THE RELATIONSHIP BETWEEN NCLB MEASURES OF TEACHER QUALITY AND CHANGES IN CALIFORNIA’S HIGH SCHOOL ACADEMIC PERFORMANCE GAINS FROM 1999-2005

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ABSTRACT

Previous research indicates that teachers indeed matter for the improvement of students’ educational outcomes, but getting good measures of what is meant by teacher quality is a continuing challenge (Goldhaber, 2002). This paper focuses on the state of California to examine the relationship between the academic achievement of high school students and teacher quality as measured by teacher certification and level of educational attainment, using school level data from 1999 to 2005. Results indicate that an increase of 10 percentage points in the fraction of teachers who are fully credentialed is estimated to increase the average school API score by 7 points (p=.0001). Similarly, it is estimated that a 10 percentage point increase in the percentage of instructional staff who have a Master’s degree or above results in a 1.5 point increase in a school’s average API score (p=.091), compared to the excluded category of the proportion of teachers without a BA or with a BA only.
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INTRODUCTION

The New Education Policy Environment

Since the release of the Education Trust’s 1998 Publication, *Good Teaching Matters*, Kati Haycock and her colleagues have been asked to make hundreds of presentations around the country on the effect of teachers on student learning. “Virtually everywhere,” Haycock writes, “the response is the same: heads nod in agreement. Almost nobody, it seems, disputes the importance of effective teachers—including teachers themselves” (Haycock, 2004). And, “common wisdom” seems to be supported by research evidence. For example, researchers Rivkin, Hanushek and Kain found that teacher quality accounted for at least 7 percent of the total variation in student achievement (Rivkin, Hanushek, Kain, 1998); similarly, Goldhaber and his colleagues found that 8.5 percent of the variation in student achievement is due to teacher characteristics (Goldhaber, 2002). Experimental research in Tennessee found that, all else being equal, students assigned to the most effective teachers for three years in a row performed 50 percentile points higher than comparable students assigned to the least effective teachers for three years in a row (Sanders & Rivers, 1996.) The debate, then, rests in what exactly constitutes a “highly qualified” teacher?

The *No Child Left Behind Act of 2001* (NCLB), designed to improve student achievement and close racial-ethnic-income-related achievement gaps, was passed with bi-partisan support from Congress and signed into law by President George W. Bush on January 8, 2002. As part of the accountability provisions set forth in the law, every state has developed benchmarks to measure progress and to make certain that every student is
learning. Additionally, states are required to disaggregate student achievement data, holding schools accountable for subgroups of students (i.e., low income or disability status, race or ethnicity), so that “no child falls through the cracks.” A district or school that does not meet the state’s definition of “adequate yearly progress” (AYP) for two consecutive years—whether it be school-wide or in any subgroup—is considered to be “in need of improvement” (Toolkit for Teachers, US Department of Education).

The required NCLB assessments are intended to help districts and schools identify subject areas and teaching methods that need improvement. If, for example, student math scores do not reach the state’s benchmarks for two years in a row, the school not only knows it needs to improve its math program, but is also committed (under NCLB) to no longer turning a “blind eye” when it isn’t meeting the needs of every student in the school’s care. Once identified as “in need of improvement,” school officials are required to work with parents, school staff, district leaders, and outside experts to develop a plan—based on scientific research—that utilizes strategies that will strengthen learning in core academic subjects, especially those in which benchmarks were not met. Moreover, districts must ensure that schools in need of improvement receive proper technical assistance and that at least 10 percent of the school’s Title I funds are spent to assist teachers.

In addition to requiring regular assessments for accountability measures, NCLB also includes provisions for teacher quality. According to the U.S. Department of Education’s NCLB: A Toolkit for Teachers, “All teachers in core academic areas must be highly qualified in the core academic subjects they teach by the end of the 2005/06
school year,” and “newly hired teachers in Title I schools must be highly qualified immediately” (NCLB: A Toolkit for Teachers, 2004). While the law provides the opportunity for each state to develop a definition of “highly qualified” that is consistent with NCLB as well as with the unique needs of the state, a “highly qualified” teacher, according to the law, means that “the teacher has obtained full State certification as a teacher (including certification obtained through alternative routes to certification) or passed the State teacher licensing examination, and holds a license to teach in such State” (NCLB, Section 9101). When used specifically with respect to a middle or secondary school teacher new to the profession, “highly qualified” additionally “means that the teacher holds at least a bachelor's degree and has demonstrated a high level of competency in each of the academic subjects in which the teacher teaches” (NCLB, Section 9101). Also, according to the Department of Education, “each state has the freedom to define certification according to its needs, and may use the opportunity to strengthen its certification requirements or create alternate routes to certification;” and with regard to subject matter competency, “the state has significant flexibility to plan ways which allow teachers to demonstrate state competency in the subjects they teach” (NCLB: A Toolkit for Teachers, 2004).

