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Representation in the classroom: The effect of own-race teachers on student achievement

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ABSTRACT

Previous research suggests that there are academic benefits when students and teachers share the same race/ethnicity because such teachers can serve as role models, mentors, advocates, or cultural translators. In this paper, we obtain estimates of achievement changes as students are assigned to teachers of different races/ethnicities from grades 3 through 10 utilizing a large administrative dataset provided by the Florida Department of Education that follows the universe of test-taking students in Florida public schools from 2001–2002 through 2008–2009. We find small but significant positive effects when black and white students are assigned to race-congruent teachers in reading (.004–.005 standard deviations) and for black, white and Asian/Pacific Island students in math (.007–.041 standard deviations). We also examine the effects of race matching by students' prior performance level, finding that lower-performing black and white students appear to particularly benefit from being assigned to a race-congruent teacher.

1. Introduction

Minority teachers are underrepresented in American public schools (Ingersoll & May, 2011; Kirby, Berends, & Naftel, 1999; Villegas, Strom, & Lucas, 2012). Though concerning in any profession, the disproportionate number of minority teachers is particularly noteworthy because a growing body of research suggests that minority students could benefit from assignment to teachers of their own race/ethnicity (Clotfelter, Ladd, & Vigdor, 2007; Dee, 2004; Ehrenberg, Goldhaber, & Brewer, 1995; Meier, Wrinkle, & Polinard, 1999; Pitts, 2007). If that is indeed the case, then the underrepresentation of minority teachers in schools could be a contributing factor to the racial test score gap in the United States.

Many practitioners, policymakers, and others in the education community have claimed that minority teachers are uniquely positioned to improve the performance of minority students directly or indirectly, by serving as role models, mentors, advocates, or cultural translators for those students (Adair, 1984; Graham, 1987; King, 1993; Ladson-Billings, 1992; Pitts, 2007; Stewart, Meier, & England, 1989). This has resulted in calls from prominent politicians and education administrators for the large-scale recruitment of minority teachers (see, for example, U.S. Department of Education, 2010). In some cases, state policies have been enacted to recruit minority teachers. For example, Florida adopted a

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strategy in 1996 to recruit and train more minority teachers by offering an annual scholarship of up to $4000 for African-American, Hispanic-American, Asian-American, and Native American students in Florida's public or private universities that are admitted into a teacher education program (Florida Fund for Minority Teachers, Inc., 2014).

Whether or not assignment to a teacher of the same race/ethnicity is related to student achievement is an empirical question that has yet to be fully resolved. The analyses presented in this paper add to a growing body of research by taking advantage of a large dataset that includes approximately three million students linked to 92,000 teachers over a period of seven years throughout the Florida public school system. Following the performance of individual students across an entire state as they are assigned to teachers of different race/ethnicities throughout their elementary and secondary education provides an especially rigorous test of the claims that minority teachers can boost the performance of minority students in both elementary and middle/high school grades.

We find that student math and reading achievement is significantly, positively influenced by the race/ethnicity of their teacher. Specifically, student math achievement increases by .008 standard deviations (SD) in math and .001 SD in reading. Although small, the overall match effect masks important heterogeneity by race. Results for black and white students are significantly positive in reading, with effect sizes of .004 and .005 SD, respectively. In math, results for black, white, and Asian students are .019, .007, and .041 SD, respectively. The largest positive impacts observed are for Asian students in grades six through ten, where student/teacher race matching is associated with a math achievement increase of .053 SD. Results for Hispanic students provide a notable exception to these findings and are discussed in further detail below.

The remainder of this paper proceeds as follows. In Section 2 we review the relevant literature on the effects of student/teacher race matching. In Section 3 we describe the data employed in this analysis and the student/teacher matching process. In Section 4 we present our empirical strategy. In Section 5 we present the primary results as well as additional analyses that evaluate our findings with regard to student performance levels. We discuss the results and the limitations of the study in the final section.

2. Literature

A number of theories exist to explain the mechanisms by which assignment to an own-race/ethnicity teacher might influence a student's achievement. Minority teachers may influence minority students in a passive way, by indirectly serving as role models (Adair, 1984; Graham, 1987; Hess & Leal, 1997; Stewart et al., 1989). If this is the case, students may respond to demographically similar role models by raising their motivation and personal expectations.[3] The presence of a demographically similar teacher may also reduce race/ethnicity-based "stereotype threat" (Steele, 1997; Steele & Aronson, 1995), which occurs when a student perceives that (s)he could be viewed through the lens of a negative stereotype and lowers academic engagement and performance as a result.

