Consortium for Educational Research and Evaluation–North Carolina

The Distribution of Teacher Value Added in North Carolina

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Executive Summary

Purpose of this Report

North Carolina's Race to the Top (RttT) plan includes several specific interventions that are designed to improve the effectiveness of teachers and reduce inequities in the distribution of and student access to effective teachers. The purpose of this report is to provide a baseline for the evaluation of the impacts on effective teacher distribution and assess that result from implementation of the state's RttT plan. On February 2, 2012, the North Carolina State Board of Education adopted the Educator Value-Added Assessment System (EVAAS), a product of the SAS Institute, as the measure of student growth to be used to assess teachers on the North Carolina Educator Evaluation System's new sixth standard. [1]

Data, Sample, Measures, and Analytical Methods

For this report, the Evaluation Team analyzed the "value-added" EVAAS index scores of approximately 35% of North Carolina teachers, grades 5 through 8, in the 2008-09 through 2009-10 school years. The report uses the EVAAS index scores calculated by the SAS Institute as the sole measure for an individual teacher's "value added," which is defined as a teacher's contribution to gains in student achievement, and for this study is based on students' prior test scores. The Team conducted two primary analyses: first, a descriptive analysis of the geographic distribution of high and low value-added teachers using a dataset comprising pooled estimates of math and reading teachers' value-added indexes for both academic years. Second, the Team assessed students' access to higher and lower value-added teachers using a dataset in which students' 2009-2010 individual, classroom, and school demographic and performance characteristics were related to their 2008-2009 teachers' value-added scores.

Key Findings

For each of the findings, teacher value added is defined as a measure of the extent to which teachers raised student test scores, as estimated by the EVAAS model.

Geographic Region/District

- Geography was related to but did not fully determine student access to teachers with higher value-added scores. Local Education Agencies (LEAs)[2] with higher-than-average concentrations of high value-added teachers were present in nearly every part of North

[1] The other five standards of the North Carolina Educator Evaluation System (NCEES) are: (1) Teachers demonstrate leadership; (2) Teachers establish a respectful environment for a diverse population of students; (3) Teachers know the content they teach; (4) Teachers facilitate learning for their students; and (5) Teachers reflect on their practice. Teachers may receive a rating of "Not Demonstrated," "Developing," "Proficient," "Accomplished," or "Distinguished" for standards 1-5.
[2] LEA is North Carolina's term for traditional school districts and charter schools.

Carolina. The Team found numerous instances of LEAs with high concentrations of high value-added teachers that were geographically adjacent to LEAs with low concentrations of high value-added teachers.

- While geography did not fully determine teacher value added, there was some variation across regions. The Mountain region[3] had a relatively large proportion of LEAs with larger concentrations of high value-added teachers. The Piedmont region contained a mix of LEAs with higher concentrations of high value-added teachers alongside LEAs with higher concentrations of low value-added teachers. The Coastal Plain had relatively few LEAs with high concentrations of high value-added teachers.

Students

- Minority, poor, and low-achieving students typically had lower value-added teachers than did non-minority, non-poor, high-achieving students. However, once classroom and school-level variables are added to the model, results suggest that individual students' characteristics matter less than a classroom's average level of prior achievement. Our findings suggest that schools tend to group students of similar achievement level together and then assign the highest value-added teachers to the classes of students with the highest levels of prior achievement.

Classrooms and Schools

- Average classroom and school poverty rates were negatively associated with teacher value added.
- Average classroom and school minority composition rates were negatively associated with teacher value added.
- Average classroom and school achievement were positively associated with teacher value added.

Conclusions

Based on analyses of EVAAS scores, the results in this report suggest that, prior to RttT, students in low-achieving, high-poverty, and high-minority schools tended to have teachers with lower value-added scores. In short, we find evidence of inequitable distribution of teachers both within and between schools prior to RttT. Since prior research stresses the importance of effective teaching in improving students' achievement, the findings in this report should stimulate policy discussions about how students in schools and classrooms with concentrations of high-poverty, high-minority, and low-achieving peers can gain more access to teachers with higher value-added scores.

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[3] The three geographic regions used in this report are Mountain, Piedmont, and Coastal Plain. The counties comprising each of these three regions are organized according to geography resources from the North Carolina Department of the Secretary of State; regions are not coterminous with the eight Regional Education Service Area (RESA) regions. A full map is included in Appendix A of the full report.

This study also clearly challenges perceptions that geography alone prescribes the distribution of high value-added teachers across the state. It appears that high value-added teachers take positions in any given region of the state and that their concentration in any LEA may be driven, at least in part, by the policies of each LEA. Thus, it may be possible for policies and programs to improve the distribution of high value-added teachers and give all students more equitable access to more high value-added teachers. North Carolina's RttT plan includes several such initiatives that are designed to make access to more effective teachers more equitable, including initiatives for the specific distribution of effective teachers and leaders, under the assumption that effective principals will attract high value-added teachers. In addition, school transformation efforts can improve access to effective teachers in low-achieving schools. The baseline assessments in this report represent a starting point from which the RttT initiatives to improve equitable access to high value-added teachers can be assessed at the end of the RttT grant period.

Introduction: Teacher Quality and North Carolina's Race to the Top Initiative

Teachers influence the academic success of students more than any other resource that policy makers and school administrators control. The evidence strongly supports the theory that more effective teachers are the key ingredient for improving instruction and raising student performance, but other studies show that too few highly-effective teachers are available to ensure that all students have effective teachers in all classes. Until recently, the best available proxy measures for teacher effectiveness have been based on comparisons of teacher credentials, and studies using those estimates reveal that, too often, classrooms with higher concentrations of minority, poor, and low-achieving students appear to be taught by lower-quality teachers (Borman & Kimball, 2005; Heck, 2007; Neild & Farley-Ripple, 2008).

Recent evidence suggests that, mirroring the national pattern, North Carolina teachers with lesser credentials and qualifications are more likely to be assigned to struggling students. Humphrey et al. (2007) showed that in several states including North Carolina, teachers with National Board Certification are not equitably distributed across schools that serve different populations of students. Poor, minority, and lower-performing students are far less likely to have access to National Board Certified teachers than are students who are more affluent, majority, and higher-performing. In addition, Clotfelter, Ladd, and Vigdor (2006) concluded that more highly-qualified teachers tend to be matched with more advantaged students, not only across schools but in many cases also within them.

While the use of credentials and years of experience as proxies for teacher effectiveness has been helpful in shedding light on some aspects of the teacher distribution dilemma, the approach also has been limiting, in that credentials alone do not necessarily capture the mechanisms behind a teacher's ability to impact her or his students' achievement. In North Carolina's Race to the Top (RttT) proposal, the state committed to adding a quantitative measure of student growth as the sixth standard[4] for its North Carolina Educator Evaluation System (NCEES) for teachers. On February 2, 2012, the North Carolina State Board of Education adopted the Educator Value-Added Assessment System (EVAAS), a product of the SAS Institute, as the measure of student growth to be used in teachers' evaluations.

The state's RttT grant provides an unprecedented opportunity to further the state's efforts to increase students' access to highly-effective teachers by focusing efforts on identifying teachers who are more effective in terms of raising students' test scores. The two-part goal of increasing educator effectiveness and achieving equitable distribution of effective educators statewide—one of the four underlying pillars of the RttT application—undergirds nearly every aspect of the North Carolina RttT plan. Specifically, the goals for North Carolina's RttT teacher and leader distribution efforts are to:

- Increase the number of high-achieving, new college graduates teaching in North Carolina;

[4] The other five standards of the North Carolina Educator Evaluation System (NCEES) are: (1) Teachers demonstrate leadership; (2) Teachers establish a respectful environment for a diverse population of students; (3) Teachers know the content they teach; (4) Teachers facilitate learning for their students; and (5) Teachers reflect on their practice.

- Strengthen the preparation of and support for novice teachers;
- Employ strategic staffing approaches to optimize the distribution of available human capital;
- Make further use of virtual and blended classes for students in an attempt to expand curriculum offerings and provide effective instruction when effective teachers for a subject are not available locally; and
- Increase the number of principals prepared to lead transformational change and improve access to high-quality instruction in high-need schools.

North Carolina's RttT proposal also included a commitment to evaluate the initiatives that were designed to help the state meet these goals. The evaluation is being conducted by the Consortium for Educational Research and Evaluation–North Carolina (CERE–NC), a partnership of the Carolina Institute for Public Policy at the University of North Carolina at Chapel Hill, the Friday Institute for Educational Innovation at North Carolina State University, and the SERVE Center at the University of North Carolina at Greensboro.

