Different Teachers, Different Peers: The Magnitude and Effects of Student Sorting Within Schools

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Abstract

In this study we use administrative data from three large urban school districts to examine sorting across classrooms within schools. Our data allow us to link students to each of their teachers and to identify students' classmates. We find differences in the average achievement levels, the racial composition, and the socioeconomic composition of classrooms within schools. This sorting occurs even in self-contained elementary school classrooms and is much larger than would be expected if students were assigned to classrooms randomly. Classrooms with the largest composition of low-achieving, minority and poor students are also more likely to have novice teachers. The process of sorting students by their achievement level has the consequence of exposing minority and poor students not only to less rigorous curriculum but also lower quality teachers and classmates. We find that within school sorting explains some of the within school gaps in student achievement gains, especially at the middle and high school levels.

Introduction

Decades of research in sociology and education have described the contours of tracking systems in American high schools. The majority of this literature has focused on the processes by which students are assigned to high school tracks and the effects of tracking on student achievement, educational aspirations, and educational attainment (Alexander & McDill, 1976; Gamoran, 1987, 1992a; Gamoran & Berends, 1987; Garet & Delany, 1988; Oakes & Guiton, 1995; Rosenbaum, 1980). Findings from this research generally suggest that track placements are the result of a complex confluence of factors including achieved characteristics (e.g., prior test scores or grades), ascribed characteristics (e.g., student race or socioeconomic status), and organizational constraints (e.g., scheduling conflicts, staff expertise, or enrollment caps in certain courses). Research on the effects of tracking tends to find that students enrolled in a more rigorous academic curriculum have higher achievement gains, higher educational aspirations, and higher educational attainment relative to those enrolled in a general or vocational course of study (Alexander & McDill, 1976; Gamoran, 1992b; Gamoran & Berends, 1987). The cause of this relationship is not clear; students entering higher tracks are likely to have had greater educational outcomes without tracking (Figlio and Page, 2002).

Studies of tracking have demonstrated that minority and poor high school students are less likely to be assigned to the more rigorous academic track than their white or higher income counterparts and that these differences in access to advanced courses may contribute to achievement gaps (Gamoran, 1992a; Gamoran & Mare, 1989), though studies in this literature generally do not have a strong causal warrant. Less clear from prior research, however, is the extent to which tracking contributes to access to different types of peers and teachers for students in high and low tracks. A few studies have documented the contribution of ability grouping to

racial segregation within schools (Samuel R. Lucas & Berends, 2002; Mickelson, 2001; Oakes, 1985; Oakes & Guiton, 1995), but much of this research focuses on the disproportionate placement of black students in low-track classes within a small set of high schools. Moreover, few studies have examined sorting across classrooms in the absence of a differentiated curriculum.

Sorting within schools need not be based on the formal assignment of students to different curricula or tracks but can also result from informal processes whereby students are assigned to different classrooms within a system that is not formally differentiated (such as in elementary schools). In particular, the preferences of middle class or well-educated parents with influence in the school to have their children in classes with high-quality teachers or high-achieving peers (Lareau, 1987), the preferences of senior teachers to teach higher achieving students (Finley, 1984) or the desire of school administrators to reward their more effective or experienced teachers with higher achieving students (Cohen-Vogel & Osborne-Lampkin, 2007; Finley, 1984; Kalogrides, Loeb, & Béteille, Forthcoming) are a few of the processes that could create variation in average achievement levels across classrooms in the absence of a differentiated curriculum. As the result of these sorting processes some students may end up in classes with lower-achieving peers, more minority and poor peers, and less experienced teachers. The teacher and peer effects that result from this type of sorting across classrooms might limit the learning gains of initially low-achieving students and exacerbate existing achievement gaps between minority and white students and between poor and non-poor students.

In this study we examine patterns of sorting across classrooms within schools in three large urban school districts. We assess the extent to which students of varying achievement levels are sorted across classrooms within schools and the extent to which this sorting varies

across grade levels. We find considerable sorting within schools by prior achievement, even in self-contained elementary school classrooms. The sorting by prior achievement we document is higher than would be expected if students were assigned to classes randomly. We also examine sorting across classrooms by student race and poverty status and the extent to which this sorting can be explained by differences in prior achievement. We find evidence of considerable sorting by student race and poverty status across classrooms at all grade levels, some, but not all, of which is accounted for by differences in prior achievement.

Classes made up of lower achieving students also tend to have more poor and minority students, more students with attendance and behavioral problems, and less experienced teachers. The effects of sorting across classrooms within schools are likely a combined effect of teachers, peers and, at the middle and high school level, the rigor of the curriculum. After describing sorting across classrooms, we estimate the relationship between teacher and peer characteristics and student learning. We use these estimates to approximate the extent to which sorting within schools contributes to minority-white and poor-non-poor gaps in achievement gains. Assignment to classes with lower achieving peers, less advantaged peers, and less experienced teachers explains a small portion of the black-white, Hispanic-white, and poor-non-poor achievement gap within elementary schools and a somewhat larger portion of these gaps at the middle and high school levels.

Prior Research

Research on Student Sorting

Research on within school sorting primarily comes from two literatures: the tracking literature and the segregation literature. The tracking literature documents how high school

students are sorted across classrooms by their prior achievement. Given the relationship between prior achievement and student demographic characteristics such as race and socioeconomic status, tracking also tends to contribute to within school segregation by race and socioeconomic status (Gamoran, 1992a; Samuel R. Lucas & Berends, 2002; Mickelson, 2001; Oakes, 1985; Oakes & Guiton, 1995). Though this literature is useful for highlighting some of the costs of ability grouping for issues of equity in access to rigorous curriculum and for inter-group contact, it reflects an examination of track placements within relatively small samples of high schools. One exception is Mickelson's (2001) study which examined the relationship between tracking and segregation within schools among all eleven of the high schools in the Charlotte-Mecklenburg School District. She found that the top academic courses are typically predominately white while the least rigorous courses are disproportionately black. She found that black students' higher likelihood of being in lower-track courses existed even when they had achievement levels that were comparable to whites. We are able to build on this line of research by examining the course placements of students in approximately 150 high schools in three large school districts.

The segregation literature provides further evidence of how students are sorted across classrooms. Most previous research on school segregation has used school-level data to examine segregation among schools or districts and has generally focused on racial segregation. Much less research has focused on student sorting within schools and disparities in the racial, economic or achievement makeup of classrooms within schools. It is challenging to study segregation within schools because the data requirements are extensive—information is needed not only on students' school attendance but also their classroom assignments within schools. A few key studies have examined within school racial segregation (Clotfelter, Ladd, & Vigdor, 2002;

Conger, 2005; Morgan & McPartland, 1981). Morgan and McPartland (1981) study classroom segregation using data collected in 1976 by the office of Civil Rights. Their data include information about classroom enrollments for 18 randomly sampled classrooms in each of more than 40,000 schools. The Morgan and McPartland paper remains the only national study of classroom segregation to date. More recently, Clotfelter, Ladd, and Vigdor (2002) and Conger (2005) conducted similar analyses in North Carolina and New York. The results of these three studies are similar: classroom segregation is higher in high schools and middle schools than in elementary schools; segregation among schools is larger than segregation within schools; and black students tend to be more segregated from white students than are Hispanics from whites. Conger (2005) also found that the segregation of immigrants within New York City schools is equal to the segregation of immigrants across schools.

Whether or not the sorting described by these studies has implications for achievement gaps is unclear. Some research on the effects of tracking finds that students enrolled in a more rigorous academic curriculum have higher achievement gains, higher educational aspirations, and higher educational attainment relative to those enrolled in a general or vocational course of study (Alexander & McDill, 1976; Gamoran, 1992b; Gamoran & Berends, 1987; Hoffer, 1992). Critics of tracking programs argue that when disadvantaged students are tracked they lose out on the opportunity to benefit from positive peer effects that might gained from regular exposure to higher achieving classmates. Epple, Newlon, and Romano (2002) also find that tracking systems redistribute resources from lower-to higher-ability students possibly exacerbating inequality. The relationship between tracking and achievement is not necessarily causal, however, since students entering higher tracks are likely to have had greater educational outcomes without tracking. In fact, studies that have attempted to adjust for the endogeneity of track placement find no

evidence that tracking hurts lower ability students (Figlio & Page, 2002). This lack of an effect could be because peer effects are actually smaller than often assumed (Burke & Sass, 2009) or because teachers are better able to tailor the curriculum to students' ability levels in tracked classrooms.

