Teacher Certification and Race/Ethnic and Economic Disparities in Early Academic Achievement

As an exploration of some of the major provisions of No Child Left Behind, this study applies the resource substitution perspectives to the early years of elementary school and conceptualizes aspects of teacher certification type as potential compensatory resources for segments of the child population deemed at-risk for early academic problems because of their race/ethnicity, economic status, or both. Applying multilevel modeling and other statistical techniques to data from the Early Childhood Longitudinal Study-Kindergarten Cohort revealed that poor and non-poor Black children were consistently the most at-risk groups in math between kindergarten and third grade and in reading by the end of third grade. Poor Black and poor Hispanic children, however, appeared to benefit more from teachers who had regular and/or elementary certification than their peers. In general, Hispanic children, regardless of economic status, tended to be the most responsive to teacher-based resources in the early grades.

Race/ethnic and economic disparities in academic performance have been the driving force of educational research and policy for some time (Rothstein 2004). Black and Hispanic children of all economic statuses and poor children of all race/ethnicities tend to enter school with academic disadvantages that then translate into greater disparities later on, such as increased school dropout rates, lower lifetime earnings, and poorer health outcomes. These patterns have motivated efforts to identify school-based solutions to the role of education in societal inequality, including No Child Left Behind (NCLB), which explicitly targets achievement disparities and specifies several school-based policy strategies for reducing such disparities (CITES). Although less true of NCLB, such policy efforts are increasingly focusing on pre-school and elementary education, given evidence suggesting that early investment and intervention provides the greatest long-term returns (Heckman, 2006).

A particular policy amenable school factor that has been linked to student outcomes is teacher certification. In fact, teacher certification is a component of the highly qualified teacher provision of NCLB that, in part, is intended to address achievement disparities (CITE). Although empirical studies investigating the focal link between teacher certification and student achievement has produced mixed results (CITE), most of this research has looked at later, rather than early, stages of schooling. This evidence had been focused to a greater degree on the later years of schooling. In theory, teacher certification should matter to early achievement disparities. For example, the resource substitution perspective (Mirowsky and Ross 2003) suggests that groups at risk in one setting of social life will benefit more from resources in another setting. To the extent that race/ethnic and economic disparities in children's achievement are rooted in their parents' relative lack of the kinds of social and human capital (e.g., inside information, knowledge of the educational system, social status) valued and

rewarded by schools (CITES), then boosting the stock of social and human capital among the school adults serving this children might have a counterbalancing effect. Teacher certification is, in turn, one possible method for achieving this theoretically grounded aim.

Following resource substitution, therefore, this study, therefore, analyzes nationally representative data from the Early Childhood Longitudinal Study-Kindergarten Cohort to assess the potential of teacher certification factors to mediate and moderate race/ethnic and economic disparities in achievement in the primary grades of elementary school. In doing so, race/ethnicity and economic status are conceptualized and operationalized as overlapping, reinforcing systems of stratification. Such research speaks to the potential of key provisions of NCLB and related to policies to work with, or against, each other.

Race/Ethnicity, *Economic Status, and Achievement*

Differential achievement by race/ethnicity has long been a concern in the educational system. Typically, the focus is on White and Asian-American children versus Black and Hispanic children. Although racial/ethnic achievement gaps narrowed in the 1970s and 1980s (Grismer & Flanagan, 1998), they now appear to be widening (Jencks & Phillips, 1998; Lee, 2002). For example, data from the National Assessment for Education Progress (NAEP) between the years of 1986 and 1999 showed that White students made twice the achievement gains of Black and Hispanic students (Lee, 2002). These trends in NAEP scores are indicative of the trends from early to late childhood and have implications for later performance (Fryer and Levitt, 2004; Murnane and ****, 2006).

Another major disparity in the educational system concerns family economic status. From prior educational and demographic research, we know that children who grow up in impoverished households start school at a disadvantage compared to children from more affluent

homes. We also know that because of this differential starting point, they eventually accumulate fewer educational credentials than their peers over their lifetimes (Corcoran, 2001). Poor children make lower grades, post lower test scores, and engage less in school than their more affluent peers (Duncan & Brooks-Gunn, 1997; Lee & Burkham, 2002). Of course, these poverty-related patterns are closely connected to other aspects of family background, such as family structure and parent education, and to institutional and contextual factors, such as lack of access to pre-school and low school quality, but the independent link between poverty and academic outcomes is well-documented (Alexander & Entwisle, 1988; Danziger, Sandefur, & Weinberg, 1994; Fuller, 2007; Barnett, Hustedt, Robin, & Schulman, 2004).

Interestingly, NCLB appears to treat these two types of disparities as distinct from each other. For example, schools must disaggregate testing data by race/ethnicity and by economic status but not by both race/ethnicity and economic status at the same time (CITE). Yet, ample evidence suggests that these two types of disparities overlap considerably (Rothstein, 2004; Mayer, 1997; Condron & Roscigno, 2003). After all, Asian-American and White children have lower overall poverty rates and higher academic achievement rates than Black and Hispanic children. Indeed, in most studies of race/ethnic disparities, including those focusing on early education, at least some of the disparity (and often almost all of it) is explained by race/ethnic differences in socioeconomic factors (Fryer & Levitt, 2006; Lee and Burkham, 2002).

Worth stressing is that the need to view race/ethnicity and economic status as a "package" is not simply a function of the fact that they overlap, not simply a question of controlling for one to examine the other. The two kinds of disparities might also amplify each other. Race/ethnicity and poverty create a double disadvantage in the educational system for many Black and Hispanic children (Borman, 2004; Crosnoe, 2005). Minority children who

come from families with lower socioeconomic status are less likely to have access to the kinds of resources at home that schools traditionally demand, which, in turn, makes them less resilient in academic settings that put them at academic risk by way of race/ethnic-related discrimination, differential treatment, and unequal opportunity structures (Borman, 2004). Thus, viewing race/ethnic and economic statuses in *combination* rather than in *isolation* and disaggregating achievement data accordingly may be a better way to achieve the goals educational accountability policies.

Teacher Characteristics and Child Achievement

Once combined race/ethnic and economic disparities are assessed, the next step is to identify potential avenues for addressing such disparities. Originally formulated in relation to the health benefits of educational attainment, resource substitution is particularly valuable in this enterprise because it stresses the counterbalancing advantages and disadvantages across demographic and contextual domains. According to this perspective (Mirowsky & Ross, 2003), the impact of some protective contextual resource will be more pronounced in demographic groups that have less access to resources overall.

As just one example from the educational realm, high quality child care has been shown to benefit the learning of children from all sectors of society, primarily by increasing the cognitive stimulation they experience before the start of formal schooling (NICHD ECCRN, 2005; Winsler, 2008), but poor children get a greater boost from high quality child care than more affluent children. Reflecting resource substation, some of the benefits of child care tend to be redundant with what can be found in socioeconomically advantaged families and communities, which tend to have more abundant outlets and opportunities for stimulation and

learning. In this case, resources available in high quality child care settings *substitute* for an imbalance of resources in other settings (Winsler, 2008).

