

**INCORPORATING ACCESS TO
MORE EFFECTIVE TEACHERS
INTO ASSESSMENTS OF
EDUCATIONAL RESOURCE EQUITY**

Kevin C. Bastian

(corresponding author)
Department of Public Policy
and Education Policy
Initiative at Carolina
University of North Carolina
at Chapel Hill
Chapel Hill, NC 27599
kbastian@email.unc.edu

Gary T. Henry

Department of Leadership,
Policy, and Organizations
Peabody College
Vanderbilt University
Nashville, TN 37203
gary.henry@vanderbilt.edu

Charles L. Thompson

Department of Public Policy
and Education Policy
Initiative at Carolina
University of North Carolina
at Chapel Hill
Chapel Hill, NC 27599
cthomps@email.unc.edu

Abstract

To address gaps in achievement between more- and less-affluent students, states and districts need to ensure that high-poverty students and schools have equitable access to educational resources. Traditionally, assessments of resource equity have focused on per-pupil expenditures and more proximal inputs, such as teacher credentials and class size, despite the inconsistent and/or weak relationships between these measures and student performance. Given the sizable and direct effects of teachers on student achievement, we argue that (1) teachers' value-added scores should be incorporated into assessments of resource equity and (2) providing schools with greater flexibility for setting salaries or using strategic staffing initiatives may be necessary to achieve an equitable distribution of effective teachers. To illustrate these assertions we incorporate teacher value added into a case study of resource allocation in the public high schools of Wayne County, North Carolina, which have been the target of a complaint by the North Carolina National Association for the Advancement of Colored People.

INTRODUCTION

Given the effects of educational attainment on desired societal outcomes—increased wages, improved health status, reduced rates of unemployment, higher rates of civic participation—strong incentives exist to encourage greater levels of academic achievement and attainment, especially for academically disadvantaged student groups (Adams 2002; Dee 2004; Lochner and Moretti 2004; Psacharopoulos and Patrinos 2004). One policy mechanism to accomplish this objective is the distribution of educational resources, making sure that academically disadvantaged students have equitable access to school-related inputs. As evidenced by the school finance lawsuits of the 1970s–1990s that challenged property tax–based school funding systems and called for adequate levels of funding in high-poverty schools, traditional views of educational resource equity focused on the distribution of financial resources (Augenblick, Myers, and Anderson 1997; Murray, Evans, and Schwab 1998; Card and Payne 2002). The assumption was that sufficient levels of school funding would lead to greater levels of achievement for academically at-risk students.

Although this litigation successfully narrowed and sometimes eliminated gaps in funding between high- and low-poverty schools, subsequent studies have not revealed a strong, consistent, or direct relationship between per-pupil expenditures and student achievement (Hanushek 1981, 1997). Research indicates that money can matter for academic outcomes, but the ends toward which it is allocated, such as retaining high-quality teachers in low-performing schools, are important (Henry, Fortner, and Thompson 2010). This suggests that the lack of a consistent relationship between increased per-pupil expenditures and student outcomes may be partly attributable to the education policy context over the past several decades in which school funding, particularly that allocated toward teacher compensation, is divorced from measures of effectiveness (e.g., teacher value added).

Beyond per-pupil expenditures, more proximal school-based inputs, such as teacher credentials and class size, also have weak associations with student achievement, especially in schools serving high concentrations of academically disadvantaged students (Hanushek 1999; Gordon, Kane, and Staiger 2006). In contrast, the school-based resource that has the greatest influence on student achievement is the effectiveness of teachers. Evidence suggests that highly effective teachers promote 7.5 and 3 additional months of student learning in mathematics and reading, respectively, and have long-term effects on students' collegiate attendance and residential status (Bill & Melinda Gates Foundation 2010; Chetty, Friedman, and Rockoff 2011). In light of these teacher effectiveness findings, recent federal policies, such as the Talent Transfer Initiative and Race to the Top, are attempting to alter the distribution of teacher quality by offering financial incentives for highly effective teachers to

work in low-performing schools. Therefore, given both the research evidence concerning school funding, class size, and teacher quality, and the recent policy focus on teacher effectiveness and its distribution, we contend that value added should be incorporated into studies of educational resource equity.

In this policy brief we (1) summarize research on the distribution and effects of school funding and teacher quality, including teachers' value-added scores, and (2) examine the distribution of resources in the public high schools of Wayne County, North Carolina, as a case study of how teacher value-added scores may add to studies of educational resource allocation.

Here, high concentrations of low-achieving and high-poverty/minority students in one school, Goldsboro High School (GHS), led the North Carolina National Association for the Advancement of Colored People (NAACP) to file a complaint with the Office of Civil Rights in December 2009. The district and state were allocating substantial amounts of compensatory funding to GHS—approximately \$3,000 more per pupil than the average for the district's seven other public high schools—and based on this funding allocation, traditional analyses of educational resource equity would have likely concluded that GHS received adequate resources to succeed. Analyses of the distribution of teacher credentials and teacher effectiveness, however, indicated that in comparison to their peers at other district high schools, GHS students were instructed by less-well-credentialed and less effective teachers. These teacher quality findings challenge the relevance of resource allocation studies focusing solely on school funding. Furthermore, the case of Wayne County highlights how restrictions on the use of compensatory funding—GHS was unable to offer increased teacher salaries or supplements—limit the efficacy of increased expenditures by inhibiting high-poverty schools' ability to attract and incentivize highly effective teachers.

Although focused on a single school district, our methods for examining resource equity and our findings regarding both the distribution of educational resources and the limitations of compensatory funding entail significant state and national policy implications. Policy lessons from Wayne County underscore the need for: (1) a more comprehensive, evidence-based view of resource equity focused on teacher effectiveness, and (2) testing alternative policies, such as flexible salary schedules, financial incentives, and strategic staffing initiatives, in order to achieve a more equitable distribution of highly effective teachers and, in turn, improve educational outcomes for academically disadvantaged students.

In the following sections we first review research findings on the distribution and effects of school funding and teacher quality. Then, we present our case study of the allocation of educational resources in Wayne County's public high schools and summarize our findings.