We build on prior research in a number of ways. First, the tracking literature focuses on within-school sorting only at the high school level. We also examine within school sorting at the elementary school and middle school level. Second, while a few studies in the segregation literature have compared levels of racial segregation within schools at different grade levels, they have not explored segregation by other characteristics such as poverty or test performance or behavior (Clotfelter, et al., 2002; Conger, 2005; Morgan & McPartland, 1981). In addition to examining racial sorting within schools, we examine sorting by socioeconomic background, prior achievement, and prior behavior, and we compare levels of sorting across grades. Third, while some studies in the tracking literature find that minority students are less likely to be enrolled in high track courses even after controlling for prior achievement levels, the segregation literature has not examined the extent to which segregation by race reflects segregation by achievement. In our analysis, we examine the average prior achievement of students' current classmates. Since we have rich longitudinal data on students with multiple years of test scores in both math and reading, we are able to provide more robust controls for prior achievement by instrumenting for prior achievement to account for measurement error in test scores. This analysis allows us to see whether minority and poor students have lower achieving classmates than white students at their school who have similar levels of prior achievement. Fourth and finally, we provide estimates of the extent to which existing sorting contributes to achievement gaps.

Mechanisms Contributing to Within-School Sorting

The sorting of students by prior achievement, race, or socioeconomic status to different classrooms within schools may result from a variety of formal and informal processes. The processes that contribute to sorting across classrooms at the middle and high school levels, where tracking is more common, may differ in from the processes that contribute to sorting in elementary schools which generally lack a differentiated curriculum.

Sorting within tracking systems. In a tracked system students are, at least in part, assigned to classrooms based on prior achievement. Prior to the 1970s, secondary students were often assigned to mutually exclusive and overarching programs such as vocational, general or academic tracks (Hallinan, 1994; Samuel R. Lucas & Berends, 2002). In more recent decades, tracking systems have become less deterministic and the same student may enroll in courses of different levels in different subjects (Samuel Roundfield Lucas, 1999). Given that tracking decisions are largely (though not entirely) related to students' prior achievement levels (Gamoran, 1992a; Oakes & Guiton, 1995), tracking systems create considerable variation in average achievement levels across classrooms within schools.

Theories regarding the placement of students in high school courses include both functional and critical explanations. Human capital theory, for example, suggests that a tracked high school curriculum prepares students for a differentiated workforce and prepares students for the job sector or postsecondary education best suited for their skill. A more critical, social reproduction theory of tracking decisions is that students are matched to courses in ways that maintain racial and socioeconomic stratification. Rather than being based solely on merit, tracking decisions are argued to be designed to reproduce the existing social order by limiting

minority and poor students' access to rigorous curriculum and, consequently, access to college and higher status careers (Bowles & Gintis, 1976; Oakes, 1985).

The way that students are assigned to courses is likely to be more complicated than these perspectives maintain. Some have argued that track placements more likely result from organizational constraints and trade-offs rather than a rational process based on merit or intentions aimed at class- or race-based social reproduction. Scheduling constraints, lack of staff expertise or limited seats in certain courses can all interfere with schools' efforts to match students to courses that best suit their skills or interests (Garet & Delany, 1988; Kilgore, 1991; Oakes & Guiton, 1995). Some evidence suggests that parent demands for courses, teacher recommendations, or peer influences on students' decisions put pressure on schools to admit students to courses they may not normally be placed in based on the schools' formal assignment criteria (Kilgore, 1991; Oakes & Guiton, 1995; Useem, 1991). The bulk of the research tends to suggest that achievement is the main factor influencing track placements, though race and socioeconomic status also seem to play some role suggesting that track assignments are not based purely on meritocratic processes (Alexander & McDill, 1976; Gamoran, 1992a; Gamoran & Berends, 1987).

Sorting mechanisms independent from a tracked system. The formal assignment of students to different courses that are vertically differentiated (i.e., via a tracking system) is only one of several processes that could induce variation across classrooms in average achievement levels and student demographics. In particular, when making class assignment decisions, school administrators may be influenced by pressures from parents and teachers. Such pressures could create variation in student characteristics across classrooms even in elementary schools where there is no formal differentiation of the curriculum.

Prior research suggests that middle and upper class parents often intervene in the class assignment process to ensure that their child is taught by a teacher whom they believe to be the most desirable (Lareau 1987; 2000). Though some principals are resistant to such efforts on the part of parents, there is some evidence that parents are often successful in influencing to which teachers their students are assigned (Clotfelter, Ladd, & Vigdor, 2005; Monk, 1987; Useem, 1991). Advantaged parents are more likely to be involved in their child's education and spend time at their school (Lareau, 1987; Useem, 1991, 1992). They are therefore likely to have better information about the best teachers in the school compared to parents with lower incomes or education levels. Lareau (1987), for example, found that middle class mothers in her study of elementary school students knew the names and academic reputations of most of the teachers in the school. They also knew the academic ability of other students in their child's class (e.g., who was the best in math or reading). In contrast, working class parents have limited information about most aspects of their child's experience at school (Lareau, 1987, 2000, 2002). Middle class parents may be able to use this information about teacher and peer ability to request the most desirable classes for their children. School administrators may feel pressure to meet the demands of the parents of higher achieving or middle class students for fear of losing these students to other schools or districts (Clotfelter, et al., 2005). Such a pattern may result in the concentration of higher achieving and higher-income students in classrooms with the higher quality teachers compared to other students at their school.

School administrators' decisions about course assignments may be further constrained by teacher preferences for certain classrooms. This constraint is especially relevant when teachers have alternative employment options in other schools, which may be the case for particularly effective or experienced teachers. In most cases, organizations prefer to retain their most

effective employees and will often offer benefits such as higher compensation and/or promotions in an effort to do so (Abelson & Baysinger, 1984). Rewarding effective employees may be challenging in the educational context, however, given rigidities of salary schedules and limited vertical differentiation of jobs within schools (Becker, 1952). In lieu of salary increases or promotions (over which principals may have little control), principals may give their best teachers the most desirable class assignments as a retention strategy. Principals may also feel pressure from senior teachers to assign them the students and courses they desire (Carey & Farris, 1994; Finley, 1984). These types of class assignment processes could contribute to the differential assignment of lower achieving students to lower quality teachers and peers.

A final mechanism that could contribute to within school sorting is the use of separate additional courses to remediate low-achieving students. For example, Taylor (2012) uses a regression discontinuity approach and finds that students who narrowly miss the proficiency threshold on the state math assessment are more likely to be assigned to a second math course the next year. These secondary math courses are strictly tracked based on students' achievement in the prior year because their intention is to remediate struggling students.

This study. This study examines the class assignments of students in three large urban school districts. First, we compare differences in the characteristics of students' peers and teachers by race, socioeconomic status, and prior achievement levels. We compare the extent of sorting that occurs among schools and that occurs within schools and how this varies across grades. We compare the amount of within school sorting we observe to the amount of sorting that would occur if students were assigned to classes at random (via simulation). Second, we examine whether minority and poor students have less experienced teachers, more minority and poor classmates and lower achieving classmates because they themselves are lower achieving.

To do so we add measures of prior achievement and grade point average to models predicting the characteristics of students' teachers and classmates. Third, we provide estimates of the extent to which sorting within schools contributes to minority-white and poor-non-poor achievement gaps.

Data

To examine student sorting among and within schools we use data from administrative files on all staff, students and schools in the Miami-Dade County Public School district, Milwaukee Public Schools (MPS), and the San Francisco Unified School District (SFUSD). Data from MDCPS and MPS are available from the 2003-04 to 2009-10 school years, while data from SFUSD are available from the 2001-02 to 2009-10 school years. In the 2009-10 school year, MDCPS enrolled about 350,000 students in 550 schools; MPS enrolled about 82,000 students in 214 schools; and SFUSD enrolled 55,000 students in 117 schools. All three districts are predominately minority and enroll large concentrations of students from disadvantaged socioeconomic backgrounds.

The data used for our analyses come from three different files provided by each district: test score and basic demographic information for all students in the district, course-level data that links students to each of their teachers and classmates in each year, and a staff-level file with information on all district employees. The student-level files include student race, gender, subsidized lunch eligibility, number of times the student was absent that year, and whether the student was suspended in each year (not available for SFUSD). Each district provided us with reading and math achievement test scores for all tested students. In Florida, the Florida Comprehensive Assessment Test (FCAT) is given in math and reading to students in grades 3-10. The FCAT includes criterion referenced tests measuring selected benchmarks from the Sunshine State Standards (SSS). In Wisconsin, test data come from the Wisconsin Knowledge Concepts Examination (WKCE) and the TerraNova. Since the 2005-06 school year, the WKCE

exam has been administered in grades 3-8 and 10. We also had WKCE scores for 4th and 8th grade students in each year that we observed, as the exam has been used as one criterion for making promotion decision for students entering the 5th and 9th grades. In years and grades in which the WKCE was not administered, TerraNova scores were available and used instead.[1] In California, test data are from the California Standards Test (CST), given to students in math and reading (among other subjects) in grades 2-11. In each district, we standardize students' test scores to have a mean of zero and a standard deviation of one within each grade and school-year.

In addition to these student-level data, we also have demographic information on all staff in each district which can be linked to the student records via course-level data. We combine this information to construct a dataset for each district with one observation for each student in each year with student characteristics and test scores, characteristics of students' teachers, and characteristics of students' classmates. For middle and high school students (who are enrolled in multiple courses), we use the teacher and classmate characteristics for their math course. If they are enrolled in multiple math courses in a given year, we randomly select one of their courses. The characteristics of students' classmates (e.g., percent minority, average prior test scores) are computed by excluding the focal student from the class averages.