Importantly, not only does NCLB highlight race/ethnic and economic disparities in education, it also identifies potential strategies for reducing such disparities, many of which deal with teachers. Moreover, a focus on teachers is grounded in the resource substitution perspective. As school-based adults in the lives of children, teachers could substitute resources that children from historically disadvantaged and disenfranchised groups might be less able to get from the family/community-based adults in their lives; specifically, resources tapping the unwritten rules and inside information of education that provide White, middle class children with a competitive advantage in school (CITES). The substitution involves social and human capital that is valued by the school and differentially helps children from different backgrounds.

The highly qualified teacher provision of NCLB is one its most debated components (CITES). In effect, it stress that ****. Importantly, the logic underlying this provision is that improvements in teacher quality, defined various ways, in the schools serving race/ethnic minority and/or poor children will help to reduce achievement disparities. This approach is rooted in a long-standing tradition in educational research to see the composition of the teaching staff of schools as central to issues of educational equality.

In general, schools that serve poor and/or race/ethnic minority populations tend to have lower percentages of high quality teachers, generally defined in standard human capital terms (education, training, certification, professional development) (Clotfelter, Ladd, Vidgor & Wheeler, 2006; Lankford, Loeb & Wyckoff, 2002). Furthermore, research on enduring or lagged teacher effects suggest that teachers in the primary grades can have enduring effects on secondary school performance that is three times that of the effects of secondary school teachers

(Ferguson, 1991). Nye, Konstantopoulos, and Hedges (2004) found that teacher effects are larger than school effects and that they are also much larger in low-SES schools. What these reports suggest is that teacher quality is not only important but also that the foundation that is set in the early grades is critical to long-term achievement.

Teacher certification is one aspect of teacher quality that has received and is receiving a great deal of attention. Teacher certification has been instituted in many states as a standard practice to ensure that children receive proper instruction from teachers who are both academically and professionally prepared (Woellner, 1949; 1955). The current debate concerning the impact of having a full regular teacher certification is one that generates much disagreement. One argument is that fully certified teachers should undergo a more extensive preparation period and receive more training and practice in classroom pedagogy. The counter-argument is that the diversity of experiences of teachers who may come to the classroom in other ways enhances the educational process in a way that is otherwise lost in the traditional certification process. Both sides of this debate have empirical support.

For example, Darling Hammond (2000, 2005) has shown that teacher certification is advantageous to student achievement. Her research indicates that "the percentage of teachers with full certification and a major in the field is a more powerful predictor of student achievement than the teachers' education level". On the other hand, Goldhaber and Brewer (2000) reported that, although there are some positive effects of certification on students' achievement outcomes, this impact is not systematic. They also suggest that requiring certification for all teachers could have a reverse effect by restricting the pool of teacher talent. Ballou and Pudgursky (2000) have also entered into this debate by suggesting that little rigorous evidence supports a link between teacher certification and student achievement.

A meeting ground in this debate is that the benefits of teacher certification may not be generalized but rather specific to certain educational outcomes, groups of students, and/or stages of schooling. Following resource substitution, teacher certification policies evoke a cogent logic of using teachers as a compensatory school-based resource to improve achievement for young race/ethnic minority and/or poor children, even if its focus is somewhat narrow. This issue is not solely about differential access to certified teachers. It is also about differential reactivity. If poor minority children do benefit more from some school-based resource than their White, non-poor peers (resource substitution), then policy interventions would not have to equal out that resource across groups to reduce achievement disparities. Something less than equality would do. Thus, establishing race/ethnicity and economic differences in the prevalence of some school-based resource, such as teacher qualifications, must be followed by an attempt to establish the degree of *reactivity* to that resource within and across race/ethnic and economic groups.

The Transition into School

One theme of the argument of this study is that the link between teacher certification and achievement disparities is especially relevant for the early years of education. According to Ramey and Ramey (1999), the transition to school is "an ongoing process that occurs during the first several years of life when children, families, and schools are making mutual adaptations to facilitate the eventual success of the child, family and school in the early elementary school years." Following the school transition model (Alexander & Entwisle, 1988) and contextual systems theory (Pianta & Walsh, 1996), early differences in achievement largely precede entry into elementary school and are more rooted in the interplay of home and school than in later stages of schooling. Thus, the roots of early disparities lie in factors outside the educational system that are often then exacerbated by the educational system.

Based on this past research and theory (Pianta & Cox, 1999), achievement disparities among race/ethnic and economic groups should be smallest as students first start school and then grow as they progress to higher grades. In line with arguments of Heckman (2006), one way to do something about race/ethnicity and economic disparities in secondary school and higher education is to make sure children have equal opportunities years before they reach these stages. This general framework of higher returns to early action suggest that teacher qualification effects will fade or decay as children move through the system. Thus, in this study, I focus on the first three years of elementary school.

Research Questions

1. What are the largest achievement disparities in core subjects during the primary grades of elementary school when race/ethnicity and economic status are considered in combination rather than separately?
2. To what extent do race-economic differences in aspects of teacher certification explain the largest achievement disparities during these critical years?
3. To what extent does equal access to the same kinds of teachers reduce the largest achievement disparities during these critical years?

Method

Data Source

Operated by the National Center for Educational Statistics (NCES), ECLS-K is a nationally representative sample of children who were enrolled in kindergarten in the 1998-1999 academic school year. The base-year child sample included 21,190 children, the total teacher sample consisted of 3,305 teachers, and the total school sample included 866 schools. The analytical sample for this study included approximately 14,887 children who participated in data

collection up through third grade (see http://nces.ed.gov.ecls.kindergarten.asp for more details). Limiting the sample through attrition in this way could introduce bias because attrition from the sample was not random, but NCES calculated longitudinal sampling weights to account for this differential attrition. These sampling weights were employed in all analyses to maintain the representativeness of the sample and reduce the attrition bias. Moreover, as explained below, multiple imputation techniques were used for all item-level missing data.

Measures

Table 1 includes descriptive statistics (means/standard deviations for continuous variables, frequencies for binary variables) for all measures created for this study.

[Table 1 About Here]

Academic achievement. The direct cognitive assessments in ECLS-K were adapted from commercial assessments and other NCES studies, including NAEP. The reading tests included items intended to gauge children's ability to, among other things, define words in context and evaluate passages of text. The math tests included items on conceptual knowledge, problem-solving, number properties, and measurement. Item Response Theory (IRT) allowed for the development of proficiency scores across test sequences so that scores could be compared from time point to time point and gains in test scores over time could be more accurately assessed. This paper used IRT scores for reading and math from the fall of kindergarten, spring of first grade, and spring of third grade. These data were converted into two sets of change scores—gains in reading (or math) test scores between kindergarten and first grade and gains in reading (or math) test scores between first grade and third grade.

*Race/ethnicity and economic status***.** Parents reported the race/ethnicity of each child during the kindergarten data collection. A set of dummy variables identifies children who were

White, Black, Hispanic, Asian-American, and Other. As for economic status, I created an income-to-needs ratio for each family by dividing total income—mothers' reports of family income from all sources (including public assistance) at the start of kindergarten—by the federal poverty threshold from 1998 for the family's household size (which ranged from 2 to 17). Following convention across states in school lunch programs and NCLB accountability reporting, this income-to-needs scale was dichotomized at 1.85 to capture families below 185% of the federal poverty line for their household size. These families are designated as low-income, or poor. Finally, the set of race/ethnicity dummy variables were cross-classified with the binary marker of poverty status to create an 8-category variable designating all possible combinations of race/ethnicity and economic status (see Table 2 for the distribution).