EDUCATIONAL RESOURCES: SCHOOL EXPENDITURES AND TEACHER QUALITY

School Expenditures

Prior to the school finance lawsuits of the 1970s–1990s, a majority of the funding for public schools was determined by the property tax base of a community/school district (Heise 1995; Kelly 1995). In comparison to more affluent communities, low-income communities often had higher tax rates but lower revenues to fund local schools. This disparity in per-pupil expenditures led to concerns about disparities in educational quality (Murray, Evans, and Schwab 1998; Card and Payne 2002). Challenges to the constitutionality of these school funding systems in over forty states forced court-ordered financial reform that ensured an adequate level of fiscal resources for high-poverty schools by increasing states' roles in funding public education (Augenblick, Myers, and Anderson 1997; Evans, Murray, and Schwab 1997). Specifically, states increased funding for their poorest districts while leaving aid to wealthier districts largely unchanged (Evans, Murray, and Schwab 1997; Dee and Levine 2004). As states provided larger shares of school expenditures (in comparison with local sources) the allocation of fiscal resources across schools became more equitable, to the extent that in some states, such as North Carolina, high-poverty schools now expend more money per pupil than low-poverty schools (Moser and Rubenstein 2002). Compared with previous decades, school funding is more equitably distributed; however, school districts continue to experiment with alternative allocation systems, especially weighted-student funding (which assigns money to schools based on student characteristics rather than staff allocations), in an attempt to ensure that financial resources address student need within districts (Miles and Roza 2006; Ladd 2008).

As states and districts take action to distribute financial resources more equitably, the question becomes whether this additional funding improves student outcomes. Detailed literature reviews and meta-analyses return instances where additional funding improved, did not influence, and sometimes adversely affected student achievement (Hanushek 1981, 1997). This mixed evidence about the effects of school funding may be attributable to: (1) the aggregation of data to the district or state level, masking important school-to-school variation in spending; (2) an inability to track how/for what purposes districts and schools allocate funds; and/or (3) policy restrictions that prevent districts and schools from efficiently allocating money toward high-quality resources (Hanushek, Rivkin, and Taylor 1996; Henry, Fortner, and Thompson 2010). To this last point, one reason why increased funding may not produce increased student achievement is the disconnect between expenditures and effectiveness. For example, in most states or districts a teacher's compensation is based on a single salary structure (determined by experience

and graduate degree status) and there are no financial incentives for highly effective teachers (pay for performance) or high-quality teachers willing to work in low-performing schools (hazard pay). When money is allocated toward effective inputs, evidence suggests that it does matter. For instance, in districts with high levels of educational disadvantage, money directed toward classrooms—to recruit/retain high-quality teachers and improve teachers' instructional practices—increased student achievement (Henry, Fortner, and Thompson 2010). Further evidence suggests that additional funding may be more beneficial for academically at-risk students—narrowing the achievement gap between more- and less-advantaged groups (Card and Payne 2002; Henry et al. 2009). Overall, the extent to which money matters depends on how that money is spent. The lack of a strong, consistent, or direct relationship between per-pupil expenditures and student achievement, however, suggests a need for a more comprehensive, outcomes-oriented view of educational resource equity.

Teacher Quality

In contrast to school funding outcomes, research consistently shows that teacher quality—more robustly, their ability to promote student achievement growth as measured by value-added scores, and more weakly, their credentials, such as experience or teacher test scores—is the most important school-related factor explaining student performance (Nye, Konstantopoulos, and Hedges 2004; Aaronson, Barrow, and Sander 2007; Clotfelter, Ladd, and Vigdor 2007, 2010). Evidence concerning the impact of teacher credentials indicates that, on average, experience and certification status are often significantly associated with student achievement gains for early-career teachers (Boyd et al. 2006; Clotfelter, Ladd, and Vigdor 2007, 2010; Henry, Bastian, and Fortner 2011). Results concerning National Board Certification and teacher test scores are mixed across research settings, but in North Carolina, both credentials generally signal teacher quality (Clotfelter, Ladd, and Vigdor 2007, 2010; Goldhaber 2007; Goldhaber and Anthony 2007; Buddin and Zamarro 2009). Because these credentials explain only a small portion of the difference in teachers' ability to promote student test score growth, however, our preferred indicator of teacher quality is the amount of student test score gains (value added) that teachers produce. Here, the effects of a high value-added teacher are substantial. In comparison with students assigned to a low-performing instructor, students assigned to a highly effective teacher gain approximately 7.5 additional months of learning in mathematics and 3 additional months of learning in reading during the school year; if high-poverty students are assigned to a highly effective teacher for three consecutive school years, that exposure significantly narrows the

achievement gap with their more advantaged peers (Bill & Melinda Gates Foundation 2010). Long-term, assignment to a high value-added teacher is also associated with higher wages, higher rates of college attendance, and living in more-affluent neighborhoods (Chetty, Friedman, and Rockoff 2011; Hanushek 2011).

Due to these sizable and direct effects of teachers on student achievement, states and districts face strong incentives to both increase teacher quality and ensure that highly effective teachers are equitably distributed to academically at-risk students. Research indicates that teachers prefer to work in environments with lower-poverty and higher-achieving students and in higher-quality working conditions, which include effective principal leadership and higher levels of teacher collaboration (Boyd et al. 2011a, 2011b; Ladd 2011). These teacher preferences, combined with schools' hiring preferences, mean that better-credentialed teachers are disproportionately employed in schools and classrooms with lower-poverty and higher-achieving students (Lankford, Loeb, and Wyckoff 2002; Clotfelter, Ladd, and Vigdor 2005). Initial evidence also suggests that high value-added teachers may not be equitably distributed to academically at-risk students. In North Carolina, for example, classes with higher average achievement from the previous year are significantly more likely to be assigned a highly effective teacher (Lauen, Henry, and Rose 2012). Work by Sass and colleagues in Florida and North Carolina indicates that average teacher effectiveness is both lower and exhibits greater variability in high-poverty schools—environments in which more than 70 percent of students qualify for subsidized school lunches (Sass et al. 2012). Finally, additional research across ten school districts in seven different states indicates that highly effective teachers are significantly more likely to teach in low-poverty middle schools (Glazerman et al. 2011). Overall, these research findings support the inclusion of teacher effectiveness analyses as a critical component in studies of educational resource equity.

