/. Methodological choices aligned with the Croninger et al. (2007) to the degree possible with the more recent data. Code for this replication can be found at https://doi.org/10.17605/OSF.IO/HSGJ2.

Sample

The analytic sample was created by extracting data on the first-grade participants because the variables associated with this grade align with previous ECLS waves of the study. We excluded all teachers with fewer than two students and all schools with fewer than two teachers because low numbers within clusters at each level limit the power to detect within-cluster effects (Snijders, 2005). The final sample included 2968 students and 882 teachers within 480 elementary schools.

Student-level variables

We included nine student-level variables related to achievement or demographic information from the Croninger et al. (2007) study that were available in the data (Table 1). We included item response scale scores from first-grade reading and mathematics assessments, along with reading and mathematics item response scale scores from kindergarten to control for previous achievement levels. Socioeconomic status was calculated by NCES, derived from the educational attainment and occupational prestige level of parents one and two along with household income. We calculated the elapsed time between kindergarten and first-grade assessment as the time between the date of kindergarten and first-grade testing. Specific variable names and descriptions can be found in Table 1.

Teacher-level variables

Teacher-level variables were created in accordance with the Croninger et al. (2007) study. We define "certified" teachers as those with regular or alternative certification (teachers have gone through formal teacher training or university educational programs) and "non-certified" as those with temporary, provisional, emergency, probationary, or no certification (for individuals without enough formal training in education or their content area). Advanced degree attainment included teachers with a master's degree or higher. "Elementary education degree status" distinguished between those teachers with an elementary education major versus teachers with a degree in other areas. Experience was separated into three categories: zero to two years of teaching first-grade, three or four years of teaching, or five or more years of teaching. Due to the differences in data collection protocol in the ECLS-K: 2011 program from previous waves of data collection, we did not compute a ratio measure of coursework from elementary reading or mathematics-specific coursework to total coursework. Instead, we included an indicator (i.e., presence or not) of whether teachers had taken subject-specific coursework in reading or mathematics. As such, these results reflect whether having *any* subject-specific coursework relates to student achievement rather than *how much* subject-specific coursework relates to student achievement. The data contained only the year of each teacher's birth. To compute each teacher's age, we computed the difference between the birth year and the year the data were collected, 2011. The final teacher-level variable was class size.

Table 1. List of Early Childhood Longitudinal Survey- Kindergarten variables and descriptions.

Level	ECLS-K Variable Name	Description
Teacher	A4STATCT	Certification status
	A4HGHSTD	Advanced degree attainment
	A4DEGELM	Elementary education degree status
	A4YRSTCH	Experience (in years)
	A4YRBORN	Age
	A4TOTAG	Class size
	A1MTHDRD	Method coursework taken in reading
	A1MTHDMA	Method coursework taken in mathematics

Student	X_WHITE_R	Race
	X_CHSEX_R	Sex
	P4PARTNR	Parents' partner status (single or not)
	X12SES1	Socioeconomic status
	X2RSCALK2	Kindergarten reading achievement scale score
	X2MSCALK2	Kindergarten mathematics achievement scale score
	X4RSCALK2	First-grade reading achievement
	X4MSCALK2	First-grade mathematics achievement
	X2ASMTDD	Kindergarten testing day
	X2ASMTMM	Kindergarten testing month
	X2ASMTYY	Kindergarten testing year
	X4ASMTDD	First-grade testing day
	X4ASMTMM	First-grade testing month
	X4ASMTYY	First-grade testing year

School-level variables

School-level variables were created in accordance with the Croninger et al. (2007) study. School-level effects were primarily derived from the aforementioned variables. Schools were coded as having high minority enrollment if their student body contained more than 50% racial or ethnic minority students (only labeled "minority" in Croninger study). The average socioeconomic status was calculated as the mean of the student socioeconomic status within each school. Each school was coded as having a high percentage of certified teachers if more than 93% of its teachers were certified, a high percentage of teachers with elementary education degrees if more than 83% had received degrees, and a high percentage of advanced teachers if more than 38% attained master's degrees or higher. These "high" determinations were made in the original study "if the percentage of teachers with a particular characteristic at a school exceeded the percentage of teachers with that characteristic in the overall teacher population" (p. 317). Average teacher experience was the mean years of experience of teachers within each school. Descriptive statistics on the variables are presented in Table 2.

Table 2. Descriptive statistics for students, teachers, and schools (2968 students, 882 teachers, & 480 schools$_a$).