This report sets the stage for ascertaining the success of the multiple RttT efforts to improve student access to quality teachers. It provides information about both the *distribution of* and *student access to high value-added teachers* across North Carolina. As noted above, while prior research has assessed access to higher-quality teachers as measured by credentials and educational qualifications such as National Board Certification, years of experience, or the prestige of the college from which the teachers graduated, this report presents evidence about the distribution of and student access to high value-added teachers, as estimated by the EVAAS model. To the best of the Evaluation Team's knowledge, this is the first analysis of the distribution of teacher quality using teacher value-added estimates. The Team reports on the geographic distribution of effective teachers across the 115 Local Education Agencies (LEAs)[5] in North Carolina, as well as across the eight educational regions and the three geographic regions containing these LEAs. The report also examines whether access to effective teachers differs by student (e.g., race, poverty level, previous performance on standardized tests), classroom, and school characteristics.

[5] LEA is North Carolina's term for traditional school districts and charter schools.

Background and Purpose

Overview of Race to the Top-Funded Educator Distribution Initiatives

Over the past two decades, North Carolina has introduced several initiatives designed to address the inequitable distribution of higher-quality educators, including financial incentive programs that attempt to encourage effective teachers to relocate to more challenging schools, targeted educator training programs intended to groom top-flight teachers for low-performing schools, and the implementation of an educator evaluation system that emphasizes the development and growth of teachers. North Carolina's RttT-supported educator distribution initiatives are far-reaching efforts that not only build on that history but also move the state's efforts in this area in new directions. The initiatives are aligned with the goals noted above and are intended to move the state rapidly toward greater equity in the distribution of educator quality. They include:

- *Addition of a sixth standard—"Teacher contributes to the academic success of students, as measured by student growth"—to the newly adopted and implemented Educator Evaluation System for teachers*: As an addition to the evaluation system for teachers that was designed to promote the development of more effective teachers throughout the state, North Carolina now incorporates EVAAS scores as a part of teachers' evaluations and may soon incorporate value-added measures for additional teachers based on results from new Measures of Student Learning.
- *North Carolina Teacher Corps Initiative and Teach for America Expansion*: Both programs aim to recruit exceptional college students not enrolled in traditional teacher preparation programs to meet the specific needs of hard-to-staff and low-performing schools.
- *New Teacher Support Program*: This program provides novice teachers in the lowest-achieving schools with a summer institute prior to the school year, designed to target the knowledge and skills most needed by these beginning teachers, and matches them with mentors who will observe them in their classrooms multiple times during the academic year and provide high-quality feedback that is targeted to improve these teachers' performance. The program also provides professional development throughout the school year that is designed to meet the needs of novice teachers.
- *Strategic Staffing Initiatives*: These initiatives encourage strategic deployment of available human capital to places where it is most needed, thereby increasing students' access to effective teachers in hard-to-staff and low-performing schools. In addition to a statewide staffing initiative, LEAs are encouraged to develop context-sensitive strategies to achieve optimal or improved distribution of their own educator talent at the local level.
- *North Carolina Virtual Public School (NCVPS) STEM Blended-Course Initiative*: NCVPS is developing and offering STEM-focused courses co-taught by on-site and expert online instructors in low-achieving schools, with a goal of improving the quality of teaching in STEM areas (science, technology, engineering, and mathematics) in participating LEAs.

Other related RttT initiatives are the development of Regional Leadership Academies, which selectively identify and recruit committed principal candidates who will be prepared to lead historically low-performing schools and improve students' access to highly effective instruction, and the inclusion of an eighth standard—academic achievement leadership, as measured by school value-added scores—to the evaluation of principals. Because these academies and principal evaluations can only indirectly affect distribution of and access to teachers, they may contribute less directly to the equitable distribution of effective teachers, which is the focus of this baseline report.

Overview and Purpose of the Study of the Equitable Distribution of and Access to Effective Teachers in North Carolina

A critical component of CERE–NC's four-year evaluation of these RttT educator distribution initiatives is a careful examination of changes in the overall distribution of effective educators statewide. To that end, CERE-NC examined the distribution of effective teachers in the period preceding implementation of the state's RttT initiatives to provide baseline analyses of student access to effective teachers. Quantitative data for the study primarily consist of measures of individual student achievement—provided by the North Carolina Department of Public Instruction (NCDPI) and compiled by the Education Policy Initiative at Carolina, a unit of the Carolina Institute for Public Policy—that are linked directly to information about the teachers who worked with those students, as well as these teachers' EVAAS scores.

This baseline report provides policymakers with specific targets of opportunity for increasing both the supply and equitable distribution of highly-effective teachers, while also providing one of the critical measures for later assessment (not only in 2014 but also after the RttT grant period) of whether the RttT educator distribution efforts, taken collectively, have been successful in reducing inequities in student access to effective teachers.

Data, Sample, Measures, and Analytical Techniques

Data and Sample

The data for this report were drawn from two sources: first, a data archive assembled and managed by one of the CERE–NC partners, the Carolina Institute for Public Policy (CIPP). This data archive contains teacher-, student-, and school-level data from NCDPI, UNC General Administration, and several other sources. The second source of data comes from EVAAS estimations of teacher "value added" as calculated by the SAS Institute. The database constructed for this study matches public school students to teachers using course rosters from the entire state of North Carolina.[6] This report analyzes baseline data from years 2008-2009 and 2009-2010, the year before RttT implementation. The EVAAS model used for this study requires an individual student to have multiple prior test scores in any subject, which in most cases requires two years to accumulate, before students can be included in the models. Data therefore include teachers in 5th, 6th, 7th, and 8th grades who have been matched to their students who have test scores in reading and math in at least two prior years. Third and fourth grade elementary teachers are not included because their students do not have two prior years of test scores. High school teachers also are excluded from this baseline analysis.[7] Value-added estimates are available for about 6,200 5th grade teachers, 2,100 6th grade teachers, 1,950 7th grade teachers, and 1,950 8th grade teachers in each year studied.

The Teacher Value-Added Model

To measure teacher effectiveness, the Evaluation Team used estimates from the SAS Institute EVAAS model. The EVAAS model requires that each student has at least three prior test scores in any subject or grade for him/her to be included in the value-added scores of her or his teachers. This value-added model assumes that students' prior test scores sufficiently adjust for all other relevant inputs of teacher productivity.[8]

This report was constructed using three measures of teacher effectiveness generated by EVAAS:

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[6] Students were matched to their teachers using the roster data obtained through NCDPI from each school district. The roster data varied in quality from district to district prior to 2010-11. The Carolina Institute for Public Policy, which is the organization responsible for putting the data into a usable dataset for analysis, conducted an extensive check on the rosters. In many cases the assignments were confirmed directly with school personnel to obtain the most accurate matches possible.

[7] Baseline and end-of-grant high school results will be included in the final report.

[8] Other factors that might affect teacher productivity include the family backgrounds of students and the resources available at particular schools and LEAs. If family backgrounds and school contexts do matter for productivity and are not adequately accounted for by the prior test scores used in the value-added model used here, the model will produce upwardly-biased estimates of teacher effectiveness in affluent areas and downwardly-biased estimates of effectiveness in poorer ones. In other words, with this model, it is possible that teachers in more affluent schools and LEAs will be given more credit for their students' achievement gains than is actually due, given the advantages these students have at home or in their communities; likewise, teachers in poorer districts will be given less credit for their students' achievement gains than is actually due, given the disadvantages they have at home and in their communities. For technical treatments about teacher value-added model specifications, see Ballou, Sanders, and Wright (2004) and McCaffrey et al. (2004).

1. *Average teacher value added*: The model described above produces for each teacher an effectiveness "score." This "score" describes whether or not a teacher's impact on instruction has met, not met, or exceeded the average impact of a teacher in the state. To allow for more precise and comparable estimates between teachers (some teachers have larger classes or a greater number of tested classes than other teachers), this report presents teacher "index" estimates of value added. The index is calculated by dividing the value-added "score" by the individual teacher's standard error. According to the model, any index value above 2 is associated with improving a student's growth beyond what would normally be expected in a year, and any value below -2 is associated with less student growth than expected. Scores between -2 and 2 are considered to mean that the teacher has met expectations. All value-added scores used in this report were calculated by the SAS Institute;
2. *Top quintile*: Whether a teacher is in the top quintile (top 20%) of teacher value added (that is, among the highest value-added teachers); and
3. *Bottom quintile*: Whether a teacher is in the bottom quintile (bottom 20%) of teacher value added (among the lowest value-added teachers).

Analytical Techniques

The Team conducted two types of analysis to examine the distribution of and student access to effective teachers across regions, LEAs, schools, and student groups: (1) a descriptive geographic analysis of teacher value-added measures to assess the distribution of effective teachers across all of North Carolina's 115 LEAs and the state's major regions, and (2) regression analyses that examined the extent to which particular groups of students, types of classrooms, or types of schools have more effective or less effective teachers, as measured by teacher value added in prior years.