THE DISTRIBUTION OF EDUCATIONAL RESOURCES IN WAYNE COUNTY: AN EMPIRICAL EXAMPLE

As an illustration of a resource equity analysis that incorporates teacher effectiveness results, we present a case study of the public high schools in Wayne County, North Carolina. Specifically, we contrast Goldsboro High School, currently at the center of a U.S. Office of Civil Rights complaint, with the seven other public high schools in the district. Like traditional resource allocation analyses, we begin our case study by examining the distribution of per-pupil expenditures in the district's high schools. Then, we analyze whether students at GHS had equitable access to better-credentialed and highly effective teachers. Thus, our case study is guided by prior equity analyses and tests the validity of these traditional equity analyses within a particular district-level context.

In the following sections we provide background information on Wayne County and briefly detail the data and methods used in our analyses before addressing two questions:

- (1) How is school funding allocated in the district?
- (2) Does compensatory funding secure equitable access to high-quality teachers?

Background on Wayne County Public Schools

On 1 December 2009, after several years of negotiations had failed to alter the student assignment policies in Wayne County, the North Carolina chapter of the NAACP filed a formal complaint with the Office of Civil Rights at the U.S. Department of Education and the Civil Rights Division at the U.S. Department of Justice. The complaint alleged that the Wayne County Board of Education, along with other public and private agencies in Wayne County, had intentionally established and carried out policies—refusing to redistrict the county’s school attendance maps, only allowing school transfers for those students who could provide their own transportation, and redistricting certain streets into white majority school attendance zones—that directly led to the resegregation of public schools in the district and unsatisfactory academic outcomes for black students (NAACP 2009).

Evidence presented for the complaint was as follows: Wayne County contains thirty-six schools, serving 19,000 students, divided into six separate attendance zones.¹ The smallest zone, operating six schools for 2,100 students, is situated within the town of Goldsboro, the county seat, and despite a nearly fifty–fifty black and white population split within Goldsboro, over 95 percent of the students attending schools in the central attendance zone are black, with more than ninety percent qualifying for subsidized school lunches. In contrast, the largest attendance zone in the district serves approximately 5,000 students, ninety percent of whom are white and only thirty-six percent of whom qualify for federally subsidized lunches.

Recognizing that this was an issue of importance to North Carolina and potentially to other states and the federal government, the Education Policy Initiative at Carolina initiated an examination of the allocation of educational resources (school funding and teacher quality) within the district. Specifically, we compared GHS, located in the central attendance zone, with the

1. Wayne County Public Schools is the nineteenth largest school district in the state of North Carolina. The racial demographics within the school district are as follows: 48 percent white, 43 percent black, 6 percent Hispanic, 2 percent Asian, and less than 1 percent Native American.

seven other public high schools in Wayne County.² Table 1 presents demographic and achievement data for the district's high schools. Consistent with the NAACP complaint, it is clear that GHS has many more black students and students who qualify for subsidized lunches than any other district high school. Furthermore, the level of academic achievement is much lower at GHS: On average, students enter GHS scoring well below their district peers on state mathematics and reading exams, and once in high school, GHS students pass only 52 percent of their End-of-Course exams and graduate at less than a 45 percent rate.

To examine the distribution of educational resources in Wayne County we used student, teacher, and school-level data provided by the North Carolina Department of Public Instruction for the 2005–06 through 2009–10 school years. We limited the descriptive information on school demographics (table 1) and school spending (table 2) to the 2008–09 school year to provide a snapshot of the district's high schools coinciding with the NAACP complaint.³ To analyze the distribution of teacher credentials and teacher value added in the district's high schools, we used all five years of data to identify longer-term trends in GHS students' access to high-quality teachers. Specifically, in teacher credentials analyses we estimated the probability that a GHS student experiences a tested-subject teacher with a particular credential (i.e., National Board Certification) in comparison with peers in the district's other high schools. Here, we intentionally omitted all student, classroom, and school covariates to estimate unadjusted probabilities (relative risk ratios). To ease interpretation of these teacher credential risk ratios, we also present percentages of tested-subject teachers with a respective credential at GHS versus the tested-subject teachers at all other Wayne County high schools.

Prior to describing our plans to estimate teacher effectiveness, it is important to briefly acknowledge the practical and methodological limitations of value-added modeling. From a practical standpoint, the most significant challenge is the relatively small number of teachers instructing in a tested grade/subject, meaning only a minority of teachers have value-added estimates. During our study period this challenge is less of a concern due to the robust set of criterion-referenced, End-of-Course exams in North Carolina high schools. As outlined by Corcoran and Goldhaber (2013), methodological

-
2. We focus our study of educational resource allocation at the high school level (rather than elementary or middle school) due to local news coverage particularly focusing on GHS. Furthermore, analyses of resource equity are more straightforward when examining one high school (GHS) rather than multiple elementary and/or middle schools. As evidenced by the eighth-grade mathematics and reading scores shown in table 1, however, student achievement concerns extend back into the central attendance zone's feeder middle schools.
 3. Data on school demographics, academic achievement, and school spending from other school years are similar to the values reported for 2008–09 and are available upon request from the authors.

