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EdWorkingPaper No. 22-590

Second Time's the Charm? How Sustained Relationships from Repeat Student-Teacher Matches Build Academic and Behavioral Skills

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VERSION: June 2022

Suggested citation: Wedenoja, Leigh, John Papay, and Matthew A. Kraft. (2022). Second Time's the Charm? How Sustained Relationships from Repeat Student-Teacher Matches Build Academic and Behavioral Skills. (EdWorkingPaper: 22-590). Retrieved from Annenberg Institute at Brown University: https://doi.org/10.26300/sddw-ag22

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Abstract

We examine the dynamic nature of student-teacher match quality by studying the effect of having a teacher for more than one year. Using data from Tennessee and panel methods, we find that having a repeat teacher improves achievement and decreases absences, truancy, and suspensions. These results are robust to a range of tests for student and teacher sorting. High-achieving students benefit most academically and boys of color benefit most behaviorally. Effects increase with the share of repeat students in a class suggesting that classroom assignment policies intended to promote sustained student-teacher relationships such as looping may have even larger benefits.

1 Introduction

Staffing all classrooms with effective teachers is a perennial goal of education policy. This focus is well justified given the large impacts teachers have on students' test scores (Rivkin et al., 2005; Rockoff, 2004), socioemotional skills (Jackson, 2018; Cunha & Heckman, 2008; Heckman et al., 2006; Gershenson, 2016; Kraft, 2019; Blazar & Kraft, 2017; Ladd & Sorensen, 2017) and long-run outcomes (Chetty et al., 2014; Jackson, 2018). Researchers and policymakers often frame this challenge in a way that assumes teacher effectiveness as a fixed characteristic – a teacher is either effective or not. Policy solutions gravitate towards human capital strategies to recruit, select, and retain high-quality teachers and dismiss low-performing teachers. However, recent studies suggest that teacher effectiveness is both dynamic and context-dependent, evolving over time (Rockoff, 2004; Harris & Sass, 2011; Ost, 2014; Papay & Kraft, 2015) and shaped by the match between individual teachers, schools, and students (Jackson, 2013).

We provide further evidence on the importance of match quality for teacher effectiveness, focusing on the role and dynamics of student-teacher matches. Prior research has largely viewed match quality as fixed, highlighting the benefits of characteristics such as shared demographics (Dee, 2005; Clotfelter, Ladd & Vigdor, 2006; Jackson, 2009; Egalite, Kisida & Winters, 2015; Gershenson et al., 2018). However, student-teacher relationships also evolve over time as teachers get to know their students better and are able to more effectively tailor their instruction to students' individual learning needs. Similarly, students adapt to a teacher's classroom management and teaching style over time. Research in education, sociology, and psychology suggests that developing strong student-teacher relationships over time can support students' academic achievement, reduce disciplinary problems, and decreased risky behavior (Hamre & Pianta, 2006; Eisenhower & Baker, 2007, Hamre & Pianta, 2001).

We bring together and extend these disparate literatures by examining the dynamic nature of student-teacher match quality when students are taught by the same teacher for more than one year. Educators and parents have long discussed the potential positive effects of repeat student-teacher interactions, often in terms of intentional looping policies that keep teachers with the same group of students for two or more years (Burke, 1997; Franz et al., 2010; George & Lounsbury, 2000). However, formally looped classrooms are not very common in the US context. In our statewide data on Tennessee public schools, less than 2% of teachers could be considered teaching in intentionally looping classrooms. Instead, teachers more often encounter "repeat students" when they switch grades within their school or teach multiple grades at once. These unsystematic repeat student-teacher matches are relatively common, with 44% of the students in our data having at least one repeat teacher in math or ELA between 3rd and 11th grade. While unintentional forms of repeat student-teacher matches may not reflect the full potential benefit of intentional looping, both students and teachers may still benefit from a second year together.

Our analyses leverage panel data on students and teachers from Tennessee to estimate the effect of repeat student-teacher matches on outcomes for students in grades 3 through 11. The breadth of the data allows us to examine the differential effect of repeat teachers on academic and behavioral outcomes across a student's career using panel methods with high-dimensional fixed effects. Our estimates derive from teachers (a) moving across grades or (b) teaching more than one grade in a given year.[1] We compare outcomes from years when students are in a classroom with a teacher they have had before (a repeat teacher) to years in which students have a teacher for the first time. We account for sorting of students to repeat teachers in two complementary ways: we make within-student comparisons with student fixed effects, and we control flexibly for lagged outcomes within an education production function framework. We conduct a range of additional tests to rule out sorting as a threat to validity.

[1] We explicitly exclude repeat interactions that occur when students are retained within a grade.

We find that repeat teachers increase students' test scores across all grade levels. Effects on tests scores are 0.02 standard deviations (SD), equivalent to a 0.10 to 0.15 standard deviations improvement in the distribution of teacher quality. We also find that these repeat interactions decrease disciplinary infractions for students across grade levels and improve attendance in high school by reducing truancy. These results are robust to a range of alternative specifications and sample restrictions suggesting that teachers become more effective working with students in their second year together.

We also find substantial heterogeneity in the effect of repeat teachers. Positive test score gains are most pronounced among higher-performing and white female students, while gains in attendance and discipline are largest for lower-performing students and male students of color. We find less heterogeneity in teacher characteristics: students benefit from repeat teachers of all levels of experience. Finally, we find evidence of positive spillovers, as both repeat and non-repeat students benefit from classes with a large share of repeat students.

This paper makes several contributions to the literature. We provide new evidence that match quality is dynamic and can improve over time as illustrated by the increasing returns to sustained student-teacher relationships. Our findings complement recent studies that find small positive effects of repeat student-teacher matches on achievement among 3rd-5th grade students in North Carolina (Hill & Jones, 2018), 3rd-8th grade students in Indiana (Hwang, Kisida & Koedel, 2021), and 8th grade students in Chile (Albornoz, Contreras, & Upward, 2021). We extend these studies by providing the first evidence of the effect of repeat teacher-student matches on student achievement in high school and on objective measures of student behavior. The expanded set of outcomes we examine reveal how the benefits of repeat teachers are dynamic, operating through different mechanisms and outcomes for students with different background characteristics.

More broadly, our analyses contribute to the larger literature on the education production function (Todd & Wolpin, 2003), efforts to optimize student-teacher assignment (Fryer, 2018), and the dynamic nature of teacher effectiveness (Jackson, 2013; Rockoff, 2004; Harris & Sass, 2011; Ost, 2014; Papay & Kraft, 2015). These findings point towards the core role that relationships play in the education production process and the potential value of efforts to strengthen student-teacher relationships in schools.