[Table 2 About Here]

Teacher characteristics. All measures of teacher characteristics are replications of past ECLS-K studies (e.g., Palardy & Rumberger, 2008) and have been created for both kindergarten and first grade. Teachers reported their *highest degree earned*, with responses, ranging from 1 (high school diploma) to 7 (doctorate). I recoded these responses into a binary variable (1 = masters degree or higher). Teachers were also asked about their *certification type* (0 = none, 1 = temporary/probational, 2 = alternative, 3 = regular, 4 = highest available), which allowed for the creation of a binary variable differentiating regular or higher-level certifications from all others. Reports of c*ertification in elementary education* (yes, no) serve as an additional binary certification variable. Two measures of *teacher tenure* assess how many years teachers had taught in the child's grade and at the study school. Lastly, teachers reported how many hours per week they designated for paid preparation (1 = two or less, 2 = more than two but less than five,

3 = 5-9, 4 = 10-14, 5 = 15+). I use these teacher reports to measure *professional development*. Additional teacher controls include teachers' age and race/ethnicity.

Following the work of Xue and Meisels (2004), I created two sets of classroom practice variables, one set for reading instruction and the other for math instruction. Teachers reported the frequency with which they taught specific math and reading skills in their classes (0 = never, 1 = once or month or less to 5 = daily). Reading instructional characteristics focused on teachers' use of phonics and whole language instruction based on factor analysis. Nine items were averaged to create the composite for phonics instruction and seventeen items were averaged to create the composite for whole language. Math instructional characteristics focused on measures of measurement approaches (average of 10 items), spatial analyses (average of 5 items), number operations (average of 5 items), comprehension (average of 5 items), and mechanics (average of 3 items).

Family controls. Parents reported their levels of educational attainment, with responses collapsed into five categories (1 = less than high school to 5 = post-graduate degree). The maximum level in the family measures parent education. I also created a binary measure of family structure (two biological/adoptive parents versus other family type). Using mother reports of the average number of hours per week that they worked at their current employment during the kindergarten data collection, I created a set of dummy variables for full-time work, part-time work, unemployment, and absent. Immigration status is important to consider given the large variation in academic outcomes within all race/ethnic groups, but especially Hispanics and Asian-Americans, by generational status. Consequently, I have combined information from parent reports about birthplace into a single binary marker differentiating the children of immigrants (regardless of the children's own birthplace) from all other children.

Child controls. A set of dummy variables captured pre-kindergarten child care: parental, relative, non-relative, preschool, center-based day care, Head Start, other. Children who did not meet the English proficiency threshold on the Oral Language Development Scale were permitted to take the math assessment in Spanish. Thus, a marker has been created to designate assessment language at each time point. These same children were excluded from taking reading assessments, but the missing data strategy described below addresses this problem. Furthermore, children took these tests over a span of several months. To control for the possible test taking timing bias, I have measured the length of time between when the first assessment was given during that data collection and when the child actually took the assessment. For similar reasons, age is controlled for with the continuous measure provided by NCES.

School controls. School sector is a binary measure differentiating private from public elementary schools. NCES provides a quasi-continuous scale for school size: 1 = 0 – 149 students, 2 = 150 – 299, 3 =300 – 499, 4 = 500 – 749, 5 = 750 +. School region is measured by a set of dummy variables (Midwest, Northeast, South, West), as is school urbanicity (central city, city fringe/large town, and small town/rural). School minority representation within the school was also controlled for based on the percent of minority students. Finally, I aggregated the individual-level poverty measure to the school level by counting the frequency of students in each school sample who met the poverty threshold.

Plan of Analysis

The basic analytical plan has several steps. I illustrate each step with the example of math test score gains between kindergarten and first grade. The first goal of the study was to assess the basic disparities in academic achievement when race/ethnicity and economic status were viewed in combination. To do so, the kindergarten-first grade math change score was

regressed on the set of dummy variables representing the combined race/ethnic and economic statuses along with the kindergarten math test score. Including the initial test score as a covariate allows for the level of achievement from which the rate of change occurs (e.g., 1 point gain for an already high achiever vs. a 1 point gain for an initially low achiever) to be considered.

The purpose of this first set of analyses was to establish a basic rank ordering of the combined race/ethnicity-economic categories for over-time learning gains. Thus, I re-estimated the model with each race/ethnicity-economic category as the omitted reference. Comparing results across modeling iterations allows for a full cataloging of all significant differences among the eight categories in the typology and identifies which groups are *most* at risk for low learning gains in the first two years of school.

These models were estimated in the mixed procedure, which is the SAS mechanism for multilevel modeling (Singer, 1998). Individual students served as the first level and schools as the second level. By allowing the intercept of the outcome to be random and partitioning the variance into within- and between-school components, multilevel modeling provides the most accurate estimates of higher-order effects; in this case, the effects of teacher/school factors on kindergarten-first grade math change scores (Raudenbush & Bryk, 2002). The multilevel approach also corrects the design effects of ECLS-K, which are related to the clustering of students in schools in the sampling frame. It can also easily incorporate the aforementioned longitudinal sampling weights, which need to be used to reduce attrition bias and maintain representativeness. A comprehensive report on ECLS-K by Denton and West (2002) provides a more complete description of the ECLS-K design effects and sampling weights.

In the second set of analyses, I expanded the comprehensive multilevel model from the first stage of analysis by adding the teacher variables as predictors of the kindergarten-first grade

change score. Significance levels and effect sizes identified which teacher qualifications best predicted over-time math test score gains. Examination of the coefficients for the race/ethnicity-economic categories before and after entering these teacher qualifications variables revealed the degree to which race/ethnic-economic disparities in early learning gains were explained (or mediated) by corresponding differences in access to certified teachers (as measured here). When mediation was suggested, I followed the procedure of MacKinnon, Fairchild and Fritz (2007) to actually establish the mediational pathway(s).

Lastly, moving from differential access to differential reactivity, I interacted the teacher certification variables with the race/ethnicity-economic status dummy variables. Significant interactions were graphed to determine whether they indicated resource substitution—children in the most at-risk groups gaining more, in terms of achievement, from having certified teachers, so that equal access to certified teachers reduces group level achievement disparities. This modeling plan was repeated for the kindergarten-first grade reading change scores and then for the first-third grade change scores in reading and math. The first-third grade models included first grade versions, when available, of all independent variables, including the initial first grade test score and teacher certification variables.

As noted above, all item-level missing data (e.g., missing data on specific variables for children who participated in the larger data collection at that wave) were handled with multiple imputation techniques. Like many multiple imputation techniques, the Imputation and Variance Estimation Software (IVEware; see Raghunathan, Van Hoewyk, & Solenberger, 2001) uses information from all available data to estimate several complete data sets with plausible values. Unlike other techniques, IVEware allows both categorical and continuous variables to be estimated simultaneously in equally accurate ways. With IVEware, I generated five fully

imputed data sets. Switching to SAS, I estimated all mixed models within each plausible sample, using MIANALYZE to average results across each of the imputed samples to produce a final set of parameter estimates for the model. Multiple imputation has proven to be a less biased strategy for dealing with missing data than mean/mode imputation, listwise deletion, or other conventional techniques, which is especially important in policy-oriented research for which unbiased estimates are crucial (McCartney, Burchinal, & Bub, 2006; Allison, 2001).