Given the Adequate Yearly Progress targets and “highly qualified” teacher requirements that states must meet under NCLB, an obvious question to ask is whether teachers who are designated as “highly qualified” under the federal mandate do in fact have statistically significant positive effects on the academic performance of their students. With the 2005/2006 school year now underway and future analysis of the
effects of NCLB likely pending, the question remains: Is teacher quality defined correctly and comprehensively by NCLB, or could other measures be equally or more indicative of students’ academic performance—beyond what NCLB and the states have outlined to date?

**The Policy Environment in California**

This paper focuses specifically on the state of California because of its size and diversity. The most populous state in the U.S., California is home to 6.3 million public school students (EDSOURCE, 2005), approximately 309,000 public school teachers, and 9,087 public schools (CA Department of Education, 2004). In 2003-2004, almost 47 percent of the state’s students were Latino, close to 33 percent were white, and about 11 percent were Asian/Filipino/Pacific Islander. In addition to the sheer magnitude of its public school system, California faces the additional challenge of educating the highest percentage of non-native English speaking students in the country, the tenth highest proportion of children from low-income families, and a national ranking of 44th or below on national assessments in reading and math (EDSOURCE, 2005).

The Academic Performance Index (API) is the cornerstone of California’s Public Schools Accountability Act (PSAA) of 1999, developed to measure the academic performance of students and schools. API scores are also reported for local education agencies (LEAs)—typically school districts—as an element of California’s accountability requirements under NCLB (Accountability Progress Report, 2005). The API, a numeric scale ranging from a low of 200 to a high of 1000, is calculated as the weighted average of student-level indicators of academic performance including the Standardized Testing
and Reporting Program (STAR) and the California High School Exit Examination (CHASEE). California schools are expected to achieve an API score of 800. Those schools that have not yet reached this level are expected to demonstrate growth equal to five percent of the distance between a school’s API base score (from spring of the preceding year) and the statewide performance target of 800, with a minimum growth target of at least one point. Schools with an API of 800 or more must maintain an API of at least 800 (API Base Manual, 2005).

Under NCLB, all schools and local education agencies in California are required to meet or exceed criteria annually in four areas in order to make Adequate Yearly Progress (AYP): (1) annual API score; (2) the participation rate in annual student testing; (3) the percent of students who are proficient (presumably in math and reading); and, for secondary schools, (4) the high school graduation rate (Accountability Progress Report, 2005). With respect to API specifically, “to demonstrate progress on the API in 2005 for NCLB purposes, a local education agency (LEA) or school must have a 2004-2005 API base of at least 590 or make at least one point of growth from the 2004 API base” (Explanatory Notes for the 2004 API Base Report). To date, the consequences of not meeting AYP requirements apply only to Title I-funded schools and LEAs. A Title I school or LEA that does not meet AYP criteria for two consecutive years within the specific areas is identified as in need of Program Improvement (PI) which requires the provision of certain types of interventions and/or services during each year it is identified as a PI entity. A PI designated school, for example, must offer school choice with paid transportation to students for attending another public school in the district that is not
designated as in need of Program Improvement (2005 Accountability Progress Report).
Under NCLB, when a school is designated as “in need of improvement” or in the case of
California a PI designated school, school staff, district leaders, outside experts and
parents are required to collaborate in developing an improvement plan for the school.
The district is responsible for ensuring that the school receives the necessary technical
assistance, including the identification of problematic instruction or curriculum, and
revising the school’s budget to target resources more effectively towards activities that
will help students learn. The school’s improvement plan must incorporate scientifically
based strategies and at least 10 percent of Title I funds must be spent assisting teachers.
The consequences of not meeting AYP increase and/or intensify with every year that
AYP is not met. By year five, for example, school staff may be replaced and by year six
a plan for alternative governance is made (2005 Accountability Progress Report, p.80). A
school or LEA is eligible to exit PI status if it makes AYP for two consecutive years
(NCLB: A Toolkit for Teachers).

Currently, NCLB defines a “highly qualified” teacher as one who has acquired
full state certification, holds a bachelor’s degree, and has demonstrated subject matter
competency. In California, full state certification is indicative of having attained the
latter two NCLB requirements: The California Commission on Teacher Credentialing
(CCTC, 2005) considers an individual who holds a Single Subject Teaching Credential to
be certified to teach the specific subject(s) named on the credential in departmentalized
classes, such as those typically in middle schools and high schools. The current
requirements for a Preliminary Five Year Credential include: a bachelor’s degree;
completion of a teacher preparation program in which a recommendation for certification is obtained by the California college or university where the program was completed; a passing score on the California Basic Education Skills Test (CBEST); satisfaction of coursework including English Language Skills, technology, and the U.S. Constitution, and, demonstrated competency in the single subject for which the credential is issued. Such competency may be demonstrated by: earning a passing score on a subject matter examination, or completing a teacher commission approved subject matter program.

**CURRENT LITERATURE ON TEACHER QUALITY**

How does one define teacher quality? In the current policy environment education stakeholders are increasingly looking to measures of student academic achievement, and particularly, improved academic achievement as measures of teacher quality. This is not to say that inspiring students to persevere, to follow their dreams, to challenge the status quo, and to become active citizens are irrelevant, but that these qualities and their resulting effects are difficult to measure, and moreover, secondary to the teacher’s ability to affect students’ academic knowledge and learning (i.e. reading, writing, arithmetic, etc.). In this context, academic attainment or improvement can be quantifiably measured by standardized testing—whether these tests are appropriate measures of student learning is still debated—yet they are to date the most widespread method for determining student knowledge and ability for millions of students across the fifty states.