Assignment to a demographically similar teacher may also affect student achievement more directly if teachers display unintended biases or different expectations for students with different demographic traits than their own (Baron, Tom, & Cooper, 1985; Cahnmann & Remillard, 2002; Ferguson, 1998; McLoyd, 1998). In their 1995 study, Ehrenberg et al. found that teachers' race, gender, and ethnicity were likely to influence teachers' subjective evaluations of their students. These and related findings have been used to support policies for rigorous recruitment of minority teachers.

Although there is broad belief in the importance of race in student–teacher relationships, it has proved challenging to measure the impacts of these racial pairings on student achievement in a rigorous way, resulting in a relatively small body of empirical support. Dee (2004) provided the first experimental analysis of the relationship between teacher race/ethnicity and student achievement, yet his analysis is limited to grades K-3.[4] Dee analyzed test score data for black and white students participating in Tennessee's Project STAR, a four-year, large-scale randomized experiment designed to measure the relationship between class size and student achievement. Dee found evidence that assignment to an own-race/ethnicity teacher increases the math and reading achievement of both black and white students by between .6 and 6 percentile points.

Clotfelter, Ladd, and Vigdor (2007) affirmed Dee's findings for elementary students using panel data from North Carolina. Conversely, Howsen and Trawick (2007) analyzed a cross-sectional dataset comprised of Kentucky third-graders in 1989–1990 with an observational model that included control variables meant to capture the effect of "student innate ability," measured by a cognitive skills index, and found no statistically significant effect on student achievement. However, these studies were limited to early grades and did not consider effects for older students for whom racial/ethnic identity is enhanced. Indeed, with the exception of Ehrenberg et al. (1995) and Ehrenberg and Brewer (1995), there has been scant research on this topic at the secondary school level.

Using data from the National Educational Longitudinal Study of 1988, Ehrenberg et al. (1995) tested the race-matching hypothesis by examining students' performance gains from 8th grade to 10th grade. They were unable to control for the characteristics of the students' 9th grade teachers, however, which makes it impossible to identify if the students experienced a race-match in that intervening year or not. This significant limitation makes it difficult to interpret their null findings. In another study analyzing secondary students' outcomes, Ehrenberg and Brewer (1995) demonstrated test score improvements for black students assigned to black teachers.

[3] A related line of research has explored the relationship between teacher gender and student achievement, with mixed results (Bettinger & Long, 2005; Dee, 2005; Ehrenberg et al., 1995; Gibb, Fergusson, & Horwood, 2008; Neumark & Gardecki, 1998; Nixon & Robinson, 1999; Robst, Keil, & Russo, 1998; Winters et al., 2013).

[4] The bulk of the evidence that classroom interactions between white teachers and minority students may be a contributing factor to the black–white achievement gap had been under-developed up until that point (Crain & Mahard, 1978; Darkenwald, 1975; Ehrenberg et al., 1995; Farkas, Grobe, Sheehan, & Shauan, 1990; Glick, 1971; Maynor & Katzenmeyer, 1974; Ohberg, 1972; Sanders, 1984).

Their analysis, however, was not robust to specifications that addressed the simultaneous determination of teacher characteristics and relied upon "synthetic" gain scores. Thus, the rich data and the extended age range examined in this study are of particular importance, especially in light of established theories of racial and ethnic identity. Phinney (1989), for example, suggested that ethnic identity development is a facet of adolescence. Similarly, Erikson (1968) identified the development of an individual's identity as an important psychosocial task associated specifically with adolescence.

Related research that indirectly addresses this topic includes research that examines teachers' subjective evaluations of students' classroom behaviors and scholastic aptitude, which may also be influenced by race/ethnicity (Ehrenberg et al., 1995; Ouazad, 2014). Multiple ethnographies in K-12 schools, for example, have reported perceptions among teachers of "whiteness" corresponding with intelligence (Morris, 2005; Staiger, 2004; Tyson, 2003). Ehrenberg et al. (1995) examined the influence of race/ethnicity-matches on teachers' subjective evaluations of students. They showed that both black and white teachers tend to give higher subjective evaluations to students of the same race/ethnicity. Similarly, Ouazad (2014) showed that teachers give more favorable assessments of ability to same-race students.