Table 1 describes the variables used in the analyses. In addition to describing the racial, ethnic and gender make-up of the district, the Table shows that eight percent of students in M-DCPS were absent for more than 21 days in a given year, compared to 23 percent in MPS and 18 percent in SFUSD. Nineteen percent of students in M-DCPS had a novice teacher (first or second year), compared to 12 percent in MPS and four percent in SFUSD.

Methods

Differences in Teacher and Classmate Characteristics

Our first research question asks to what extent students differ systematically in the characteristics of their teachers and of their peers in the classroom. In answering this, we describe differences by student race/ethnicity, socioeconomic background (free-lunch eligibility) and by prior achievement using models based on the following equation:

$$Y_{igsy} = \beta_0 + \beta_1 X_{igsy} + \pi_{gsy} + \varepsilon_{igsy} \quad (1)$$

Where a teacher or average classmate characteristic, Y_{igsy}, for student *i* in grade *g*, in school *s,* in year *y* is a function of the student's characteristic, X - which include race/ethnicity (with white students serving as the omitted group), whether the student is eligible for free school lunches, and whether a student was in the top or bottom 25 percent of the achievement distribution in their grade in the prior year (with the middle 50 percent serving as the omitted group). All models also include a school-by-grade-by-year fixed effect, π_{gsy}, and, thus, the identification comes from differences in teacher or class characteristics across students within the same school and grade in a given year. We first enter the student characteristic variables separately in each model to get the overall within school difference and in subsequent models enter the variables together along with other controls. Our outcomes include a wide range of teacher and classmate characteristics: whether the student has a novice teacher, the average prior year achievement of students' classmates, the proportion of students' classmates that are black, Hispanic, receive free lunches, were suspended in the prior year and were absent 21 days or more in the prior year. We exclude student *i* in the computation of the classmate averages so that, for example, the percent black in student *i's* class is computed without including that student's own race.

The extent to which students are sorted across classrooms is likely to vary across grade levels; therefore, we estimate the models separately for elementary school students (grades K-5)

and middle and high school students (grades 6-12). For comparison purposes, we also estimate the models without the school-by-grade fixed effect. Models that exclude the fixed effect show, for example, the overall difference between all black and white students in the district in the percentage of students' classmates who are black. Models with the school-by-grade fixed effect show the difference between blacks and whites who attend the same grade and the same school in the percentage of classmates who are black.

We also examine within and between school sorting descriptively using the dissimilarity index. We use the dissimilarity index to compute segregation between schools and between classrooms in each district. We compute segregation between blacks and whites, Hispanics and whites, free lunch and not free lunch students and low and high achieving students (defined as students who scored in the highest and lowest quintiles on the state test in the prior year). Consider the black-white dissimilarity index capturing between school segregation. The dissimilarity index measures departures from evenness by taking the average absolute difference of each school's black population from the district's black population, weighted by the enrollment of each school. The dissimilarity index may range from 0 to 1 and can be interpreted as the proportion of black students that would have to change schools to be evenly distributed across the district (James & Taeuber, 1985). We compare segregation that occurs between schools to that which occurs between classrooms.

Though we find many differences in the characteristics of the teachers and peers to which minority, poor, and low achieving students are exposed, it is possible that these differences result from random processes. Only a deliberate effort to achieve perfect racial or socioeconomic integration within schools would result in evenly distributed classrooms, while a random allocation process is likely to deviate somewhat from a perfectly even distribution (Carrington &

Troske, 1997; Conger, 2005). To investigate this further, we use simulation techniques to examine how students would be distributed across classrooms if assignment was random. To do so we count the number of classes enrolling students in each grade in each school and in each year (using math classes for middle and high school students). We then assign students a random number and assign them to equally sized classes based on their random number (keeping the same number of classes for that school-grade-year combination as are observed in the data). We repeat the simulation 100 times. This repetition allows us to create distributions of likely assignment characteristics. We can then compare students actual assignment to this sampling distribution to assess how likely the observed assignment would have been if the class assignment had been random.

The Role of Achievement in Differences in Teacher and Classmate Characteristics

Our next set of analyses asks whether prior achievement differences across students explain differences in teacher and peer characteristics within grades and schools. We build on Equation 1, but add control variables. In particular, poor students as well as black and Hispanic students might be concentrated in classrooms with other poor or similar-race or similar-ethnicity students or with low achieving students because they themselves have lower achievement. We take a variety of approaches to evaluating the role of achievement differences in contributing to within school sorting by student race and free lunch eligibility. First, we simply control for students' prior year test scores in both math and reading. Models with controls for prior achievement show whether students of different race and poverty status but with the same prior achievement are assigned different types of teachers and classmates.

Schools have more information about students' ability levels than a single test score (i.e., multiple years of test scores, course grades, teacher evaluations, etc.), and are likely to use this

information when making assignment decisions. Measurement error in a single year's test score makes them imperfect measures of student ability. We therefore adjust for measurement error in prior test scores by instrumenting for the prior year's score using the twice lagged score. Instrumenting for prior test scores with the twice lagged score helps adjust for mean reversion which may bias our estimates. For example, consider a black and white student with similar test scores in a given year. Since the average black student tends to be lower scoring than the average white student, chances are that the black student had a particularly good test day and the white student had a particularly bad test day. The students' "true" achievement may not actually be identical even though their observed achievement test scores are the same. Instrumenting for prior achievement therefore gives us a better way of controlling for true achievement differences among students from different backgrounds. As a final way of controlling for achievement differences, we control for (high school) students' cumulative grade point average. Our full model examines whether minority and white and poor and non-poor students who attend the same school and have the same grades and prior test scores are assigned to different types of teachers and classmates.

Peer Characteristics and Achievement Gains

In our final set of models we examine the association between classmate characteristics and student achievement. A large research literature attempts to identify peer effects—our goal is not necessarily to build or improve on that literature here (e.g., Burke & Sass, 2009; Hoxby, 2000; Vigdor & Nechyba, 2007; Zabel, 2008). Rather, we estimate the relationship between peer characteristics and student achievement to better understand the extent to which the sorting by achievement and demographics we document is likely to affect achievement gaps among students in the districts we study. Grouping students in classrooms by ability (or by race and

socioeconomic status) might have significant impacts on student achievement but this depends on the magnitude of peer influences (Burke & Sass, 2009; Epple, et al., 2002).

Identifying peer and teacher effects is challenging given the non-random assignment of students to classrooms. We cope with this endogeneity by isolating quasi-experimental variation in peer and teacher characteristics within students over time using student fixed effects. We predict how much greater a students' learning will be in a given year in comparison to his or her achievement gains in other years if the student is in a classroom with particular teacher or classmate characteristics. Equation 2 describes the model:

$$A_{igt} - A_{ig(t-1)} = A_{ig(t-1)} + \beta X_{igt} + \eta C_{igt} + \gamma T_{igt} + \pi_i + \pi_g + \pi_t + \varepsilon_{igt} \quad (2)$$

Where the achievement gain (in math) between year *t-1* and year *t* for student *i* is a function of prior year math achievement, time-varying student characteristics (X_{igt}), grade fixed effects (π_g), year fixed effects (π_t), student fixed effects (π_i), and teacher (T_{igt}) and classmate characteristics (C_{igt}). The parameters in η and γ reflect the contribution of given teacher and classmate characteristics to growth in student achievement after controlling for all observed time-varying student characteristics and observed and unobserved time invariant student characteristics that may be associated with learning. Note that these models account for all unobserved time-invariant attributes of students that may be associated with learning (via the student fixed effect), but not for differences across classrooms in unobservable time-varying student characteristics that are associated with learning. Since teachers and classmates may have different effects on student achievement gains at different grade levels, we estimate equation (4) separately for elementary school students and for middle/high school students.

The parameters in equation (4) are identified from variation within students over time in the various covariates. Including student fixed effects is our preferred model specification given the endogeneity of classmate and teacher characteristics. However, since the effects of teacher and classmate characteristics may vary across grades (and we conduct the analysis separately for elementary and middle/high school students) and students are only tested in grades 3-10 we have only a few years of data on which to identify variation within students in teacher and peer characteristics. We therefore also estimate the model shown by equation (4) by removing the student fixed effect and including a school fixed effect instead.

Results

In Table 2 we begin by describing sorting between schools and classrooms using the dissimilarity index. We present the results separately for grades K-5, 6-8, and 9-12. By definition segregation is always larger across classrooms than across schools since the between classroom measure combines sorting that occurs both across and within schools. The results suggest that overall segregation by race/ethnicity and free lunch receipt tends to decline across grades. This is driven by lower between school segregation at the middle and high school grades relative to the elementary grades. Segregation across schools is higher at the elementary school level because there are a greater number of elementary schools. A larger number of units leads to higher segregation since it creates more opportunity for sorting. While overall segregation is smaller in middle and high school than in elementary school, the proportion of segregation that occurs within schools increases across grades. In all grades, the majority of segregation comes from sorting across schools; however, the proportion of sorting that occurs within schools is largest in high schools. Segregation by achievement increases across grades, as between school segregation stays about the same and within school segregation across classrooms increases.