	MEAN	**STD**	**MIN**	**MAX**
School Variables				
High Certification Status (>93%)	0.877	0.329	0.000	1.000
High Advanced Degrees (>38%)	0.563	0.497	0.000	1.000
High elem. educ. degrees (>83%)	0.850	0.357	0.000	1.000
Avg. yrs. experience	15.839	8.807	1.000	42.000
Avg. method course	0.916	0.219	0.000	1.000
High minority enrollment (50%+)	0.250	0.433	0.000	1.000
Avg. socioeconomic status	0.696	0.290	0.040	1.828
Teacher Variables				
Certification status (1 = yes)	0.929	0.258	0.000	1.000
Advanced degree (MA plus)	0.534	0.499	0.000	1.000
Elem. Degree (1 = yes)	0.912	0.284	0.000	1.000

Experience (0-2 yrs.)	0.074	0.261	0.000	1.000
Experience (5+ yrs.)	0.867	0.339	0.000	1.000
Method courses in reading	0.955	0.168	0.000	1.000
Method courses in math	0.919	0.219	0.000	1.000
Teacher age	43.539	11.652	23.000	76.000
Class size	20.965	4.417	1.000	55.000
Student Variables				
First-grade mathematics achievement	92.210	12.470	35.480	116.590
Kindergarten mathematics achievement	67.960	13.300	30.610	109.920
First-grade reading achievement	74.960	12.950	19.610	109.010
Kindergarten reading achievement	51.790	10.920	11.750	86.990
Elapsed time between testing	365.755	24.427	289.000	435.000
Socioeconomic status	0.750	0.500	0.000	2.600
Single parent household (1 = yes)	0.090	0.290	0.000	1.000
Female student (1 = yes)	0.510	0.500	0.000	1.000
Minority student (1 = yes)	0.090	0.280	0.000	1.000

[a] As in the Croninger et al. (2007) study, we dropped all schools with fewer than two teachers and all teachers with fewer than two students.
[b] We standardized all continuous variables in the analysis (M = 0, SD = 1).

Analytical procedure

Given the nested structure of the data (i.e., students nested within teachers who are nested within schools), we used a three-level model with reading or mathematics achievement scores as the outcome measure. This analytic approach allowed us to (1) appropriately model the nested data structure (i.e., accounting for violation of error independence), (2) evaluate the proportion of variability accounted for by student-, teacher-, and school-level characteristics, and (3) include characteristics at each level (i.e, student, teacher, or school) to examine each relationship with reading and/or mathematics achievement. Prior to estimating the unconditional and conditional multilevel models, we first generated descriptive statistics for each of the included variables in the analytic dataset. Next, we estimated the unconditional, three-level model, which produced the random effects for students (σ2), teachers (τ_π), and schools (τ_β). These estimates were used to compute the intraclass correlation coefficient (ICC) for each unit. The teacher-level ICC was computed as:

$$ICC = \frac{\tau_\pi}{\tau_\beta + \tau_\pi + \sigma^2} \quad (1)$$

and the school-level ICC was computed as:

$$ICC = \frac{\tau_\pi}{\tau_\beta + \tau_\pi + \sigma^2} \quad (2)$$

The unconditional, mixed model can be expressed as:

$$Y_{ijk} = \sum_{k=0}^{n} \binom{n}{k} x^k a^{n-k} \quad (3)$$

where γ_{000} is the grand mean, u_{00k} is the random effect of school k, r_{0jk} is the random effect of teacher j in school k, and e_{ijk} is the random effect of student i nested within teacher j in school k. The conditional model included each of the student-, teacher-, and school-level variables described above. We used a pre-established Type I error rate of

5% for interpreting fixed effects. Data management was conducted in SAS and the multilevel model analyses were done in R.

Results

The estimates for each random effect and the ICCs are provided in Table 3. The student-, teacher-, and school-level random effects for the reading achievement model were respectively .87 (σ2), .08 (τ_π), and .06 (τ_β) and for the mathematics achievement model were respectively .88 (σ2), .11 (τ_π), and .01 (τ_β). That is, in the model predicting first grade reading scores, student-, teacher-, and school-level variables respectively accounted for about 86.8%, 7.6%, and 5.8% of the total variability. In the model predicting first grade mathematics scores, student-, teacher-, and school-level variables respectively accounted for about 87.7%, 11.1%, and 1.1% of the total variability. ICCs can also be interpreted as the average correlation of lower level units nested within higher level units. For example, the teacher ICC in the mathematics model of 0.111 (11.1%) suggests that the average correlation between students within each teacher's class is about 0.111.

Table 3. Random effects, intraclass correlations, and reliability estimates for first-grade reading and mathematics achievement (2968 students, 882 teachers, 480 elementary schools).