A recent analysis of the 2002 Education Longitudinal Study by McGrady and Reynolds (2012) also revealed significant mismatch effects on subjective evaluations of classroom behavior and perceptions of scholastic aptitude across racial/ethnic groups. McGrady and Reynolds found that both Hispanic and black students evaluated by white teachers had lower odds of being rated attentive than white students. In contrast, Asian students had higher odds of being rated hard working, attentive, and not disruptive than white students. In terms of scholastic ability, relative to white students, the authors found that in three of four outcome measures, white teachers rated black students as having lower scholastic aptitude and rated Asian students as having higher aptitude. Using panel data from the National Education Longitudinal Study of 1988, Dee (2005) found that the odds that a teacher will report a student as inattentive are 33% higher when the teacher and student do not share a common race/ethnicity. Similarly, the odds that a teacher will report a student as rarely completing homework are 22% higher when the teacher and student do not share a racial/ethnic designation. Finally, Casteel (1998) examined the interactions between students and teachers and found that black students were not treated as favorably by their teachers as their white counterparts.

In this paper, we make an important contribution to the existing literature by analyzing student achievement outcomes using a large administrative dataset of student-level data provided by the Florida Department of Education. As is the case nationally, minority teachers are underrepresented in Florida public schools. The ratio of white students to white teachers is much smaller than the comparable statistics for black and Hispanic students (Table 1). In the fall of 2002, the first year in our data, there were 10.8 white students per white teacher, compared to 26.5 black students per black teacher, 41.4 Hispanic/Latino students per Hispanic/Latino teacher, and 47.1 Asian students per Asian teacher.

Table 1
Ratio of students to teachers by same-race groupings.

Year	White	Black	Hispanic/Latino	Asian
2002–2003	10.8:1	26.5:1	41.4:1	47.1:1
2003–2004	10.1:1	25.4:1	40.3:1	42.7:1
2004–2005	9.7:1	23.4:1	37.4:1	38.3:1
2005–2006	9.3:1	22.5:1	36.7:1	35.4:1
2006–2007	8.8:1	21.5:1	34.7:1	33.0:1
2007–2008	8.4:1	21.2:1	34.1:1	30.7:1
2008–2009	8.2:1	21.2:1	32.2:1	31.2:1

Source: Florida Department of Education, student and teacher demographic files for selected years.

Our dataset allows us to follow a substantially large number of students in elementary through high school grades over a period of seven years, allowing us to estimate how the same students fare when assigned to a teacher of similar race/ethnicity as they proceed through grades three through ten, tracking changes in achievement at the individual level. This allows us to examine whether the academic performance of students whose teachers' racial/ethnic background does not match their own is significantly different from when those students are assigned to teachers that share a common racial/ethnic background, ceteris paribus.

3. Data

The student-level dataset we use contains observable characteristics for the universe of test-taking Florida public school students in grades three through ten for each year from 2001–2002 through 2008–2009. In addition to student demographic information, the dataset includes each student's test scores on the math and reading portions of the state-mandated standardized exam, the Florida Comprehensive Assessment Test (FCAT).[5]

A unique student identifier allows us to track students as they progress from grade to grade and a classroom identifier allows us to link students to teachers through a complex matching algorithm. Over 2.9 million students linked to more than 92,000 teachers are represented in the dataset. The teacher/student matching process is possible because the data include a unique identifier for each specific class (i.e. A grouping of students being taught by a particular teacher in a given year) that appears in both the student and teacher datasets. This allows us to match students to particular teachers and classrooms over time. Moreover, the dataset includes a unique identifier for the course number of a class that allows us to identify the class subject.

[5] The Florida Department of Education publishes comprehensive information including technical reports, frequently asked questions, and an overview of the Florida Comprehensive Assessment Test (FCAT) on their website (www.fldoe.org). A 2011 report by the National Center for Education Statistics that mapped individual state assessments on the National Assessment of Educational Progress (NAEP) scale, categorized Florida's reading and math tests as having similar proficiency standards as 13 other states at grade 4 and 28 other states at grade 8 (Bandeira de Mello, 2011). The FCAT math and reading results have also been shown to be highly correlated with results from a standardized, nationally normed test, the Stanford 9, which suggests that studies using FCAT data can be reliably generalized to other states (Greene, Winters, & Forster, 2004).

Table 2
Teacher/student matching success.

Grade	Reading, all years			Math, all years		
	Student observations by subject, grade, year	Number of student observations matched to teachers	Proportion of student observations matched to teachers	Student observations by subject, grade, year	Number of student observations matched to teachers	Proportion of student observations matched to teachers
3	1,335,014	1,281,584	96.00%	1,370,461	1,329,091	96.98%
4	1,260,959	1,219,521	96.71%	1,141,304	1,103,911	96.72%
5	1,262,880	1,224,179	96.94%	1,306,640	1,269,755	97.18%
6	1,275,768	1,231,046	96.49%	1,314,489	1,271,074	96.70%
7	1,358,973	1,297,608	95.48%	1,317,260	1,272,986	96.64%
8	1,353,926	1,296,099	95.73%	1,284,199	1,238,832	96.47%
9	1,429,970	1,354,959	94.75%	1,416,835	1,349,387	95.24%
10	812,891	766,967	94.35%	1,081,031	1,029,360	95.22%
Total	10,090,381	9,671,963	95.85%	10,232,219	9,864,396	96.41%

Source: Data from the Florida Education Data Warehouse, 2001–2002 through 2008–2009.