2 Temporal Dynamics of Student-Teacher Match

Standard education production function models apply the logic of firm production to schools, framing a student's academic and behavioral outcomes in a given year as the direct result of the student's ability, effort, and all other productive inputs including teacher, school, and parent influences (Todd & Wolpin, 2003). Recent research has developed in detail some elements of this model, such as documenting substantial variation in teacher productivity (Hanushek & Rivkin, 2010; Chetty, Friedman, & Rockoff, 2014) and exploring the dynamic nature of teacher productivity over time (Papay & Kraft, 2015; Ladd & Sorenson, 2017).

These production function models have also incorporated a range of other theoretical advances from literature on the firm, including the canonical models of worker-firm match in determining productivity (Jovanovic, 1979). We begin by specifying a stylized education production function model that focuses on match quality between teachers and schools (workers and firms). Our model builds on work by Jackson (2013) that documents the presence of teacher-school match effects on student outcomes independent of teacher and school inputs.

$$y_{ijst} = f(y_{i,t-1}) + \delta_s + \tau_j + \gamma_{js} + \eta_{ijst} \tag{1}$$

Here, student outcomes in a given year for student i with teacher j in school s at time t depend on prior family and school investments in the student's learning,

$f(y_{i,t-1})$, contemporaneous learning derived from school productivity (δ_s), teacher productivity (τ_j), and teacher-school match quality (γ_{js}).

We extend this worker-firm framing of match quality to the match between a teacher and her students within a given school. There is a long literature documenting the benefits of certain matches. For example, students of color benefit from being taught by a teacher of the same race, independent of that teacher's overall level of productivity (Dee, 2005; Clotfelter, Ladd & Vigdor, 2006; Jackson, 2009; Egalite, Kisidab & Winters, 2015; Gershenson et al., 2018). Some teachers are more effective with English learners than non-English learners, and vice versa (Loeb, Soland, & Fox, 2014). These models hypothesize a match parameter between students and teachers (λ_{ij}), such that individual teachers are more productive with certain types of students, or that individual students exert more effort or learn better from certain types of teachers.

Match quality, whether at the organizational or individual level, may also evolve dynamically over time. For example, match quality improves as a teacher gains experience with a particular student, building student-specific human capital over time. We, therefore, allow the match quality parameter to be time varying (λ_{ijt}). Our analyses focus on estimating the relationship between dynamic student-teacher match quality and student outcomes as implied by the production function:

$$y_{ijst} = f(y_{i,t-1}) + \delta_s + \tau_j + \gamma_{js} + \lambda_{ijt} + \eta_{ijst} \tag{2}$$

Importantly, this function allows the student-teacher match to change over time. If match quality improves when teachers and students are paired together in classrooms for more than a year, we would expect $\lambda_{ijt} > \lambda_{ijt-1}$.

Though we often discuss teacher-student match quality as a component of teacher effectiveness, it is inherently bidirectional. Just as teachers develop student-specific human capital over time, students also develop teacher-specific human capital. Any improvement in teacher effectiveness from a repeat student-teacher match is likely the result of both the teacher and the student building a relationship and adapting to each other's teaching and learning styles. However, our measure of improved effectiveness for repeat teachers cannot distinguish between the mechanisms of teachers adapting to their students, students adapting to their teachers, or the more likely combination of the two.

3 Data and Descriptive Analysis

Data for this paper come from the Tennessee Education Research Alliance and are compiled from Tennessee Department of Education administrative records. The state links all students to teachers in tested grades and subjects. We identify each teacher that a student has in a tested grade and subject and whether the student has had that teacher before. We focus on students in Math and English Language Arts (ELA) who take grade-level Tennessee Comprehensive Assessment Program (TCAP) tests in grades 3 – 8 and specific-subject tests in high school for Algebra I, Algebra II, Geometry, English I, English II, and English III.[2] These courses cover nearly all students in grades 3 – 8 and the vast majority of high school students in grades 9 – 11. We use elementary and middle school data from spring 2007 to spring 2015 and high school data from spring 2007 to spring 2017.[3]

We focus our analyses on a student's primary teacher for each grade and subject.[4] We also exclude students who are repeating a grade or taking a test for the second time. While these students may have the same teacher for a second year, there are many other reasons why we would expect their test performance to be better when repeating the same content. Our final analytical sample includes 1.3

[2]Given the availability of high-school testing data, we focus on math and ELA.

[3]Due to implementation challenges with TCAP testing in spring 2016 and 2017, we omit those years from the analysis. Not all EOC test subjects are available for all data years: Algebra I, English I, and English II are available for all years of the data; Algebra II and English III were introduced in 2012; and Geometry was introduced in 2016.

[4]Because we are interested in the effect of having a repeat primary classroom teacher rather than a repeat support teacher or English language learner specialist, we limit the sample to student-teacher matches where the teacher claims at least 50% responsibility for the student in a given subject, the student has been enrolled in Tennessee schools for at least half the school year, the teacher's job title is "classroom teacher," and the teacher has at least 5 students and no more than 200 students in the subject. These restrictions eliminate less than 1% of the sample. It is possible students with repeat primary classroom teachers also had repeat support teachers.

million unique students and more than 50,000 unique teachers. Additional student data include demographic information on gender, race, ethnicity, special education status, English learner (EL) status, and receipt of free or reduced-price lunch.

In addition to test scores, we also examine three behavioral outcomes available in our administrative data, attendance, truancy, and suspensions. These measures are important outcomes in their own right (Lleras 2008; Bertrand & Pan 2013; Kautz and Zanoni 2014; Heckman et al., 2016; Jackson, 2018) and serve as proxies for well-established measures of socioemotional skills (Heckman, 2006; Barbaranelli et al., 2003; Lounsbury et al., 2004; Carneiro, Crawford & Goodman 2007; Duckworth et al., 2007). Our data on attendance and suspension are at the student-school-year level and are not tied to a specific teacher or class period. We use two measures of attendance: total days absent during the school year and total days with unexcused (truant) absences for high school students.[5] Total absences account for the amount of time that a student is out of school, while truant absences in high school can be used as a measure of student engagement (Wedenoja, 2017; Imberman, 2011). Suspension is measured on the extensive margin as whether or not a student has had a serious disciplinary incident resulting in an in-school or out-of-school suspension during the school year. Due to evidence of racial bias in school discipline, we control for student race in all models where we examine these outcomes (Owens & McLanahan, 2020).

Table 1 contains the average demographic characteristics of students and teachers in our sample and documents differences between students who have at least one repeat teacher in a year in our panel and students who do not. Students with at least one repeat teacher are more likely to be white, low income, and have lower test scores in the year before they are repeat students, but they are also less likely to be absent or truant. In supplemental analyses, we find that these differences largely reflect the fact that repeat student-teacher interactions are more frequent in

[5] The distinction between excused and unexcused absences is imprecise and complicated in elementary and middle school when parents are primarily responsible for their child's attendance. Truancy is well defined and linked to school engagement in high school.

smaller schools, which tend to be whiter and lower-performing. We see no differences if we compare students in the same school.