Table 1. High School Demographic Information for the 2008–09 School Year

School Name	School Size	Percent Black	Percent Eligible for Subsidized Lunches	Standardized 8th Grade		Standardized 8th Grade Reading Scores	Percentage of HS End-of-Course Tests Passed	Four Year Graduation Rate
				Math Scores	Math Scores			
Goldsboro High School	559	96.00	87.30	-0.400	-0.456	52.60	44.80	
Weighted District Average Excluding Goldsboro High School	733	32.32	47.60	0.148	0.057	71.75	80.22	
Charles Aycock High School	1,191	23.72	34.80	0.147	0.112	74.90	82.70	
Eastern Wayne High School	1,132	44.98	38.70	0.215	0.128	77.60	91.10	
Rosewood High School	500	16.98	40.00	0.065	0.096	78.00	80.70	
Southern Wayne High School	1,047	46.34	65.50	-0.128	-0.204	55.80	70.90	
Spring Creek High School	931	19.67	59.70	0.245	0.012	69.10	71.40	
Wayne Early-Middle College	168	19.77	35.70	0.793	0.668	100.00	95.00	
Wayne School of Engineering	160	50.36	54.40	0.496	0.392	77.20	—	

Notes: A four-year graduation rate is not available for the Wayne School of Engineering because in 2008–09 its grade range was 9–10 only. The standardized eighth-grade mathematics and reading scores come from the North Carolina End-of-Grade exams.

Table 2. The Distribution of Per-Pupil Expenditures in Wayne County High Schools (2008–2009)

School Name	Total Per-Pupil Expenditures	Regular Instruction Expenditures (Per-Pupil)	Special Instruction Expenditures (Per-Pupil)	School Leadership Expenditures (Per-Pupil)
Goldsboro High School	\$10,954.84	\$6,514.16	\$960.06	\$738.62
Weighted Average Excluding Goldsboro High School	\$7,878.09	\$4,626.58	\$550.82	\$425.07
Charles Aycock High School	\$7,108.67	\$4,123.79	\$467.31	\$359.35
Eastern Wayne High School	\$8,043.51	\$5,038.20	\$477.56	\$358.46
Rosewood High School	\$8,630.21	\$4,772.58	\$901.15	\$496.05
Southern Wayne High School	\$8,171.88	\$4,778.71	\$711.38	\$425.75
Spring Creek High School	\$7,734.02	\$4,302.82	\$548.28	\$373.28
Wayne Early-Middle College	\$9,240.89	\$5,694.33	\$74.61	\$829.52
Wayne School of Engineering	\$7,565.51	\$4,761.17	\$67.24	\$1,038.66

Note: The expenditure categories shown in columns 2–4 (regular instruction through school leadership), reflect real (not district average) per-pupil spending at GHS and the remaining public high schools in Wayne County.

challenges include the sensitivity of teacher effectiveness estimates to model specification choices, particularly the inclusion of student or school fixed effects, the non-random assignment of students to teachers (both between and within schools), and the presence of measurement error (noise) in value-added estimates (McCaffrey et al. 2009; Baker et al. 2010; Rothstein 2010; Corcoran and Goldhaber 2013).⁴ These issues introduce bias and imprecision into teacher effectiveness estimates—the extent of this bias and noise determines the usefulness of value added (Goldhaber and Corcoran 2013). As detailed subsequently and in the Appendix, we take steps to mitigate these concerns.

For analyses of the distribution of teacher effectiveness, we used statewide student achievement data to estimate the value added of all North Carolina public school teachers who taught any of the five courses in which passing

4. For a fuller description of the challenges inherent in using student test score data to estimate individual teacher effectiveness, see Baker et al. 2010.

End-of-Course exams is required for graduation—English 1, algebra 1, biology, U.S. history, and civics/economics. To estimate individual teacher value added in these high school subjects we generated teacher-by-year fixed effects with the user-written Stata package *felsdvregdm* (Mihaly et al. 2010). We estimated these value-added models, including all North Carolina high schools in the sample (not just Wayne County), with a rich set of student, classroom, and school covariates. Post-estimation, we kept the teacher-by-year fixed effects for Wayne County and used *t*-tests to compare the average effectiveness of GHS teachers with the average effectiveness of all other high school teachers in the district (see the Appendix for a more detailed description of the teacher value-added estimation).

Together, the teacher credential and value-added analyses indicate whether GHS students enjoy equitable access to high-quality teachers. Combining these results with per-pupil expenditure data provides a more comprehensive, outcomes-oriented analysis of resource allocation.

How is School Funding Allocated in the District?

As in most equity analyses, we begin our study of resource allocation in Wayne County high schools by examining the distribution of school funding. Here, we use school finance data to calculate the total per-pupil expenditures at each high school and then use state accounting codes to separate these school-level expenditures into thirteen distinct categories. For this case study we present information on the three most relevant categories—regular instruction, special instruction, and school leadership.⁵

Table 2 clearly shows that GHS receives substantially more per-pupil funding than other district high schools. In 2008–09, GHS spent nearly \$11,000 per pupil, which is approximately \$3,000 above the average for the district’s other high schools and in the top quartile of spending among high schools in the state. Goldsboro High School expended much of this additional per-pupil funding—approximately \$2,000 more than the district average—on the salaries, benefits, and salary supplements of regular classroom teachers, and another large portion of the additional per-pupil funding—approximately \$400 more than the district average—went toward the salaries, benefits, and salary supplements of special education teachers. Paralleling their expenditures for teachers, GHS expended approximately \$300 more than the district average, per pupil, to pay the salaries, benefits, and salary supplements of its school leadership team (principals and assistant principals).

5. All categories of school-level expenditures shown in columns 2–4 of table 2 (regular instruction through school leadership) reflect real (not district averages) spending at GHS and the remaining public high schools in Wayne County.

Overall, these patterns of spending in Wayne County are similar to those across North Carolina: On average, high-poverty and low-performing schools spend more money, per pupil, than more advantaged counterparts. For example, in 2008–09, high schools in the top quartile of school poverty spent nearly \$10,500, per pupil, whereas high schools in the bottom quartile of school poverty spent approximately \$8,600, per pupil (authors' analysis). From this allocation of funding in Wayne County, traditional analyses of resource equity would have likely concluded that GHS received sufficient compensatory funding to provide adequate levels of educational resources, especially because GHS targeted the additional funding to classroom instruction and school leadership. It remains unclear, however, whether better-credentialed or highly effective teachers were equitably distributed across the high schools in Wayne County.

Does Compensatory Funding Secure Equitable Access to High-Quality Teachers?