Geographic Analysis

The first research question for this study was:

1. *Across the state, do certain regions or LEAs have more effective teachers than others?*

For this portion of the analyses, this report displays maps of teacher value added to show the geographic distribution of effective teachers across North Carolina's 115 LEAs, eight education regions, and three geographic areas.[9] To increase the precision of LEA-average teacher value-added scores, the analysis pooled estimates across all available years, grades, and subjects (2008-2009 to 2009–2010, 5th through 8th grades, mathematics and reading).[10]

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[9] The three geographic regions used in this report are Mountain, Piedmont, and Coastal Plain. The counties comprising each of these three regions are organized according to geography resources from the North Carolina Department of the Secretary of State (see Appendix A for a list of counties by region). These three geographic regions are not coterminous with the eight Regional Education Service Area (RESA) regions.

[10] All available scores in reading and math, over the course of the two academic years 2008-2009 and 2009-2010, were averaged to produce one estimate per teacher in each district. Teacher average scores were then averaged by district.

Access Analysis

The second and third questions were:

2. *Across the state, do students with different characteristics have more or less access to effective teachers?*
3. *Across the state, do students in classrooms and schools with different characteristics have more or less access to effective teachers?*

To explore possible differences in the effectiveness of teachers assigned to different types of students, classrooms, and schools, this report presents tables from analyses in which student, classroom, and school characteristics in 2009–2010 are used to predict their teachers' effectiveness based on the teachers' effectiveness measured in the prior year (2008-2009).[11] Investigating the relationships between current-year (in this case, 2009-2010) student, classroom, and school status and teacher effectiveness from the previous year helps to estimate the extent to which a student's current assignment might be based at least in part on her or his teacher's prior performance. The goal for this "access" analyses is to examine the extent to which certain types of students, classrooms, and schools are likely to be assigned more effective or less effective teachers. These models take the following general form:

$$\text{Teacher Value Added}_{08\text{-}09} = f(\text{Student}_{09\text{-}10}, \text{Classroom}_{09\text{-}10}, \text{School Characteristics}_{09\text{-}10})$$

These models consider the relationship between a teacher's *previous* value added and her or his *current* students. The analyses do not use student characteristics and the teacher value-added measure from the *same* time period. To generate the model above, a teacher's 2008–2009 value-added score is used in the analysis of 2009–2010 teachers' assignments to students, classrooms, and schools. In other words, the analyses examine teacher effectiveness measures from one year to see if they are "predicted" by the characteristics of the students with which teachers work in the next school year, and/or by the characteristics of the classrooms and schools in which they work in the next school year. This approach shows the extent to which more (or less) effective teachers teach certain types of students or classes, or teach in different types of schools.

Additional details about the analyses can be found in the technical appendix (Appendix B).

[11] For these analyses, models were run using both the student as the unit of analysis and the classroom as the unit of analysis. When the student is the unit of analysis, 2-level HLM models (students nested within schools) were run. Because there is no within-teacher variation in students' teachers' value added (in other words, all students in the class will have the same teacher value added score), students cannot be nested within teachers, only within schools. When the classroom is the unit of analysis, 2-level HLM models (teachers nested within schools) were run.

Findings

Context

As noted above, teacher value added is a teacher effectiveness measure that quantifies average student test score gain that is attributable to the teacher while accounting for prior test scores in any subject. Because this effectiveness measure is somewhat abstract, it is useful to connect it to more concrete concepts. For example, value added is closely related to a classroom's average student test score gain over the course of the academic year. If the teacher value-added measure used in this report were exactly the same thing as student gain, then we would find a correlation of 1 (perfect correlation) between that measure and the average gain of a teacher's students in a particular year. The actual correlation is less than 1 but nevertheless quite strong, particularly for mathematics (correlations of this type range from –1 to 1.) The correlation between our measure of teacher value added and classroom average math gain is between 0.66 and 0.77, depending on grade level; the corresponding correlations for reading teachers are between 0.49 and 0.65. These statistics indicate a fairly strong relationship between the teacher value-added model and a classroom's average student test score gain.

For these analyses, the Team placed each teacher in one of five equal-sized groups based on her or his value-added score, from highest (top quintile, or top 20%) to lowest (bottom quintile, or bottom 20%). There were large differences in classroom gain scores relative to teacher value-added quintiles. On average, reading and mathematics teachers in the top quintile had classroom gains that were between .8 and 1 standard deviation higher than the gains of the middle 60% of teachers, whereas the bottom quintile reading and mathematics teachers had classroom gains that were between .8 and 1 standard deviation lower than the middle 60%. Thus, the differences between teachers in the top quintile and bottom quintile of effectiveness are fairly large, and exposure to teachers in the top and bottom can make a substantial difference in students' academic success.

Finally, prior research shows that novice teachers in North Carolina are generally less effective than more experienced teachers (Clotfelter, Ladd, & Vigdor, 2007, 2010; Henry, Bastian, & Fortner, 2011). The analyses for this report support those findings and indicate that novice teachers (defined as those with three or fewer years of experience) have value-added scores about .53 and .26 standard deviations lower than more experienced mathematics and reading teachers, respectively.

Research Question 1: Across the state, do certain regions or districts have more effective teachers than others?

Key Finding: The distribution of effective teachers is associated with but not fully determined by geographic location within the state.

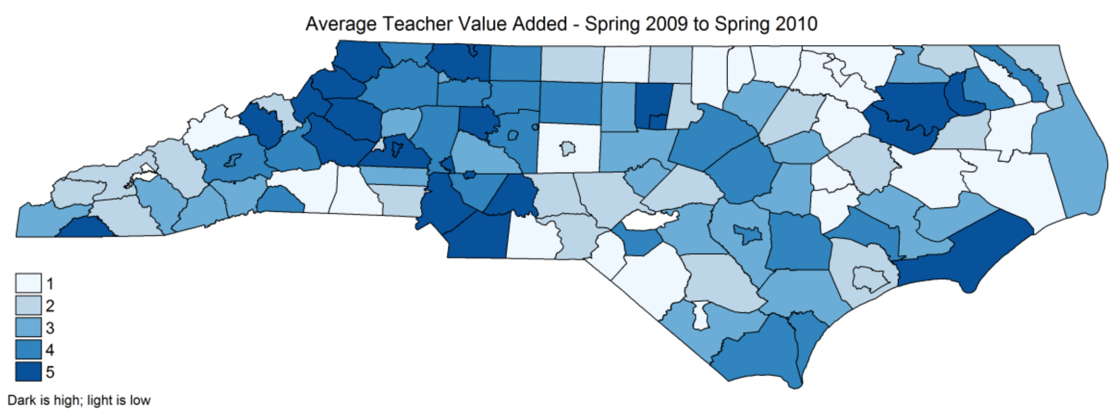
Figures 1, 2, and 3 (following pages) display LEA quintiles of average teacher value added, percentage of top-quintile teachers, and percentage of bottom-quintile teachers, respectively. The shading on the maps ranges from highest value added in dark blue to lowest value added in white (unshaded). For these analyses, teacher value-added scores are averaged across all available years of EVAAS scores (2008-09 through 2009-10), grades, and both subject areas, to get a more precise estimate of each LEA's average teacher value added. A complete table of LEAs by teacher value-added quintile can be found in Appendix C. A note of caution: while the Team used all available data from every teacher in every LEA, averages for small LEAs will be less reliable than averages for large LEAs, leading to some overrepresentation of smaller LEAs in top and bottom quintiles of teacher value added.

Some geographic patterns emerge in Figure 1, which divides the average teacher value-added statewide distribution into quintiles (with the top quintile shaded dark blue and the bottom quintile white or unshaded). The Piedmont had the greatest number of LEAs with teachers in the top two quintiles of value added (19 out of 43; 44%), but the Mountain region had the greatest percentage of high average value-added LEAs (14 out of 27; 52% in the top two quintiles). The Coastal Plain had the fewest number of LEAs in the top two quintiles (13 out of 45; 29%). Consistent with this, the Team observed that in two of the eight educational regions designated by NCDPI (Regions 6 and 7) 50% or more of their teachers were in the two top quintiles of teacher value added.

While there were some geographic patterns, it is also clear that geographic location by no means fully explains student access to effective teaching. LEAs in the top quintile of average teacher effectiveness frequently bordered LEAs in the bottom quintile. For example, Edgecombe County Schools (bottom quintile) borders Bertie County Schools (top quintile).

Charlotte-Mecklenburg is the only LEA out of the largest five LEAs that fell into the top quintile. Wake, Winston-Salem/Forsyth, and Guilford fell in the fourth quintile (second to top), and Cumberland fell in the middle quintile.