Next we examine the relationship between student characteristics and the probability of having a novice teacher. In Table 3 we present the results separately for each district and grade level (elementary and middle/high school students). Model 1 examines the black-white, Hispanic-white, poor-non-poor, and high-low prior-achievement gaps in the probability of having a novice teacher. Model 2 is similar but adds a school-by-grade-by-year fixed effect so that comparisons are made between students with different characteristics who attend the same grade in the same school. Note that student race/ethnicity, free-lunch status, and prior year achievement quartile variables are each entered in a separate model so that, for example, the black-white difference in the probability of having a novice teacher does not control for free lunch status or prior achievement.

The results from these analyses are quite consistent: black and Hispanic students are more likely than white students to have novice teachers both overall and within schools. The differences are larger in the middle and high school grades than in the elementary grades but significant differences are evident across grade levels. For example, in MDCPS the probability of having a novice teacher is approximately 10 percent higher for black students than for white students in both elementary and middle/high schools (Model 1). The difference is approximately two percent, a fifth as large, when we include the school-by-grade-by-year fixed effect in Model 2. Similarly, poor students are more likely to have novice teachers, though this relationship is not as consistent within elementary schools; the magnitude is small in all three districts and the point estimates are strongly significant only in SFUSD.

Low achieving students (bottom quartile of math achievement in the prior year) are more likely to be assigned novice teachers than students in the middle 50 percent of the prior year's achievement distribution, while high achieving students are the least likely to have novice

teachers. For example, in MDCPS the probability of having a novice teacher is about two percent higher for low achieving students and four percent lower for high achieving students within elementary schools. At the middle and high school level, the probability of having a novice teacher is about two percent higher for low achieving students and two to seven percent lower for high achieving students within schools across the three districts.

Students of different race or ethnicity, poverty status, and prior achievement also differ in the characteristics of their classmates. The analyses presented in Table 4 (elementary school students) and Table 5 (middle and high school students) are similar to those in Table 3 except that the outcomes are attributes of students' classmates. We predict the proportion of students' classmates that are black or Hispanic, the proportion that receive free lunches, and the average prior standardized math achievement of students' classmates. In all grades, black and Hispanic students have more same race peers than their white counterparts in the district overall and at their school. Black elementary school students have between three and six percent more black classmates than white students in their grade at their school in a given year while black middle and high school students have between six and 10 percent more black classmates than whites at their school in their grade and year. Similarly, poor students have between two and seven percent more poor classmates than non-poor students in their grade at their school in a given year—this is true in both the elementary and middle/high school grades.

The most striking difference in peer characteristics among different groups of students is differences in peer achievement. Black elementary school students in MDCPS, for example, have classmates whose average prior achievement is nearly one-fifth of a standard deviation lower than the average achievement of whites' classmates at their school in their grade in that year. In SFUSD the difference in average classmate achievement for blacks and whites is about

one-tenth of a standard deviation. The differences are even larger in middle and high schools (0.2-0.4 standard deviations), likely due to greater tracking and ability grouping at these grades. We observe similar patterns for Hispanics compared to whites and for poor students compared to non-poor students. Students' prior achievement is also strongly related to their classmates' prior achievement, even in elementary schools. For example, in MDCPS the average difference in classmates' prior math achievement is nearly a standard deviation for high versus low scoring students (-.424+.407=-.831). The difference is between 0.2 or 0.3 standard deviation in MPS and SFUSD. The differences are even larger among middle and high school students at between 0.4 and 1.3 standard deviations.

Though there are many statistically significant differences in the characteristics of the teachers and peers to which minority, poor, and low achieving students are exposed, it is possible that some differences would occur even if students were assigned to classrooms randomly. Only a deliberate effort to achieve perfect racial or socioeconomic integration within schools would result in evenly distributed classrooms. A random allocation process is likely to deviate somewhat from a perfectly even distribution (Carrington & Troske, 1997; Conger, 2005) and it is not clear whether the differences shown in Table 4 and 5 are larger than what we would expect to find if assignments were random. To investigate this further, we examine how students are distributed across classrooms after randomly assigning them to classrooms via a simulation.

The simulation works as follows: First, we count the number of classrooms that enroll students in a given grade at a school each year. Then we randomly assign students to classes within schools-grades-years. We assign students to the same number of classrooms that are observed and make the classes each have equal size. We repeat the simulation 100 times. After randomly assigning students to classes within school-grade-year group, we compute

characteristics of students' randomly assigned classrooms and then compare the distribution of student characteristics that results from random assignment to the distribution observed in the data. Table 6 shows the results, plotting the 95% confidence interval of the observed estimates, which are obtained by regressing a class characteristic on student characteristics (i.e., race, free lunch eligibility, and quartile of prior year math achievement) and a school-by-year-by-grade fixed effect. We can compare these estimates to the estimates derived from the random class assignments. We derived the simulated estimates the same way we derived the observed estimates—we regress a class characteristic (from random assignment) on student characteristics and a school-by-year-by-grade fixed effect. We repeated this process for each simulation (100 times) and then averaged the estimates.

The results are very consistent and show that there are few differences in classmate characteristics between white and black, white and Hispanic, free lunch and not free lunch and low achieving versus higher achieving students within schools when students are assigned to classes randomly. For example, the observed data show that black elementary school students have about 4 percent more black classmates than white students in their grade and at their school. The mean of the simulated estimates, by contrast, is essentially 0. Similarly, black elementary school students have classmates whose prior year math achievement is about .12 standard deviations lower than the classmates of white students at their school whereas the simulated estimates show no difference.

The Role of Achievement in Differences in Teacher and Classmate Characteristics

The next stage of our analysis adds additional controls for prior achievement to the models shown in Tables 3-5. In Table 7 we examine novice teacher assignments, assignment to black classmates, and the average prior achievement of students' classmates. The goal of this

analysis is to understand the extent to which racial/ethnic and socioeconomic differences in prior achievement contribute to the differences in teacher and classmate characteristics observed for poor, minority and low-achieving students. In Model 1 we include controls for students' prior year reading and math test scores, in Model 2 we instrument for prior math test scores using the twice lagged math score, and in Model 3 we control for middle and high school students' cumulative grade point averages.

Including controls for prior achievement explains much of the racial/ethnic and socioeconomic differences in the probability of having a novice teacher, especially among elementary school students. The probability of having a novice teacher is higher for black and Hispanic middle and high school students relative to white students after controlling for prior achievement but the differences in the probability are less than one percent. The same is true for the difference between poor and non-poor students.

Controlling for prior achievement, however, does little to change the relationship between student race and the proportion of black classmates. Even after controlling for prior achievement and cumulative grade point average among middle and high school students, black students still have one to five percent more black classmates than similar scoring white students in their grade at their school. The differences are smaller in elementary school than in middle/high school, but they are statistically significant in all grades.

In the bottom panel of Table 7 we show the relationship between student race/ethnicity, socioeconomic status and average classmate achievement. The findings suggest that minority and poor students are in classrooms with lower achieving peers even after controlling for their own prior achievement. The differences are larger in grades six through 12 than they are in elementary school. There are some exceptions—for example, in the IV models (model 2) black

and white students have classmates with similar levels of prior achievement at all grade levels. In SFUSD, there are no significant differences in the prior achievement of black and white students' classmates at the elementary school grades.

Peer Characteristics and Achievement Gains- A Back-of-the-Envelope Calculation

To better understand the effects of the sorting we have documented on achievement gaps, we next examine the relationship between teacher and peer characteristics and achievement gains. Table 8 provides the results. We focus on MDCPS for this analysis for the sake of brevity but the results are similar in MPS and SFUSD. We show the estimates for all students pooled and then separately for elementary and middle/high school students. Model 1 includes a school fixed effect while Model 2 includes a student fixed effect. The models with student fixed effects are preferable to models with school fixed effects because students are sorted within schools. However, we also show results from school fixed effects models because some of the class characteristics measures do not vary considerably within students. The outcome variable in the models is the difference in students' test scores between the current and prior years.

In all grade levels, students have higher achievement gains when their classmates are higher achieving. This is true in the models with school fixed effects and in the models with student fixed effects, though the effects are smaller in models with student fixed effects. A standard deviation increase in the prior year math achievement of students' classmates is associated with math achievement gains that are 0.21 standard deviations higher in the models with school fixed effects (controlling for student's own prior year test scores and other factors). The model with student fixed effects generates an estimate of .07.

Having a novice teacher and more classmates who were suspended in the prior year are also negatively associated with achievement gains in Models 1 and 2. The direction of the

relationship between the class proportion black and student achievement gains varies by whether or not the student fixed effect is included. In Model 1 (includes a school fixed effect but no student fixed effect), the proportion of black classmates is negatively associated with achievement gains while in Model 2 (includes a student fixed effect but no school fixed effect), it is positively associated with achievement gains. There is limited variation in this measure within students over time (due to a great deal of racial sorting within and among schools), which makes these estimates unstable in models with student fixed effects.