Repeat students also differ in the teachers they are likely to encounter in their classrooms. We compare teachers for whom more than 10% of their students in a given year are students they have taught before to teachers with less than 10% repeat students. Overall teachers with at least 10% repeat students have an extra year of experience, are a year older, and, much like their students, are 2 percentage points more likely to be white. We also find that repeat teachers have a slightly lower measured effectiveness, as measured by value-added scores, than their peers.

3.1 Prevalence of Repeat Student-Teacher Assignments in Tennessee

We define a student-teacher pair as a "repeat" in year t if the teacher is a student's primary teacher in a subject in both year t and any previous year, and the student is not repeating a grade or test. We do not limit teacher repetition to consecutive years: an eighth-grade student with the same math teacher she had in sixth grade has a repeat teacher. Repetition in a given year is relatively rare with only 6% of students in the sample having a repeat teacher in math or ELA at any given time. However, repetition is more common over the course of a student's career: 44% of the students we observe from grades 3 – 11 have had at least one repeat teacher over the course of their school career. These estimates are likely understated because we only focus on math and ELA teachers in tested grades and subjects.[6]

There is significant variation in the prevalence of repeat student-teacher assignments by grade and subject. In Table 2, we show the number of student-year observations in each tested subject as well as the probability of a student having a repeat teacher in a given subject and year. Not surprisingly, repeat teachers are

[6] Due to our reliance on tested subjects, we are particularly likely to understate the prevalence of repetition in elementary grades and in high school as most courses do not have EOC exams and, as a result, do not have student-teacher links. If a student had their math teacher previously in an un-tested subject, such as statistics, we would not identify that as repetition. EOC coverage in English is much better. Virtually all students in our sample take both the English I and English II EOC exams during high school, and a little more than half take English III as well. English III has the highest percentage of students with repeat teachers (9.5%, compared to approximately 5% for the other EOC subjects).

more common in higher grades, ranging from only 2% of fourth grade students to 11% of eighth grade students.

Teachers are much more likely to have repeat students than students are to have repeat teachers. Column 4 of Table 2 gives the percentage of teachers that have any repeat students in a given year and column 5 gives the percentage of teachers who have at least 10% repeat students. Repeat matches are most common in 8th grade, when nearly 30% of teachers are teaching classes where they have previously taught at least 10% of the students. However, few of these teachers are engaged in intentional looping where they are teaching intact classes of students across multiple years – column 7 shows that, in any given year, only 1.5% of teachers are assigned to classrooms where at least 90% of their students are ones they have taught in previous years.

3.2 Sources of Repeat Student-Teacher Assignments

We examine the sources of repeat assignments for teachers who have had at least 10% repeat students in a given year and for whom we observe in the data the year before and after they are repeat teachers. Table 3 documents how these teachers end up with repeat students across different grades and subjects. The vast majority of repeat student-teacher assignments that we observe arise from unintentional looping – teachers switching grades or consistently teaching multiple grades.

In elementary school (grades 4 and 5), most teachers who have repeat students moved from a lower grade to a higher grade along with their students. This type of repetition accounts for 87% of fourth grade repeat teachers and 67% of fifth grade repeat teachers. As shown in column 5, these moves into higher grades also tend to be permanent, rather than a temporary reassignment or an intentional loop. Over two thirds of these teachers stay in that same grade the following year. The remaining repeat elementary school teachers are those who teach multiple grades simultaneously.

In middle and high school, the story is different. In these grades (6 – 11), most repetition is due to teaching assignments spanning multiple grades at the same time. Here, 53% to 77% of all repeat teachers have students in multiple grades. Furthermore, the majority of repeat teachers after grade 6 are teaching the same grade they taught the year before (column 4) and continue to teach that grade the following year (column 5).

4 Econometric Methodology and Identification

We explore the dynamic nature of student-teacher matches by estimating whether student outcomes improve more in years when they have a repeat teacher compared to other years. While relatively few students are assigned to repeat teachers because of intentional looping, other endogenous classroom assignment policies may affect which students have repeat teachers in a given years. This potential endogeneity makes it inappropriate to directly compare the outcomes of students with repeat teachers to those without repeat teachers. We control for non-random student assignment within an education production function framework using fixed effects and observable characteristics to address potential bias.

We employ two complementary identification strategies: (1) including student fixed effects and (2) controlling directly and simultaneously for lagged outcomes (i.e., prior measures of achievement in math and ELA, absences, and having ever been suspended). Because we believe that student sorting into classrooms is the largest threat to validity, our preferred specification includes student fixed effects. Thus, our identification derives from comparing students in years and subjects in which they have repeat teachers to themselves in years they do not. We present complementary results controlling for student outcomes from the prior year – a cubic of math and reading test scores, log of attendance, and an indicator for whether the student was suspended. This lagged specification compares different students with similar outcome histories in the same year, district, and subject.

Across both specifications, we also control for district-by-year fixed effects, test-by-year fixed effects, and time varying school-level and class-level demographics. The district-by-year fixed effects control for yearly differences in school calendars, leadership, testing policies, and other idiosyncrasies that vary between districts and years. The school-level and class-level demographic and lagged outcome averages account for peer effects and the sorting of students between and within schools and within districts.

Specifically, we fit the following models:

$$y_{ijlt} = \beta_0 + \beta_r * REP_{ijlt} + \beta_e^{'} S_{st} + \beta_c^{'} C_{jlt} + \beta_p^{'} P_{jt} + \beta_x^{'} X_{it} + \alpha_i + \delta_{dt} + \epsilon_{ijlst} \quad (3)$$

$$y_{ijlt} = \beta_0 + \beta_r * REP_{ijlt} + \beta_e^{'} S_{st} + \beta_c^{'} C_{jlt} + \beta_p^{'} P_{jt} + \beta_x^{'} X_{it} + \beta_y^{'} Y_{it-1} + \delta_{dt} + \epsilon_{ijlst} \quad (4)$$

Where y_{ijlt} is the outcome of interest for student i with teacher j in subject l and year t. In both models REP is a dummy variable such that $REP = 1$ when a teacher has had the student before and 0 otherwise, and β_r measures the effect of being with a teacher for a second (or more) time. As discussed above, X is a vector of student control variables, S_{st} is a vector of school-by-year control variables for school s in year t, C_{jlt} is a vector of classroom controls for teacher j in subject l in year t, and δ_{dt} is the district-by-year fixed effect. Equation 3 also contains a fixed effect α_i for student i and Equation 4 contains a vector of lagged outcomes Y_{it-1}. Because teacher effectiveness improves with experience, particularly early in their career (Rockoff, 2004; Harris & Sass, 2011; Papay & Kraft, 2015), and teachers are by definition more experienced in their second year of teaching a student, we include a full set of dummy variables (vector P_{jt}) for teacher experience in all of our models.