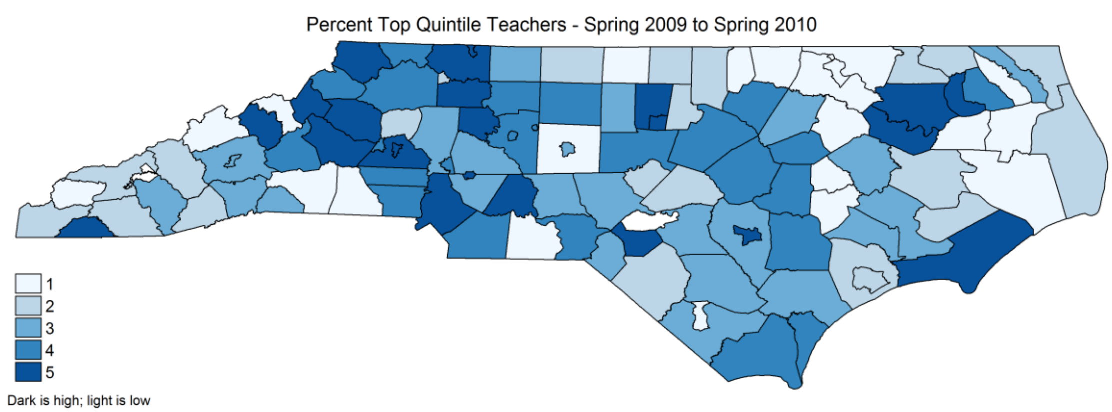
Figure 1. Average Teacher Value Added, by LEA



An LEA's average teacher value added does not, however, provide important information about the *relative proportions* of more effective and less effective teachers within a given LEA. For example, one LEA could have an equal proportion of teachers in both the top and bottom quintiles, while in another, the majority of its teachers could be in the middle quintiles, yet both of their overall teacher value-added averages could be similar. To address this issue, the Team compared each LEA's proportion of top- and bottom-quintile teachers with its average teacher value-added estimation. Our findings showed a very strong relationship between the average teacher value added in an LEA and the proportion of teachers in that LEA who were in the top quintile, though the correspondence was not one-to-one (the correlation is about 0.85). In other words, rankings of LEAs by their quintile of *average* teacher quality generally corresponded to rankings of LEAs by their quintile of *proportion of top-quintile* teachers. Generally speaking, LEAs shaded in darker shades of blue in Figure 1 are often (though not always) similarly shaded in Figure 2 (below; darker indicates higher effectiveness in all three figures). For consistency, we reversed the color coding of quintiles shown in Figure 3 (following page), so that LEAs with darker shading have *lower* percentages of bottom-quintile teachers (making the association of darker shading with desired outcomes consistent across all figures).

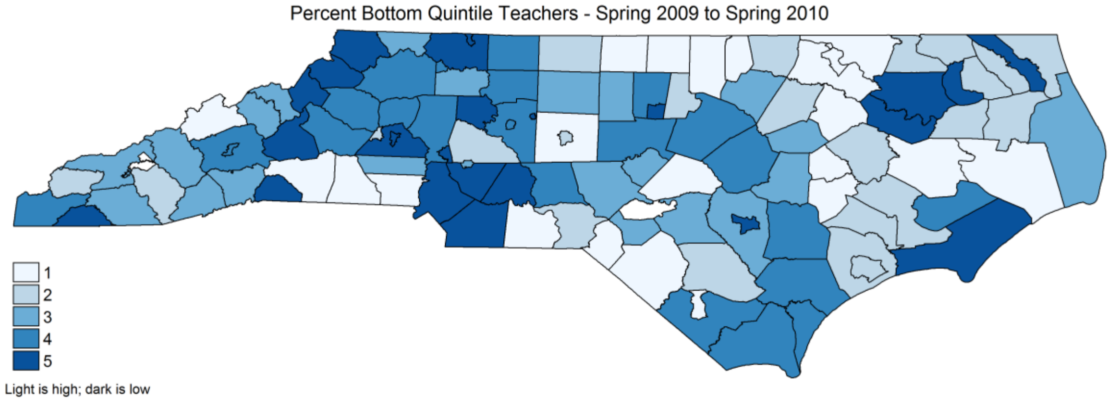
Randolph County (central Piedmont), for example, has no shading in any of the three maps, which indicates that it was in the bottom quintile of the average teacher value-added distribution, in the bottom quintile with respect to its proportion of high value-added teachers, and in the top quintile with respect to its proportion of lower value-added teachers. To highlight a less typical example, Richmond County (Piedmont, bordering South Carolina) was in the second (second from bottom) quintile of teacher value added and the fourth quintile with respect to its proportion of lower value-added teachers, but it was also in the fourth quintile with respect to its proportion of high value-added teachers. Thus, while Richmond has an overall teacher value-added average that is low enough to be in the second quintile, and a larger-than-average proportion of low value-added teachers, it also has a larger-than-average proportion of high value-added teachers.[12] This implies that there are fewer teachers in the middle quintiles of average effectiveness in Richmond County, compared to the rest of the state's LEAs.

Figure 2. Proportion of Teachers in the Top Quintile, by LEA



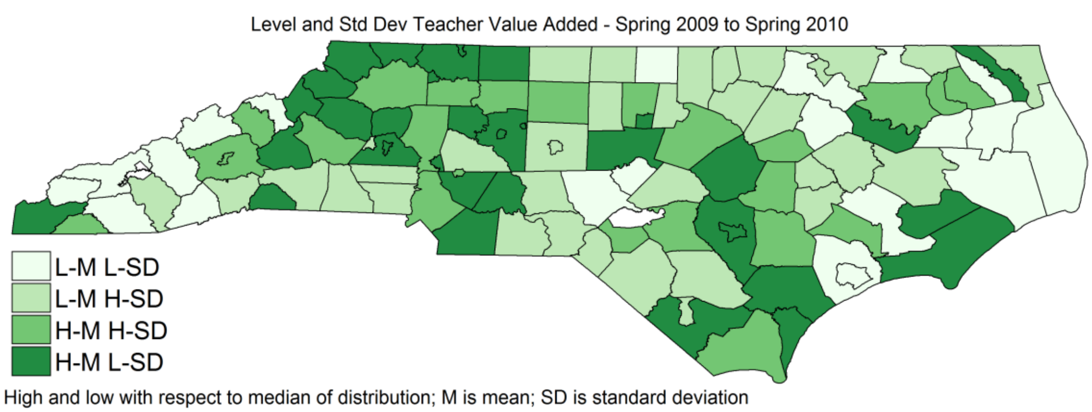
[12] If teacher value-added were perfectly distributed across the state, then each LEA would have exactly 20% of its teachers in the top quintile and 20% in the bottom quintile of the teacher value-added measure.

Figure 3. Proportion of Teachers in the Bottom Quintile, by LEA



The figures discussed so far only consider the *average* value of teacher value added and the proportion of teachers in the top and bottom quintiles. Figure 4 displays both the average and the *variability* of teacher value added within each LEA. A best-case scenario is for an LEA to have a high teacher value-added average and low variability (shaded dark green). The second-best scenario is to have a high teacher value-added average and high variability (green), and the next is to have a low teacher value-added average and high variability (light green). The least desirable scenario is to have a low average and low variability (white). The Team used a median split for both the average and the variability (standard deviation) of teacher value added. LEAs above the median for the teacher value-added average were coded as "high"; those below it were coded as "low." Similarly, LEAs above the median on the *standard deviation* of teacher value added (the measure of the variability of teacher quality within an LEA; a higher standard deviation indicates greater variability in the quality of teachers) were coded as "high"; those below it were coded as "low." This coding yields four possibilities: High teacher value added–Low variability (HL), High-High (HH), Low-High (LH), and Low-Low (LL).

Figure 4. Level and Variation in Teacher Value Added, by LEA



Consider, for example, two neighboring LEAs in central North Carolina. Chatham is shaded dark green, indicating high average teacher value added and low variability in teacher quality across the LEA. Lee, which borders Chatham to the south, is not shaded, indicating a low average and low variability. Numerous instances of each of these four scenarios across all regions reinforces the notion that the distribution of effective teachers is a result of actions (intended or unintended) that affect where high value-added teachers work, and not merely the result of geographic location within the state.

The next section presents analyses of student access to more effective teachers. Access is examined in two ways: (1) by individual student characteristics and (2) by classrooms and schools, in each case paying particular attention to minority and poverty status or classroom/school composition of minority and poor students, as well as achievement level or composition of high- or low-achieving students. As discussed above, the Team analyzed the differences across groups in terms of average teacher value added.

Research Question 2: Across the state, do students with different characteristics have more or less access to effective teachers?

Key finding: Minority, poor, and low-achieving students have less effective teachers. When assessing the effects of student, classroom, and school characteristics on access to high-quality teachers, the strongest relationship is with classroom average prior achievement. Apparently, low-achieving students are assigned to classes with other low-achieving students and less effective teachers are assigned to those classrooms, while high-achieving students are assigned to classes with other high-achieving students and more effective teachers are assigned to those classrooms.