One challenge of the matching process is that students are occasionally assigned to more than one classroom and/or more than one teacher for a given academic subject. This could complicate our analysis because the unit of observation must be a single child-year observation and his/her pairing with a single teacher for each subject per year. As such, in creating the merged dataset to run our analysis, we credit only one teacher as responsible for each child's academic growth in math or reading. This is easily addressed at the elementary level, where it is typically the case that the child's main classroom teacher is primarily responsible for that child's math and reading achievement. In the case of middle and high school, we have to employ a more complex matching process in order to arrive at a single student-year observation matched to a single teacher-year observation.

We first match students to teachers using the classroom identifier present in both sets of data files. This results in multiple student/teacher matches but most of these occur across subjects (e.g., a student is matched to a biology teacher and also a math teacher). Multiple matches within subjects rarely occur. We then employ a series of screening rules to eliminate multiple student–teacher-year matches so that students are matched to the teacher most responsible for that student's score in a particular subject. Similar screens were recently imposed in another paper using these Florida data (Winters, Haight, Swaim, & Pickering, 2013). The first screen identifies students enrolled in a general class (i.e. a class designated as "Third Grade"). For grades six through ten we start at the second screen. This involves matching students to teachers in classes aligned with the particular subject that is under consideration, either math or reading. In the third screen, we exclude any matches where the teacher is classified as "part time". Part time teachers in Florida typically serve as aides to the main teacher, handle special instructional interventions, or are filling in temporarily while the classroom teachers is on some form of leave. By excluding them, we ensure that our matching process comes as close as possible to aligning students with teachers who are primarily responsible for their education in a given subject. Through this screening process, over 96% of students were successfully matched to teachers. The small number of students who could not be reliably matched to a single teacher were dropped from the dataset. Table 2 demonstrates match success rates, by grade.

4. Empirical strategy

We use student fixed effects to estimate the relationship between student/teacher race-matching and student achievement. This procedure eliminates potentially biasing unobservable student characteristics by estimating the coefficients within, rather than between students. We estimate models taking the form:

$$Y_{ijkst} = \beta_0 + \beta_1 Z_{ijkst} + \beta_2 RaceMatch_{ijkst} + \beta_3 X_{st} + \phi_t + \alpha_i + \gamma_{it} + \tau_k + \varepsilon_{ijkst} \quad (1)$$

where Y_{ijkst} is the test score of student i, assigned to teacher j, in course k, and school s, during year t. Z is a vector of teacher characteristics including the years of experience, years of experience squared (to allow for non-linear effects of teaching experience on student achievement), teacher race, and teacher gender. In some models, we also control for unobserved differences in teacher quality by including an estimate of teachers' value-added. We estimate teacher value-added using a two-stage average residual approach, which has been widely used in the literature (see for example, Chetty, Friedman, & Rockoff, 2014; Kane & Staiger, 2008). In the first stage, we remove the effects of student and school-level demographic control variables from current-year student scores. These control variables are student gender, free-lunch status, race, language proficiency, and prior-year test scores. We also include school-level averages for each of these variables. We fit linear models to predict the scores from these control variables and retain the residuals from these models. The second stage then estimates teacher-specific value-added scores as the average of the stage one residuals, producing separate teacher quality estimates for math and reading. As a result, we are able to isolate the additional effect of an own-race match between teachers and students, controlling for the average effect of teacher quality, as well as the average effect of teachers' race, experience, and gender.

RaceMatch is an indicator variable that equals one if there is a match between the student and teacher's race/ethnicity. X is a vector of school-level characteristics including the percent of students in a school that belong to each race/ethnicity, school-level poverty (measured by the proportion of students that qualify for the federal free and reduced price lunch program), and average school-level performance in math or

Table 3
Overall effects of teacher race/ethnicity matching on student math and reading achievement.