The composition of control variables and lagged outcomes varies slightly in high school. Because students take math classes in different sequences across different years of high school, we use eighth grade test scores in lieu of lagged high-school test scores. This limits our high school sample to students who also attended eighth grade in Tennessee. Further, following Jackson (2014), we include controls for high school "tracks" based on the sequence of courses students take.

Our specification for behavioral outcomes closely mirrors our achievement models. Because behavioral outcomes are measured at the student-year rather than student-teacher-year level, we attribute these outcomes to all the student's observed teachers. In elementary school, most students have a single teacher so there is no effective difference in our models. However, for students in middle and high school who have multiple teachers, our approach is likely to attenuate any effects we find. Like other count variables, attendance and truancy are heavily skewed distributions with long right-hand tails. To account for this skewness and the fact that many high school students have no truancies, we transform the absence and truancy outcomes by adding one and taking the natural log of this value. We measure suspension on the extensive margin as a binary variable for whether or not the student was suspended (in-school or out of school) during the year. This accounts for different school policies relating to severity of suspensions and other, lesser disciplinary consequences that may be recorded differently across schools.

Our measures of teachers' effects on student behavior should be viewed as lower bounds of the true effect of repeat teachers on behavioral outcomes for two reasons. First, we do not observe class-specific attendance or discipline; if a teacher reduces absenteeism within only her class, these effects will be diluted across several teachers. Second, full-day absences likely understate the overall frequency of students missing class, particularly in higher grades, as most absences are for individual classes and not full days (Liu & Loeb, 2021). Similarly, we measure suspension on the extensive margin and only estimate the effect of repeat teachers on the probability that the student is ever suspended during the year, not on whether a repeat teacher reduces the frequency or length of suspensions or impacts other, lesser disciplinary consequences.

5 Results

Having a repeat teacher improves student test scores. Panel A of Table 4 contains pooled results for Math and ELA in row one and each subject separately in rows two and three. Across both the student fixed effects and lagged outcome specifications, we find that having a repeat teacher raises test scores by 0.02 SD, which represents an improvement of approximately 0.10 to 0.15 standard deviations in distribution teacher effectiveness in our data. Despite similar point estimates across school levels, the effects in high school are substantially larger – roughly equivalent to an additional month of learning – due to declining achievement growth rates as students age (Hill et al., 2008). Estimates of the effect of repeat teachers are quite consistent across school levels, subjects, and model specifications.

In Panel B we present results for three behavioral outcomes: absences, suspensions, and truancies. Having a repeat teacher reduces absences and suspensions across all grade levels and specifications. The reduction of absences in high school can be attributed almost entirely to a reduction in truancies. Despite the consistent and significant reduction in absences and truancies, the estimated effects are modest. Absences are reduced by only 0.5% overall, and the probability that students are suspended during the year is reduced by 1 percentage point (a 10% reduction). The reduction in high school truancies is likely more meaningful than the reduction in absences in earlier grades because even a single truancy in 9th grade predicts lower test scores, a lower GPA, and a reduced probability of graduating from high school (Wedenoja, 2018). Conversely, the percentage reduction in disciplinary incidence is higher in elementary and middle school because of the lower levels of suspensions overall compared to high school.

5.1 Robustness

5.1.1 Teachers

Given the two-way match between teachers and students, our estimated effects of repeat student-teacher matches derive from changes in teacher effectiveness and/or the student's ability to learn from the teacher. Our preferred student-fixed-effects models identify the effect of repeat teachers by comparing students in years they have a repeat teacher to years in which they do not. This approach is attractive, because it accounts for the sorting of students to repeat classrooms based on both observable and unobservable time-invariant student characteristics. However, other types of selection may be at play. For example, it may be that more effective teachers are more likely to repeat with students. Descriptively, we find that this is not the case: the average lagged value-added of repeat teachers is lower than that of non-repeat teachers, conditional on experience (Table 2). Repeat students have teachers with measured lagged value added 0.03 SD lower than teachers of non-repeat students, and that difference is consistent when controlling for school FE, school-by-year FE, test FE as well as teacher experience.

In order to address this bi-directional effect, we control for teachers in our econometric specifications in two complementary ways: by using teacher fixed effects and by controlling directly for lagged teacher effectiveness as measured by test score value added. In Table 5, we present results from models that include teacher fixed effects to directly control for selection into being repeat teachers on both observed and unobserved time-invariant characteristics (columns 1 and 2). To further explore the role of teachers and teacher effectiveness in repeat student-teacher matches, we directly control for the teacher's measured value added (VAM) from the previous year (columns 5 and 6). This reduces our sample by about one-third because we limit our analysis to teachers in tested grades and subjects in the previous year. Our results are largely robust to the inclusion of teacher fixed effects and value-added measures. We view this as strong evidence that the effect of repeat teachers is not driven by teacher selection.

5.1.2 Schools and Classrooms

We restrict our analyses in several ways to account for differences in policies and characteristics between schools and classrooms. First, we replace our district fixed effects with school-by-year fixed effects in both our student fixed effects and lagged specifications (columns 7 and 8). These models explicitly compare differences in achievement for students with repeat teachers to that of students without repeat teachers in the same school and year. We also fit a model with teacher-by-year fixed effects (column 9), explicitly identifying the effect of repeat teachers by comparing students with the same teacher in a given year who did and did not have that teacher in the past. The effective variation used to identify these effects comes from a somewhat different sample than our preferred approach, because schools or classrooms with only repeat students, or only non-repeat students, do not contribute to the estimates. For the teacher-by-year fixed effects, we only use the student lagged outcome framework due to collinearity.

Importantly, these models explicitly change the interpretation of our parameters of interest, and we expect the estimates to be somewhat attenuated because they explicitly restrict the mechanism through which a repeat teacher can "affect" her students. In particular, comparing students within classrooms would attenuate our estimates if non-repeat students benefit from having repeat students in their class. If repeat interactions improve student-teacher match quality, teachers may not only be more effective with their repeat students, but they may also be able to reallocate additional time and effort to their new students. Improved achievement and behavior among repeat students may also have positive spillovers to their classmates via peer effects. Below we test for and find evidence of such positive spillovers.

As shown in Table 5, our results are robust to the inclusion of school-by-year and teacher-by-year fixed effects. While our test score results are attenuated from the inclusion of school-by-year fixed effects, there is still a significant increase in student test scores. We find that the reduction in suspensions and absences is also robust to these alternative model specifications with the exception of estimates on absences from our model with student and school-by-year fixed effects.