This section examines the relationship between access to higher value-added teachers and student, classroom, and school characteristics. The findings presented here have been distilled from several alternative analyses that we believe provide the clearest picture of assignment patters and disparities in access to high value-added teachers. Table 1 (following page) presents disparities in access to teacher quality by individual student, classroom, and school characteristics for students in grade 5 through 8 in the 2009–2010 school year. The table displays the unit increase or decrease in a teacher's value-added index, given the characteristics of the student, classroom, and school listed in the left-hand column. There are two dichotomous predictors (minority and poor) and three continuous predictors (student prior achievement, class average prior achievement, and school percent poor). Minority is coded as 1 if a student is identified as black, Hispanic, American Indian, or Multiracial and 0 if Asian or white.[13] Poverty is coded as 1 if a student is eligible for free or reduced-price lunch and 0 if not. All continuous predictors are center-standardized, meaning that a one-unit increase in the variable corresponds to a one-standard-deviation increase in that variable. The outcome, teacher value-added index, is not center-standardized, and all coefficients in the table represent the real increase or decrease in the teacher value-added index associated with a one-standard-deviation increase in the characteristic, holding constant all other

[13] For a table with results broken down into more specific racial/ethnic groups, see Appendix C. Because Asian students tend to have structural and educational advantages similar to those of white students, Asian students are not considered minorities in these analyses.

variables in the model.[14] Due to technical considerations, we only include two compositional variables—average classroom prior achievement and school poverty, which we selected from our analyses that suggested that these were the classroom- and school-level variables that were most closely associated with differences in access to higher value-added teachers.[15] The estimates in Table 1 are produced from a 2-level HLM model that accounts for the clustering of students' teachers' value-added estimates within schools. Starred estimates denote a statistically significant relationship between the characteristic and teacher value-added score.

Table 1. Teacher Value-Added Index, by Student, Classroom, and School Characteristics

	Mathematics			
***Model*:**	(1)	(2)	(3)	(4)
Minority	-0.040 **	-0.035 *	-0.039 **	-0.035 *
Poor	-0.075 ***	-0.053 ***	-0.073 ***	-0.053 ***
Prior Achievement	0.099 ***	-0.011 ***	0.098 ***	-0.011 ***
Class Avg. Prior Achievement		0.425 ***		0.425 ***
School Pct. Poor			-0.211 ***	0.002
Observations	363,824	363,824	363,824	363,824
Variance Components				
Within Schools	5.213	5.146	5.213	5.146
Between Schools	3.160	3.160	3.161	3.161
Percent Between-School Variance	37.7%	38%	37.8%	38.1%

	Reading			
***Model*:**	(1)	(2)	(3)	(4)
Minority	-0.012 +	-0.008	-0.011	-0.007
Poor	-0.037 ***	-0.028 ***	-0.036 ***	-0.027 ***
Prior Achievement	0.028 ***	-0.005 ***	0.027 ***	-0.005 ***
Class Avg. Prior Achievement		0.143 ***		0.142 ***
School Pct. Poor			-0.182 ***	-0.104 ***
Observations	421,498	421,498	363,824	363,824
Variance Components				
Within Schools	1.162	1.153	1.162	1.153
Between Schools	0.806	0.806	0.806	0.806
Percent Between-School Variance	40%	41.1%	41%	41.1%

Note: * denotes sig diff at *p*<.05, ** at p<.01, *** at p<.001.

Mathematics

Model 1 examines the conditional associations between individual student characteristics and teacher value added. Results from Model 1 show that, controlling for student race/ethnicity and poverty level, student prior achievement is positively associated with mathematics teacher

[14] Tables displaying the outcome in terms of standard deviation units are available from the authors upon request.
[15] Only two compositional variables—classroom achievement and school poverty—are included because including more compositional factors at each level introduces multicollinearity due to the strong correlations among the classroom and school compositional variables. Estimates of within- and between-school compositional effects are provided in the next section.

effectiveness. With each standard deviation increase in average prior achievement, mathematics teacher value added increases by almost 0.10 index point. However, even net of prior achievement, poor and minority students have significantly less access to effective mathematics teachers. Specifically, poor students have teachers with value-added scores 0.075 points lower than students from more privileged backgrounds of similar achievement, and minority students have teachers with value-added scores 0.04 points lower than white and Asian students of similar achievement and poverty level.

Model 2 adjusts for classroom average prior achievement, which is measured as the average of the spring 2009 test scores of the students taught by teachers in the 2009-10 school year. Results show that classroom average prior achievement is a sizeable and significant predictor of access to a teacher with high valued added. With each standard deviation increase in classroom prior achievement, teacher value added increases by 0.425 index point. Once adjustments are made for classroom prior achievement, individual student characteristics matter less for predicting teachers' value added, suggesting that the access advantage a student has from having higher achievement is partly driven by higher-achieving students being grouped together and being assigned a higher value-added teacher. After controlling for classroom average prior achievement, minority and poor students have less access to higher value-added teachers. Higher achieving students appear to have less access to higher value-added teachers after controlling for the classroom average prior achievement score, which indicates that the grouping of students by achievement level is mainly responsible for the positive relationship in Model 1. Also, it appears that minority students' greater likelihood for having teachers with lower value-added scores is therefore partly due to lower value-added teachers being assigned to classrooms with greater percentages of low-achieving students, classrooms to which more minority students are likely to be assigned.

Model 3 adjusts for school percent poor to see if and how student characteristics matter in the context of more- versus less-privileged schools. School poverty is negatively related to teacher value added in this model and the coefficients on student-level minority and poverty variables are largely unchanged, suggesting that between-school differences in poverty rates do not explain student-level differentials. The sign on the student-level achievement variable switches back to positive, which supports the interpretation that classroom assignments of higher achieving students drives the student-level relationships seen between prior achievement and access to higher value-added teachers. In other words, it is grouping students by prior achievement and then assigning higher value-added teachers to classes with higher levels of prior achievement that appears to be responsible for the relationship between student- and classroom-level prior achievement and access to higher value-added teachers.

Model 4, which includes both classroom achievement and school poverty, reveals that classroom poverty remains significant, while school poverty shrinks to non-significance. This suggests that classroom achievement may be a stronger predictor of math teacher value-added than school poverty. In addition, the sign on prior achievement is reversed from Model 1, which excluded classroom and school compositional variables. Minority students appear to have less access to high value-added teachers in all models.

Reading

The magnitudes of the relationships are not as large for reading as for math and the pattern of results is somewhat different for reading. Model 1 shows that students with higher prior levels of achievement have access to teachers with higher value-added scores, and poor students have access to teachers with significantly lower value-added scores. However, net of poverty and achievement, minority students appear to have the same access to teachers as their white counterparts.

Model 2 controls for average classroom prior achievement, and as in mathematics, the average prior reading achievement of the classroom is positively related to teacher effectiveness. After controlling for average classroom prior achievement, poor and minority students still appear to have significantly less access to higher value-added teachers but the magnitude of the relationship diminishes. The sign on student prior achievement changes to negative. In Model 3, when school poverty is added to the model, we see that students in high-poverty school have less access to higher value-added teachers and that the relationships with the student-level variables remain largely similar to Model 1. As Model 4 shows, and unlike in mathematics, school poverty is independently, negatively, and significantly related to access to higher reading teacher effectiveness, even after accounting for classroom average prior achievement scores. For each standard deviation increase in the composition of poor students at the school (which is a 23-percentage-point increase), teacher value added decreases by .1 point. However, the magnitude of classroom prior achievement remains quite strong, suggesting that access to more reading teachers with higher value-added scores is also driven by schools grouping students with higher average prior achievement together.

Research Question 3: Across the state, do students in classrooms and schools with different characteristics have more or less access to higher value-added teachers?

Key findings:

1. *Higher average classroom and school poverty rates and higher average minority composition rates are associated with access to lower value-added teachers.*
2. *Higher average classroom and school achievement are associated with access to higher value-added teachers.*

The purpose of this analysis is to attempt to disentangle the sorting of higher value-added teachers into schools and classrooms separately for three compositional factors: percent minority, percent poor, and average achievement. Table 2 (following page) presents classroom- and school-level estimates of teacher value added because student-level analyses reveal that differences in students' access to higher value-added teachers are partly due to classroom and school characteristic. To do this, we present 2-level HLM models, this time nesting classrooms within schools. Since in these analyses classroom characteristics are "group mean centered" around their respective school-level means, classroom-level variables can be interpreted as "within-school" (or, between-classroom) effects. School-level variables can be interpreted as "between-school" effects rather than school context effects. Starred estimates denote a statistically significant relationship between the variable and teacher effectiveness.