Overall, the results from Table 8 consistently show that students make lower achievement gains when they have a novice teacher, lower achieving classmates and classmates with disciplinary problems. Given that minority, poor, and initially low-achieving students have more of such classmates than their white, non-poor, and higher achieving peers at their schools, it is likely that the within school sorting we documented exacerbates achievement gaps.

To better understand the extent to which within school sorting exacerbates achievement gaps, we combine the estimates from Table 8 (shows the effect of classmate characteristics on achievement gains) and the estimates from Tables 3, 4 and 5 (show the minority-white and poor-non poor gaps in classmate characteristics). Table 9 shows the estimates. Column A shows the estimates from Model 1 in Table 8, while column B shows the estimates from Model 2 in Table 8. These are the estimates of the effect of classmate characteristics on student achievement gains. Column C shows the black-white and poor-non-poor differences in these classmate characteristics within schools. These estimates are from Model 2 in Tables 3-5. Next, we take the effect of a classmate characteristic on achievement gains coefficient and multiply it by the black-white and poor-non poor difference in a given class characteristic. Each product shows how much less black or poor students learn in a given year relative to white or non-poor students due

to differences in a given teacher or classmate characteristic. We sum these products together to get the total contribution of differences in teacher and classmate characteristics to black-white and poor-non-poor achievement gaps.

When we compare the total estimated effects in Table 9 to the size of the gap in achievement gains within schools[2], we find that within school sorting accounts for a some of the black-white and poor-non-poor gaps, though much more so when we use the estimates of the effect of classmate characteristics that include a school fixed effect (and not a student fixed effect). For example, the figures in column D show that within school sorting explains about 23 percent of the black-white gap in achievement gains among elementary school students and 63 percent of the black-white gap in achievement gains among middle/high school students. Within school sorting explains about 43 percent of the poor-non-poor gap in achievement gains among elementary school students and 100 percent of the poor-non poor gap in achievement gains among middle/high school students. Column E suggests that within school sorting accounts for a smaller proportion of the gaps in achievement gains when the classmate characteristic effects are estimated in a model with student fixed effects – only two percent for elementary schools and 12 percent in middle schools for the black-white gap, and eight percent in elementary schools and 24 percent in middle schools for the poor-non-poor gap. Even these smaller differences are educationally meaningful. In either case, the results provide evidence that within school sorting contributes to black-white and poor-non poor gaps in achievement gains to at least some extent.

Discussion

In this paper we studied the pattern of school sorting within schools in three large urban districts. We examined the relationship between student characteristics (race/ethnicity, socioeconomic background, and prior achievement) and the characteristics of students' teachers

and classmates. We found that segregation among schools is larger than segregation within schools but some level of sorting across classrooms within schools occurs at all grade levels, particularly in high school. Minority, poor and low achieving students are more likely to be in classes taught by novice teachers and to have lower achieving and less advantaged classmates compared to white and non-poor students in their grade at their school. These patterns are found both at the elementary school level and at the middle/high school level. Racial/ethnic and socioeconomic differences in prior achievement do not entirely explain the inequality in teacher and peer characteristics we document.

Our data do not allow us to investigate all of the possible mechanisms that may generate differences in student characteristics across classrooms within schools. Prior achievement does explain some of the difference in teacher experience and classmate characteristics for minority and poor students relative to white and non-poor students. Interestingly, this is true both at the elementary and at the middle/high school levels. The elementary school classrooms included in our data are self-contained with one teacher--- these are the types of contexts where we would not necessarily expect ability grouping and/or (prior) achievement differences across classrooms. However, low achieving students in elementary schools are more likely to have novice teachers and to have low achieving classmates, more poor and minority classmates, and more classmates with attendance and disciplinary problems. We are not certain as to why this is the case. Prior research suggests that principals may feel pressure from parents and teachers when making class assignments. In particular, the preferences of middle class parents to have their children in classes with more experienced or effective teachers and better students and the preferences of senior teachers to teach high achieving students could contribute to the patterns we document at the elementary school level. The same processes may also be at work at the middle/high school

levels, though class assignments in the higher grades are more complex given the differentiation of the curriculum.

Though we cannot be certain of the causes of the sorting we document, we do find evidence that such sorting contributes to gaps in achievement gains. Given their higher likelihood of receiving a novice teacher, lower achieving classmates and classmates with more attendance and disciplinary problems, the achievement of black, Hispanic, and poor students suffers as a result of the patterns of sorting we document.

Notes

[1] We believe this is reasonable since both the WKCE and TerraNova were administered to virtually all public school students in our sample (in the relevant grades), and a study of the score comparability of TerraNova and WKCE scores found the scores to be reasonably comparable (CTB/McGraw-Hill 2003).

[2] We compute the black-white and poor non-poor gap in achievement gains by regressing the difference in students' test score in year t and t-1 on students' prior year test scores, a school fixed effect, and student race or poverty status.

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Table 1. Descriptive Statistics

	MDCPS	MPS	SFUSD
Student Race			
White	0.09	0.14	0.09
Black	0.27	0.57	0.13
Hispanic	0.61	0.2	0.21
Other	0.02	0.09	0.56
Student Gender			
Female	0.49	0.49	0.49
Male	0.51	0.51	0.51
Student Free Lunch Status			
Receives Free Lunch	0.53	0.64	0.39
Does not Receive Free Lunch	0.47	0.36	0.61
Chronically Absent in Prior Year (21 Days or More)	0.08	0.23	0.18
Suspended in Prior Year	0.07	0.19	NA
Student has a Novice Teacher	0.19	0.12	0.04
Student's Teacher's Years of Experience	9.35	9.61	13.38
Total Number of Student Observations	2212307	582667	735820
Total Number of Unique Students	598717	169454	97925

Notes : Data are available for 2003-04 to 2009-10 in MDCPS and MPS. Data are available from 2001-02 to 2009-10 for SFUSD. The figures in this table are pooled over all available years.

Table 2. Dissimilarity Indices for Segregation Across Schools and Classrooms

	Black-White				Hispanic-White				Free Lunch-Not Free Lunch				Low Ach-High Ach			
	School	Class	% Btwn	% Win	School	Class	% Btwn	% Win	School	Class	% Btwn	% Win	School	Class	% Btwn	% Win
MIAMI																
Grades K-5	0.78	0.81	96%	4%	0.47	0.55	85%	15%	0.43	0.47	91%	9%	0.45	0.71	63%	37%
Grades 6-8	0.69	0.75	92%	8%	0.43	0.52	83%	17%	0.37	0.43	86%	14%	0.49	0.89	55%	45%
Grades 9-12	0.65	0.72	90%	10%	0.43	0.52	83%	17%	0.27	0.36	75%	25%	0.46	0.85	54%	46%
MPS																
Grades K-5	0.73	0.75	97%	3%	0.67	0.69	97%	3%	0.48	0.51	94%	6%	0.53	0.60	88%	12%
Grades 6-8	0.71	0.73	97%	3%	0.59	0.62	95%	5%	0.36	0.39	92%	8%	0.55	0.63	87%	13%
Grades 9-12	0.51	0.58	88%	12%	0.43	0.51	84%	16%	0.27	0.30	90%	10%	0.58	0.68	85%	15%
SF																
Grades K-5	0.64	0.69	93%	7%	0.65	0.69	94%	6%	0.36	0.42	86%	14%	0.56	0.68	82%	18%
Grades 6-8	0.51	0.63	81%	19%	0.51	0.63	81%	19%	0.27	0.35	77%	23%	0.55	0.83	66%	34%
Grades 9-12	0.50	0.61	82%	18%	0.50	0.61	82%	18%	0.23	0.36	64%	36%	0.62	0.87	71%	29%

Notes: The dissimilarity indices are computed separately for each grade and each year and the averaged estimates are presented here.