Initial Modeling Estimates

Prior to conducting the analysis, I computed the intraclass correlation (ICC) to estimate the total variance that can be explained by cluster membership within a school. The ICC in kindergarten was .22 for math, meaning that 22% of the variation in the kindergarten math scores was between students in different schools and 78% was between students in the same school. The ICC was .18 for kindergarten reading. The between-school variance in changes in test scores between kindergarten and first grade was 10% for math and 12% for reading. The corresponding values for first-third grade change scores was 14% for math and 13% for reading. Thus, there was much less between-school variation—the variation that can be explained by school factors—in change over time than in starting level.

Results

Race/Ethnic and Economic Disparities in Early Academic Achievement

A key argument of this study is that children's race/ethnic and economic statuses cannot be so easily separated. Having already given the basic distribution of children across race/ethnic and economic categories, Table 3 presents the results from several models in which kindergarten math and reading test scores were regressed on the focal race/ethnicity and

economic status variables, before (Model 1) and after (Model 2) controlling for a large set of individual, family, and school variables. For the models presented in this table, non-poor White children served as the reference category. Again, I also re-estimated each model with each race/ethnicity-economic status category as the reference and then summarized results across modeling iterations to develop a rank ordering of the race/ethnicity-economic status groups in terms of their scores on the tests.

[Table 3 About Here]

Beginning with kindergarten math achievement, all groups, with the exception of non-poor Asian-American children, scored significantly lower than non-poor White children when no other child, family, or school factors were taken into account (Model 1 in Table 3). When all of these covariates were controlled (Model 2), all race/ethnicity-economic status coefficients remained statistically significant with the exception of those for the poor and non-poor Asian-American groups. The overall magnitude of the disparities, however, was reduced. The largest kindergarten math disparity, relative to non-poor White children, was for poor Black children, who scored about 3 points lower on the math test (an effect size equaling 33% of a standard deviation on the kindergarten math test score distribution).

As for the overall rank ordering of groups on the kindergarten math test, derived from all pairwise comparisons across models with different reference categories, the 8 groups fell into the following ranks: 1) White non-poor, Asian-American non-poor; 2) Asian-American poor, White poor; 3) Hispanic non-poor; and 4) Hispanic poor, Black non-poor and Black poor. Groups in the same rank had average test scores that did not differ from each other. Groups in different ranks, however, differed significantly in their average scores. Based on these ranks and the magnitude of the coefficients (and clear breaks in the order of coefficients), the groups

that appeared to be most at-risk in math at the start of elementary school were poor and non-poor Black and poor (and to a lesser extent non-poor) Hispanic children.

Turning to kindergarten reading achievement, the results were quite similar to those just described for math. The overall magnitude of the race/ethnicity-economic statuses disparities was smaller. The largest kindergarten reading disparities, relative to non-poor White children, were for poor Hispanic children, who scored 2.60 points lower, and poor Black children, who scored 2.28 points lower on the reading test (approximately 27% of a standard deviation on the test distribution).

As for the overall rank ordering on the kindergarten reading test, the 8 groups fell into the following ranks: 1) Asian-American non-poor; 2) White non-poor; 3) Asian-American poor, White poor, Black non-poor; and 4) Hispanic non-poor, Black poor, and Hispanic poor. Based on these rank orderings and the magnitude of the coefficients, the groups that appeared to be most at-risk in reading at the start of kindergarten were poor Black children and Hispanic children (regardless of economic status).

As a next step, I examined test score gains between kindergarten and first grade by regressing the kindergarten-first grade change score in each subject on the same sets of predictors. Table 4 presents the results for math gains between kindergarten and first grade. The coefficients that remained significant despite the controls included poor White (b = -1.38, $p < .01$), non-poor Hispanic (b = -1.16, $p < .01$), poor Black (b = -3.72, $p < .001$), and non-poor Black children (b = -3.27, $p < .001$). The biggest of these disparities (poor Black vs. non-poor White) had an effect size equal to 23% of a standard deviation in the kindergarten-first grade change score and equal to 41% of a standard deviation in the kindergarten math test score.

[Table 4 About Here]

In terms of math test score gains between kindergarten and first grade, the basic rank ordering of the race/ethnicity-economic status groups was as follows: 1) Hispanic poor; 2) White non-poor; 3) Hispanic non-poor, White poor; 4) Asian-American poor, Asian-American non-poor; and 5) Black non-poor and Black poor. Thus, poor Hispanic children gained more on the test during this period, even though this greater rate of gain did not allow them to catch up to the top performing groups (it just narrowed the gap). The poor and non-poor Black groups appeared to be the most at-risk during this time point.

Table 5 presents the results for reading. White children posted significantly larger gains on the reading test over time than poor White (b = -0.90, p < .01), poor Black (b = -2.29, p < .001), poor Hispanic (b = -2.59, p < .001), non-poor Black (b = -.88, p <.01) and non-poor Hispanic (b = -2.09, p <.001) children. Differences in reading test score gains between White non-poor children and Asian-American children (poor or not) were not statistically significant.

[Table 5 About Here]

The final rank ordering of race/ethnicity-economic status groups in terms of reading test score gains was: 1) Asian-American non-poor, White non-poor; 2) Asian-American poor; 3) White poor; 4) Black non-poor; and 5) Hispanic non-poor, Hispanic poor, and Black poor. The most at-risk groups were economically disadvantaged White and poor and non-poor Hispanic, and Black children. To expand the window even wider, I next examined test score gains between the spring of first grade and the end of the primary grades of elementary school (the spring of third grade).

The disparities (vs. non-poor Whites) in math between first and third grade that persisted despite the control of key variables were for poor White (b = -1.02, p < .01), poor Black (b = -4.58, p < .001), and non-poor Black (b = -2.36, p < .001) children. These

coefficients were still quite large, particularly for Black children. For example, the largest of these disparities (Black poor vs. White non-poor) equaled 39% of a standard deviation in the first-third grade change score. These results indicated that the gap not only *persisted* between the White non-poor group and the Black groups but that the inequalities *grew* as students progressed through school. In terms of math test score gains between first and third grade, the basic rank ordering of the race/ethnicity-economic status groups was: 1) Asian-American non-poor, Hispanic non-poor and White non-poor; 2) Hispanic poor, Asian-American poor, White poor; and 3) Black non-poor and Black poor. The Black children (regardless of economic status) were again the most at-risk between first and third grade.

Turning to reading gains between first and third grade, White children posted significantly larger gains on the reading test over time than poor White (b = -1.51, $p < .01$), poor Black (b = -4.42, $p < .001$), poor Hispanic (b = -2.12, $p < .01$), non-poor Black (b = -4.51, $p < .001$) and non-poor Asian-American (b = -2.35, $p < .01$). The final rank ordering of the race/ethnicity-economic status groups in reading test gains during this period was: 1) White non-poor, Hispanic non-poor; 2) White poor, Hispanic poor; 3) Asian-American poor, Asian-American non-poor; and 4) Black poor, and Black non-poor. Thus, the gains of Asian-American children (regardless of economic status) began to slow as they moved to the end of the primary grades, and Black children (poor or non-poor) appeared most at risk by this point.