Table 2. Teacher Value Added by Classroom Characteristics

	Mathematics	Reading
Unconditional Model		
	0.116**	0.065**
n	6278	6279
Variance Components		
Within Schools	5.683	1.433
Between Schools	1.010	0.238
Percent Between-School Variance	15.1%	14.2%
Poverty Composition		
Classroom	-0.692***	-0.298***
School	-0.311***	-0.220***
n	6278	6279
Variance Components		
Within Schools	5.574	1.414
Between Schools	0.990	0.203
Percent Between-School Variance	15.1%	12.5%
Minority Composition		
Classroom	-0.818***	-0.318***
School	-0.332***	-0.189***
n	6278	6279
Variance Components		
Within Schools	5.610	1.423
Between Schools	0.947	0.207
Percent Between-School Variance	14.4%	12.7%
Average Achievement		
Classroom	0.386***	0.158***
School	0.599***	0.294***
n	6278	6279
Variance Components		
Within Schools	5.580	1.420
Between Schools	0.760	0.171
Percent Between-School Variance	12%	10.7%

Note: * denotes sig diff at $p<.05$, ** at p<.01, *** at p<.001

Mathematics

High minority and poverty composition are negatively associated with mathematics teacher value added, both between and within schools. As the percent of poor students in a school increases by one standard deviation (24 percentage points), mathematics teacher value added decreases by .31 points. As the percent of minority students in a school increases by one standard deviation (29 percentage points), mathematics teacher value added decreases by .33 points. If LEAs were, on average, providing equitable access for all students to the available effective teachers within the school, the school coefficients would be very close to zero and statistically insignificant.

Because of the strong correlation between minority and poverty status, the within-school classroom-level relationships between percent minority, percent poverty, and teacher value added also are very similar. However, these relationships are more than twice as large as the between-school effects noted above. In classrooms with one-standard-deviation higher poverty rate (which is a 23-percentage-point increase), mathematics teachers' value-added index decreases by approximately .69 points. The same pattern exists for classrooms with larger concentrations of minority students. One standard deviation increase in the percent of the classroom composed of minority students (which is 29 percentage points) is associated with a decrease of average teacher value added decreases of .82 points. If schools were, on average, providing equitable access for all students to the available effective teachers within the school, the classroom coefficients would be very close to zero and statistically insignificant.

Both between and within schools, as average prior achievement increases, so does mathematics teacher effectiveness. As the prior achievement level of a classroom increases by one standard deviation, mathematics teacher value added increases by .39 points, and as the prior achievement of a school increases, mathematics teacher value added increases by .60 points.

In summary, schools that tend to have mathematics teachers with higher value added are those with higher levels of prior achievement and are composed of fewer poor and minority students. Similarly, within schools, classrooms with higher levels of prior achievement and classrooms with lower poverty and minority rates tend to have higher value-added teachers. In addition, as is indicated by the percent of variation in teacher value added that lies between schools (12-15%), the vast majority of variation in teacher value added lies within, not between, schools.

Reading

Reading results are quite similar to the mathematics results. Like mathematics, increased poverty and minority compositions have statistically significant negative associations with reading teacher effectiveness, both between and within schools. However, unlike mathematics, between- and within-school effects of percent poor are more equal in magnitude. Specifically, a one-standard-deviation increase in student poverty composition is associated with a .2 decrease in teacher value added between schools and a .3 point decrease within schools. A one-standard-deviation increase in the percent of minority students is associated with a .19 decrease in teacher value added between schools, and a .31 point decrease in teacher value added within schools.

As in mathematics, both between and within schools, as average prior achievement increases, so does reading teacher effectiveness. As the prior achievement level of a classroom increases by one standard deviation, reading teacher value added increases by .16 points, and as the prior achievement of a school increases, reading teacher value added increases by .29 points. As in mathematics, more of the variation in access to higher value-added teachers lies between classrooms within schools rather than between schools.

Conclusions

This study assessed the extent to which individual students, classrooms, schools, and LEAs have access to effective teachers. The measures of effectiveness used are calculated by the SAS Institute using the EVAAS value-added model for mathematics and reading teachers in grades 5 through 8. The Evaluation Team will use this baseline assessment to understand how North Carolina's RttT initiatives affect these inequities over time, possibly even beyond the end of the grant period.

The analyses have revealed several key findings. First, inequities in the distribution of teachers based on their value-added scores exist both between and within schools. In fact, the within-school differences in access are greater than the between-school differences in access. This suggests that both the assignment of teachers and students to classrooms and the employment of more high value-added teachers may be important leverage points for reducing inequities in the distribution of high value-added teachers.

Second, higher-achieving schools have more high value-added teachers. This may be because higher value-added teachers produce more growth gains for students. However, readers should interpret this with caution because, as noted previously, the measurement of teacher value added might overestimate the effect of the teacher in schools in which students are already advantaged and likely to be academically successful.

Finally, geographic location does not appear to completely determine a student's access to high value-added teachers in North Carolina. The Team found LEAs with concentrations of high value-added teachers in each of the state's regions; sometimes, LEAs with higher concentrations of the most effective teachers were adjacent to those with higher concentration of the least effective teachers. However, though geographic location does not fully determine student access to higher-quality teachers, the analyses reveal some important differences: In the Mountain region, a greater proportion of LEAs had more effective teachers than did LEAs in the Piedmont and Coastal Plain. The Coastal Plain had the lowest proportion of LEAs in the highest quintiles for average value added.

These analyses clearly indicate that the distribution of effective teachers is not determined by geographic location alone, which strongly suggests that it can be improved. These patterns have emerged as a result of a complex set of specific actions and decisions that lead teachers with higher value added to end up in one LEA and not another and in classes with higher-achieving students. Teachers make some of these decisions. LEA hiring officials make some of the decisions. Local school boards and LEA administrators make others. It is difficult if not impossible to discern if the prior actions affecting the distribution of teachers with higher value added were intentional, unintentional, or the result of negative side-effects from decisions considered unrelated. But no matter the reasons for the differences, having much greater access to higher value-added teachers in one LEA than in an adjacent LEA should be a concern to educators and educational policymakers alike. In addition, the distribution also indicates that actions can be taken to reduce inequities in access to teachers with high value added.

The intent of several of North Carolina's RttT initiatives is to increase the supply of effective teachers statewide while also more equitably distributing these teachers into high-need schools. The conclusions of prior research on the distribution of effective teachers (which have used measures of teacher qualifications and credentials as proxies for direct measures of teacher effectiveness) have indicated that access to higher-quality teachers has been inequitable, with less access to higher-quality teachers being provided to poor, minority, and lower-achieving students. The results of the current study, which uses EVAAS scores as the measure of effectiveness, indicate that a student's race/ethnicity and poverty alone were predictive of the effectiveness of the teachers to whom they were assigned in North Carolina for the 2009-10 school year and that school and classroom poverty also negatively predict teachers' value-added scores.

These findings raise important questions about what should be done to improve the access of low-achieving students to high-quality teachers. Should schools equalize access to higher value-added teachers by reassigning them to low-achieving students? Or should schools maintain the status quo? Until the supply of higher-quality teachers is unlimited, determining who gets the more effective teachers will be controversial. When there are no significant differences between teacher effectiveness by type of student, classroom, school, LEA, or region, we will have achieved equity. Increasing the supply of effective teachers could improve the equity of access to more effective teachers, but if current policies and practices are maintained, it is unlikely to fully address the inequities.

Discussion also should continue on the most robust approach to measuring teacher effectiveness. The teacher value-added measure used in this report—teachers' EVAAS scores—is an adjusted test score gain, a step forward from prior research that used years of experience and credentials as measures of teacher quality. But the measure only takes test score gains into account, which is one important outcome for teachers, but not the *only* important one. A teacher must also provide leadership, teach social skills, foster democratic values, build character and teamwork, motivate students, and maintain order—aspects of the profession that the North Carolina Educator Evaluation System takes into account with standards 1 through 5.

The Evaluation Team hopes that the findings in this report will help to stimulate policy discussions about how effective teachers can best be developed, retained, and equitably distributed throughout North Carolina, and also promote discussions about the best ways to measure teacher effectiveness.

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Appendix A. Definition of Geographic Regions