	Reading			Math		
	All grades (grades 3–10)	Elementary (grades 3–5)	Middle/high (grades 6–10)	All grades (grades 3–10)	Elementary (grades 3–5)	Middle/high (grades 6–10)
Student fixed effects						
Race match	.002**	.004***	−.001	.008***	.014***	.002**
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
R-squared	.85	.89	.88	.87	.90	.90
Observations	8,598,592	3,142,898	5,455,694	8,729,364	3,090,124	5,639,240
Student fixed effects, controlling for teacher quality						
Race match	.001**	.005***	−.001	.008***	.013***	.002***
	(.001)	(.001)	(.001)	(.001)	(.002)	(.001)
R-squared	.85	.89	.88	.87	.91	.90
Observations	8,226,338	2,889,193	5,337,145	8,379,356	2,837,907	5,541,449
Student and course fixed effects, controlling for teacher quality						
Race match	.002**	.004***	.000	.008***	.013***	.002***
	(.001)	(.001)	(.000)	(.001)	(.002)	(.001)
R-squared	.85	.89	.88	.87	.91	.90
Observations	8,226,338	2,889,193	5,337,145	8,379,356	2,837,907	5,541,449

Note: The dependent variable is the student's standardized score on the FCAT reading or math test. Models include controls for year, grade, teacher gender, teacher race, teacher quality (i.e. a teacher-specific, average value-added score), teacher experience, teacher experience squared, school level race, school level poverty, average school-level achievement, course fixed effects, and student fixed effects. Standard errors in parentheses are clustered at the classroom level. We also experiment with clustering the standard errors at the school and teacher level. Results do not change substantially under either of these alternative specifications and are available from the authors by request. $^{**}p < .05$, $^{***}p < .01$ (two-tailed tests).

reading. ϕ is a fixed effect for school year; α is a student fixed effect; γ is a grade-level fixed effect; τ (included in some models) is a fixed effect for the specific course a student is taking (e.g. Algebra); and ε is a stochastic error term clustered at the classroom level. β_2 is the parameter of interest.

The coefficient associated with *RaceMatch* is generated from the variation within a given student, over time. In some years, a student experiences a race match with his/her teacher, whereas in other years the student does not. The β_2 coefficient, therefore, is an estimate of the change in math or reading achievement associated with a teacher/student race match and is informed by students who have experienced both conditions—sharing a race with the teacher compared to not sharing a race with the teacher—with the student serving as his/her own counterfactual. It should be noted that the variable *RaceMatch* is constant for 59% of students, meaning those students either always had a same-race teacher or never had a same-race teacher. Such students do not contribute to the estimation of β_2.

When we analyze the effects of race matching for each race/ethnicity separately, we replace the binary *RaceMatch* indicator with a vector of indicator variables for each student/teacher match (i.e. *white student/white teacher, black student/black teacher,* etc.). Because estimates using student-fixed effects are generated within individuals, the omitted category for each racial pairing is the group of students of that same race/ethnicity when they are not matched to a race-congruent teacher.

5. Results

We first perform an analysis over the full sample, testing for the aggregate effect of any own-race/ethnicity matching in grades three through ten (Table 3). Using this approach, we find small, positive effects in both reading and math.

Table 3 presents the results of three separate models. For ease of interpretation, all test scores have been standardized within grade by year to have a mean of zero and a standard deviation of one. The first panel relies upon student fixed effects for identification, incorporating all of the control variables outlined in (i) except for average teacher quality and fixed effects for course type. The second panel presents our preferred model, which adds the teacher quality control to account for any systematic differences in teacher quality that might be associated with our variable of interest. We find significant positive impacts of .001 SD in reading and.008 SD in math in grades 3–10. Breaking these results apart by grade level, we find significant positive impacts of .005 SD in reading and .013 SD in math in the elementary grades and a significant positive impact of .002 SD in math in the middle/high school grades. To test the possibility that differences in teacher quality might be driven by unobservable characteristics related to student and teacher sorting into different subjects, the third panel incorporates course fixed effects (e.g. Algebra, Geometry), which allows us to compare student/teacher race matching effects within specific courses. This approach further reduces the potential for systematic variation in teacher quality that could potentially bias the results by estimating own-race matches within similar courses. The coefficient on *RaceMatch* continues to be positive and statistically significant in both subjects in grades three through ten under this specification. Results are generally larger in elementary grades.

In the next set of analyses, we replace the overall *RaceMatch* indicator with separate indicator variables for each same-race student/teacher pair in order to estimate which pairings are driving the results in the main specification.

Table 4 reports separate estimates of race matching on the reading achievement of black, white, Hispanic, and Asian/Pacific Islander students. For ease of exposition, the

Table 4
Effects of teacher race/ethnicity matching on student math and reading achievement, by race.