Focusing on Teachers

Having established the basic levels of disparities in early math and reading achievement by race/ethnicity and economic status, the next goal of this paper was to explore the potentially multi-faceted role of teacher certification in these overlapping disparities. In doing so, I was

especially interested in the race/ethnicity-economic status groups that appeared to be the most at risk at each stage of early schooling.

Recall that I was interested in two ways that the kinds of teacher certification targeted by educational policies may be related to achievement in general and race/ethnic and economic disparities in achievement in particular: mediation (disparities in teacher characteristics explain corresponding disparities in achievement) and moderation (disparities in achievement fluctuate in magnitude and direction according to exposure to different kinds of teachers). Mediation was assessed following the steps laid out by McKinnon and colleagues.

In Model 3 of Tables 4 and 5, I added teacher certification (plus the teacher control variables) as predictors of the outcomes. For kindergarten-first grade math, having a teacher with elementary certification appeared to partially mediate the associations between the outcome and being a poor and non-poor Black, non-poor Hispanic, and poor White child. Basically, the previously observed coefficients for these groups were attenuated when the elementary certification variable was added to the model (compare the coefficients in Model 2 to the corresponding coefficients in Model 3). This attenuation was so small, however, that any mediation by elementary certification could not have been strong or even meaningful. Turning to the kindergarten-first grade reading change score, teacher certification did not significantly predict the outcome (see Model 3 in Table 5). Thus, mediation was not possible.

Adding the first grade teacher certification (and teacher controls) to the models for first-third grade test score changes revealed no significant predictors of the outcomes and, therefore, no mediation of race/ethnicity-economic disparities by teacher certification status. This finding (or lack of a finding) suggests that differences in test score gains between first and third grade were not a function of having certified teacher, at least as captured by these standard measures.

As an additional sensitivity tests, I gauged the robustness of the teacher characteristic that looked to be mediating the focal disparities by calculating ITCV for the elementary certification coefficient in each model in which it was significant. The ITVC scores for elementary certification were quite low (e.g., less than .01). A low ITCV suggests that the observed effect of the elementary certification variable would be vulnerable to controls for other heretofore uncontrolled factors.

Teachers as Potential Protective Factors

Turning to moderation, the next modeling steps were intended to assess the extent to which equal exposure to the same kinds of teachers might reduce achievement disparities during the early years of elementary school. Each of the four main models (kindergarten-first grade and first-third grade in each subject) was extended to include interactions between the race/ethnicity-economic status dummy variables and the teacher certification variables. Each set of interactions (e.g. the interactions for each focal teacher characteristic) were modeled separately from each other, although all modeling iterations controlled for the full set of child, family, and school factors. The top part of Table 6 presents the results of these interactions for math test score gains between kindergarten and first grade. Teacher certification type significantly interacted with the marker for poor Black children ($b = 2.48$, $p < .05$). Elementary certification significantly interacted with the marker for poor Hispanic children ($b = 3.52$, $p < .01$).

Calculating the predicted change scores revealed that the certification interactions were all in the direction of resource substitution. Poor White and Hispanic children and Black non-poor children benefited more from having a teacher with elementary certification than did non-poor White children (see Figure 1). Poor Black children also benefitted more than non-poor White children from being in classrooms with teachers who had a regular teaching certificate.

This example of resource substitution also led to a reduction in the size of this disparity. When a teacher characteristic was associated with greater math gains between kindergarten and first grade, this association was stronger for White non-poor children than for the comparison group.

[Figure 1 About Here]

The significant results of the interaction models for kindergarten-first grade reading gains are presented in the bottom portion of Table 6. Elementary certification significantly interacted with the marker for poor Hispanic children ($b = 5.33$, $p < .01$). This interaction also suggested resource substitution, with the most at-risk groups appearing to benefit more from the certified teacher (in terms of greater kindergarten-first grade reading gains) than non-poor White children.

As for first-third grade gains in math (Table 6), teacher certification significantly interacted with the markers for poor White ($b = 1.38$, $p < .05$), poor Black ($b = 1.89$, $p < .01$), poor Hispanic ($b = 1.52$, $p < .05$) and non-poor Asian ($b = 4.07$, $p < .01$) children. Graphing these significant interaction effects revealed that poor Black children with certified teachers had bigger test score gains than poor Black children without a certified teacher, The same pattern was true for poor Hispanic and non-poor Asian but not for non-poor White children. This pattern is consistent with resource substitution. The observed benefits of certification ranged from a difference of .82 points (7% standard deviation in the first-third grade math change score) between those with and without a certified teacher for poor White children to 1.23 points (11% standard deviation) for poor Black children.

Finally, for first-third grade gains in reading test scores, teacher certification type was significantly interacted with the markers for several race/ethnicity-economic status groups: poor White ($b = 1.98$, $p < .05$), poor Black ($b = 2.46$, $p < .01$), poor Hispanic ($b = 3.02$, $p < .01$), and non-poor Black ($b = 3.66$, $p < .01$) children. As seen in Figure 2, having a teacher with regular

teacher certification was associated with reading gains for poor and non-poor Black children, poor Hispanic children, and poor White children. For non-poor White children, however, having a certified teacher was associated with smaller gains.

[Figure 2 About Here]

Discussion

The purpose of this study was to identify the most at-risk child groups during the first three years of schooling and assess the potential for investments in teacher certification to reduce such academic disparities in this critical period of schooling. The findings yield both support for theoretical perspectives on risk and protection and, perhaps, some guidance to policymakers who struggle with finding ways to do something about academic disparities.

Social and educational researchers consistently target approaches used in school or community contexts to better understand the degree and variation in achievement disparities between the most at-risk children and the most advantaged children in society. In the U.S., these disparities often fall along the lines of race/ethnicity and economic disadvantage. This study took a slightly different approach by *cross-classifying* race/ethnicity with economic status rather than by looking at one while controlling for the other. We know from prior research that poor children of all race/ethnicities and minority children of all economic statuses are typically most academically at-risk (with risk defined in terms of relative standing on achievement tests and other academic indicators) throughout their school careers. What is perhaps more informative is how these two kinds of disadvantage work in conjunction with each other. Combining them allowed me to think about children in terms of gradations between who is most advantaged and who is most at-risk. More specifically, I could look into which of these probabilistically and

relatively at-risk groups are *most* at-risk, whether they maintain their relative positions in the hierarchy or risk over time, and whether their positions were reactive to fluctuations in teachers' certification status.

Following prior work on the doubly disadvantaged in school (Borman, 2004; Crosnoe, 2005), I expected economically disadvantaged Black and Hispanic children to post lower levels of achievement than White and Asian-American children in the early grades of elementary school. As expected, poor and non-poor White and Asian-American children out-performed the poor and non-poor Black and Hispanic children from the ECLS-K in kindergarten. Yet, the overall patterns of disparities were much more complicated than this first look suggested.

In math, poor and non-poor Black children made the least gains between kindergarten and first grade and between first grade and third grade. Earlier, I cited the well-known Fryer and Levitt (2004) study, which found that Black children lose ground between school entry and third grade, net of a host of family, school, and individual factors. This study confirmed that finding in a different way, by demonstrating that non-poor Black children (not just poor Black children) are academically at risk compared to non-poor White children, even those who are poor. This trend held over time, which suggests that being Black (regardless of economic status) is a critical factor for policy intervention in the early years of education.