Given teachers' documented preferences to work in environments with more advantaged students and better working conditions (Boyd et al. 2011a, 2011b; Ladd 2011), it does not necessarily follow that more funding for instruction at GHS will result in better-credentialed or highly effective teachers. For instance, prior studies have shown that additional funding in high poverty schools may be used for smaller classes and more inexperienced teachers (Rubenstein et al. 2007). Therefore, to examine the distribution of teacher quality in Wayne County high schools we analyzed measures of teacher qualifications and teacher value-added scores.

For our teacher credential analyses we estimated the probability (relative risk ratio) that a GHS student is instructed by a tested-subject teacher holding a certain credential compared with the probability for all other high school students in Wayne County. Based on previous research findings in North Carolina high schools, we selected five teacher quality measures that are significantly associated—the first positively, the other four negatively—with student achievement: (1) National Board Certification; (2) scoring poorly (more than 1 standard deviation below the mean) on Praxis II licensure exams;⁶ (3) having less than three years teaching experience; (4) entering the profession alternatively;⁷ and (5) teaching out-of-field (Clotfelter, Ladd, and Vigdor 2007,

6. During the study period (2005–06 through 2009–10) there were no teachers employed at GHS whose average Praxis II test score was more than one standard deviation higher than the standardized, state-wide mean.

7. In this analysis alternative entry refers to teachers who entered the profession prior to completing requirements for initial licensure. Prior work in North Carolina indicates that these alternative entry instructors are significantly less effective than in-state traditionally prepared teachers in high school (Henry et al. 2014). We do not include Teach For America corps members in this category.

Table 3. The Distribution of Teacher Credentials in Wayne County High Schools (2005–06 through 2009–10)

	National Board Certification (%)	Low-Scoring			Out-of-Field Teacher (%)
		Praxis II Performance (%)	Novice Teacher (%)	Alternative Entry Teacher (%)	
Goldsboro High School	7.07%	15.15%	27.27%	38.38%	48.74%
All Other Wayne County High Schools	14.69%	6.42%	18.07%	20.95%	23.28%
Goldsboro High School Student	0.401** (-3.60)	3.39** (4.23)	1.64* (1.98)	2.19** (7.15)	2.17** (9.01)

Notes: In the top portion of the table, the values for columns 1–4 (National Board Certification through Alternative Entry Teacher) identify unique teacher-by-year percentages for GHS and the remaining public high schools in Wayne County. The last column (Out-of-Field Teacher) identifies unique teacher-by-class percentages. The bottom portion of the table displays the probability (risk ratio) that a GHS student has a teacher with the following credentials, compared with all other high school peers in Wayne County. Z-scores are reported in parentheses.

*Significant at the 5% level; **significant at the 1% level.

2010; Henry, Bastian, and Fortner 2011; Henry et al. 2014). While estimates (risk ratios) can be interpreted as probabilities, to further ease interpretation we also present percentages of tested-subject teachers at GHS and all other Wayne County high schools with the respective credentials. Results in table 3 show that GHS students do not receive equitable access to better-credentialed teachers when compared with the students attending other Wayne County high schools. Examining the risk ratio probabilities, GHS students are one-half as likely to be taught by a Nationally Board Certified (NBC) instructor, three times more likely to have a teacher scoring poorly on his/her licensure exams, 1.6 times more likely to be taught by a novice instructor, and two times more likely to have an alternatively prepared or out-of-field teacher. Teacher-by-year or teacher-by-class (out-of-field) percentages return very similar results—for instance, over the 2005–06 through 2009–10 period, only 7 percent of the tested-subject teachers at GHS held NBC status, whereas more than 14 percent of tested-subject teachers had attained the credential at other district high schools. Although significantly associated with student achievement gains in prior research in North Carolina, each of these credentials, alone, explains only a small portion of the variation in teacher effectiveness. When considered jointly (e.g., a teacher who is novice, low-scoring, and out-of-field), however, this distribution of teacher credentials could have much larger effects on the achievement of GHS students (Clotfelter, Ladd, and Vigdor 2010).

Table 4. The Distribution of Teacher Effectiveness in Wayne County High Schools (2005–06 through 2009–10)

Standardized Teacher Effectiveness	English 1	Algebra 1	Biology	U.S. History	Civics/ Economics
Average GHS Teacher Effectiveness	0.071	−0.570	−1.931	−0.526	1.038
Average Wayne County Teacher Effectiveness	0.302	0.126	−0.685	0.022	−0.229
Significance Test P-Value	0.361	0.000	0.003	0.004	0.000
Significance Result	No Different	GHS Less Effective	GHS Less Effective	GHS Less Effective	GHS More Effective

Note: The top half of this table displays average, standardized teacher effectiveness for GHS and the seven other Wayne County high schools, combined. The bottom half of this table displays *p*-values from significance tests comparing the mean effectiveness values.

Although it is likely that this distribution of credentials adversely affects the achievement of GHS students, the most direct way to examine teacher quality and determine whether GHS students have equitable access to effective teachers is through teacher value-added analyses. Therefore, using a value-added model with a rich set of student, classroom, and school covariates, we estimated individual teacher-by-year fixed effects for each of the North Carolina End-of-Course exams required for graduation—English 1, algebra 1, biology, U.S. history, and civics/economics—and tested whether the average teacher effectiveness at GHS was significantly different from that in the district’s seven other high schools. Results in table 4 suggest that in the classes GHS students are required to pass for graduation, they are often taught by less effective instructors. In three of five comparisons (algebra 1, biology, and U.S. history), GHS teachers were significantly less effective than their district peers, with the effectiveness estimate for GHS biology teachers nearly two standard deviations below the statewide subject average. In one comparison (civics/economics) GHS teachers were significantly more effective, and in the final comparison (English 1) there were no significant differences. Overall, even with substantial amounts of compensatory funding, GHS was unable to provide equitable access to better-credentialed or highly effective teachers.