	Aggregate (grades 3–10)		Elementary (grades 3–5)		Middle/high (grades 6–10)	
	Reading (1)	Math (2)	Reading (3)	Math (4)	Reading (5)	Math (6)
Student fixed effects						
White teacher/white student	.005***	.008***	.003	.007**	.001	−.001
	(.001)	(.001)	(.003)	(.003)	(.002)	(.002)
Black teacher/black student	.005***	.018***	.013***	.029***	.003	.011***
	(.002)	(.002)	(.003)	(.004)	(.002)	(.002)
Hispanic teacher/Hispanic student	−.010***	−.008***	.079	.003	−.013***	−.009***
	(.002)	(.002)	(.004)	(.004)	(.003)	(.002)
Asian teacher/Asian student	−.008	.042***	.000	−.052	−.007	.055***
	(.000)	(.010)	(.004)	(.027)	(.018)	(.011)
R-squared	.85	.87	.89	.90	.88	.90
Observations	8,598,592	8,729,364	3,142,898	3,090,124	5,455,694	5,639,240
Student fixed effects, controlling for teacher quality						
White teacher/white student	.005***	.007***	.005	.007**	.001	−.001
	(.001)	(.001)	(.003)	(.003)	(.002)	(.002)
Black teacher/black student	.004***	.019***	.012***	.030***	.003	.012***
	(.002)	(.002)	(.003)	(.004)	(.002)	(.002)
Hispanic teacher/Hispanic student	−.011***	−.007***	−.009**	−.001	−.015***	−.007***
	(.002)	(.002)	(.004)	(.004)	(.003)	(.002)
Asian Teacher/Asian student	−.008	.041***	−.002	−.045	−.006	.053***
	(.000)	(.010)	(.031)	(.029)	(.018)	(.011)
R-squared	.85	.87	.89	.91	.88	.90
Observations	8,226,338	8,379,356	2,889,193	2,837,907	5,337,145	5541449.00
Student and course fixed effects, controlling for teacher quality						
White teacher/white student	.005***	.007***	.005	.007**	.002	−.001
	(.001)	(.001)	(.003)	(.003)	(.002)	(.002)
Black teacher/black student	.004***	.019***	.012***	.030***	.001	.012***
	(.002)	(.002)	(.003)	(.004)	(.002)	(.002)
Hispanic teacher/Hispanic student	−.009***	−.007***	−.009**	−.001	−.005	−.007***
	(.002)	(.002)	(.004)	(.004)	(.003)	(.002)
Asian teacher/Asian student	−.006	.039***	−.002	−.045	.000	.051***
	(.015)	(.010)	(.031)	(.029)	(.018)	(.011)
R-squared	.85	.87	.89	.91	.88	.90
Observations	8,226,338	8,379,356	2,889,193	2,837,907	5,337,145	5541449.00

Note: This table presents the results of two separate regressions. The dependent variable is the student's standardized score on the FCAT reading or math test. Models include controls for year, grade, teacher gender, teacher race, teacher experience, teacher experience squared, teacher race, school level race, school level poverty, average school-level achievement, course fixed effects, and student fixed effects. FLDOE includes Pacific Islanders in the Asian category. In models that include teacher quality, it is measured as that teacher's average value-added score. Standard errors clustered by classroom in parentheses.
$^{**}p < .05$, $^{***}p < .01$ (two-tailed tests).

coefficients on the control variables in this regression are not presented but they are in the expected direction.[6] As before, our preferred model incorporates student fixed effects and a control for teacher quality and is presented in the second panel of Table 4. Overall, there is a statistically significant positive achievement effect associated with race matching for black and white students in reading and for black, white, and Asian/Pacific Island students in math.

For black students, the impacts are larger in math (.019 SD) than in reading (.004 SD). This seems to be primarily driven by positive impacts in the elementary grades. For white students, we also observe a positive, statistically significant effect in both math (.007 SD) and reading (.005 SD). Breaking this apart by grade level, the math effect for white students is present in the elementary grades but not in the middle/high school grades. We also observe significant positive impacts for Asian/Pacific Island students in math (.041 SD), which appears to be driven by the positive effects of race-matching for Asian/Pacific Island students in math in the middle/high school grades (.053 SD).

For Hispanic students, the overall effects are negative, with an effect size -.011 SD in reading and -.007 SD in math. It is important to note, however, that there are data limitations that weaken our ability to effectively code own-race matches with regard to Hispanics. Florida not only has a large Hispanic population, but also a particularly diverse Hispanic population. For example, 54% of Floridian Hispanics identify as having a Caribbean origin, 17% identify as South American, 11% identify as Central American, and 15% identify as Mexican (Pew Research Center, 2010). Moreover, these Floridian Hispanics vary considerably in the degree to which they are foreign or native born. For example, 57% of Mexican Hispanics in Florida are native born, and 58% of Caribbean Hispanics are native born. At the other end of the spectrum, only 33% and 29% of Central American and South American Hispanics in Florida are native born, respectively. Unfortunately, the data do not allow us to determine how these various types of Hispanic students are matched to various types of Hispanic teachers. As a result, we would advise readers to interpret the

[6] For example, teacher experience has a small, positive, significant effect on student achievement; male teachers have a small, negative effect; and school-average test scores are positively related to student achievement.