Given such measures of teacher performance, however imperfect they may be, the next challenge is to identify quantifiable teacher characteristics than can then be
positively correlated with improved student achievement. Without a doubt, the demeanor, commitment, energy level, etc., of a teacher are likely to impact student learning, but such qualities are difficult to measure in a consistent and objective way. Thus, researchers are left with other measures or proxies for teacher quality: NCLB identifiers such as education level, subject matter competency and certification, and if they’re lucky, other identifiers such as teachers’ own test scores, the “quality” of their undergraduate institutions, grade point averages, etc. But how appropriate are these current measures? Furthermore, do other potential measures of teacher quality exist? Finally, whereas full state certification is required by federal mandate and typically indicative of holding a bachelor’s degree and demonstrating subject matter competency (the other two NCLB requirements), what are the policy issues, values, and implications of certification as a public policy? The following discussion begins with the question of whether, and/or to what extent, NCLB measures of a “highly qualified” teacher adequately capture teacher quality indeed, and moreover, whether other promising measures may exist. This is followed by a discussion of certification’s current role in public education and raises questions as to its appropriateness and/or sufficiency in determining high quality teaching candidates.

**Measuring Teacher Quality**

Research shows that teacher quality matters. In his article, *The Mystery of Good Teaching*, Goldhaber (Goldhaber, 2002) reiterates the work of economists Hanushek, Kain, and Rivkin, (Hunsheck Kain, Rivkin, 2005) reporting their estimates that variations in teacher quality account for 7.5 percent of the total variation in student achievement.
Similarly, Goldhaber and his colleagues found that 8.5 percent of the variation in student achievement is due to teacher characteristics. And, an analysis of the Tennessee Value-Added Assessment System also indicated that that elementary students assigned to more effective teachers for three consecutive years demonstrated higher student achievement of up to 50 percentile points on statewide tests (Sanders & Rivers, 1996). The question, then, is not whether good teachers matter but “what makes for a good teacher” (Goldhaber, 2002).

Unfortunately, although a significant amount of research has been done on a number of proposed measures for teacher quality, including those delineated by NCLB, a strong consensus as to the direction and magnitude of the effects of these characteristics on student achievement has yet to be reached. Darling-Hammond (2000), for example, finds in an analysis of nationwide data that “teacher quality characteristics such as certification status and degree in the field taught are very significantly and positively correlated with student outcomes,” and that “characteristics such as education level (percentage of teachers with master’s degrees) show positive but less strong relationships with education outcomes” (Darling-Hammond, 2000). On the other hand, Brewer and Goldhaber (2002), using nationwide data from a different source, find that “contrary to conventional wisdom, mathematics and science students who have teachers with emergency credentials do no worse than students whose teachers have standard teaching credentials.” Additional Golhaber findings were that “mathematics students whose teachers had master’s degrees in mathematics had higher achievement gains than those whose teachers had either no advanced degrees or advanced degrees in non-mathematics
subjects” (Wayne & Young, 2003). Hence, intelligent and experienced researchers on either side of the board produce findings many times in conflict with one another, preventing a consensus as to the “true” effect of teacher quality measures such as certification and education.

The impact of non-NCLB indicators of teacher quality also lack consensus. With respect to teacher test scores, Ferguson found, for example, that districts where teachers had higher TECAT (Texas Examination of Current Administrators and Teachers) scores were more likely to have higher gains in student scores in reading, especially in the 3rd and 7th grades. Yet in another study by Ferguson, collaborating with Ladd, although student reading score gains from 3rd to 5th grade were positively related to the average teacher ACT score at the students’ schools, the relationship was unclear for mathematics score gains (both reported in Wayne & Young, 2003). Or, according to Wayne and Young (2003), “some relationship exists between college ratings and achievement gains,” but implications differ by college rating system (Wayne & Young, 2003).

Goldhaber (2000) cautions that when looking at the empirical evidence about specific teacher characteristics and their relationship to student achievement, one must remember that studies focus on different grade levels, subjects, and types of students taught; that in some cases the estimated effect of particular attributes are not consistent across the board; and that studies vary in quality. Nevertheless, it is useful to look at the types of teacher attributes examined as well as study methodologies, in order to apply research to the appropriate contexts, to pave the way for future experiments, and to understand the complexity of the teacher quality issue.
Teacher Certification: An Attempt to Measure Teacher Quality

Statewide certification of teachers was first adopted in New York in 1843, when the state’s superintendent was authorized to set examinations and issue certificates valid statewide. Prior to this point, teaching licenses were allocated by local officials and the licensing decisions based largely upon the applicant’s knowledge and qualifications. By the 1920’s, state-level exams had largely displaced local control. In 1919 the state of Vermont began the new era of teacher certification by substituting professional training for exam performance in their licensure requirements. By 1937, 28 states had followed Vermont’s course and eliminated examinations in favor of professional training. The professional-training-in-place-of-examination model carried through until the 1980s and 1990s when states continued to focus on professional training but also started to revive basic skills testing. By 1987-88, approximately 35 percent of public school districts required applicants to pass state tests of basic skills; in 1993-94 this number had risen to almost 50 percent of districts (Hess, 2001). According to the National Center for Education Statistics, by the 1999-2000 school year 63.9 percent of public school districts require a passing score on a state test of basic skills (Gruber, 2001).