These analyses leave us with an important question: What did GHS purchase with the compensatory funding? Instead of getting better teachers, GHS funded more teachers—a common practice at high-poverty schools in intra-district analyses (Rubenstein et al. 2007). In 2008–09 the pupil-to-teacher ratio at GHS was 9.16 to 1; the district average was 13.95 to 1. In courses with End-of-Course exams the average class size at GHS was 12.30 students;

the district average was 17.20 students. During that school year GHS employed 61 teachers, but had the school maintained the same pupil-to-teacher ratio as Wayne County's other public high schools, GHS would have only employed 40 teachers. Although this may suggest that Wayne County and GHS pursued a particular human capital strategy—trying to recruit better teachers by offering smaller class sizes—it more likely reflects limited flexibility in the use of school funding. Teachers in North Carolina are paid according to a single, statewide salary structure, to which some school districts add uniform salary supplements. This combination of compensation policies results in nearly uniform salaries within districts for teachers with similar experience, levels of education, or NBC status and almost no within-district flexibility to offer financial incentives to recruit and retain highly effective teachers for particular schools. Previous research does show benefits to class size reduction, especially in lower elementary grades, but overall, class size reduction is unlikely to be as effective and is likely less cost effective than initiatives to increase teacher quality (Mosteller 1995; Angrist and Lavy 1999; Nye, Hedges, and Konstantopoulos 2000; Boozer and Rouse 2001; Nye, Konstantopoulos, and Hedges 2004). Therefore, without sufficient flexibility in the allocation of financial resources, Wayne County and GHS appear to have expended the compensatory funding on a less effective strategy for improving student achievement.

SUMMARY

Despite the inequitable distribution of high-quality teachers in Wayne County, this case study should not be interpreted as an argument against spending more to address educational disadvantage in schools. Rather, the results indicate that what matters is how districts and schools spend compensatory funding. Here, research evinces that teacher effectiveness has the largest and most direct impact on student achievement, but due to North Carolina's single salary structure and uniform salary supplements within districts, GHS was unable to direct its additional resources toward recruiting and retaining high-quality teachers, and instead, pursued a less efficacious strategy of buying more, not better, teachers.

Given the broader policy context focused on teacher effectiveness and the distribution of high-quality teachers—exemplified by federal initiatives such as Race to the Top—findings from prior research and this case study entail two recommendations. First, estimates of teacher value added should be routinely incorporated into studies of resource equity. This is particularly important due to the size of teacher effects and research which shows the inequitable distribution of better-credentialed and more effective teachers. Second, to achieve a more equitable distribution of teachers, schools and

districts should have greater flexibility to determine teacher compensation and use strategic staffing initiatives. Examples of such policies in Wayne County could include financial incentives (hazard pay) for high-quality teachers to work at GHS, increased pay for teachers who produce significant achievement gains (pay for performance) with GHS students, or programs that allow principals transitioning to GHS to bring with them the highly effective teachers from their previous school. Money can matter for student performance but using it to provide the most effective resources, namely high-quality teachers, is essential.

The authors are grateful for the assistance of Dr. C. Kevin Fortner, Dr. Adrienne Smith, Jade Marcus, and Elizabeth D'Amico, and the comments of session participants at the 37th Annual AAFP Conference. This research was funded in part by the Teacher Quality Research Initiative sponsored by the University of North Carolina General Administration.

REFERENCES

- Adams, Scott. 2002. Educational attainment and health: Evidence from a sample of older adults. *Education Economics* 10(1): 97–109. doi:10.1080/09645290110110227
- Aaronson, Daniel, Lisa Barrow, and William Sander. 2007. Teachers and student achievement in the Chicago public high schools. *Journal of Labor Economics* 25(1): 95–135. doi:10.1086/508733
- Angrist, Joshua, and Victor Lavy. 1999. Using Maimonides' Rule to estimate the effect of class size on scholastic achievement. *Quarterly Journal of Economics* 114(2): 533–75. doi:10.1162/003355399556061
- Augenblick, John, John Myers, and Amy Anderson. 1997. Equity and adequacy in school funding. *Future of Children* 7(3): 63–78. doi:10.2307/1602446
- Baker, Eva, Paul Barton, Linda Darling-Hammond, Edward Haertel, Helen Ladd, Robert Linn, Diane Ravitch, Richard Rothstein, Richard Shavelson, and Lorrie Shepard. 2010. Problems with the use of student test scores to evaluate teachers. Economic Policy Institute Briefing Paper No. 278.
- Bifulco, Robert. 2012. Can non-experimental estimates replicate estimates based on random assignment in evaluations of school choice? A within-study comparison. *Journal of Policy Analysis and Management* 24(1): 113–32.
- Bill & Melinda Gates Foundation. 2010. *Learning about teaching: Initial findings from the measures of effective teaching project—Policy brief*. Available www.gatesfoundation.org/college-ready-education/Documents/preliminary-finding-policy-brief.pdf. Accessed 21 February 2013.
- Boozer, Michael, and Cecilia Rouse. 2001. Intra-school variation in class size: Patterns and implications. *Journal of Urban Economics* 50(1): 163–89. doi:10.1006/juec.2001.2216
- Boyd, Donald, Pamela Grossman, Hamilton Lankford, Susanna Loeb, and James Wyck-off. 2006. How changes in entry requirements alter the teacher workforce and affect

student achievement. *Education Finance and Policy* 1(2): 176–216. doi:10.1162/edfp.2006.1.2.176

Boyd, Donald, Pamela Grossman, Marsha Ing, Hamilton Lankford, Susanna Loeb, and James Wyckoff. 2011a. The influence of school administrators on teacher retention decisions. *American Educational Research Journal* 48(2): 303–33. doi:10.3102/0002831210380788

Boyd, Donald, Hamilton Lankford, Susanna Loeb, Matthew Ronfeldt, and James Wyckoff. 2011b. The role of teacher quality in retention and hiring: Using applications to transfer to uncover preferences of teachers and schools. *Journal of Policy Analysis and Management* 30(1): 88–110. doi:10.1002/pam.20545

Buddin, Richard, and Gema Zamarro. 2009. Teacher qualifications and student achievement in urban elementary schools. *Journal of Urban Economics* 66(2): 103–15. doi:10.1016/j.jue.2009.05.001

Card, David, and Abigail Payne. 2002. School finance reform, the distribution of school spending, and the distribution of student test scores. *Journal of Public Economics* 83(1): 49–82. doi:10.1016/S0047-2727(00)00177-8

Chetty, Raj, John Friedman, and Jonah Rockoff. 2011. The long-term impacts of teachers: Teacher value-added and student outcomes in adulthood. NBER Working Paper No. 17699.