Another group that warranted concern was poor Hispanic children. Unlike Black children, the combination of race/ethnicity and economic status mattered in the Hispanic population; in other words, non-poor Hispanic children did significantly better than poor Hispanic children. Indeed, the latter group of children posted low levels of math test performance at the start of kindergarten. In contrast to poor and non-poor Black children in math, however, they made significant gains between kindergarten and third grade that reduced,

but did not close, the math achievement gap with the more advantaged non-poor White children. Thus, math interventions targeting Hispanic children would be served by focusing on the very start of elementary school and by looking at the most economically disadvantaged children within this large (and growing) segment of the student population.

Turning to reading, combined race/ethnicity-economic disparities were pronounced at the start of school through first grade, and then race/ethnicity disparities were pronounced by the end of third grade. At the start of kindergarten, the groups that ranked at the bottom of the performance hierarchy were poor and/or Hispanic. Thus, non-poor Hispanic children appeared to be at-risk in reading if not in math. One explanation for this difference is that these children could come from homes that are primarily Spanish speaking. Although I controlled for whether the child took the math test in Spanish, there may be some lingering language issues that go undetected and emerge at the start of school. Math may also be a subject that transcends language barriers more than reading.

The analysis of kindergarten to first grade reading gains revealed growing disparities between poor and non-poor children, with most of the poor groups (poor Black, White, and Hispanic) ranking at the bottom of the distribution. This finding was consistent with what we know about poverty and achievement. Poor children have lower achievement when compared to more economically advantaged children. Gains made between first and third grades, however, again emphasized race/ethnicity. Poor and non-poor Black children ranked lower on the testing gains distribution than all other groups during this period. Whereas the at-risk groups in math were fairly consistent over time, the at-risk groups for reading changed considerably for each time frame. Moreover, an early at-risk group, poor Hispanic children, made gains to close in on the achievement of non-poor White children by third grade. Schools may be more resourced to

make necessary changes needed to address language issues early on when children are young. Spanish-speaking Hispanic children may also progress academically as language issues become more of a secondary problem. On balance, looking across all models, poor and non-poor Black and poor Hispanic children warrant additional investments beginning at the start of kindergarten.

The research on whether teachers actually make a difference in achievement and whether having teachers with more training can potentially reduce the disparities between the most at-risk children and the most advantaged is mixed, although I have argued that the inconsistency in this literature may be due to a lack of attention to the earliest stages of education. Accordingly, I hypothesized that certification deserves a closer look in relation to early achievement disparities. In ECLS-K, elementary certification was a significant predictor of math gains between kindergarten and first grade. It did not appear to be robust to threats to causal inference in the full sample. Teacher certification type did not significantly predict either subject between first and third grade. Thus, teacher certification did not appear to be an important mediator of race/ethnic and economic disparities in early education.

Turning from mediation (differential access) to moderation (differential reactivity), I looked into whether having teachers with the same levels of certification was associated with reduced achievement disparities between the most and least at-risk groups of children early in elementary school. What I wanted to find out with these analyses was whether teachers can serve as a protective factor or a buffer for the most at-risk children, which would either support or undermine calls for investments in teacher certification as a means of reducing achievement disparities. The findings offered some limited evidence for theoretical underpinnings of the resource substitution concept and provided support to counter some current education policy practices, such as school reconstitution.

In line with resource substitution, poor Black and poor Hispanic children occasionally appeared to benefit more than non-poor White children from having teachers with the same certification levels. Recall from the review of literature, teacher certification is one of the characteristics that has been tested and shown to have *both* positive effects on child achievement (Darling-Hammond, 2000) *and* no effect (Croninger, Rice, Rathbun, & Nishio, 2007) on student achievement outcomes. The findings from this study suggest that teacher certification could be instrumental in narrowing the gap between poor Black and Hispanic children and non-poor White children. This finding could reflect the way in which I analyzed the data. Previous studies have reported certification effects and other teacher effects solely by race/ethnic and/or economic categories rather than by their combination. The two groups that most consistently received a boost were the poor Black and poor Hispanic children, not poor children in general or Black and Hispanic children in general.

What we see here is a case for the highly specific nature of teacher human capital characteristics in relation to achievement disparities. In other words, early debates about whether teacher certification matters for student achievement may be resolved by looking at when, where, and for whom it matters. These findings suggests that it matters most for poor Black and poor Hispanic children and are quite significant in a policy context. A large part of the academic underperformance of public schools is rooted in the low performance of poor and minority children. Given these findings that having a certified teacher may provide some small degree of protection against these achievement gaps for poor Black and Hispanic children, certification programs may be especially beneficial for public schools serving these populations.

As for the more practical implications of these findings, one of the most controversial pieces of NCLB that is causing great opposition in the education community concerns school

reconstitution. School reconstitution forces schools to release all of the existing teachers in a consistently low-performing school and hire new teachers, with the hope of raising student achievement. One problem with this policy is that many of the schools that are being reconstituted are high-poverty and high-minority. Moreover, many of the teachers being brought into these schools do not hold the type of certification that this paper suggests could actually make a difference for the most at-risk children. This is largely due to districts having difficulty with recruiting certified teachers (Kane, Rockoff, & Staiger, 2006). If certification matters to the extent shown in this study, to what degree could reconstituted schools benefit by having a strict policy of only hiring teachers with regular and/or elementary certification? The potential impact on policy decisions could be quite significant

In closing, one contribution of this study is a simple but important one. It recognized the substantial overlap between race/ethnic and economic stratification rather than teasing apart each as a separate form of inequality. In doing so, I was able to determine how two forms of risk, in combination, related to achievement gains over time. Another contribution was that this study revealed some limited evidence that teacher certification could serve as a protective factor for the most at-risk groups of young children—a buffering mechanism in which teachers can provide the inside information, advocacy, and assistance that might be more difficult for parents from historically disenfranchised groups or be more actively blocked by school personnel when coming from such parents.

The findings of this study also have implications for the broader policy argument about multiple forms of inter-related achievement gaps and what can be done to close such gaps. One example of a policy change that could be influenced by these findings, if confirmed by future studies, is NCLB's school reconstitution provision—the removal of the majority of teachers and

staff in persistently low-performing schools (Hassel, Hassel, Arkin, Kowal & Steiner, 2006; Spitser, 2007). Specifically, how much can we expect teachers with these certification characteristics to reduce the achievement gap and what characteristics serve as academic protective factors for the most at-risk children? NCLB suggests that these characteristics are the focal factors necessary for reducing disparities. Although this paper joins with some other studies to identify some protective power of these teacher factors, they clearly cannot be viewed as the sole approach.