5.2 Classroom Composition

Because most repeat student-teacher assignments come from teachers moving across grades or teaching multiple grades, both teachers and students may have the opportunity to "choose" to repeat with only well-matched students or teachers. For example, if there are two fifth-grade teachers but only one had taught fourth grade the year before, it is possible that only the students with whom the teacher was effective will select into her class during fifth grade. To account directly for this type of selection, we limit our sample to schools in which there is a single teacher for a tested grade and subject; in such schools, students cannot select a specific teacher and teachers cannot select specific students. Columns 3 and 4 of Table 6 show that the results are remarkably consistent to the preferred results in columns 1 and 2, although they are notably less precise because only 10% of our preferred sample attend a school with only one teacher in the subject. We find consistent positive effects on test scores, and although we lose substantial power for the student behavior outcome estimates, we still find negative point estimates for both absences and suspensions.[7]

Just as students may follow a well-matched teacher, teachers may choose to follow a particularly well-matched cohort of students into a higher grade. To avoid potential bias from this type of teacher selection, we limit our sample of teachers to those that are not teaching in a new grade or subject.[8] In other words, we restrict our estimates to teachers who could not have chosen to follow a particularly well-

[7] Additionally, limiting the sample to schools with a single teacher per grade skews our observations both to smaller schools and to earlier grades.

[8] This restriction skews the sample toward middle and high schools.

matched cohort of students into a new grade because the teacher already teaches in that grade. We do this for teachers who taught the exact same combination of grades and subjects in the prior year (columns 5 and 6) and for teachers who taught the focal subject in the prior year but could have changes to other classes (columns 7 and 8).[9] Again, we find largely consistent results as shown in Table 6. We find a positive and significant effect on test scores and a negative effect on both absences and suspension. In contrast to limiting the sample to schools with a single teacher in each grade, this restriction skews the sample toward middle and high schools.

6 Student Heterogeneity

Different students benefit from different types of teachers and have different learning styles. It is possible that having a repeat teacher is more effective for certain types of students than it is for others. Put differently, match quality may be more dynamic for certain types of student-teacher matches than it may be for others. We have already shown largely consistent effects of having a repeat teacher across different grades and subjects. Here, we expand that analysis to examine the differential effects by student characteristics, such as prior academic performance, race, and gender.

We present our results in Table 7, showing the overall effect for the reference group (top row) and the difference in impact for every other group. As show in Panel A, we find that the positive achievement effects of having a repeat teacher are driven by students in the top half of the test score distribution (third and fourth quartile in the previous year).[10] However, while achievement effects are concentrated among higher-performing students, improvements in behavioral outcomes are more concentrated among lower-performing students. This is consistent with existing evidence that teachers contribute to students' long-term outcomes not only through their ef-

[9] An additional benefit of limiting the sample to teachers who consistently teach in the same set of grades and subjects is that we control for the possibility that teachers only move into grades where they believe they will be more effective.

[10] This is contrary to what would be expected if our results were driven by mean reversion.

fects on academic skills but also through their effects on social-emotional skills not captured by test scores (Jackson, 2018; Kraft, 2019).

Another source of heterogeneity in the effect of a repeat teacher could result from differential effects by gender and race. Recent work on implicit bias suggests that teachers may enter the classroom with significant biases against students of color (Papageorge, Gershenson, & Kang, 2020; Starck et al., 2020); if building a relationship with individual students helps to ameliorate such biases, match quality may be more malleable over time for students of color than for white students. To explore this possibility, we interact a set of indicators for a student's race and gender with our repeat variable in Panel B of Table 7. White female students (the reference group) see the largest gains in test scores from having a repeat teacher, while the difference is particularly stark for female students of color who appear to have virtually no benefit to their test scores. These differential effects are not driven by the fact that white female students are higher achieving, on average, as they are robust even when controlling directly for students' lagged test scores and for student FE. However, patterns are very different for the behavioral outcomes. The reduction in suspension and particularly absences from having a repeat teacher is highest for male students of color. In fact, having a repeat teacher reduces absences by approximately 3% for male students of color. The additional effect of repeat teachers on male students of color is particularly notable because there is extensive evidence that they are more likely to be suspended and disciplined than their white peers: those suspensions can lead to negative outcomes like incarceration and lower earnings later in life (Cuellar & Markowitz, 2015; Costenbader & Markson, 1998; Mendez, 2003; Bacher-Hicks, Billings & Deming, 2019).

6.1 The Concentration of Repeat Students and Spillover Effects

There is substantial scope for positive spillovers of repeat students on non-repeat students. Teachers with a high number of repeat students may be able to better focus on building relationships with non-repeat students and may require less time at the beginning of the year to establish classroom protocols and norms. In other words, they may be able to both reallocate effort to non-repeat students and improve their match quality with these students more rapidly. To test for potential spillovers, we include a classroom-level indicator for whether 50% or more of a teacher's students in that subject year are also repeat students (a high-repeat classroom) and interact this term with our student-level repeat indicator.[11]

As shown in Table 8, both repeat students and their non-repeat peers perform better academically in majority repeat student classrooms. The coefficient associated with the indicator for high-repeat classrooms captures the differential effect of being in a high-repeat classroom for non-repeaters. The linear combination of the coefficients for high-repeat classroom and its interaction with the repeat student indicator captures the differential effect of being in a high-repeat classroom (vs. a low-repeat classroom) for repeaters. We find evidence of positive spillover effects on achievement for non-repeat students who are in repeat heavy classes (0.006 SD) as well as additional benefits for repeat students (0.022 SD). We also find beneficial spillover effects on the likelihood a non-repeat student is suspended. Non-repeat students in repeat-heavy classrooms have a reduced probability of being suspended of approximately 2 percentage points. Estimates for the differential effect of being in a high-repeat classroom on student attendance are inconsistent across specifications. These results suggest that policies such as intentional looping might produce even larger effects for repeat students than our overall estimates suggest and that intentional looping may also produce positive classroom-level spillovers for non-repeat students.

[11] Alternative specifications ranging from indicators from 20% repeat students to 80% show positive spillover for all levels 40% and above

7 Teacher Heterogeneity

Student-teacher match is two-sided, suggesting that the characteristics of teachers might also matter. For example, repeat interactions may be particularly valuable for less experienced teachers if it takes them longer to build strong relationships with students. On the other hand, more experienced teachers may be better able to reallocate classroom time to maximize their knowledge of students individual learning needs. To test the possibility that the effect of a repeat teacher varies by teacher experience, we interact the indicator for repeat students and different ranges of teacher experience.[12] As seen in Table 9, we find no differences in the effect of repeat student-teacher matches on achievement across experience categories. We do, however, find that more experienced repeat teachers, particularly mid-career teachers with 5-9 years of experience, are more effective at reducing student absences and suspensions relative to early-career repeat teachers. These findings suggest that having repeat teachers is beneficial regardless of whether the teachers are early in their careers or veterans, but it may be particularly beneficial when teachers have more years of experience.