Clotfelter, Charles, Helen Ladd, and Jacob Vigdor. 2005. Who teaches whom? Race and the distribution of novice teachers. *Economics of Education Review* 24(4): 377–92. doi:10.1016/j.econedurev.2004.06.008

Clotfelter, Charles, Helen Ladd, and Jacob Vigdor. 2007. Teacher credentials and student achievement: Longitudinal analysis with student fixed effects. *Economics of Education Review* 26(4): 673–82. doi:10.1016/j.econedurev.2007.10.002

Clotfelter, Charles, Helen Ladd, and Jacob Vigdor. 2010. Teacher credentials and student achievement in high school: A cross-subject analysis with student fixed effects. *Journal of Human Resources* 45(4): 655–81. doi:10.1353/jhr.2010.0023

Corcoran, Sean, and Dan Goldhaber. 2013. Value added and its uses: Where you stand depends on where you sit. *Education Finance and Policy* 8(3): 418–34.

Dee, Thomas. 2004. Are there civic returns to education? *Journal of Public Economics* 88(9–10): 1697–720. doi:10.1016/j.jpubeco.2003.11.002

Dee, Thomas, and Jeffrey Levine. 2004. The fate of new funding: Evidence from Massachusetts' Education Finance Reforms. *Educational Evaluation and Policy Analysis* 26(3): 199–215. doi:10.3102/01623737026003199

Evans, William, Sheila Murray, and Robert Schwab. 1997. Schoolhouses, courthouses, and statehouses after Serrano. *Journal of Policy Analysis and Management* 16(1): 10–31. doi:10.1002/(SICI)1520-6688(199724)16:1<10::AID-PAM2>3.0.CO;2-L

Glazerman, Steven, Jeffrey Max, Bing-Ru Teh, and Ali Protik. 2011. *Do low-income students have equal access to the highest performing teachers?* Available <http://ies.ed.gov/ncee/pubs/20114016/pdf/20114016.pdf>. Accessed 19 February 2013.

Goldhaber, Dan. 2007. Everyone's doing it, but what does teacher testing tell us about teacher effectiveness? *Journal of Human Resources* 42(4): 765–94.

Goldhaber, Dan, and Emily Anthony. 2007. Can teacher quality be effectively assessed? National Board Certification as a signal of effective teaching. *Review of Economics and Statistics* 89(1): 134–50. doi:10.1162/rest.89.1.134

Gordon, Robert, Thomas Kane, and Douglas Staiger. 2006. Identifying effective teachers using performance on the job. The Brookings Institution: The Hamilton Project White Paper No. 2006–01.

Hanushek, Eric. 1981. Throwing money at schools. *Journal of Policy Analysis and Management* 1(1): 19–41. doi:10.2307/3324107

Hanushek, Eric, Steven Rivkin, and Lori Taylor. 1996. Aggregation and the estimated effects of school resources. *Review of Economics and Statistics* 78(4): 611–27. doi:10.2307/2109949

Hanushek, Eric. 1997. Assessing the effects of school resources on student performance: An update. *Educational Evaluation and Policy Analysis* 19(2): 141–64.

Hanushek, Eric. 1999. Some findings from an independent investigation of the Tennessee STAR experiment and from other investigations of class size effects. *Educational Evaluation and Policy Analysis* 21(2): 143–63. doi:10.3102/01623737021002143

Hanushek, Eric. 2011. The economic value of higher teacher quality. *Economics of Education Review* 30(3): 466–79. doi:10.1016/j.econedurev.2010.12.006

Heise, Michael. 1995. State constitutions, school finance litigation, and the “third wave”: From equity to adequacy. *Temple Law Review* 68(1): 1151–176.

Henry, Gary T., Charles L. Thompson, C. K. Fortner, and Rebecca A. Zulli. 2009. The impact of the disadvantaged student supplemental fund on middle school student performance in pilot districts. Unpublished paper, Carolina Institute for Public Policy.

Henry, Gary T., C. K. Fortner, and Charles L. Thompson. 2010. Targeted funding for educationally disadvantaged students: A regression discontinuity estimate of the impact on high school student achievement. *Educational Evaluation and Policy Analysis* 32(2): 183–204. doi:10.3102/0162373710370620

Henry, Gary T., Kevin C. Bastian, and C. K. Fortner. 2011. Stayers and leavers: Early-career teacher effectiveness and attrition. *Educational Researcher* 40(6): 271–80. doi:10.3102/0013189X11419042

Henry, Gary T., Kevin C. Bastian, C. K. Fortner, David C. Kershaw, Kelly M. Purtell, Charles L. Thompson, and Rebecca A. Zulli. 2014. Teacher preparation policies and their effects on student achievement. *Education Finance and Policy*. In press.

Kelly, Erin. 1995. All students are not created equal: The inequitable combination of property-tax-based school finance systems and local control. *Duke Law Journal* 45(2): 397–435. doi:10.2307/1372907

Ladd, Helen F. 2008. Reflections on equity, adequacy, and weighted student funding. *Education Finance and Policy* 3(4): 402–23. doi:10.1162/edfp.2008.3.4.402