Today, each state certifies teachers according to its own guidelines. All states require a degree that entails both pedagogy and subject matter (Ballou & Podgursky, 1997; Hess, 2001); many also require coursework in special education and issues related to health, drugs, alcohol and nutrition (Hess, 2001). Despite these guidelines, no state makes clear what teachers need to learn in the required coursework or ensures that teachers have actually acquired the essential knowledge or skills. To illustrate this point,
in 1998-99 about half of all states required a basic skills and/or a content based exam. Although these exams might be a useful screen if “basic skills” were defined rigorously, as Hess (2001) notes, the required skills tend to be defined and measured at the 8th or 10th grade level. Meanwhile, according to the Education Trust, most of the subject area tests are too oversimplified to determine knowledge (Mitchell & Barth, 1999). In this way, both types of tests (basic or subject) are too weak to set a bar for what content and skills a teacher must master in order to enter the profession.

States also vary in the amount of practice teaching and classroom observations required of an applicant, ranging from 10 or more weeks of an internship to no internship at all (Ballou & Podgursky, 1997; Hess, 2001). Finally, more than 1,300 institutions provide the training required for licensure (Feistritzer, 1999) ranging from elite institutions as Center X at UCLA to lesser-known regional institutions. Only five percent of the roughly 200,000 new teacher graduates that programs produced each year are trained at the top 25 education schools in the U.S. (Hess, 2001).

**The Role of Subject Matter Competency in Certification**

Although NCLB identifies “subject matter competency” as a separate requirement from “full state certification,” practically speaking many states incorporate the demonstration of subject matter knowledge into the credentialing process. According to the *NCLB Toolkit for Teachers*, states have significant flexibility in designing ways in which teachers may demonstrate competency in the subjects they teach, especially for teachers with experience. The law also requires that “states consider the differences between elementary and secondary teachers, as well as the differences between newly
hired and experienced teachers” (U.S. Department of Education). At the middle and high school level, new teachers must demonstrate competency either by passing a rigorous state test in each subject they teach or by completing an academic major or coursework equivalent to an academic major or an advanced degree. “Experienced” teachers, however, may meet the subject matter competency requirement either by fulfilling the requirements for new teachers or by meeting requirements system designed by each state. Still, it is unclear as to how difficult or challenging the subject matter examinations may be, and whether or not such examinations and/or an academic major are indicative competency in a particular subject.

**Rationale for Certification**

In his article, *Tear Down this Wall*, Hess points out three assumptions supporting the existing approach to certification: 1) the training one receives while getting certified is so useful that uncertified people will not be able to perform adequately; 2) certification weeds out unsuitable people and keeps them out of schools; and, 3) certification helps to make teaching more “professional” and thereby bolsters its allure (Hess, 2001). Hess then goes on to refute each of these assumptions. First he argues that licensing does not ensure talented practitioners, only that they have demonstrated an established degree of professional knowledge. Since “we have refused to establish a specific, measurable body of skills or knowledge that teachers must master,” he writes, it is unclear how standardized licensing helps to safeguard teacher quality. Absent concrete benchmarks, certification demands that “any screening of aspirants rely on subjective judgments about what kinds of preparation and behavior is acceptable” (Hess, 2001). Based on a sampling
of the coursework requirements in some of the most highly regarded schools of education, Steiner and Rozen (2004) find that not even elite education schools are doing an adequate job of conveying fundamental, broad-based knowledge and skills to prospective teachers.

In response to the second assumption that certification weeds out the unsuitable, Hess writes that while certification can serve to screen out those applicants failing to meet a minimal performance standard, the current system is not designed to do so (Hess, 2001). In general, schools of education are not selective, fail few if any students for inadequate performance, and see more than 95 percent of their graduates receive teaching licenses. In a confidential survey of graduate and undergraduate education programs, Leal (2004) found that the average graduate education program accepted 78 percent of applicants and that pass rates on certification exams were about 95 percent, in contrast to the 63 percent average pass rate for state bar exams in 2002. According to Hess, the current model of certification is more like that of cosmetology than law or medicine. In the former, certification does not screen out the unskilled or provide an assurance of mastery so much as it provides assurance that the applicant has simply completed a determined course of study and logged in the practice hours.