Table 3. Probability of Having a Novice Teacher by Student Characteristics {Linear Probability}

	MDCPS				MPS				SFUSD			
	1		*2*		*1*		*2*		*1*		*2*	
ELEMENTARY SCHOOL STUDENTS (K-5)												
Black	0.108	***	0.023	***	0.029	***	0.006	***	0.019	***	0.003	*
	(0.002)		(0.002)		(0.002)		(0.002)		(0.001)		(0.001)	
Hispanic	0.028	***	0.009	***	0.047	***	0.008	***	0.009	***	0.002	
	(0.002)		(0.002)		(0.002)		(0.002)		(0.001)		(0.001)	
Eligible for Free Lunch	0.047	***	0.014	***	0.015	***	0.001		0.004	***	0.002	**
	(0.001)		(0.001)		(0.001)		(0.001)		(0.001)		(0.001)	
Bottom Quartile of Prior Math Score	0.038	***	0.020	***	0.008	*	0.007	**	0.016	***	0.006	***
in Prior Year	(0.003)		(0.002)		(0.003)		(0.002)		(0.001)		(0.001)	
Top Quartile of Prior Math Score	-0.066	***	-0.047	***	-0.004		-0.006	*	-0.005	***	-0.000	
in Prior Year	(0.003)		(0.002)		(0.003)		(0.002)		(0.001)		(0.001)	
MIDDLE/HIGH SCHOOL STUDENTS (6-10)												
Black	0.088	***	0.026	***	0.004		0.015	***	0.050	***	0.018	***
	(0.001)		(0.001)		(0.004)		(0.003)		(0.002)		(0.002)	
Hispanic	0.020	***	0.016	***	0.001		0.004		0.041	***	0.012	***
	(0.001)		(0.001)		(0.004)		(0.003)		(0.002)		(0.002)	
Eligible for Free Lunch	0.035	***	0.011	***	0.008	***	0.005	*	0.013	***	-0.000	
	(0.001)		(0.001)		(0.002)		(0.002)		(0.001)		(0.001)	
Bottom Quartile of Prior Math Score	0.045	***	0.027	***	0.014	**	0.012	***	0.033	***	0.016	***
in Prior Year	(0.001)		(0.001)		(0.004)		(0.003)		(0.001)		(0.001)	
Top Quartile of Prior Math Score	-0.075	***	-0.062	***	-0.012	**	-0.022	***	-0.026	***	-0.011	***
in Prior Year	(0.001)		(0.001)		(0.004)		(0.003)		(0.001)		(0.001)	
School by Grade by Year Fixed Effect	---		X		---		X		---		X	

Notes: *p<.05, **p<.01, ***p<.001 Student race/ethnicity, free lunch status, and prior achievement are entered in separate models. Teacher experience refers to the classroom teacher for elementary school students and to students' math teachers for high school students. White is the omitted racial/ethnic group. A variable for other race students is also included in the model but excluded from the table. Students who scored in the middle 50 percent of the achievement distribution in the prior year are the omitted group for the prior achievement measure.

Table 4. Classmate Characteristics by Student Characteristics {Grades K-5}

	MDCPS		MPS		SFUSD	
	1	*2*	*1*	*2*	*1*	*2*
Proportion of Black Classmates						
Black	0.558 ***	0.036 ***	0.523 ***	0.006 ***	0.267 ***	0.035 ***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Hispanic	-0.012 ***	-0.006 ***	-0.125 ***	-0.037 ***	-0.003 *	-0.036 ***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Eligible for Free Lunch	0.184 ***	0.003 ***	0.147 ***	0.002 ***	0.046 ***	0.002 ***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
Bottom Quartile of Prior Math Score	0.106 ***	0.006 ***	0.132 ***	0.004 ***	0.086 ***	0.016 ***
	(0.002)	(0.000)	(0.004)	(0.001)	(0.001)	(0.001)
Top Quartile of Prior Math Score	-0.103 ***	-0.011 ***	-0.092 ***	-0.004 ***	-0.044 ***	-0.005 ***
	(0.002)	(0.000)	(0.004)	(0.001)	(0.002)	(0.001)
Proportion of Hispanic Classmates						
Black	-0.322 ***	-0.019 ***	-0.141 ***	-0.014 ***	0.022 ***	-0.028 ***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Hispanic	0.200 ***	0.025 ***	0.456 ***	0.055 ***	0.387 ***	0.159 ***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)	(0.001)
Eligible for Free Lunch	-0.078 ***	0.008 ***	0.040 ***	0.001 **	0.091 ***	0.019 ***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)
Bottom Quartile of Prior Math Score	-0.062 ***	0.002 ***	-0.065 ***	-0.009 ***	0.115 ***	0.033 ***
	(0.002)	(0.001)	(0.003)	(0.001)	(0.002)	(0.001)
Top Quartile of Prior Math Score	0.031 ***	-0.012 ***	-0.009 **	0.004 ***	-0.092 ***	-0.021 ***
	(0.002)	(0.001)	(0.003)	(0.001)	(0.002)	(0.001)
Proportion of F/R Lunch Classmates						
Black	0.404 ***	0.027 ***	0.281 ***	0.008 ***	0.234 ***	0.017 ***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Hispanic	0.204 ***	0.024 ***	0.263 ***	0.007 ***	0.245 ***	0.034 ***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)	(0.001)
Eligible for Free Lunch	0.265 ***	0.018 ***	0.203 ***	-0.001 **	0.196 ***	0.001 *
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)
Bottom Quartile of Prior Math Score	0.123 ***	0.028 ***	0.069 ***	0.003 ***	0.098 ***	0.019 ***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Top Quartile of Prior Math Score	-0.148 ***	-0.046 ***	-0.096 ***	-0.003 ***	-0.067 ***	-0.009 ***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Average Prior (Standardized) Math Score of Classmates						
Black	-0.612 ***	-0.126 ***	-0.483 ***	-0.003	-0.520 ***	-0.073 ***
	(0.005)	(0.005)	(0.006)	(0.004)	(0.007)	(0.005)
Hispanic	-0.295 ***	-0.090 ***	-0.248 ***	0.041 ***	-0.463 ***	-0.093 ***
	(0.005)	(0.004)	(0.006)	(0.004)	(0.007)	(0.005)
Eligible for Free Lunch	-0.387 ***	-0.111 ***	-0.271 ***	-0.007 **	-0.241 ***	-0.040 ***
	(0.003)	(0.002)	(0.004)	(0.003)	(0.004)	(0.003)
Bottom Quartile of Prior Math Score	-0.531 ***	-0.240 ***	-0.260 ***	-0.038 ***	-0.458 ***	-0.156 ***
	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)	(0.003)
Top Quartile of Prior Math Score	0.505 ***	0.319 ***	0.291 ***	0.013 ***	0.339 ***	0.089 ***
	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)	(0.003)
School-Year-Grade FE	---	X	---	X	---	X

Notes: *p<.05, **p<.01, ***p<.001 Student race/ethnicity, free lunch status, and prior achievement are entered in separate models. White is the omitted racial/ethnic group. A variable for other race students is also included in the model but excluded from the table. Students who scored in the middle 50 percent of the achievement distribution in the prior year are the omitted group for the prior achievement measure. Classroom averages are computed by excluding student *i* from the mean.

Table 5. Classmate Characteristics by Student Characteristics {Grades 6-12}

	MDCPS		MPS		SFUSD	
	1	*2*	*1*	*2*	*1*	*2*
Proportion of Black Classmates						
Black	0.438 ***	0.049 ***	0.362 ***	0.064 ***	0.192 ***	0.093 ***
	(0.001)	(0.000)	(0.002)	(0.001)	(0.001)	(0.001)
Hispanic	-0.022 ***	0.012 ***	-0.101 ***	-0.010 ***	0.049 ***	0.006 ***
	(0.001)	(0.000)	(0.003)	(0.002)	(0.001)	(0.001)
Eligible for Free Lunch	0.106 ***	0.011 ***	0.083 ***	0.013 ***	0.030 ***	0.006 ***
	(0.001)	(0.000)	(0.002)	(0.001)	(0.001)	(0.001)
Bottom Quartile of Prior Math Score	0.118 ***	0.027 ***	0.110 ***	0.008 ***	0.105 ***	0.064 ***
	(0.001)	(0.000)	(0.003)	(0.001)	(0.001)	(0.001)
Top Quartile of Prior Math Score	-0.106 ***	-0.040 ***	-0.149 ***	-0.048 ***	-0.066 ***	-0.040 ***
	(0.001)	(0.000)	(0.003)	(0.001)	(0.001)	(0.001)
Proportion of Hispanic Classmates						
Black	-0.250 ***	-0.007 ***	-0.100 ***	-0.013 ***	0.090 ***	0.020 ***
	(0.001)	(0.000)	(0.002)	(0.001)	(0.002)	(0.001)
Hispanic	0.176 ***	0.017 ***	0.292 ***	0.061 ***	0.256 ***	0.090 ***
	(0.001)	(0.000)	(0.002)	(0.001)	(0.002)	(0.001)
Eligible for Free Lunch	-0.029 ***	0.005 ***	0.019 ***	0.002 *	0.057 ***	0.014 ***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Bottom Quartile of Prior Math Score	-0.072 ***	-0.006 ***	-0.043 ***	-0.001	0.123 ***	0.056 ***
	(0.001)	(0.000)	(0.003)	(0.001)	(0.001)	(0.001)
Top Quartile of Prior Math Score	0.005 ***	-0.013 ***	0.005 +	-0.002 +	-0.115 ***	-0.057 ***
	(0.001)	(0.000)	(0.002)	(0.001)	(0.001)	(0.001)
Proportion of F/R Lunch Classmates						
Black	0.264 ***	0.046 ***	0.185 ***	0.030 ***	0.150 ***	0.035 ***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Hispanic	0.150 ***	0.031 ***	0.181 ***	0.022 ***	0.162 ***	0.040 ***
	(0.001)	(0.000)	(0.002)	(0.001)	(0.002)	(0.001)
Eligible for Free Lunch	0.191 ***	0.028 ***	0.139 ***	0.003 ***	0.122 ***	0.028 ***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Bottom Quartile of Prior Math Score	0.130 ***	0.050 ***	0.085 ***	0.012 ***	0.102 ***	0.052 ***
	(0.001)	(0.000)	(0.002)	(0.001)	(0.001)	(0.001)
Top Quartile of Prior Math Score	-0.159 ***	-0.080 ***	-0.143 ***	-0.030 ***	-0.109 ***	-0.050 ***
	(0.001)	(0.000)	(0.002)	(0.001)	(0.001)	(0.001)
Average Prior (Standardized) Math Score of Classmates						
Black	-0.662 ***	-0.291 ***	-0.527 ***	-0.162 ***	-0.836 ***	-0.400 ***
	(0.003)	(0.003)	(0.006)	(0.005)	(0.008)	(0.006)
Hispanic	-0.328 ***	-0.162 ***	-0.303 ***	-0.093 ***	-0.776 ***	-0.341 ***
	(0.003)	(0.002)	(0.007)	(0.006)	(0.007)	(0.006)
Eligible for Free Lunch	-0.378 ***	-0.174 ***	-0.321 ***	-0.060 ***	-0.331 ***	-0.130 ***
	(0.002)	(0.002)	(0.004)	(0.003)	(0.004)	(0.003)
Bottom Quartile of Prior Math Score	-0.810 ***	-0.677 ***	-0.338 ***	-0.114 ***	-0.637 ***	-0.431 ***
	(0.002)	(0.002)	(0.006)	(0.004)	(0.004)	(0.004)
Top Quartile of Prior Math Score	0.755 ***	0.628 ***	0.492 ***	0.192 ***	0.925 ***	0.646 ***
	(0.002)	(0.001)	(0.005)	(0.004)	(0.004)	(0.003)
School by Grade by Year Fixed Effect	---	X	---	X	---	X