8 Conclusion

Match quality matters for employees and firms as well as for teachers and schools. We study one specific type of match quality within schools, student-teacher matches, and document how match quality is dynamic over time rather than fixed. We find substantial evidence that having a repeat teacher improves students' achievement and behavioral outcomes. Although we use the language of teacher effects to discuss these estimates, the improved match quality from a repeat student-teacher assignment is likely a combination of both the teacher adapting to a student and more effectively teaching that student, and the student adapting to and more easily learning from

[12]Repeat teachers must have at least one year of experience by definition

the teacher.

We also find substantial heterogeneity in the effect of repeat teachers across student demographic and achievement groups. High achievers and white female students have larger tests score gains in years with repeat teachers compared to their classmates. However, the opposite is true for behavioral outcomes. Students with lower test scores and male students of color have a greater reduction in absences and suspensions compared to their peers.

Documenting the potential gains from student-teacher match quality is important because policies to improve matches within schools can improve student outcomes. The type of repeated student-teacher interactions we identify are generally an unintentional side effect of teachers moving between grades and subjects or teaching multiple grades and subjects at the same time. Despite the idiosyncratic nature of these repeat interactions, they still have a positive effect on student test scores and behaviors.

Our results are consistent with the literature on the importance of student-teacher relationships in building academic and socioemotional skills. Educating students is an inherently interpersonal endeavor. Caring relationships between teachers and students foster a sense of belonging for students and create classroom climates where students are poised to do their best learning. Repeat students and teachers have more time to get to know each other's teaching styles and learning needs, as well as to develop stronger, more trusting relationships. This can be particularly important in high school where teachers often have well over 100 students in a school year. Investing in efforts to improve student-teacher relationships – even in instances where teachers have students for only a single year — may well improve students' academic and behavioral outcomes.

Although the benefits of unintentional repeat student-teacher matches are relatively small, our estimates also likely understate the effects of more formal efforts to create repeat pairings between teachers and students such as intentional looping.

With intentional loops, teachers can realize other benefits, such as adjusting the content of classes over two years in order to maximize learning. That students, both those with repeat teachers and those without, have higher test scores in classrooms in which more than half the students have had the teacher before is further suggestive evidence of additional benefits from planned looping. These findings point towards the potential to increase school productivity by improving student and teacher assignment policies to allow for more sustained relationships over time.

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9 Tables

Table 1: Repeater and Non-Repeater Characteristics

	Panel A: Student Characteristics			
	Full Sample	Students with a Repeat Teacher	Students without a Repeat Teacher	Difference
	(1)	(2)	(3)	(4)
FRPL	0.488	0.501	0.488	0.013***
SPED	0.069	0.068	0.069	-0.001***
Female	0.499	0.499	0.499	0.000***
EL	0.03	0.018	0.031	-0.013***
White	0.683	0.78	0.679	0.101***
Black	0.231	0.161	0.234	-0.073***
Hispanic	0.062	0.043	0.063	-0.020***
Asian	0.018	0.01	0.018	-0.008***
Lagged Math	0.07	0.036	0.072	-0.036***
Lagged Reading	0.06	0.029	0.061	-0.032***
Lagged Suspend	0.112	0.106	0.112	-0.006***
Lagged Absent	7.69	7.44	7.7	-0.260***
Lagged Truant	2.837	2.57	2.84	-0.270***
n(Student-Years)	3,683,583	3,407,570	276,013	
	Panel B: Teacher Characteristics			
	Teachers with Full Sample	Teachers with >10% repeaters	<10% repeaters	Difference
	(1)	(2)	(3)	(4)
Experience	11.35	12.31	11.22	1.086***
White	0.864	0.883	0.862	0.021***
Black	0.13	0.112	0.132	-0.020***
Hispanic	0.002	0.001	0.002	-0.001**
Age	41.57	42.4	41.44	0.956***
Female	0.857	0.832	0.861	-0.029***
Masters Degree	0.569	0.603	0.565	0.038***
Lagged VAM	0.011	0.003	0.011	-0.008***
n(Teacher-Year)	154,159	17,646	136,513	

Note. FRPL stands for free or reduced price lunch eligibility. SPED stands for special education status. EL stands for English learner status. VAM stands for for teacher value added score. Table contains all student-by-year observations in which a student is taking one of the following courses: Math 4 - Math 8, Reading 4 - Reading 8, Algebra II, Geometry, English II, English III. "Repearters" have a repeat teacher in at least one of those subjects, "Nonrepeaters" have no repeat teachers. The raw difference column is the the mean difference in characteristic between repeaters and non-repeaters with a two mean t-test. Significance levels: *0.1 **0.05 ***.01.

Table 2: Repetition by Grade and Subject

	Students		Teachers				
	n	% Repeat	n	>0%	≥10%	≥50%	≥90%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: TCAP Math Tests							
4th Grade	578,068	0.023	27,302	0.06	0.054	0.02	0.002
5th Grade	572,874	0.034	21,718	0.094	0.083	0.035	0.007
6th Grade	570,421	0.027	12,677	0.092	0.076	0.045	0.011
7th Grade	563,728	0.043	11,571	0.16	0.141	0.086	0.022
8th Grade	527,144	0.11	11,041	0.328	0.287	0.177	0.053
Total	2,812,235	0.046	84,309	0.119	0.104	0.055	0.013
Panel B: TCAP ELA Tests							
4th Grade	607,206	0.022	29,192	0.061	0.056	0.023	0.003
5th Grade	636,073	0.034	24,685	0.094	0.084	0.037	0.007
6th Grade	718,405	0.027	17,287	0.087	0.075	0.044	0.01
7th Grade	716,328	0.051	15,590	0.185	0.164	0.102	0.026
8th Grade	703,402	0.109	14,748	0.327	0.296	0.186	0.059
Total	3,381,414	0.049	101,502	0.128	0.115	0.063	0.016
Panel C: High School EOC Tests							
Algebra II	402,854	0.055	7,543	0.303	0.193	0.04	0.009
Geometry I	171,141	0.052	3,014	0.305	0.209	0.068	0.019
English II	719,320	0.056	13,595	0.243	0.188	0.075	0.023
English III	390,707	0.095	7,656	0.364	0.298	0.121	0.04
Total	1,684,022	0.064	31,808	0.303	0.223	0.074	0.016

Note. Columns "n" and" "% Repeat" under student are the total number of student-year observations for each subject and the percentage of those students that have a repeat teacher in a different grade or EOC subject. Columns "n," "≥0%," "≥10%," "≥50%," and "≥90%" under teacher contain the number of teacher-year observations in each tested subject and the percentage of those teacher-year observations that have any, 10%+ , 50%+ , and 90%+ repeat students for that subject respectively. TCAP referes to Tenessee Comprehensive Assessment Program. EOC refers to end of course exams.