Finally, Hess addresses the third assumption of false prestige. Nothing about certification, he says, necessarily raises a profession’s prestige or lures more capable individuals into the profession. If this were not the case, “we might expect that more respect would be accorded to cosmetologists, traffic school instructors …and the practitioners of the multitude of other certified fields for which the public exhibits no special regard” (Hess, 2001). The often cited cases of law or medicine differ in the sense
that licensure contributes to prestige in three essential ways: 1) the public has evidence that practitioners have demonstrated a mastery of essential knowledge; 2) practitioners are held accountable for certain professional norms and standards of behavior, and licensing agencies ensure that dissatisfied clients have formal mechanisms for pursuing grievances; and, 3) professional training programs are intense and demanding and applicants must survive a rigorous application process if they wish to obtain graduate training. Educational certification does nothing to address these concerns. IF proponents of certification wanted to adopt a rigorous model in which aspirants are held to clear standards and programs had reason to be choosy about whom they accepted and permitted to graduate, certification could help to address these concerns. However, Hess indicates there is no evidence that this is what certification proponents have in mind.

Ballou and Podgursky (1997) add their own contention that teacher certification has been traditionally defended as a protection against incompetent or corrupt school administrators. At one time, certification was indeed the primary requirement for teachers and under this circumstance may have provided that teachers meet a minimum standard of competency. Now that states expect their teachers to hold a diploma from a four year college this might be less the case.

Despite the debate over whether teacher certification and educational attainment are “good” or “bad” measures of teacher quality, practically speaking they are the few measures available for use both by administrators and policy makers to inform, shape, and drive public education policy and practice. Also important to note is that certification is typically indicative of having a college degree and subject matter
competency, hence, in analyzing its impact on student achievement one must realize that the “true” effect of certification alone may be difficult to disentangle from the other measures that are wrapped up in certification.

RESEARCH DESIGN

This study seeks to answer two primary research questions:

- Is there a relationship between existing school-level measures of teacher quality (percent of teachers who have a bachelor’s degree, state certification, and demonstrated competency in core subject as determined by the state) and changes in high school academic performance gains over time, ceteris paribus?

- Is the effect of certification on the gain in high school academic performance the same as the effect of teacher education on gain in high school academic performance, ceteris paribus?

In an initial report of their findings released October 26, 2005, EdSource found (based upon a large-scale survey of teachers and principals in 257 California elementary schools serving similar student populations, using API as measure): “Where more teachers reported having regular or standard certification for teaching in California, schools had, on average, higher API scores.” This study seeks to complement the findings of EdSource with an analysis of the relationship between teachers and student achievement in California high schools. The results will contribute to existing knowledge by focusing on NCLB teacher quality indicators in the state of California,
whereas many previous studies have utilized nationwide data or focused on different states.

As noted, this analysis examines the relationship between two of the three required NCLB teacher characteristics (i.e., bachelor’s degree and full certification), as well as related measures (i.e., master’s degree), and the academic performance of high school students, controlling for confounding school-level factors such as socio-economic status and parental education, through the use of a fixed-effects regression model. The limitations of the data from California do not allow for an analysis of the third NCLB measure, or subject matter content knowledge. Additionally, the data available from California also do not allow the tracking of individual teachers over time. Consequently, the unit of analysis is individual high schools, and variables are defined as school level means, i.e. average teacher characteristics and average student academic performance at a particular school. Data are available for six years for each school resulting in a repeated measures design with the following general model specification:

\[
API_t = B_0 + B_1(\text{STUDENT and SCHOOL CHARACTERISTICS}) + B_2(\text{ED\_BA30}) \\
+ B_3(\text{MA\_OR\_ABOVE}) + B_4(\text{FULL\_CRED}) + B_5(\text{TENURE}) + B_6(\text{YRS TEACH}) \\
+ B_7(\text{YRS TEACH})^2 + B_8(\text{YEAR DUMMIES})
\]

1 The “unique” 6-digit identification code assigned to each certificated staff member in California public schools is an “identifier with no meaning,” and “the code assigned to a record for 1998-99 will not match the code assigned to the same staff members’ record for prior or future years. Therefore, the code cannot be used to match records over time.” California Department of Education.
In this model, estimated using a fixed effects regression, the dependent variable (API) represents each high school’s annual academic performance in time t, and the YEAR DUMMIES are used to distinguish the different points of measurement for each school (e.g., YEAR2=1 if t=2, otherwise YEAR2=0).

The key policy variables in the model are: (1) the proportion of teachers at a high school with a bachelor’s degree (ED_BA); (2) the proportion of teachers at a high school with a bachelor’s degree plus 30 units (ED_BA30); (3) the proportion of teachers at a high school with a master’s degree or above (MA_OR_ABOVE); and (4) the proportion of teachers at a high school who are fully credentialed (FULL_CRED). The excluded categories of educational attainment are teachers without a college degree (accounting for less than one percent of teachers, on average), and ED_BA. As such, the model estimates the relationship between more education than is minimally required and API scores.

Other covariates included in the model control for both average student and school demographics and additional teacher characteristics that are expected to influence average academic performance. These include the following: (1) whether the number socio-economically disadvantaged students is “significant”\(^2\), (2) the proportion of English Learners at the school; (3) the average parent education level; (4) student mobility; (5) average teacher tenure status; and, (6) average number of years teaching for the instructional staff (entered both as school average and as a squared term to allow the effect of the number of years in the classroom to vary by the level of time). Ideally, a

\(^2\) It is unclear as to what criteria a school used in order to identify itself as “Socioeconomically Disadvantaged Significant,” only that it was coded as Yes/No.
separate measure of subject matter competency (outside of full certification) would be included, but the data available is limited in the respect.