	Reading achievement	**Math achievement**
Random effects		
Intercept, β_{00k}		
Between school variance, u_{00}	.06	.01
Intercept, π_{0jk}		
Between teacher variance, r_0	.08	.11
Between student variance, e	.87	.88
Intraclass correlations		
$\tau_{\beta 00}/\tau_{\beta 00} + \tau_{\pi 00} + \sigma^2$ School and student achievement	.08	.11
$\tau_{\pi 00}/\tau_{\beta 00} + \tau_{\pi 00} + \sigma^2$ Teacher and student achievement	.06	.01
Reliability estimates		
Intercept, β_{00k}		
Average teacher achievement within schools	.032	.006
Intercept, π_{0jk}		
Average student achievement within teachers	.176	.042

Reading achievement

Among the school-level predictors of reading achievement, only the average number of reading courses taken by faculty and average student SES were significant. Percentage of teachers having taken a reading methods course was inversely related to student reading scores (γ_{500} = -0.30, p = 0.04, CI_{95} = -0.58, -0.01). Schools with greater average SES tended to have slightly higher student reading scores (γ_{700} = 0.03, p = 0.05, CI_{95} = 0.00, 0.07). Among the teacher-level predictors of reading achievement, none was statistically or practically significant. Among the student-level predictors, previous reading achievement (β_{100} = 0.74, p < .001, CI_{95} = 0.71, 0.77), elapsed time between testing administrations (β_{200} = 0.10, p <.001, CI_{95} = 0.07, 0.13), student SES (β_{300} = 0.04, p = .006, CI_{95} = 0.01, 0.07), and gender (β_{500} = 0.12, p < .001, CI_{95} = 0.07, 0.17) were significant. That is, higher previous reading achievement, more elapsed time between

test administrations, SES, and/or being female was associated with higher reading achievement scores controlling for the other predictors in the model.

Mathematics achievement

In the mathematics achievement model, school-level information accounted for slightly more than 1% of the variability. There was, therefore, little variance available to explain by the school-level variables. No school-level predictor was statistically or practically significant. Similarly, none of the teacher-level predictors explained a significant portion of the 11% of total variability attributable to teacher-level characteristics. Most of the total variability in mathematics achievement scores was accounted for by student-level variables. Among them, previous reading achievement (β_{100} = 0.76, p < .001, CI_{95} = 0.74, 0.79), elapsed time between testing administrations (β_{200} = 0.06, p <.001, CI_{95} = 0.03, 0.09), student SES (β_{300} = 0.05, p = .004, CI_{95} = 0.02, 0.08), and gender (β_{500} = -0.15, p < .001, CI_{95} = -0.10, -0.20) were significant. After controlling for the other predictors in the model, higher previous mathematics achievement, more elapsed time between test administrations, and/or SES was associated with higher mathematics achievement scores. Females tended to score lower than males on the mathematics achievement test.

The fixed effect estimates for the school-, teacher-, and student-level variables for both reading and mathematics achievement are presented in Table 4.

Table 4. Effects of teacher qualifications on first-grade reading and mathematics achievement (2968 students, 882 teachers, 480 elementary schools).

	Reading achievement		**Mathematics achievement**	
School-level model	Estimate	SE	Estimate	SE
High certification status (>93%) [Non-high certification (<93%)]	-0.02	0.06	0.01	0.06
High advanced degree [Non-high advanced degree]	0.06	0.05	-0.03	0.04
High elem. ed. degree [Non-high elem. ed. degree]	-0.02	0.06	-0.04	0.05
Avg. yrs. experience	0.03	0.02	0.03	0.02
Method course average	-0.30*	0.14	-0.32	0.13
High minority enrollment [Non-high minority enrollment]	-0.04	0.04	-0.05	0.04
Avg. socioeconomic status	0.03*	0.02	0.01	0.02
Teacher-level model				
Certification status [Not certified]	-0.00	0.09	0.04	0.08
Advanced degree (MA plus) [No advanced degree]	-0.04	0.05	0.05	0.04
Elementary ed. degree [No elem. Ed. degree]	-0.04	0.07	-0.05	0.06
Experience (0-2 yrs.) [Experience 3-5 yrs.]	-0.03	0.08	-0.07	0.07
Experience (5+ yrs.) [Experience 3-5 yrs.]	0.01	0.07	-0.09	0.06
Method course (reading, math) [No methods course]	-0.08	0.09	0.05	0.09
Teacher age	0.01	0.02	-0.02	0.02
Class size	-0.01	0.02	0.01	0.01
Student-level model				

Minority student [Non-minority student]	-0.08	0.05	-0.07	0.05
Female student [Male student]	0.12*	0.03	-0.15*	0.02
Single parent household [Non-single parent household]	0.03	0.04	0.01	0.04
Socioeconomic status	0.04*	0.01	0.05*	0.01
Kindergarten achievement	0.74*	0.01	0.76*	0.01
Elapsed time between testing	0.10*	0.02	0.06*	0.01

*$p < .05$; Reference groups given in square brackets beneath categorical predictor variables.