Table 5
Effects of teacher race/ethnicity on student reading and math achievement, by students' prior performance level, all grades.

	Reading			Math		
	All grades	Elementary grades	Middle/high grades	All grades	Elementary grades	Middle/high grades
Race match	.000	−.001	−.001	.005***	.005**	.003***
	(.001)	(.002)	(.001)	(.001)	(.002)	(.001)
Race match × low performer	.006***	.019***	.004**	.007***	.015***	.003
	(.002)	(.004)	(.002)	(.001)	(.004)	(.002)
R-squared	.87	.92	.89	.89	.93	.90
Observations	5,106,697	1,443,623	3,663,074	5,177,527	1,410,310	3,767,217

Note: This table presents the results of six separate regressions. The dependent variable is the student's standardized score on the FCAT reading or math test. Low performing students are identified as students who were in the bottom tertile of performance in their grade across the entire state in the previous year. Models include controls for year, grade, teacher gender, teacher race, teacher experience, teacher experience squared, teacher quality (i.e. a teacher-specific, average value-added score), school level race, school level poverty, average school-level achievement, a dummy variable indicating low-performance and student fixed effects. FLDOE includes Pacific Islanders in the Asian category. Standard errors clustered by classroom in parentheses. $^{**}p < .05$, $^{***}p < .01$ (two-tailed tests).

results for Hispanics in Florida with caution, as our assumption of own-race matching in this case is especially weak. As a result of the significant heterogeneity of this ethnic group, it is questionable how accurate it is to broadly define matches based solely on the designation of Hispanic.

To assess whether students in a particular part of the performance distribution experience a differential benefit from the match, we create annual performance indicators that divide students into performance tertiles, by subject. For each year, students in the bottom tertile of math or reading achievement for their grade across the entire state that year receive a one for a "low-performing" indicator variable and a zero otherwise. We then lag this indicator and interact it with the contemporaneous *RaceMatch* variable to assess if students at different points along the prior year's performance distribution benefit differentially from the teacher/student race matching effect. This allows us to determine if the effect of race-matching differentially effects students who were lower-performing in the previous year.

Table 5 displays the results of teacher race/ethnicity matching on student reading and math achievement with an interaction variable identifying race-matched students who were lower performing in the prior year. Under this specification, lower-performing students appear to particularly benefit from being assigned to a race-congruent teacher. In reading, the overall match effect is insignificant while the interaction for low-performing students has an effect size of .006 SD, which is significant at $p < .01$. In math, the overall race-matching effect is .005 SD, with an interaction effect of .007 SD. These results suggest that race-matching may be particularly beneficial for lower performing students.

We also look at the differential effect of race matching on lower-performing students, by race. Table 6 shows that low-performing white students have a statistically significant interaction effect size of .016 SD in reading and .014 SD in math. For black students, the interaction effect is also significant in both reading (.020 SD) and math (.027 SD). There is no interaction effect for Asian/Pacific Island students, suggesting that the math impacts previously observed for this group are not differentially related to prior performance. Finally, we again observe a statistically significant negative effect of race-matching for Hispanic students, but only for those Hispanic students who were low-performing in the prior year.

6. Discussion

Overall, the results presented here indicate that assignment to an own-race/ethnicity teacher has positive and potentially policy relevant reading achievement impacts for black and white students, and significant math achievement impacts for black, white, and Asian/Pacific Island students. In general, the results for black and white students are strongest at the elementary level whereas results for Asian/Pacific students are strongest at the middle/high school level. We also examine the effects of race matching by students' prior performance level, finding that lower-performing black and white students appear to particularly benefit from being assigned to a race-congruent teacher. It is worth noting that although the positive effect sizes observed here might seem small, these estimates represent the achievement benefit from just one year of assignment to an own-race/ethnicity teacher. Thus, the effect sizes reported are statistically and, if compounded, also potentially policy significant.

There are a number of limitations that apply to these results. First, although our dataset is large and Florida is geographically and ethnically diverse, more research is needed to determine if these effects would be consistent in other locations, including locations outside of the United States, which has a unique history associated with race relations in schools.