Figure A1. Geographic Regions Map

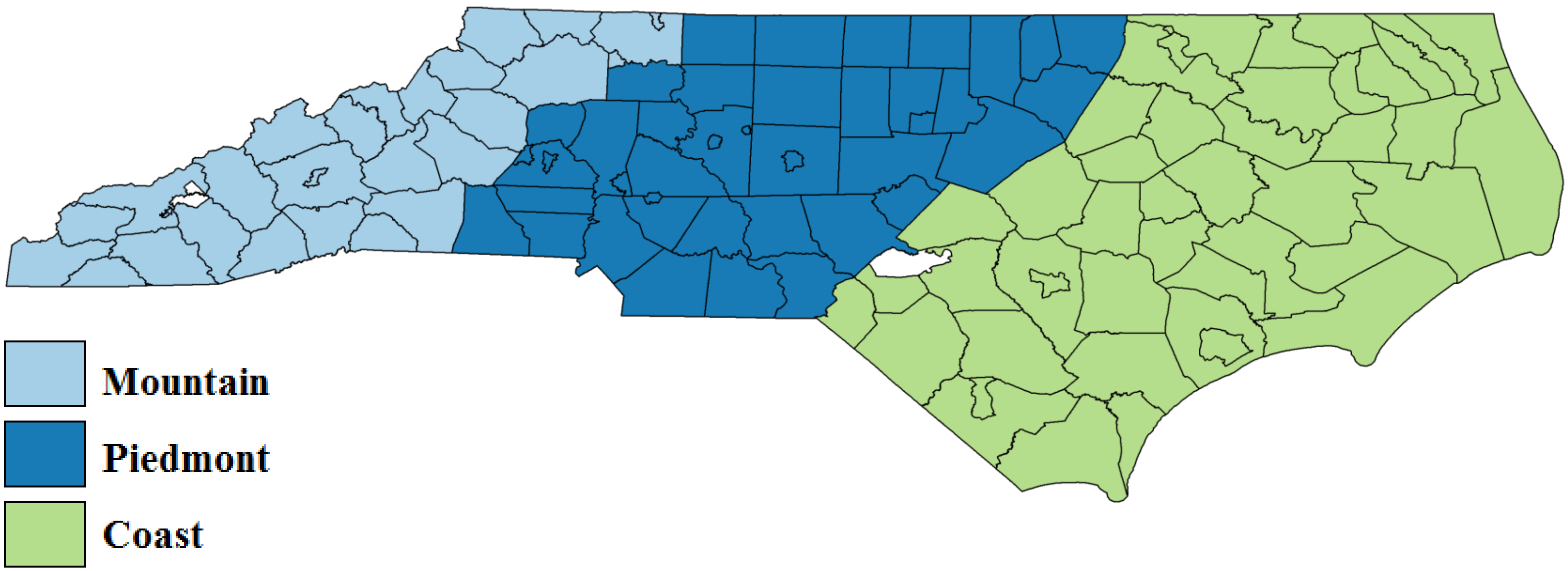

Table A1. Counties by Region

Mountain	Piedmont	Coastal Plain
Alleghany County Schools	Alamance-Burlington Schools	Beaufort County Schools
Ashe County Schools	Alexander County Schools	Bertie County Schools
Asheville City Schools	Anson County Schools	Bladen County Schools
Avery County Schools	Asheboro City Schools	Brunswick County Schools
Buncombe County Schools	Cabarrus County Schools	Camden County Schools
Burke County Schools	Caswell County Schools	Carteret County Public Schools
Caldwell County Schools	Catawba County Schools	Clinton City Schools
Cherokee County Schools	Chapel Hill-Carrboro Schools	Columbus County Schools
Clay County Schools	Charlotte-Mecklenburg Schools	Craven County Schools
Elkin City Schools	Chatham County Schools	Cumberland County Schools
Graham County Schools	Cleveland County Schools	Currituck County Schools
Haywood County Schools	Davidson County Schools	Dare County Schools
Henderson County Schools	Davie County Schools	Duplin County Schools
Jackson County Schools	Durham Public Schools	Edenton-Chowan Schools
Macon County Schools	Forsyth County Schools	Edgecombe County Schools
Madison County Schools	Franklin County Schools	Gates County Schools
McDowell County Schools	Gaston County Schools	Greene County Schools
Mitchell County Schools	Granville County Schools	Halifax County Schools
Mount Airy City Schools	Guilford County Schools	Harnett County Schools
Polk County Schools	Hickory City Schools	Hertford County Schools
Rutherford County Schools	Iredell-Statesville Schools	Hoke County Schools
Surry County Schools	Kannapolis City Schools	Hyde County Schools
Swain County Schools	Lee County Schools	Johnston County Schools
Transylvania County Schools	Lexington City Schools	Jones County Schools
Watauga County Schools	Lincoln County Schools	Lenoir County Public Schools
Wilkes County Schools	Montgomery County Schools	Martin County Schools
Yancey County Schools	Moore County Schools	Nash-Rocky Mount Schools
	Mooresville City Schools	New Hanover County Schools
	Newton-Conover City Schools	Northampton County Schools
	Orange County Schools	Onslow County Schools
	Person County Schools	Pamlico County Schools
	Randolph County Schools	Pasquotank County Schools
	Richmond County Schools	Pender County Schools
	Rockingham County Schools	Perquimans County Schools
	Rowan-Salisbury Schools	Pitt County Schools
	Stanly County Schools	Roanoke Rapids City Schools
	Stokes County Schools	Robeson County Schools
	Thomasville City Schools	Sampson County Schools
	Union County Public Schools	Scotland County Schools
	Vance County Schools	Tyrrell County Schools
	Wake County Schools	Washington County Schools
	Warren County Schools	Wayne County Public Schools
	Yadkin County Schools	Weldon City Schools
		Whiteville City Schools
		Wilson County Schools

Appendix B. Technical Appendix

Data & Measures

Data Sources

The data for the baseline report on the Distribution of Teacher Value-Added in North Carolina came from two sources: 1) a data archive assembled and managed by the Carolina Institute for Public Policy (CIPP); and 2) the SAS Institute's EVAAS scores. CIPP has archived longitudinal student-, classroom-, and school-level data from the North Carolina Department of Public Instruction (NCDPI), UNC General Administration, and several other sources for third grade through high school. From this data archive we assembled student, classroom, and school demographic data from the 2009-10 school year for 5th, 6th, 7th, and 8th grade students. Third and fourth grade students were excluded from analyses because the value-added model used to calculate EVAAS scores required at least three prior test scores. High school students also were excluded from these baseline analyses.

The second source of data, provided by the SAS Institute, contained EVAAS teacher value-added scores for teachers in North Carolina. For our geographic analysis, we used EVAAS scores for all teachers who taught in 2008-09 and 2009-10 (approximately 21,000 teachers). For our access analysis, we used EVAAS data for all teachers in 2008-09 who could be matched to students in 2009-10 (approximately 12,000 teachers: 6,200 5th grade, 2,100 6th grade, 1,950 7th grade, and 1,950 8th grade).

Data Merging

The data used in this study included student achievement and demographic information linked to class rosters. Students were matched to their teachers using the roster data obtained through NCDPI from each Local Education Agency (LEA). The roster data varied in quality from LEA to LEA prior to 2010-11. CIPP, which is the organization responsible for putting the data into a usable dataset for analysis, conducted extensive checks on the rosters. In many cases the assignments were confirmed directly with school personnel to obtain the most accurate matches possible. We matched student, classroom, and school characteristics to teacher EVAAS scores provided by SAS. Approximately 74% of students in 2009-10 were matched with their teachers in 2008-09 (75.8% for mathematics, 72.6% for reading).

Outcome Measures

The outcome variable we used in this report is teacher value-added, as measured by the SAS Institute's EVAAS model. The value-added model used for this study takes into account at least three prior test scores in any subject or grade for each student and produces a score for each teacher, which indicates whether or not a teacher's impact on instruction has met, has not met, or has exceeded the average impact of a teacher in the state. To increase comparability among estimates—some teachers have smaller classes or a smaller number of tested classes than others—we utilized teacher index estimates of value-added, which divides the value-added score by the score's (individual teacher's) standard error. According to the model, any index value above 2 was associated with improving a student's growth beyond what would normally be expected in a year, and any value below -2 was associated with negative student growth.

Predictors

Dichotomous variables were used in the models to indicate minority (black, Hispanic, and American Indian students) and poverty (whether or not a student is eligible for free or reduced price lunch) status. We used the student's prior test performance on EOG exams in both reading and mathematics in the preceding year. All prior test scores were center standardized with a mean of 0 and a standard deviation of 1. These individual-level variables were aggregated to the classroom and school levels to create measures of minority and poverty rates and average achievement.

Analyses

Geographic Analysis

In the geographic analysis, we generated an average teacher value-added (TVA) for each LEA in the state. To do this, we used all available reading and mathematics teacher EVAAS index scores from the 2008-09 and 2009-10 school years to produce one average score per teacher in the LEA. Pooling across all available years and subjects not only increased precision of a single teacher's TVA, but it also ensured that teachers were not weighed more or less heavily by virtue of teaching more or fewer subjects over more or fewer evaluation years. Once we produced for each teacher in each LEA one average TVA score, we then averaged all teachers' TVA scores by LEA. Once we produced for each LEA one average TVA score, we divided the 115 LEAs into five equal quintiles on the basis of the LEA's average TVA score, with Quintile 5 representing the LEAs with the highest average TVA scores and Quintile 1 representing the LEAs with the lowest average TVA scores.

In addition to producing five quintiles of average TVA by LEA, we also placed LEAs in five quintiles of percent of teachers in each LEA that we identified in the top quintile of teacher value-added across the state and in five quintiles of percent of teachers in each LEA that we identified in the bottom quintile of teacher value-added across the state. This permitted assessments about not only average TVA, but also concentrations of teachers in the upper and lower parts of the TVA distribution. Finally, we computed the standard deviation of an LEA's TVA scores to permit evaluation of the variability of TVA scores within LEAs.

