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Joshua Price
Cornell University, jap224@cornell.edu

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Abstract
The objective of this study is to determine if minority and female students are more likely to persist in a science, technology, engineering, and math (STEM) major when they enroll in classes taught by instructors of their own race or gender. I utilize within institution variation of the number of black and female instructors assigned to teach introductory STEM courses to account for systematic differences between black and female students who sort into classes taught by instructors with similar racial or gender characteristics. Results indicate that black students are more likely to persist in a STEM major if they have a STEM course taught by a black instructor. Similar to previous findings, female students are no more likely to persist when more of their STEM courses are taught by female instructors. These results suggest that policies to increase the minority representation among faculty members might also be an effective means of increasing the representation of minorities who persist and ultimately graduate within STEM fields.

Keywords
science, technology, engineering, math, STEM, minorities, gender, faculty, higher education

Comments

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The Effect of Instructor Race and Gender on Student Persistence in STEM Fields

Joshua Price[1]

Cornell University

The objective of this study is to determine if minority and female students are more likely to persist in a science, technology, engineering, and math (STEM) major when they enroll in classes taught by instructors of their own race or gender. I utilize within institution variation of the number of black and female instructors assigned to teach introductory STEM courses to account for systematic differences between black and female students who sort into classes taught by instructors with similar racial or gender characteristics. Results indicate that black students are more likely to persist in a STEM major if they have a STEM course taught by a black instructor. Similar to previous findings, female students are no more likely to persist when more of their STEM courses are taught by female instructors. These results suggest that policies to increase the minority representation among faculty members might also be an effective means of increasing the representation of minorities who persist and ultimately graduate within STEM fields.

[1] Author can be contacted at: josh.price@cornell.edu, Ives Hall Room 273, Ithaca, NY, 14853

Introduction

Historically, women and minorities have been underrepresented in science and engineering occupations. In an effort to increase the number of women and minorities in these occupations, many recent policies have been focused on increasing the number of female and minority students who enter college in science, technology, engineering, or math (STEM) fields. However, the NSF's Science and Engineering Indicators report (2008) finds that students who begin college as STEM majors have a lower probability of receiving a degree in their initial field than students in other majors. Of even greater concern is that women and historically disadvantaged minorities who initially intend to major in a STEM field are the least likely to persist toward a degree in one of these fields. For example at 4-year public universities in the state of Ohio, only 39 percent of initial STEM majors who are black persist in a STEM field after three years compared to 50 percent of white STEM Majors. Similarly, 40 percent of female STEM majors persist after three years whereas 52 percent of male students persist.

It is hypothesized that students experience better educational outcomes when they are able to interact and associate with faculty who are of their own race or gender. Thus one approach to increase the persistence of women and minority students is to increase the number of female and minority faculty in STEM departments. Female college students get better grades when a course is taught by a female instructor (Bettinger & Long, 2005; Carrell et al, 2009; Hoffman & Oreopoulos, 2009), however, these same studies indicate that female instructors do not increase future performance or persistence in the subject of the course. There even is evidence to suggest that female students who take STEM courses taught by female instructors are less likely to major in STEM fields. While there is research that links positive academic outcomes to having an own race teacher in elementary and secondary school (Klopfenstein, 2005; Dee, 2004), there is little research that identifies the causal effect of having an instructor of the same race on academic outcomes in college. The primary objective of this study is to estimate the effect of having own-race instructors on persistence in STEM fields using within institution variation of the number of black faculty assigned to teach introductory courses.

The outcome of interest in the current study is persistence in a STEM field major, with persistence being defined as entering college with the intent of majoring in a STEM field and remaining in a STEM field major in subsequent semesters. The focus is placed on the intermediate measurement of intended major in order to identify when students begin to transition from STEM to non-STEM fields while in college. Many students change their major during their first years of college (40 percent after the first year and 74 percent after the second year). With findings from previous research that faculty have the strongest influence on students within the first years of their college experience (Canes & Rosen 1995; Solnick, 1995), this study focuses on the student-faculty interaction that occurs during the freshmen year.