Second, it could be the case that some of the positive effects of same race/ethnicity matching we observe are not the effect of race-matching but are indicative of systematic differences in teacher quality that vary by a teacher's race/ethnicity, which would be an interesting finding but one with a very different policy interpretation. In the Appendix, we provide a test of this hypothesis, which provides credible evidence that our primary results are indicative of a race/ethnicity matching effect rather than systematic differences in teacher quality by race/ethnicity. Still, though we control for the average effect of teacher race in our models, as well as incorporating a measure of average teacher quality, our results should be interpreted with caution. Future research, especially additional experimental analyses, is needed. To date, Dee (2004) has conducted the only experimental analysis on this topic. Our estimates for student/teacher race-matching for black and white students at the elementary level are consistent in directionality and size

Table 6
Effects of teacher race/ethnicity on student reading and math achievement, by students' prior performance level, all grades.

	Reading			Math		
	All grades	Elementary grades	Middle/high grades	All grades	Elementary grades	Middle/high grades
White race match	.003	.006	.001	.004**	.004	.000
	(.002)	(.005)	(.002)	(.002)	(.005)	(.002)
White race match × low performing	.016***	.030***	.013***	.014***	.016***	.008***
	(.002)	(.004)	(.002)	(.002)	(.004)	(.002)
Black race match	.003	−.006	.004	.015***	.011	.011***
	(.002)	(.006)	(.003)	(.002)	(.006)	(.002)
Black race match × low performing	.000	.020***	−.002	−.001	.027***	−.004
	(.003)	(.007)	(.003)	(.002)	(.007)	(.003)
Hispanic race match	.000	.000	−.002	−.001	.000	.000
	(.003)	(.007)	(.003)	(.002)	(.007)	(.003)
Hispanic race match × low performing	−.018***	−.014	−.020***	−.007**	−.012	−.007
	(.003)	(.008)	(.004)	(.003)	(.008)	(.004)
Asian race match	.008	.034	.003	.035***	−.043	.042***
	(.019)	(.052)	(.022)	(.012)	(.050)	(.014)
Asian race match × low performing	−.039	−.108	−.047	.020	.014	−.010
	(.053)	(.170)	(.065)	(.043)	(.111)	(.047)
R-squared	.87	.92	.89	.89	.93	.90
Observations	5,106,697	1,443,623	3,663,074	5,177,527	1,410,310	3,767,217

Note: This table presents the results of six separate regressions. The dependent variable is the student's standardized score on the FCAT reading or math test. Low performing students are identified as students who were in the bottom tertile of performance in their grade across the entire state in the previous year. Models include controls for year, grade, teacher gender, teacher race, teacher experience, teacher experience squared, teacher quality (i.e. a teacher-specific, average value-added score), school level race, school level poverty, average school-level achievement, a dummy variable indicating low-performance, and student fixed effects. FLDOE includes Pacific Islanders in the Asian category. Standard errors clustered by classroom in parentheses. $^{**}p < .05$, $^{***}p < .01$ (two-tailed tests).

to his findings. Future research could further confirm our findings using experimental data in older grades and in more locations.

Furthermore, this study does not address the mechanisms by which own-race/ethnicity teachers might influence students, either passively or actively. Further research in this area should examine a broader range of outcomes and the potential mechanisms by which these effects might occur. Still, in light of previous findings about elementary-level achievement benefits and previous findings about differential subjective evaluations and expectations for minority students, the small but significant impacts on student achievement presented here lend additional credence to the idea that increasing the amount of diversity within the teacher workforce can have positive impacts on students' performance in the classroom.

Finally, it is not yet clear if policies like the Minority Teacher Education Scholarship in Florida or similar policies, which increase the recruitment of minority teachers, can produce the same positive effects that have been observed here. In our analysis, we estimate the effects using the existing universe of teachers in Florida, while also controlling for a variety of teacher characteristics. As such, we find that given teachers of similar quality, students seem to benefit from teachers who share their race/ethnicity. It is possible, however, that newly recruited teachers will not be of similar quality. In general, it is unclear if policies designed to actively increase the presence of minority teachers will attract the kinds of teachers that will reduce the racial achievement gap. This will be an important area for future research.

Addressing the achievement gap between minority and white students is a significant policy concern that has been the subject of much debate and efforts at reform. In response to this concern, aggressive recruitment of minority teachers is one policy lever that has been proposed by leaders in the education field. Teachers of the same race/ethnicity could theoretically narrow the performance gap between students of different races/ethnicities by serving as high-quality, academic role models or because they are more inclined to hold high expectations for a student's potential. As the proportion of minority students in American schools continues to grow, it will be increasingly important to address issues of teacher recruitment and representation and learn more about the effects through rigorous investigations.

Supplementary Materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.econedurev.2015.01.007.

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