Table 3: Paths of Repeat Teachers

	Number of Teachers	Teaches Multiple Grades	New to Grade or EOC test	Same Tests Last Year	Stays in Grade Next Year
	(1)	(2)	(3)	(4)	(5)
Panel A: TCAP Math Tests					
4th Grade	874	15.3%	86.5%	9.5%	67.0%
5th Grade	1,034	26.2%	66.8%	26.0%	67.3%
6th Grade	522	52.5%	52.7%	37.9%	63.2%
7th Grade	875	74.4%	37.8%	49.8%	75.3%
8th Grade	1,708	71.7%	30.6%	59.5%	76.3%
Panel B: TCAP ELA Tests					
4th Grade	963	19.1%	85.6%	10.3%	63.6%
5th Grade	1,204	29.2%	66.9%	26.7%	62.7%
6th Grade	704	58.5%	48.6%	41.8%	62.8%
7th Grade	1,376	76.9%	38.7%	51.2%	68.7%
8th Grade	2,369	72.4%	30.9%	60.7%	73.7%
Total TCAP Math and ELA Tests	11,611	54.0%	49.9%	41.8%	69.5%
Panel C: High School EOC Tests					
Algebra II	1,026	58.3%	43.8%	50.2%	75.0%
Geometry	325	71.7%	72.6%	23.1%	70.5%
English II	1,620	71.2%	36.0%	55.8%	71.1%
English III	1,500	69.0%	42.3%	52.3%	72.7%
Total	4,450	67.5%	42.5%	51.0%	72.5%

Note. Column 1 indicates the number of teachers tested in a grade and subject combination for teachers with at least 10% repeat students with available data for the year before and after they are repeat teachers. Column 2 is the percent of repeat teachers that have students in multiple grades (for grades 4-8) or tests (EOC subjects in high school.). Column 3 is the percent of teachers who were not teaching in a given grade and subject combination during the prior year, "same tests last year" indicates that teachers taught the exact same tests in the previous year (for example taught both 6th and 7th grade math both years.) "Stays in grade next year" indicates teachers that continue teaching in the subject the following year. TCAP referes to Tenessee Comprehensive Assessment Program. EOC refers to end of course exams.

Table 4: Effects of Repeat Student-Teacher Matches

	All Grades		Grades 3 - 8		High School	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Achievement Outcomes						
Math and ELA Test Scores	0.019***	0.024***	0.012***	0.023***	0.017 ***	0.026***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
n(student-years)	8,039,335	7,179,281	5,675,085	5,213,443	2,295,120	1,965,836
Math Test Scores	0.032***	0.022***	0.024***	0.018***	0.041***	0.026***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.004)
n(student-years)	3,364,006	3,156,440	2,358,861	2,356,010	733,428	800,424
ELA Test Scores	0.015***	0.025***	0.013***	0.026***	0.007**	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)
n(student-years)	4,300,688	3,963,516	2,878,113	2,811,876	1,252,531	1,151,634
Panel B: Behavioral Outcomes						
Total Absences (log[+ 1])	-0.005***	-0.013***	-0.001	-0.013***	-0.006***	-0.015***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)
Ever Suspended	-0.010***	-0.017***	-0.006***	-0.017***	-0.003**	-0.012***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Total Truancies (log[+1])					-0.003	-0.016***
					(0.002)	(0.004)
n(student-years)	8,039,335	7,179,281	5,675,085	5,213,443	2,295,120	1,965,836
District x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Student FE	Yes		Yes		Yes	
Lagged Outcome		Yes		Yes		Yes

Note. Table contains main results for the effect of having a repeat teacher on students' cognitive and non-cognitive outcomes. Columns 1 & 2 contain pooled estimates for all grades, 3 & 4 for grades 3-8, and columns 5 & 6 for High School EOC exams along. Panel A includes cognitive results for high pooled math and reading, math alone, and reading/ELA alone. Panel B includes non-cognitive results for ln(1+total absences), ln(1+total truancies), and an indicator for whether the student had been suspended during the year. All specifications include controls for class and school level demographics including race, gender, ELL status, FRPL status, and lagged test scores, absences, and suspension as well as teacher experience controls. All columns also include district-by-year FE. Lagged columns also contain controls for student demographics, a cubic in lagged test scores (or 8th grade test scores for high schol students), and lagged absences and suspension. FE columns also contain student fixed effects and time-varying student controls. Robust standard errors in parentheses. Significance levels: *0.1 **0.05 ***.01.

Table 5: Alternative Specifications

	Teacher FE		Teacher Value Added Sample				Alternative FE		
							School	School	Teacher
	FE	Lagged	FE	Lagged	FE	Lagged	by Year	by Year	by Year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Math and ELA Test Scores	0.010***	0.012 ***	0.009***	0.015***	0.009***	0.014***	0.008***	0.011***	0.012***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Total Absences (log[+ 1])	-0.010***	-0.025***	-0.009***	-0.024***	-0.009***	-0.012***	0.001	-0.024***	-0.023***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.002)	(0.002)
Ever Suspended	0.002***	-0.007***	0.002***	-0.007***	0.002***	-0.007***	0.003***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(004))	(0.001)
n(student-years)	7,882,858	7,055,755	5,714,747	5,181,662	5,714,747	5,181,662	8,039,335	7,179,281	7,179,281
District x Year FE	Yes	Yes	Yes	Yes	Yes	Yes			
Student FE	Yes		Yes		Yes		Yes		
Lagged Outcomes		Yes		Yes		Yes		Yes	Yes
Teacher FE	Yes	Yes					Yes	Yes	
VAM Controls					Yes	Yes			
School x Year FE							Yes	Yes	
Teacher x Year FE									Yes

Note. Columns 1-6 directly control for teachers and include the controls from our preffered specification from Table 4 with modifications to sample and/or control variables. Columns 1 & 2 additionally include teacher fixed effects. Columns 3 & 4 contain the preferred results specification on the sample of teachers with lagged value added scores. Columns 5 & 6 additionally include controls for those lagged value added scores. Columns 7 & 8 additionally control for school-by-year rather than district-by-year fixed effects. Column 9 additionally controls for teacher-by-subject-by-year (classroom) fixed effects in the lagged outcome specification. Robust standard errors in parentheses. Significance levels: *0.1 **0.05 ***.01.