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Table 1. Descriptive Statistics for Study Variables

	Kindergarten	First Grade	Third Grade
Child Academic Achievement (M/SD)			
Math test score	*21.77*	*54.95*	
	(9.02)	*(15.98)*	
Change in math test score (k-1st)		*33.17*	
		(11.74)	
Change in math test score (1st-3rd)			*29.61*
			(11.53)
Reading test score	*27.39*	*68.27*	
	(10.23)	*(20.74)*	
Change in reading test score (k-1st)		*40.82*	
		(16.06)	
Change in reading test score (1st-3rd)			*39.18*
			(16.34)
Race/Ethnicity(%) and Economic Status			
White (%)	57.26		
Black (%)	13.00		
Hispanic (%)	17.83		
Asian-American (%)	6.54		
Other (%)	5.39		
185% of the Federal Poverty Line	39.31		
Teacher Characteristics			
Level of education (% with masters or higher)	34.62	37.39	43.32
Type of certification (% regular)	86.54	72.20	88.33
Elementary certification (%)	85.09	87.53	93.21
Grade tenure	*9.37*	*12.89*	*8.12*
	(7.52)	*(15.33)*	*(6.69)*
School tenure	*9.69*	*15.61*	*9.86*
	(7.77)	*(16.93)*	*(7.77)*
Paid professional development	23.57	22.48	
Teacher age	*42.03*		
	(9.99)		
Teacher Race/Ethnicity			
White (%)	81.19		
Black (%)	5.87		
Hispanic (%)	6.06		
Asian-American (%)	2.36		
Other (%)	1.21		
Family Controls			
Parent education (M/SD)	*2.96*		
	(1.16)		
Family structure (two-parent)	73.85		
Mother employed full-time (%)	38.81	42.42	41.71
Mother employed part-time (%)	19.06	20.15	20.36
Mother not employed (%)	27.34	26.43	22.92
Mother absent (%)	13.44	1.75	2.00
Immigration status (%)	20.81		

Table 1 continued on next page

Table 1 continued

	Kindergarten	First Grade	Third Grade
Child Controls			
Age (years at start of school) (M/SD)	*5.70*		
	(0.36)		
Gender (% female)	49.13		
Spanish assessment language status (%)	5.14	1.74	
Timing of assessment (M/SD)	*60.81*	*65.23*	*59.84*
	(17.59)	*(17.23)*	*(19.67)*
Pre-K not in child care (%)	15.84		
Pre-K relative care (%)	11.90		
Pre-K non-relative care (%)	9.13		
Pre-K day care (%)	6.18		
Pre-K preschool care (%)	31.28		
Pre-K Head Start (%)	7.52		
Pre-K other type of care (%)	4.14		
School Controls			
School sector (% private)	21.45	19.45	18.02
School size (M/SD)	*3.29*	*3.40*	*3.37*
	(1.16)	*(1.15)*	*(1.09)*
School poverty rate (M/SD)	*29.59*	*27.54*	*31.77*
	(27.68)	*(28.51)*	*(29.01)*
Minority representation (%)	*35.04*	*35.76*	*36.59*
	(33.89)	*(34.17)*	*(34.08)*
Receipt of title I funding (%)	51.94	52.52	50.30
School region: Midwest (%)	25.86		
School region: Northeast (%)	18.65		
School region: South (%)	32.94		
School region: West (%)	22.55		
School urbanicity: central city (%)	46.74	38.37	37.41
School urbanicity: fringe/large town (%)	30.79	40.15	40.86
School urbanicity: small town/rural (%)	22.48	21.49	21.73

N = 14887

Note. Families at or below 185% of the FPL are "poor" and families above 185% of the FPL are "non-poor."

Table 2. Distribution of Race-Economic Typology

	%
Race/Ethnicity by Economic Status	
White poor	14.09
Black poor	8.76
Hispanic poor	10.98
Asian-American poor	2.68
Other race/ethnicity poor	2.80
White non-poor	43.16
Black non-poor	4.24
Hispanic non-poor	6.84
Asian-American non-poor	3.85
Other race/ethnicity non-poor	2.59

(***N*** = 14887)

Table 3. Results of Multilevel Models Predicting Kindergarten Math and Reading Test Scores (n = 14,887)

	Unstandardized *B* Coefficients			
	Math		Reading	
Variable	Model 1	Model 2	Model 1	Model 2
White poor	-2.95***	-1.05***	-2.99***	-0.91**
Black poor	-5.80***	-3.05***	-4.98***	-2.28***
Hispanic poor	-6.93***	-2.85***	-5.66***	-2.60***
Asian-American poor	-2.02**	0.43	-2.72**	-0.26
Black non-poor	-3.92***	-2.79***	-2.11***	-1.09**
Hispanic non-poor	-3.34***	-1.92***	-3.12***	-2.09***
Asian-American non-poor	0.43	0.59	1.84**	1.64*
Gender (female)		-0.25+		1.25***
Immigration status		-0.33		-0.15
Pre-K relative care		0.19		0.21
Pre-K non-relative care		1.10**		0.72*
Pre-K day care		1.23***		1.17**
Pre-K preschool care		1.78***		2.05***
Pre-K Head Start		-0.28		-0.54
Pre-K other type of care		0.77*		0.48
Assessment language status		-2.91***		---
Timing of assessment		-0.01		-0.01
Parent education		1.61***		1.66***
Mother employed full time		-0.20		-1.07+
Mother employed part time		0.36		-0.46
Mother not employed		-0.08		-0.73
School sector		1.48**		1.48**
School size		0.02		0.01
School poverty rate		0.00		-0.04
Minority representation		-0.00+		-0.00+
Receipt of title I funding		-0.82**		-0.85**
School region: midwest		-0.11		-0.86*
School region: northeast		-0.61+		-0.75+
School region: west		-0.38		-0.47
School urbancity: central city		1.63***		1.66***
School urbanicity: fringe/large town		0.43		0.34
Black teacher		0.49		0.19
Hispanic teacher		-0.03		0.06
Asian-American teacher		-0.33		-0.34
Other teacher		-1.24		-1.33
Teacher age		-0.00		-0.01

+ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Note. White was the reference category for race/ethnicity, maternal care for pre-K care, not employed for maternal employment, south for region, and rural for urbanicity.

Table 4. Results of Multilevel Models Predicting Change in Math Test Scores between Kindergarten and First Grade (n = 14,887)

	Unstandardized *B* Coefficients		
Variable	Model 1	Model 2	Model 3
Kindergarten math score	0.23***	0.19***	0.19***
White poor	-2.32***	-1.38**	-1.36**
Black poor	-5.19***	-3.72***	-3.67***
Hispanic poor	-2.07***	0.05	0.05
Asian-American poor	-3.71**	-2.19	-2.19*
Black non-poor	-3.75***	-3.27***	-3.25***
Hispanic non-poor	-1.84***	-1.16**	-1.15**
Asian-American non-poor	-1.97*	-1.79*	-1.79*
Gender (female)		-0.91***	-0.91***
Immigration status		-0.24	-0.23
Pre-K relative care		0.38*	0.38
Pre-K non-relative care		0.79**	0.79*
Pre-K day care		0.37**	0.35
Pre-K preschool care		-0.02*	-0.01
Pre-K Head Start		-1.79*	-1.79***
Pre-K other type of care		-0.19*	0.15
Assessment language status		-1.74**	-1.44***
Timing of assessment		0.05***	0.05***
Parent education		1.06***	1.06***
Mother employed full time		0.69	0.69*
Mother employed part time		0.85	0.86*
Mother not employed		1.09**	1.10**
Two-parent family		0.28	0.28
School sector		0.22	-0.55
School size		0.28+	0.28+
School poverty rate		0.02	-0.00
Minority representation		0.00	-0.00
Receipt of Title I funding		0.14	0.16
School region: midwest		-1.35**	-1.03**
School region: northeast		-3.49***	-3.58***
School region: west		-0.93*	-1.03**
School urbancity: central city		0.34	0.38
School urbanicity: fringe/large town		0.35	0.38
Black teacher		-0.23	-0.23
Hispanic teacher		-0.52	-0.51
Asian-American teacher		0.34	0.34
Other teacher		-0.35	-0.35
Teacher age		0.01	0.01
Teacher Characteristics			
Certification type			-0.34
Elementary certification			1.02**
Teacher education			-0.06
Tenure in grade			-0.01
Tenure in school			0.01
Paid professional development			-0.00

+ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Note. White was the reference category for race/ethnicity, maternal care for pre-K care, not employed for maternal employment, south for region, and rural for urbanicity.