The data used for this analysis were obtained from two data sources. The first was the API data files compiled by the California Department of Education. The number of high schools included in the dataset varies from 843 observations in 1999-2000 to 2156 observations in 2004-2005, and the original dataset (inclusive of ALL public schools, elementary, middle, and high school) contains 104 school-level variables, with slight changes in definition/inclusion of certain variables over time.

This analysis was limited to those high schools (n=597) for which data were available for all six years. A comparison of the characteristics of the schools used in the analysis to other high schools in California indicate that the excluded schools have a lower average API score across all six years (e.g., in year 1, the average API of excluded schools was 43 points lower than the study schools; in year 6, the average API of excluded schools was 152 points lower than the study schools). Consequently, the sampled schools are systematically different but it is not clear how much this may have biased the relationship between average teacher characteristics and API scores (i.e., although the excluded schools have, on average, lower annual API scores, it is not known if the relationship between average teacher characteristics and API scores would be different if these schools were able to be included in the analysis).

The second data source, providing information on teacher characteristics, is the California Basic Educational Data System (CBEDS) Professional Assignment Information Form (PAIF) downloadable data files covering the years 1999-000 through
2004-2005 (to match the API file). Unlike the API files which are at the school-level and include a variable designating the school type (elementary, middle, high), the PAIF data files are at the individual-level where each teacher or administrator is connected to his/her school via a school code. Because the number of records in the PAIF files (ranging from 333,530 observations in 1999-2000 to 353,097 observations in 2004-2005) includes all teachers (elementary, middle, high) statewide, only those teachers matching the high schools from the API school-level files were included. In order to aggregate and transform the individual-level teacher characteristics to the school-level, I calculated the mean teacher characteristics for each school.

**Treatment of Missing Data**

Because data regarding English learners was not collected in the first year of this analysis (1999-2000), and given the expectation that the proportion of English learners at a school is unlikely to change drastically from one year to the next, the values for this variable in year two were used for year one. With respect to student mobility, one school failed to provide data for this variable for any of years studied, and as a consequence, the mean for all other schools was used to impute the missing data for each year. Finally, about 40 schools were missing entries for the “HS_OR_LESS” variable measuring the proportion of parents at a school who held a high school degree or less. For these

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3 For unexplained reasons, the 2001-2002 and 2002-2003 data was included in such a way that the usual staffing characteristic variables did not include the TEACH variable to distinguish teachers from administrators. To solve this problem, multiple PAIF files for these two particular years were merged to pick up a similar variable, CTYPE, which designated the type of teaching assignment (teaching vs. administrative).
observations, the missing value was replaced with the first available value for a subsequent year at the same school.

RESULTS

Descriptive Results

As seen in Table 1, the average API score for the sample of 597 California high schools increased from an average of approximately 646 in the 1999-2000 school year to 710 in the 2004-2005 school year. The percentage of students who are classified as “socioeconomically disadvantaged” appears to have also increased from 69 percent in 1999-2000 to 84 percent in 2000-2001, although the criteria which schools used to determine “socioeconomically disadvantaged” is unknown.

With respect to teaching characteristics (Table 2), average levels of educational attainment was generally consistent over the six years studied with, on average, 37 percent of teachers at a high school holding a master’s degree or above, 44 percent of teachers at a high school having attained 30 units in addition to a bachelor’s degree, and 18 percent of teachers at a high school having only a bachelor’s degree. The average proportion of teachers without a BA is only one percent. Unlike teacher education levels which generally remained constant over time, the average percentage of teachers with a full credential increased slightly from 88 percent in the 1999-2000 school year to 92 percent in the 2004-2005 school year. But, on average, most high schools have a very high proportion of fully credentialed teachers.

4 Average of the proportions across schools in the sample
Regression Results

Table 3 presents coefficient estimates from a fixed-effects regression of 597 public high schools in California over six years of time (N=3582). As expected, the relationship between API scores and the proportion of students who are English language learners, and whether the school is identified as being socioeconomically disadvantaged, is negative and highly statistically significant (p=.001), as is the relationship with the proportion of parents who reportedly have a high school degree only or less (p=.078). The relationship between API scores and average student mobility, however, was not statistically significant.

With respect to average teacher education levels, the relationship between the proportion of teachers who have a bachelor’s degree plus thirty units on student performance was not statistically significant, with respect to the excluded category of the proportion of teachers without a BA or with a BA only. However, there is a statistically significant, albeit small, relationship between the proportion of teachers who have an advanced degree and a high school’s average API score, i.e., a 10 percentage point increase in the percentage of the staff who have a Master’s degree or above is estimated to increase average API scores by 1.5 points (p=.091), compared to the excluded category of the proportion of teachers without a BA or with a BA only. The estimates for full credential also show a small, but statistically significant, relationship between the percentage of teachers who are fully credentialed and average API scores, i.e., an increase of 10 percentage points in the fraction of teachers who are fully credentialed is estimated to increase the average school API score by 7 points (p<.0001).
It should be noted, however, that this model was unable to include measures of subject matter acquisition, teacher test scores, and so forth, which are hypothesized to be positively correlated to both student academic achievement and credential status. As a consequence, the estimated relationship between average teacher credential status and API score is most likely biased upward—i.e. the true impact of fully credentialed teachers on API is presumably smaller than the coefficient in this model, due to omitted variable bias.