Table 6: Selection

	Preferred		One Teacher per Grade		Same Grades Last Year		This Grade Last Year	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: All Grades Math and Reading/ELA Teachers								
Math and ELA Test Scores	0.019***	0.024***	0.013***	0.020***	0.011***	0.016***	0.009***	0.017***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Total Absences (log[+ 1])	-0.005***	-0.013***	-0.004	-0.037***	-0.011***	-0.028***	-0.010***	-0.028***
	(0.001)	(0.001)	(0.004)	(0.005)	(0.003)	(0.003)	(0.002)	(.002))
Ever Suspended	-0.010***	-0.017***	0.000	-0.009***	0.001	-0.009***	0.001	-0.008***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
n(student-years)	8,039,335	7,179,281	973,197	986,890	5,300,457	4,498,884	5,343,669	4,876,173
Panel B: High School EOC Math and ELA Teachers								
Total Truancies (log[+1])	-0.003	-0.016***	0.004	-0.040***	0	-0.018***	-0.006	-0.021***
	(0.002)	(0.004)	(0.011)	(0.011)	(0.004)	(0.005)	(0.004)	(0.005)
n(student-years)	2,295,120	1,965,836	114,991	142,176	1,247,208	1,178,090	1,380,553	1,277,974
District x year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Student FE	Yes		Yes		Yes		Yes	
Lagged Outcome		Yes		Yes		Yes		Yes

Note. The preferred columns are the results from table 4. Columnns 3 & 4 contain the subsample of schools for which there is only a single teacher for each tested grade/subject. Columns 5 & 6 contain the subsample of teachers that taught the same combination of grades/subjects during the previous year. Column 7 & 8 contain the subsample of teachers that taught in this specific subject in the previous year regardless of the other subjects they taught in that year. Robust standard errors in parentheses. Significance levels: *0.1 **0.05 ***.01

Table 7: Student Heterogeneity by Prior Achievement, Race, and Gender

	Math and ELA Test Scores		Total Absences (log[+1])		Ever Suspended	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Heterogeneity by Prior Student Achievement						
Repeat student	-0.002	-0.003	-0.013***	-0.035***	0.004***	-0.017***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)
Repeat student*2nd quartile	0.002	0.002	0.004	0.014***	-0.004**	0.007***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.001)	(0.002)
Repeat student*3rd quartile	0.015***	0.016***	0.004	0.017***	-0.005***	0.012***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.001)	(0.002)
Repeat student*4th quartile	0.022***	0.043***	-0.001	0.017***	-0.001	0.023***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.001)	(0.002)
Panel B: Heterogeneity by Student Race and Gender						
Repeat student	0.017***	0.014***	0.002	-0.014***	0.002**	0.002**
	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)
Repeat student*white male	-0.008***	-0.001	-0.009**	-0.006***	0.002	-0.013***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)
Repeat student*female of color	-0.017***	-0.015***	-0.014***	-0.015***	0.003*	-0.014***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.002)	(0.002)
Repeat student*male of color	-0.011***	-0.001	-0.034***	-0.039***	-0.004***	-0.018***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)
n(student-years)	7,008,620	7,899,958	7,008,620	7,899,958	7,008,620	7,899,958
District x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Student FE	Yes		Yes		Yes	
Lagged Outcome		Yes		Yes		Yes

Note. Each column is a regression that includes an indicator variable "Repeat" that equals 1 when a student is repeating with a teacher and interaction variables that equal 1 when a student both has a repeat teacher and is a member of the indicated group. The "Repeat *" effect is the marginal effect of repeating for a member of the indicated group, compared to the effect of repeating for the omitted group (first quartile students and white female students, respectively.) Robust standard errors in parentheses. TCAP referes to Tenessee Comprehensive Assessment Program. Significance levels: *0.1 **0.05 ***.01.

Table 8: Heterogeneity by Concentration of Repeat Students and Spillover Effects

	Math and ELA Test Scores		Total Absences (log[+1])		Ever Suspended	
	(1)	(2)	(3)	(4)	(5)	(6)
Repeat student	0.003**	0.004**	-0.007**	-0.008***	-0.003***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
High repeat class (>50% repeat students)	0.006**	0.005*	0.000	0.024**	-0.020***	-0.011***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)
Repeat student*High-repeat class (>50% repeat students)	0.016***	0.020***	0.003	-0.032***	0.006	-0.004**
	(0.003)	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)
n(student-years)	8,203,126	7,159,550	8,203,126	7,159,550	8,203,126	7,159,550
District x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Student FE	Yes		Yes		Yes	
Lagged Outcome		Yes		Yes		Yes

Note. Student repeating is an indicator that a student has had a teacher in the past. High-repeat class indicates years when a student is in a class where at least 50% of students are repeaters. Student repeating in a high-repeat class is specified by the interaction of indicators for student repeating and student in a high-repeat class (≥50% repeaters). Robust standard errors in parentheses. Significance levels: *0.1 **0.05 ***.01.

Table 9: Heterogeneity by Teacher Experience

	Math and ELA Test Scores		Total Absences (log[+1])		Ever Suspended	
	(1)	(2)	(3)	(4)	(5)	(6)
Repeat student	0.007***	0.010***	-0.004***	-0.018***	-0.004***	0.006***
	(0.002)	(0.003)	(0.003)	(0.005)	(0.001)	(0.001)
Repeat student*teacher with 5-9 years experience	0.003	0.003	-0.006*	-0.009*	-0.003***	-0.005**
	(0.003)	(0.003)	(0.003)	(0.005)	(0.001)	(0.002)
Repeat student*teacher with 10-17 years experience	0.005*	0.003	-0.005*	-0.004	0.001	0.003
	(0.003)	(0.003)	(0.003)	(0.005)	(0.001)	(0.002)
Repeat student*teacher with $\geq$18 years experience	0.004	-0.001	-0.003	-0.003	-0.003**	-0.002
	(0.003)	(0.003)	(0.003)	(0.005)	(0.001)	(0.002)
n(student-years)	8,039,335	7,179,281	8,039,335	7,179,281	8,039,335	7,179,281
District x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Student FE	Yes		Yes		Yes	
Lagged Outcome		Yes		Yes		Yes

Note. Repeat is an indicator that a student is repeating with a teacher. Repeat X group are indicators that a student is repeating with a teacher and that teacher belongs to that group. The repeat X variables are the marginal, or additional effect of repeating with a teacher that is a member of the indicated group relative to the omitted group, teachers in the first quartile of measured VAM and teachers with less than 5 years of experience respectively. Robust standard errors in parentheses. Significance levels: *0.1 **0.05 ***.01