Table 5. Results of Multilevel Models Predicting Change in Reading Test Scores between Kindergarten and First Grade (n = 14,887)

	Unstandardized *B* Coefficients		
Variable	Model 1	Model 2	Model 3
Kindergarten reading score	0.32***	0.26***	0.26***
White poor	-2.99***	-0.90**	-0.92**
Black poor	-4.98***	-2.29***	-2.31***
Hispanic poor	-5.66***	-2.59***	-2.64***
Asian-American poor	-2.72**	-0.29	-0.39
Black non-poor	-2.11***	-1.09**	-1.07**
Hispanic non-poor	-3.12***	-2.09***	-2.08***
Asian-American non-poor	1.84**	1.63*	1.59*
Gender (female)		1.26***	1.27***
Immigration status		-0.14	-0.15
Pre-K relative care		0.21	0.34
Pre-K non-relative care		0.73**	0.86**
Pre-K day care		1.17**	1.31**
Pre-K preschool care		2.05***	2.15***
Pre-K Head Start		-0.54	-0.46
Pre-K other type of care		0.47	0.62
Timing of assessment		0.01	0.01
Parent education		1.66	1.65
Mother employed full time		0.10	0.27
Mother employed part time		0.73	0.88
Mother not employed		0.46	0.55
Two-parent family		0.89	0.91
School sector		1.48**	1.61**
School size		0.01	0.02
School poverty rate		-0.04	-0.04
Minority representation		-0.00	-0.04
Receipt of Title I funding		-0.86**	-0.79**
School region: midwest		-0.87*	-0.87**
School region: northeast		-0.76+	-0.81+
School region: west		-0.47	-0.53
School urbancity: central city		1.66***	1.57**
School urbanicity: fringe/large town		0.32	0.32
Black teacher		1.01**	1.02**
Hispanic teacher		0.04	-0.02
Asian-American teacher		0.32	0.26
Other teacher		-0.86	-0.92
Teacher age		-0.01*	0.01
Teacher Characteristics			
Certification type			-0.11
Teacher education			-0.07
Tenure in grade			-0.00
Tenure in school			-0.03
Paid professional development			0.10

+ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Note. White was the reference category for race/ethnicity, maternal care for pre-K care, not employed for maternal employment, south for region, and rural for urbanicity.

Table 6
Significant Race/Poverty x Teacher Interactions from Multilevel Models Predicting Change in Math and Reading Test Scores (n = 14,887)

	Unstandardized B Coefficients				
Variable	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
K-1st Grade Math: Race/Poverty x Certification Type					
White poor x certification type	1.51				
Black poor x certification type	2.48*				
Hispanic poor x certification type	0.82				
Asian-American poor x certification type	0.31				
Black non-poor x certification type	1.20				
Hispanic non-poor x certification type	-0.65				
Asian-American non-poor x certification type	1.63				
K-1st Grade Math: Race/Poverty x Elementary Certification					
White poor x elementary certification		1.61			
Black poor x elementary certification		1.18+			
Hispanic poor x elementary certification		3.52**			
Asian-American poor x elementary certification		-0.46			
Black non-poor x elementary certification		1.24			
Hispanic non-poor x elementary certification		-0.38			
Asian-American non-poor x elementary certification		1.61			
K-1st Grade Reading: Race/Poverty x Elementary Certification					
White poor x elementary certification			2.44+		
Black poor x elementary certification			0.38		
Hispanic poor x elementary certification			5.33**		
Asian-American poor x elementary certification			3.64		
Black non-poor x elementary certification			0.30		
Hispanic non-poor x elementary certification			0.54		
Asian-American non-poor x elementary certification			2.94		
1st-3rd Grade Math: Race/Poverty x Certification Type					
White poor x certification type				1.38*	
Black poor x certification type				1.89**	
Hispanic poor x certification type				1.52*	
Asian-American poor x certification type				3.69+	
Black non-poor x certification type				0.84	
Hispanic non-poor x certification type				0.37	
Asian-American non-poor x certification type				4.07**	
1st-3rd Grade Reading: Race/Poverty x Certification Type					
White poor x certification type					1.98*
Black poor x certification type					2.46**
Hispanic poor x certification type					3.02**
Asian-American poor x certification type					4.62+
Black non-poor x certification type					3.66**
Hispanic non-poor x certification type					-0.89
Asian-American non-poor x certification type					1.80

+ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$. *Note.* All models included the full set of control variables, family economic disadvantage, teacher characteristic mediators, and kindergarten test score.

Figure 1. Links between Elementary Certification and Math Gains from Kindergarten to First Grade, by Race/Ethnicity and Economic Status

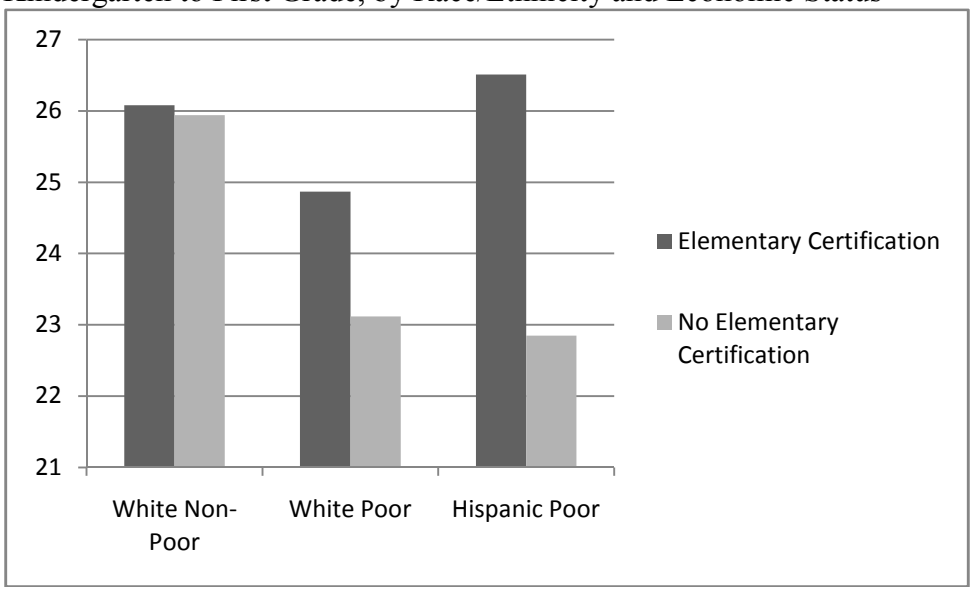

Figure 2. Links between Certification Type and Reading Gains from First to Third Grade, by Race/Ethnicity and Economic Status