To answer the second research question of whether the effect of certification on the gain in high school academic performance is the same as the effect of teacher education on gain in high school academic performance, an F-Test of Equality was used for two different teacher education levels: ED_BA30 and MA_or_Above (Table 3). First using the null hypothesis that the effect of holding a bachelor’s degree plus 30 units is equal to the effect of full certification:

\[ H_0: B_{\text{ED_BA30}} = B_{\text{FULL_CRED}} \]

\[ H_0: B_{\text{ED_BA30}} \neq B_{\text{FULL_CRED}} \]

the resulting Prob>F=.3737 indicates that at all conventional levels one fails to reject the null hypothesis that the impact of a bachelor’s degree plus 30 units and full credential are equal. This outcome is expected in the sense that earning a teaching credential in California requires a bachelor’s degree and some kind of teacher preparation program—which, incidentally, is typically 30 units of coursework. The second F-test hypothesizes that the effect of a master’s degree or above and full credential are equal:

\[ H_0: B_{\text{MA_OR ABOVE}} = B_{\text{FULL_CRED}} \]
\[ H_0: B_{\text{MA OR ABOVE}} \neq B_{\text{FULL CRED}} \]

This test also results in failing to reject the null hypothesis that the effect of having a master’s degree or above and being fully credentialed are equal (Prob>F=.9330).

**POLICY IMPLICATIONS**

Although the estimated effects of this model are small, this is not surprising given that the analysis is at the school level and that it is difficult to show effects for average teacher qualifications and school level student performance measures. Ideally, California should make student-teacher data available so such analysis can be done at a more finely grained level where there is likely to be more variation and a greater ability to detect effects, if they are in fact true.

In addition, it is important to keep in mind that these results apply only to the 597 schools that had all six years of API data. If it is the case that the schools missing API scores (ranging from 246 schools in 1999-2000 to 1559 schools in 2004-2005) are systematically different from the schools in this analysis, then the results have limited generalizability. In this respect, it is extremely important that the California Department of Education and individual schools be more diligent in collecting API data in order to better analyze the impacts of certain inputs on student achievement\(^5\) when developing public policy.

Next, the fact that the proportion of teachers without a bachelor’s degree was small (.01 or 1%), and constant over all six years (NCLB passed during year 3) seems to

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\(^5\) Although statisticians have tools for handling missing data with respect to *independent* variables, accurate analyses cannot be performed when data for the *dependent* variable is missing.
suggest that in fact NCLB is not very strict in this respect and that California might want to consider setting the bar higher. But just how high? After all, how does one explain the fact that ED_BA30 is not significant? One would expect that the more education teachers earn, the greater the impact on student achievement and thus the coefficient on ED_BA30 compared to BA only would be positive and significant. The best explanation for these findings is the high correlation between the education variables beyond ED_NOBA. For example, ED_BA30 and ED_BA are highly correlated, as are MA_OR_ABOVE and ED_BA in the sense that in either case the higher education level requires having a bachelor’s degree and thus it might be difficult to disentangle the effect of the additional 30 units or master’s degree from a bachelor’s alone. Furthermore, given that full certification requires a bachelor’s degree plus additional teacher preparation (typically 30 units), the variable ED_BA30 and fully credentialed are highly correlated as well. That ED_BA30 is not statistically significant could suggest that in fact certification actually has some negative consequences that are being picked up by the education level associated with it.