- Ladd, Helen F. 2011. Teachers' perceptions of their working conditions: How predictive of planned and actual teacher movement? *Educational Evaluation and Policy Analysis* 33(2): 235–61. doi:10.3102/0162373711398128
- Lankford, Hamilton, Susanna Loeb, and James Wyckoff. 2002. Teacher sorting and the plight of urban schools: A descriptive analysis. *Educational Evaluation and Policy Analysis* 24(1): 37–62. doi:10.3102/01623737024001037
- Lauen, Douglas L., Gary T. Henry, and Roderick Rose. 2012. The distribution of effective teachers in North Carolina. Paper presented at the APPAM Fall Research Conference, Baltimore, MD, November.
- Lochner, Lance, and Enrico Moretti. 2004. The effect of education on crime: Evidence from prison inmates, arrests, and self-reports. *American Economic Review* 94(1): 155–89. doi:10.1257/000282804322970751
- McCaffrey, Daniel, Tim Sass, J. R. Lockwood, and Kata Mihaly. 2009. The intertemporal variability of teacher effect estimates. *Education Finance and Policy* 4(4): 572–606. doi:10.1162/edfp.2009.4.4.572
- Mihaly, Kata, Daniel McCaffrey, J. R. Lockwood, and Tim Sass. 2010. Centering and reference groups for estimates of fixed effects: Modifications to felsdsvreg. *Stata Journal* 10(1): 1–22.
- Miles, Karen H., and Marguerite Roza. 2006. Understanding student-weighted allocation as a means to greater school resource equity. *Peabody Journal of Education* 81(3): 39–62. doi:10.1207/s15327930pje8103_2
- Moser, Michele, and Ross Rubenstein. 2002. The equality of public school district funding in the United States: A national status report. *Public Administration Review* 62(1): 63–72. doi:10.1111/1540-6210.00155
- Mosteller, Frederick. 1995. The Tennessee study of class size in early school grades. *Future of Children* 5(2): 113–27. doi:10.2307/1602360
- Murray, Sheila, William Evans, and Robert Schwab. 1998. Education-finance reform and the distribution of educational resources. *American Economic Review* 88(4): 789–812.
- National Association for the Advancement of Colored People (NAACP). 2009. *NAACP v. Board of Education, Wayne County, NC*. Available www.newsobserver.com/content/media/2009/12/1/NAACP.pdf. Accessed 20 February 2013.
- Nye, Barbara, Larry Hedges, and Spyros Konstantopoulos. 2000. The effects of small classes on academic achievement: The results of the Tennessee class size experiment. *American Educational Research Journal* 37(1): 123–51. doi:10.3102/00028312037001123
- Nye, Barbara, Spyros Konstantopoulos, and Larry Hedges. 2004. How large are teacher effects? *Educational Evaluation and Policy Analysis* 26(3): 237–57. doi:10.3102/01623737026003237
- Psacharopoulos, George, and Harry A. Patrinos. 2004. Returns to investment in education: A further update. *Education Economics* 12(2): 111–34. doi:10.1080/0964529042000239140

Rothstein, Jesse. 2010. Teacher quality in education production: Tracking, decay, and student achievement. *Quarterly Journal of Economics* 125(1): 175–214. doi:10.1162/qjec.2010.125.1.175

Rubenstein, Ross, Amy Ellen Schwartz, Leanna Stiefel, and Hella B. H. Amor. 2007. From districts to schools: The distribution of resources across schools in big city school districts. *Economics of Education Review* 26(5): 532–45. doi:10.1016/j.econedurev.2006.08.002

Sass, Tim, Jane Hannaway, Zeyu Xu, David Figlio, and Li Feng. 2012. Value added of teachers in high-poverty schools and lower poverty schools. *Journal of Urban Economics* 72(2–3): 104–22. doi:10.1016/j.jue.2012.04.004

APPENDIX: ESTIMATING INDIVIDUAL TEACHER-BY-YEAR EFFECTIVENESS

To examine the distribution of teacher effectiveness in Wayne County high schools, we estimated individual teacher-by-year value added for each of the five End-of-Course (EOC) exams required for graduation—English 1, algebra 1, biology, U.S. history, civics/economics—and tested for statistically significant differences in the average effectiveness of GHS teachers versus the average effectiveness of peers at other district high schools. To do this, we used the user-written Stata package *felsdvregdm* to specify a value-added model controlling for a rich set of student, classroom, and school covariates, including the variable of interest, the teacher-by-year fixed effect. In these models a student's standardized EOC exam score (standardized within subject and year) served as the dependent variable and standardized mathematics and reading scores (standardized within subject, grade, and year) from End-of-Grade (EOG) tests in eighth grade controlled for prior achievement.⁸ Unlike the teacher credential analyses, in which we estimated unadjusted risk ratios, these value-added models explicitly controlled for a rich set of student, classroom, and school covariates to isolate individual teacher effectiveness from other factors influencing student achievement. Recent studies assessing alternative identification strategies indicate that a rich set of covariates substantially reduce bias in effect estimates (Bifulco 2012). We included the following variables in our models—(1) student: prior test scores, classmates' prior test scores, and indicators for mobility (structural, between year, within year), race/ethnicity, gender, poverty, giftedness, disability, and underage/overage for grade; (2) classroom: the dispersion of prior test scores, class size, and indicators for curriculum status (advanced or remedial); and (3) school: school size, total per-pupil expenditures, district teacher salary supplements, suspension rate, violent acts rate,

8. Students in grades 3–8 in North Carolina public schools take EOG exams in mathematics and reading.

and percentages of minority students and students in poverty. The equation used to estimate individual teacher-by-year effectiveness is as follows:

$$A_{ijst} = \hat{\alpha} A_{it-n} + \tilde{\alpha} X_{ijst} + \tilde{\alpha} Z_{jst} + \hat{\epsilon} W_{st} + \lambda_t + \hat{\alpha}_{ijst}$$

where A_{ijst} is the standardized EOC exam score for student i in classroom j in school s at time t ;

A_{it-n} represents the eighth grade mathematics and reading EOG scores for student i ;

X_{ijst} , Z_{jst} , and W_{st} represent vectors of student, classroom, and school controls;

λ_t is the individual teacher-by-year fixed effect; and $\hat{\alpha}_{ijst}$ is a disturbance term representing all unexplained variation in student achievement.

Post estimation, we recovered and standardized λ_t (individual teacher-by-year value added) and limited our sample to estimates from Wayne County high schools only. Then, for each EOC exam required for graduation, we tested for statistically significant differences in the average effectiveness of GHS teachers versus peers in other district high schools. Average teacher effectiveness in each course and results of these t -tests are reported in table 4.