Notes: *p<.05, **p<.01, ***p<.001 Student race/ethnicity, free lunch status, and prior achievement are entered in separate models. White is the omitted racial/ethnic group. A variable for other race students is also included in the model but excluded from the table. Students who scored in the middle 50 percent of the achievement distribution in the prior year are the omitted group for the prior achievement measure. Classmate characteristics for middle/high school students refers to the attributes of students' peers in their math classes. Classroom averages are computed by excluding student *i* from the mean.

Table 6. Comparing Differences in Classmate Characteristics in Students' Observed and Randomly Assigned (Simulated) Classrooms

	Elementary School Grades			Middle and High School Grades		
	95% CI of Observed Estimate	Mean of Simulated Estimates	SD of Simulated Estimates	95% CI of Observed Estimate	Mean of Simulated Estimates	SD of Simulated Estimates
MIAMI						
Proportion of Black Classmates						
Black	.035,.037	-0.009	0.001	.048,.05	-0.004	0.001
Hispanic	-.007,-.005	0.000	0.000	.012,.013	0.000	0.000
Eligible for Free Lunch	.003,.004	0.000	0.000	.01,.011	0.000	0.000
Bottom Quartile of Prior Math Score	.005,.007	0.000	0.001	.025,.026	0.000	0.000
Proportion of F/R Lunch Classmates						
Black	.026,.028	-0.002	0.001	.044,.046	-0.001	0.001
Hispanic	.023,.025	-0.001	0.000	.03,.032	-0.001	0.000
Eligible for Free Lunch	.018,.019	-0.008	0.000	.027,.028	-0.003	0.000
Bottom Quartile of Prior Math Score	.027,.029	-0.001	0.001	.045,.046	0.000	0.000
Average Prior (Standardized) Math Score of Classmates						
Black	-.135,-.117	0.005	0.002	-.301,-.289	0.002	0.001
Hispanic	-.098,-.083	0.002	0.002	-.172,-.163	0.001	0.001
Eligible for Free Lunch	-.115,-.106	0.003	0.001	-.172,-.167	0.001	0.001
Bottom Quartile of Prior Math Score	-.245,-.235	0.019	0.002	-.661,-.656	0.006	0.001
MILWAUKEE						
Proportion of Black Classmates						
Black	.004,.007	-0.013	0.001	.064,.069	-0.009	0.002
Hispanic	-.039,-.036	-0.001	0.001	-.012,-.006	0.000	0.002
Eligible for Free Lunch	.002,.003	-0.001	0.000	.011,.014	-0.001	0.001
Bottom Quartile of Prior Math Score	.003,.006	-0.001	0.001	.006,.01	-0.001	0.001
Proportion of F/R Lunch Classmates						
Black	.006,.009	-0.003	0.001	.029,.032	-0.003	0.001
Hispanic	.005,.008	-0.003	0.001	.02,.024	-0.002	0.001
Eligible for Free Lunch	-.002,0	-0.012	0.001	.003,.005	-0.010	0.001
Bottom Quartile of Prior Math Score	.001,.004	-0.001	0.001	.01,.013	-0.001	0.001
Average Prior (Standardized) Math Score of Classmates						
Black	-.011,.005	0.012	0.004	-.173,-.155	0.008	0.003
Hispanic	.032,.05	0.007	0.003	-.104,-.084	0.004	0.004
Eligible for Free Lunch	-.012,-.002	0.006	0.002	-.064,-.053	0.003	0.002
Bottom Quartile of Prior Math Score	-.044,-.033	0.033	0.002	-.123,-.108	0.033	0.004
SAN FRANCISCO						
Proportion of Black Classmates						
Black	.033,.036	-0.018	0.001	.09,.094	-0.001	0.000
Hispanic	-.038,-.035	0.000	0.001	.003,.007	0.000	0.000
Eligible for Free Lunch	.001,.003	-0.001	0.000	.005,.007	0.000	0.000
Bottom Quartile of Prior Math Score	.015,.018	-0.003	0.001	.061,.064	0.000	0.000
Proportion of F/R Lunch Classmates						
Black	.015,.019	-0.005	0.001	.031,.036	0.000	0.000
Hispanic	.032,.036	-0.004	0.001	.037,.041	0.000	0.000
Eligible for Free Lunch	0,.002	-0.016	0.001	.026,.028	-0.001	0.000
Bottom Quartile of Prior Math Score	.018,.021	-0.002	0.001	.045,.049	0.000	0.000
Average Prior (Standardized) Math Score of Classmates						
Black	-.084,-.063	0.017	0.003	-.401,-.376	0.001	0.000
Hispanic	-.103,-.084	0.011	0.003	-.347,-.325	0.000	0.000
Eligible for Free Lunch	-.045,-.035	0.006	0.002	-.129,-.117	0.000	0.000
Bottom Quartile of Prior Math Score	-.162,-.151	0.026	0.002	-.423,-.41	0.001	0.000

Table 7. Student Race, Poverty Status and Characteristics of Classrooms, with Controls for Prior Achievement