Although the F-tests of equality fail to reject the null hypotheses that the effect of a bachelor’s degree plus 30 units and full credential are equal, and that the effect of having a master’s degree or above and full credential are equal, one cannot say that the effects are in fact equal, i.e. a failure to reject the null hypothesis is not proof that the null hypothesis is true. As such, one must avoid the temptation to think that ED_BA30 or MA_OR_ABOVE can replace full credential, especially due to the high correlation between both education levels and certification and the difficulty in disentangling their
separate effects. Rather, as this entire analysis suggests, additional potential measures of teacher quality must be diligently gathered in order to more precisely understand the influence of teacher characteristics on student achievement: i.e. ranking of teacher’s undergraduate institution, college GPA, scores on tests such as the PRAXIS or even the SAT, ranking of teacher’s post-graduate or certification institution, etc. Having these additional measures might shed further light on desirable teacher character characteristics that, by informing the public, might improve the preparation, recruiting, and retention of high quality teachers.
<table>
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<td>(Year 1)</td>
<td>(Year 2)</td>
<td>(Year 3)</td>
<td>(Year 4)</td>
<td>(Year 5)</td>
<td>(Year 6)</td>
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<td>Ending API in a particular year</td>
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<td>687.49</td>
<td>710.24</td>
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<td>105.72</td>
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<td>597.00</td>
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<td>597.00</td>
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<td>97.06</td>
<td>97.71</td>
<td>98.07</td>
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<td>597.00</td>
<td>597.00</td>
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<td>0.84</td>
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<td>-</td>
<td>597.00</td>
<td>597.00</td>
<td>597.00</td>
<td>597.00</td>
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<td>Proportion of students who are English Learners</td>
<td>Mean - 14.36</td>
<td>15.14</td>
<td>15.47</td>
<td>14.99</td>
<td>15.05</td>
<td></td>
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<tr>
<td>nSMOB</td>
<td>N</td>
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<td>596.00</td>
<td>596.00</td>
<td>596.00</td>
<td>596.00</td>
</tr>
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<td>Percentage of students who first attended this school in the present year</td>
<td>Mean 12.49</td>
<td>12.46</td>
<td>11.91</td>
<td>12.32</td>
<td>11.55</td>
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<td>10.60</td>
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<td>HS_or_Less</td>
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<td>596.00</td>
<td>585.00</td>
<td>584.00</td>
<td>581.00</td>
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<td>Percent of parents whose highest level of education is high school degree or less</td>
<td>Mean 36.03</td>
<td>35.91</td>
<td>38.22</td>
<td>39.25</td>
<td>39.83</td>
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*S.D. indicates standard deviation; ***EL was not recorded in Year 1
TABLE 2. Descriptive Statistics of Teacher Characteristics in Study Schools

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<td>0.08</td>
<td>0.07</td>
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<td>nYRS_TEACH</td>
<td>Number of years teaching</td>
<td>Mean</td>
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<td>14.02</td>
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<td>2.78</td>
<td>2.72</td>
<td>2.75</td>
<td>2.81</td>
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<td>MA_or_Above</td>
<td>Teachers with Master's degree or more</td>
<td>Proportion</td>
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<td>0.37</td>
<td>0.36</td>
<td>0.36</td>
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<td>ED_BA30</td>
<td>Teachers with BA + 30 units</td>
<td>Proportion</td>
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<td>0.44</td>
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<tr>
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<td>Teachers with BA</td>
<td>Proportion</td>
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<td>0.18</td>
<td>0.19</td>
<td>0.19</td>
<td>0.18</td>
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<td>0.13</td>
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<td>ED_NOBA</td>
<td>Teachers without BA</td>
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<td>nFULL_CRED</td>
<td>Teachers with full credential</td>
<td>Proportion</td>
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<td>0.09</td>
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<tr>
<td>nEMERGENCY</td>
<td>Teachers with emergency credentials</td>
<td>Proportion</td>
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<td>0.11</td>
<td>0.11</td>
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<td>0.05</td>
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<td>0.08</td>
<td>0.05</td>
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<td>nWAIVER</td>
<td>Teachers with waivers</td>
<td>Proportion</td>
<td>0.02</td>
<td>0.01</td>
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<td>TENURE</td>
<td>Teachers with &quot;tenure&quot; status</td>
<td>Proportion</td>
<td>0.70</td>
<td>0.68</td>
<td>0.65</td>
<td>0.65</td>
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<td>0.14</td>
<td>0.19</td>
<td>0.19</td>
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<td>0.19</td>
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<td>PROBATIONARY</td>
<td>Teachers with &quot;probationary&quot; status</td>
<td>Proportion</td>
<td>0.20</td>
<td>0.20</td>
<td>0.21</td>
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<td>0.18</td>
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<tr>
<td>LONGTERMSUB</td>
<td>Teachers who are long term substitutes</td>
<td>Proportion</td>
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<td>0.07</td>
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### TABLE 3. Fixed Effects OLS Regression Results: School Annual API

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<th>Academic Performance Index</th>
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<td><strong>School Characteristics</strong></td>
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<td>Socioeconomically Disadvantaged</td>
<td>-10.512</td>
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<tr>
<td>(p&lt;.0001)</td>
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<tr>
<td>English Learners</td>
<td>-0.431</td>
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<td>(0.001)</td>
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<td>Student Mobility</td>
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<td>(0.966)</td>
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<td>Parents with high school degree or less</td>
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<td>(0.078)</td>
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<tr>
<td><strong>Teacher Characteristics</strong></td>
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<td>Teachers with BA + 30 units</td>
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<td>(0.101)</td>
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<td>Teachers with MA or above</td>
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<td>(0.091)</td>
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<td>Teachers Fully Credentialed</td>
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<td>(p&lt;.0001)</td>
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<td>Tenured Teachers</td>
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<td>(0.149)</td>
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<td>Number of Years Teaching -squared-</td>
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<td>(0.033)</td>
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<td><strong>R²: 0.5610</strong></td>
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#### Test of Equality

- test ma_or_above=nfull_cred
  - F (1, 2969) = .9330
  - Prob>F = .3737

- test ed_ba30=nfull_cred
  - F (1, 2969) = .9330
  - Prob>F = .3737
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