Access Analysis

The purpose of this analysis was to examine the extent to which certain types of students, classrooms, and schools were likely to be assigned more effective or less effective teachers. These models consider the relationship between a teacher's *previous* value-added and her or his *current* students. The analyses do not use student characteristics and the teacher value-added measure from the *same* time period. Instead, we used a teacher's 2008–09 value-added score as the outcome in an analysis of 2009–10 teachers' assignments to students, classrooms, and schools.

In our first model, we separately estimated for mathematics and reading TVA scores the relationship between those TVA scores and student characteristics and classroom and school composition variables, using a two-level hierarchical linear model (HLM). In these models, students were the units of analysis and the outcome was teacher value-added, so there was no within-teacher variation in students' teachers' value-added. Thus we could not nest students within teachers and produce estimates based on both within- and between-teacher variation in the outcome. Our first model therefore accounted for the clustering of students within schools by estimating a two-level HLM, with students nested within schools:

$$(1)\ TVA_{ijk,08-09} = \alpha + \beta_1 \boldsymbol{X}_{ijk,09-10} + \beta_2 \boldsymbol{C}_{jk,09-10} + \beta_3 \boldsymbol{S}_{k,09-10} + \zeta_k^{(3)} + \varepsilon_{ijk}$$

Where

> *TVA* was the teacher value-added EVAAS score from 2008-09 for the teacher assigned to student *i* in classroom *j* in school *k* in the 2009-10 school year
>
> ***X*** were the individual student characteristics (i.e., race/ethnicity, poverty level, prior achievement) of student *i* in the 2009-10 school year
>
> ***C*** were the classroom characteristics (average achievement, minority and poverty rates) of student *i* in the 2009-10 school year
>
> ***S*** were the school characteristics (average achievement, minority and poverty rates) of student *i* in the 2009-10 school year
>
> $\zeta_k^{(3)}$ was a school random intercept, representing residual variation at the school level, and
>
> ε_{ijk} was a student-level error term

Within this model, continuous predictor variables were center standardized around a mean of 0 and a standard deviation of 1 such that one unit increase in a predictor variable was associated with one standard deviation increase. Teacher value-added scores were not center standardized so that coefficients in the model represent unit increases in the EVAAS index score.

To better disentangle between- and within-school sorting, we also estimated a 2-Level HLM model where classrooms are nested within schools. Suppressing year subscripts for clarity:

$$(2)\ TVA_{jk} = \alpha + \beta_1 (C_{jk} - \bar{C}_{.k}) + \beta_2 S_k + \zeta_k^{(3)} + \varepsilon_{ijk}$$

Where

> *TVA* was the teacher value-added EVAAS score from 2008-09 for the teacher assigned to classroom *j* in school *k* in the 2009-10 school year
>
> *C* was a classroom characteristic (e.g., classroom average achievement) centered on the classroom mean of school *k*

S was a school characteristic (e.g., school average achievement)

$\zeta_k^{(3)}$ was a school random intercept, representing residual variation at the school level, and

ε_{ijk} was a student-level error term

The coefficient on *C*, β_1, was interpreted as the "within-school" effect and the coefficient on *S*, β_2, was the "between-school" effect. This specification permitted a clean decomposition of within- and between-school differences in TVA across classrooms that varied in achievement, minority composition, and poverty composition.

Appendix C. Complete Model Results

Table B1. LEAs by Average Teacher Value Added (TVA) Quintile

Top Quintile (Quintile 5)	Quintile 4	Quintile 3	Quintile 2	Bottom Quintile (Quintile 1)
Ashe County Schools	Alleghany County Schools	Alamance-Burlington Schools	Asheboro City Schools	Anson County Schools
Avery County Schools	Brunswick County Schools	Alexander County Schools	Bladen County Schools	Beaufort County Schools
Bertie County Schools	Buncombe County Schools	Asheville City Schools	Currituck County Schools	Caswell County Schools
Burke County Schools	Cabarrus County Schools	Chatham County Schools	Durham Public Schools	Cleveland County Schools
Caldwell County Schools	Camden County Schools	Cherokee County Schools	Gaston County Schools	Edgecombe County Schools
Carteret County Public Schools	Clinton City Schools	Columbus County Schools	Gates County Schools	Granville County Schools
Catawba County Schools	Davidson County Schools	Craven County Schools	Graham County Schools	Greene County Schools
Chapel Hill-Carrboro Schools	Duplin County Schools	Cumberland County Schools	Harnett County Schools	Halifax County Schools
Charlotte-Mecklenburg Schools	Forsyth County Schools	Dare County Schools	Haywood County Schools	Hyde County Schools
Clay County Schools	Guilford County Schools	Elkin City Schools	Hickory City Schools	Lenoir County Public Schools
Davie County Schools	Hoke County Schools	Franklin County Schools	Lexington City Schools	Madison County Schools
Edenton-Chowan Schools	Iredell-Statesville Schools	Henderson County Schools	Macon County Schools	Northampton County Schools
Kannapolis City Schools	Johnston County Schools	Hertford County Schools	Mitchell County Schools	Pasquotank County Schools
Martin County Schools	Jones County Schools	Jackson County Schools	Montgomery County Schools	Randolph County Schools
Mooresville City Schools	McDowell County Schools	Lee County Schools	Moore County Schools	Roanoke Rapids City Schools
Mount Airy City Schools	New Hanover County Schools	Lincoln County Schools	Nash-Rocky Mount Schools	Robeson County Schools
Newton-Conover City Schools	Perquimans County Schools	Pamlico County Schools	Onslow County Schools	Rutherford County Schools
Orange County Schools	Polk County Schools	Pender County Schools	Person County Schools	Scotland County Schools
Stanly County Schools	Stokes County Schools	Rowan-Salisbury Schools	Pitt County Schools	Tyrrell County Schools
Surry County Schools	Thomasville City Schools	Sampson County Schools	Richmond County Schools	Vance County Schools
Union County Public Schools	Wake County Schools	Transylvania County Schools	Rockingham County Schools	Warren County Schools
Watauga County Schools	Wilkes County Schools	Wayne County Public Schools	Swain County Schools	Weldon City Schools
Yancey County Schools	Yadkin County Schools	Wilson County Schools	Washington County Schools	Whiteville City Schools

Table B2. Summary TVA Statistics, by Quintile

Quintile	Avg TVA	Avg SD for AvgTVA	Avg Proportion Top Quintile Teachers	Avg Proportion Bottom Quintile Teachers
5 (Top)	0.568	2.028	0.290	0.104
4	0.081	2.043	0.208	0.162
3	-0.156	1.985	0.170	0.196
2	-0.471	2.052	0.142	0.253
1 (Bottom)	-1.073	2.154	0.084	0.358

Table B3. Mathematics Teacher Value Added, by Student, Classroom, and School Characteristics

Model:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Black	-0.139 ***			-0.094 ***	-0.039 *	-0.034 +	-0.034 +
Hispanic	-0.143 ***			-0.085 ***	-0.060 **	-0.056 **	-0.056 **
American Indian	-0.132 **			-0.103 *	-0.071	-0.067 +	-0.067
Multiracial	-0.042 +			-0.014	0.005	0.011	0.011
Poor		-0.146 ***		-0.116 ***	-0.072 ***	-0.051 ***	-0.051 ***
Prior Achievement			0.113 ***		0.099 ***	-0.011 ***	-0.011 ***
Class Avg. Prior Achievement						0.425 ***	0.425 ***
School Percent Poor							0.003
Observations	365,567	364,030	365,325	364,030	363,824	363,824	363,824

Variance Components

Within Schools	5.217	5.217	5.208	5.216	5.212	5.144	5.144
Between Schools	3.495	3.471	3.265	3.415	3.160	3.160	3.160
Percent Between-School Variance	40.1%	39.9%	38.5%	39.6%	37.7%	38%	38%

Note: * denotes sig diff at *p*<.05, ** at p<.01, *** at p<.001.

Table B4. Reading Teacher Value Added, by Student, Classroom, and School Characteristics

Model:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Black	-0.055 ***			-0.036 ***	-0.022 **	-0.017 *	-0.017 *
Hispanic	-0.036 ***			-0.012	-0.002	-0.000	-0.000
American Indian	-0.006			0.003	0.012	0.019	0.020
Multiracial	-0.009			0.004	0.007	0.011	0.011
Poor		-0.057 ***		-0.049 ***	-0.037 ***	-0.028 ***	-0.027 ***
Prior Achievement			0.035 ***		0.027 ***	-0.006 ***	-0.006 **
Class Avg. Prior Achievement						0.143 ***	0.142 ***
School Percent Poor							-0.103 **
Observations	424,200	422,300	423,385	422,300	421,598	421,598	421,598

Variance Components							
Within Schools	1.162	1.162	1.162	1.162	1.162	1.153	1.153
Between Schools	0.828	0.832	0.806	0.812	0.790	0.789	0.790
Percent Between-School Variance	41.6%	41.7%	41%	41.2%	40.5%	40.6%	40.6%

Note: * denotes sig diff at *p*<.05, ** at p<.01, *** at p<.001.

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