Discussion

This study aimed to provide a replication and updated examination of how student, teacher, and school characteristics related to first grade achievement in reading and mathematics in the United States, from Croninger et al. (2007). Previous research has been mixed, on what contributes to student success in early grades and recent reforms have taken place since much of the work has been completed. We will now discuss how new, nationally representative data compares to past findings.

For reading and mathematics achievement in first grade, important student-level variables included gender and socioeconomic status. Our study found that being a female positively relates to reading achievement and negatively relates to mathematics achievement even in the beginning school years. These findings complement other research stating that gender differences exist in reading and math achievement (Bedard & Cho, 2010; Beekman & Ober, 2015; Chipere, 2014; Robinson & Lubienski, 2011; Schwabe et al., 2015). Socioeconomic status at the individual level has been found to impact achievement in a plethora of studies (e.g. Max & Glazerman, 2014; Singh, 2015), and our study demonstrates that it has a small yet measurable impact in both math and reading (0.040 & 0.048).

Socioeconomic status aggregated to the school level continues to be important for student achievement in early grades. What has been deemed “The Coleman Report” (Coleman, 1966) found that the school level characteristics (including socioeconomic status) greatly impacted achievement levels of students. Using data from 1998-1999, Croninger et al. (2007) found that reading achievement was positively related to average socioeconomic status of the school yet resonating with the findings of this study. The coefficients in both studies were low for both reading and math, with relationships higher for reading than math in both studies. However, the Croninger et al. (2007) study found that mathematics achievement was statistically significant to school-level socioeconomic status while it was not statistically significant in this study. Given the small numerical differences in the coefficients, we believe this may be due to the fact the Croninger et al. (2007) study included over 2000 more students and 400 teachers which could impact statistical significance.

Our findings indicate that teacher qualifications do not have significant impacts on first grade achievement in contrast to similar studies on this topic. Other studies that have analyzed the ECLS-K data have noted that teacher differences matter. In 2006, Guarino and Hamilton claimed that the number of courses that teachers had taken impacted achievement indirectly, in that teachers with more previous coursework implemented various instructional practices that then contributed to student gains in achievement. Similarly, studies by Heck (2007) and Easton- Brooks and Davis (2009) promoted teacher qualifications as a significant mediator in explaining student score differences, especially regarding NCLB. Teacher education increased preschool student scores even more than experience in the classroom increased scores (Brown et al., 2008). For fourth graders, the increase of reading comprehension scores could be linked to indicators of teacher quality, including the teachers’ education (Hairrell et al., 2011).

Differences in the findings of previous research may be due to a number of factors. Many of these studies examine data at the district or state level rather than the nation as a whole. Brown, Molfese, and Molfese (2008) examines an unnamed district, Easton-Brooks and Davis (2009) and Hairrell et al. (2011) both use data from Texas schools, and Heck (2007) utilizes data from Hawaii; the data from this study is nationally representative and therefore provides a different picture. For studies that used nationally representative data, such as the report by Guarino et al. (2006), used different analytical models. This paper utilized a three level hierarchical linear model to account for variability at the school, teacher, and student levels, while Guarino et al. (2006) used a two level model using only student and teacher characteristics, leaving out variability between schools.

Other studies with statistically significant teacher characteristics have important considerations. For example, Huang and Moon (2009) found that education, certification, and total years teaching did not impact second grade achievement, but the years taught *for that particular grade level* did increase reading achievement scores. As the definition of experience may differ from study to study, it may be difficult to claim that overall experience consistently impacts student achievement. Easton-Brooks and Davis (2009) further postulated that certification helped decrease the achievement gap between White and Black/African American students. The context in which the study takes place (i.e., using data from different states or student groups) may highlight how teacher characteristics differentially impact student achievement.

The replicated study, a three level hierarchical linear model with nationally representative data by Croninger et al. (2007), allows us to examine how teacher characteristics relate to first grade student reading and mathematics achievement before and after the implementation of national reforms. In the Croninger et al. (2007) study, the authors found that important teacher-level characteristics for achievement include having an elementary education degree. Teacher characteristics aggregated to the school level, such as the average number of courses teachers have taken in reading or having a high number of teachers with advanced degrees, are related to reading and mathematics achievement. Similar to the Croninger et al. (2007) study, the aggregate average of teachers who have had a reading course did positively relate to reading achievement, but no other teacher characteristics were statistically significant. These differences suggest that, despite all of the educational reforms that focused on teacher characteristics, student achievement largely comes from student-level characteristics. This may be due to the fact that multiple teacher education reform policies have been enacted rather than one unified, national reform (Cochran-Smith et al., 2013) with states implementing policies in different ways (Wiseman, 2012). Additionally, we must acknowledge the fact that reforming teacher education is complex and difficult to enact even within individual programs (Wang et al., 2010). Policies around teacher education must understand the political nature of reform along with the practical realities that impact stakeholders' ability to measure the effects of such reform.

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