	ELEMENTARY SCHOOL STUDENTS				MIDDLE/HIGH SCHOOL STUDENTS					
	1		2		1		2		3	
Outcome: Novice Teacher										
MDCPS										
Black	0.006	*	0.009	***	0.009	***	0.009	***		
	(0.003)		(0.002)		(0.002)		(0.002)			
Hispanic	0.002		0.005	**	0.005	**	0.005	**		
	(0.003)		(0.002)		(0.002)		(0.002)			
Eligible for Free Lunch	-0.010	***	-0.010	***	-0.006	***	-0.010	***		
	(0.002)		(0.001)		(0.001)		(0.001)			
MPS										
Black	0.007		0.000		-0.001		0.000		0.000	
	(0.005)		(0.003)		(0.004)		(0.003)		(0.004)	
Hispanic	0.006		-0.007	*	-0.010	*	-0.007	*	-0.013	**
	(0.005)		(0.004)		(0.004)		(0.004)		(0.004)	
Eligible for Free Lunch	-0.001		0.001		0.003		0.001		0.004	
	(0.003)		(0.002)		(0.002)		(0.002)		(0.002)	
SFUSD										
Black	-0.000		0.003		0.002		0.003		0.003	
	(0.003)		(0.003)		(0.003)		(0.003)		(0.003)	
Hispanic	0.001		0.006	**	0.008	***	0.006	**	0.009	***
	(0.002)		(0.002)		(0.002)		(0.002)		(0.002)	
Eligible for Free Lunch	0.003	*	0.002	*	0.004	**	0.002	*	0.004	**
	(0.001)		(0.001)		(0.001)		(0.001)		(0.001)	
Outcome: Percentage of Black Classmates										
MDCPS										
Black	0.029	***	0.030	***	0.038	***	0.030	***		
	(0.001)		(0.001)		(0.000)		(0.001)			
Hispanic	0.004	***	0.007	***	0.008	***	0.007	***		
	(0.001)		(0.000)		(0.000)		(0.000)			
Eligible for Free Lunch	0.003	***	0.004	***	0.004	***	0.004	***		
	(0.000)		(0.000)		(0.000)		(0.000)			
MPS										
Black	0.010	***	0.043	***	0.056	***	0.045	***	0.050	***
	(0.002)		(0.002)		(0.002)		(0.002)		(0.002)	
Hispanic	-0.014	***	-0.030	***	-0.028	***	-0.030	***	-0.012	***
	(0.002)		(0.002)		(0.002)		(0.002)		(0.002)	
Eligible for Free Lunch	0.003	**	0.006	***	0.007	***	0.006	***	0.007	***
	(0.001)		(0.001)		(0.001)		(0.001)		(0.001)	
SFUSD										
Black	0.028	***	0.036	***	0.044	***	0.036	***	0.044	***
	(0.002)		(0.001)		(0.002)		(0.001)		(0.002)	
Hispanic	-0.025	***	-0.006	***	-0.003	*	-0.006	***	-0.003	*
	(0.001)		(0.001)		(0.001)		(0.001)		(0.001)	
Eligible for Free Lunch	0.003	***	-0.000		-0.002	*	-0.000		-0.002	*
	(0.001)		(0.001)		(0.001)		(0.001)		(0.001)	
Outcome: Prior Achievement of Classmates										
MDCPS										
Black	-0.019	***	0.005	*	-0.029	***	0.005	*		
	(0.004)		(0.003)		(0.002)		(0.003)			
Hispanic	-0.015	***	-0.010	***	-0.017	***	-0.010	***		
	(0.003)		(0.002)		(0.002)		(0.002)			
Eligible for Free Lunch	-0.030	***	-0.025	***	-0.038	***	-0.025	***		
	(0.002)		(0.001)		(0.001)		(0.001)			
MPS										
Black	0.009	+	-0.043	***	-0.068	***	-0.044	***	-0.068	***
	(0.006)		(0.004)		(0.005)		(0.004)		(0.005)	
Hispanic	0.038	***	-0.008	+	-0.024	***	-0.007		-0.028	***
	(0.006)		(0.005)		(0.005)		(0.005)		(0.005)	
Eligible for Free Lunch	0.000		-0.012	***	-0.015	***	-0.012	***	-0.018	***
	(0.003)		(0.003)		(0.003)		(0.003)		(0.003)	
SFUSD										
Black	0.004		-0.010		-0.034	***	-0.010		-0.036	***
	(0.006)		(0.006)		(0.006)		(0.006)		(0.006)	
Hispanic	-0.045	***	-0.031	***	-0.047	***	-0.031	***	-0.048	***
	(0.006)		(0.005)		(0.005)		(0.005)		(0.005)	
Eligible for Free Lunch	-0.013	***	-0.011	***	-0.010	***	-0.011	***	-0.010	***
	(0.003)		(0.003)		(0.003)		(0.003)		(0.003)	
School by Grade by Year Fixed Effect	X		X		X		X		X	
Prior Math and Reading Achievement	X		X		X		X		X	
IV for Prior Math Achievement	---		X		---		X		---	
Student GPA	---		---		---		---		X	

Notes: *p<.05, **p<.01, ***p<.001 Classmate characteristics for high school students refers to the attributes of students' peers in their math classes. Classroom averages are computed by excluding student *i* from the mean.

Table 8. Characteristics of Students' Classrooms and Math Achievement Gains in MDCPS

	All Tested Students: Grades 4-10				*Elementary School: Grades 4-5*				*Middle and High School: Grades 6-10*			
	1		*2*		*1*		*2*		*1*		*2*	
Novice Teacher	-0.030	***	-0.020	***	-0.061	***	-0.040	***	-0.018	***	-0.013	***
	(0.002)		(0.002)		(0.003)		(0.003)		(0.002)		(0.002)	
Class Proportion Black	-0.144	***	0.059	***	-0.130	***	0.052	*	-0.143	***	0.030	**
	(0.009)		(0.008)		(0.017)		(0.021)		(0.011)		(0.011)	
Class Prorpotion Hispanic	-0.062	***	0.012		-0.064	***	-0.013		-0.058	***	-0.005	
	(0.008)		(0.008)		(0.014)		(0.018)		(0.009)		(0.010)	
Class Proportion F/R Lunch	-0.086	***	0.004		-0.110	***	0.013		-0.070	***	-0.018	**
	(0.005)		(0.005)		(0.009)		(0.010)		(0.006)		(0.006)	
Class Average Prior Math	0.212	***	0.068	***	0.148	***	0.036	***	0.250	***	0.061	***
Achievement	(0.001)		(0.002)		(0.003)		(0.003)		(0.002)		(0.002)	
Class Proportion Chronically	-0.194	***	0.006		-0.297	***	-0.040	+	-0.150	***	0.017	
Absent Last Year	(0.010)		(0.010)		(0.021)		(0.023)		(0.011)		(0.012)	
Class Proportion Suspended	-0.228	***	-0.080	***	-0.218	***	-0.149	***	-0.229	***	-0.035	***
Last Year	(0.008)		(0.008)		(0.021)		(0.024)		(0.009)		(0.010)	
School Fixed Effect	X		---		X		---		X		---	
Student Fixed Effect	---		X		---		X		---		X	

Notes: *p<.05; **p<.01; ***p<.001. The outcome is the difference in students' math achievement between year t and t-1. The models also include controls for last year's math achievement, grade fixed effects, and student-level control variables (race, gender, ELL status, free lunch eligibility, prior year absences, and prior year suspensions). Average classmate prior achievement is computed by excluding student *i* from the mean. Classmate characteristics for middle/high school students refers to the attributes of students' peers in their math classes.

Table 9. Effect of Within-School Sorting on Black-White and Poor-Non Poor Differences in Learning Gains in Math {MDCPS}

	Elementary School					***Middle/High School***				
	Effect Coeff. Schl FE (A)	*Effect Coeff. Stu FE (B)*	*Gap Within Schools (C)*	Product of: *(A)*(C) (D)*	Product of: *(B)*(C) (E)*	*Effect Coeff. Schl FE (A)*	*Effect Coeff. Stu FE (B)*	*Gap Within Schools (C)*	Product of: *(A)*(C) (D)*	Product of: *(B)*(C) (E)*
Black-White Gaps										
Novice Teacher	-0.06	-0.04	0.02	0.00	0.00	-0.02	-0.01	0.02	0.00	0.00
Class Proportion Black	-0.13	0.05	0.06	-0.01	0.00	-0.14	0.03	0.06	-0.01	0.00
Class Proportion Hispanic	-0.06	-0.01	-0.03	0.00	0.00	-0.06	-0.01	-0.01	0.00	0.00
Class Proportion F/R Lunch	-0.11	0.01	0.04	0.00	0.00	-0.07	-0.02	0.05	0.00	0.00
Class Average Prior Math Achievement	0.15	0.04	-0.18	-0.03	-0.01	0.25	0.06	-0.31	-0.08	-0.02
Class Proportion Chronically Absent	-0.30	-0.04	0.00	0.00	0.00	-0.15	0.02	0.02	0.00	0.00
Class Proportion Suspended	-0.22	-0.15	0.00	0.00	0.00	-0.23	-0.04	0.03	-0.01	0.00
Total (Sum of Column D/E)				-0.04	0.00				-0.10	-0.02
Size of Black-White Gap in Gains (within Schools)				-0.18	-0.18				-0.15	-0.15
Percent of within School Gap Explained				23%	2%				63%	12%
Poor-Non Poor Gaps										
Novice Teacher	-0.06	-0.04	0.00	0.00	0.00	-0.02	-0.01	0.00	0.00	0.00
Class Proportion Black	-0.13	0.05	0.00	0.00	0.00	-0.14	0.03	0.01	0.00	0.00
Class Proportion Hispanic	-0.06	-0.01	0.01	0.00	0.00	-0.06	-0.01	0.01	0.00	0.00
Class Proportion F/R Lunch	-0.11	0.01	0.04	0.00	0.00	-0.07	-0.02	0.04	0.00	0.00
Class Average Prior Math Achievement	0.15	0.04	-0.15	-0.02	-0.01	0.25	0.06	-0.17	-0.04	-0.01
Class Proportion Chronically Absent	-0.30	-0.04	0.00	0.00	0.00	-0.15	0.02	0.01	0.00	0.00
Class Proportion Suspended	-0.22	-0.15	0.00	0.00	0.00	-0.23	-0.04	0.01	0.00	0.00
Total (Sum of Column D/E)				-0.03	-0.01				-0.05	-0.01
Size of Poor-Non Poor Gap in Gains (within Schools)				-0.07	-0.07				-0.05	-0.05
Percent of within School Gap Explained				43%	8%				108%	24%
Source	*T8, M1*	*T8, M2*	*T3-5, M2*	*(A)*(C)*	*(B)*(C)*	*T8, M1*	*T8, M2*	*T3-5, M2*	*(A)*(C)*	*(B)*(C)*

Notes: The figures in columns A and B are from model 1 and 2 in Table 7. The figures in column C are the black-white or poor non-poor difference in a given class characteristic within schools (from Tables 2-4, model 2). Column D is the product of column A and C while column D is the product of column B and C. The size of the within school achievement gaps are computed by regressing the change in math score on the lagged math score and student race or poverty status and including a school fixed effect.