I use a fixed effects model to estimate the effect of STEM instructor's race on student persistence in STEM fields. The key explanatory variable is the number of STEM courses in which a student enrolls in the first semester that are taught by black instructors. I use data from the Ohio Board of Regents, which includes course enrollment data for first time freshmen who enrolled between 1998 and 2002 in all public 4-year institutions in the state of Ohio. One of the empirical challenges of identifying casual effects of instructors is that students may differentially select into courses based on the race or gender of the instructor. For example, the data used in this study indicates that courses taught by a black instructor have a 10 to 15 percent higher fraction of black students enrolled in the course.

To address this selection issue, I instrument for whether a STEM course is taught by a black instructor with the fraction of STEM courses taught by black instructors during that semester. The fraction of STEM courses taught by black instructors within an institution varies due to several factors such as recent hires, course assignments, sabbaticals, and faculty leaving the institution. I also include a measure for the total number of black faculty in STEM fields within each institution to capture factors that may change within an institution over time. I use a similar instrumental variable to estimate the causal effects of female instructors on persistence.

My IV estimates indicate that having a black instructor increases the likelihood that black students persist in a STEM field. In contrast to past studies on elementary and secondary school students (Dee, 2004), I find that black instructors in college have no effect on persistence of white students in STEM fields. These results illustrate the positive effect that own-race instructors can have on academic outcomes early on in college for underrepresented minorities. In addition, I find that female instructors do not have a positive effect on the likelihood that female students persist in a STEM field (which is consistent with past studies).

II. Background

Several theories have been presented to explain why having an instructor with similar racial or gender characteristics might increase a student's academic performance. One of the explanations most thoroughly studied in past literature is the idea that faculty members serve as a mentor or role model for students, and having a mentor or role model of the same gender or race increases academic performance (Jacobi, 1991; Crisp & Cruz, 2009). A consistent finding over time is that students tend to choose role models who have the same characteristics as themselves (Erku & Mokros, 1984; Jacobi, 1991; and Karunanayake & Nautu, 2004).

Multiple studies have examined whether having a teacher of the same gender increases academic performance of students in elementary and secondary school. Using data from the National Longitudinal Survey of Youth of 1979, Nixon and Robinson (1999) show that girls who have a female teacher in high school have higher levels of educational attainment. Using data from the National Education Longitudinal Study of 1988, Dee (2007) finds that having an own-gender teacher in 8th grade increases test scores and student engagement with academic subjects. Additionally, in a sample of high school aged students in Sweden, Holmlund and Sund (2006) show a positive association between grades of female students and female teachers.

Several studies have examined whether female role models have positive effects on academic performance on female college students. In the past it has been difficult to identify specific role models and mentors due to data constraints, so studies have utilized the gender composition of university departments as a proxy for role models or possible mentors. Rothstein (1995) utilizes data from the National Longitudinal Study of 1972 and find a positive association between the percentage of female faculty at the school and the probability that a female student attains an advanced degree. Canes and Rosen (1995) look within three institutions and find no evidence that the share of women on a department's faculty lead to an increase in the share of female majors within that department. Robst, Keil, and Russo (1998) use data from the State University of New York at Binghamton and examine the fraction of classes that are taught by female instructors. Their results indicate a positive correlation between the percentage of science and math courses taught by female instructors and retention of female students in those majors.

Although these studies describe an association between female instructors and academic outcomes for female students, they may not identify a causal relationship. More recent studies have focused on estimating the causal effect of an instructor's gender on academic outcomes of female college students, while accounting for possible selection issues. Hoffman and Oreopoulos (2009) examine the effect of female instructors in first semester courses on academic performance and the number of additional same-subject courses taken. They assert that introductory courses are chosen independent of gender of instructors and provide evidence that sections taught by female instructors (within a course) do not have a significantly higher share of female students than sections taught by male faculty. They show that female students' average grade performance is not significantly higher when their introductory courses are taught by female instructors, but male student performance decreases with female instructors. Pooling men and women and estimating the effect of same-sex instructor, they show that having an own-gender instructor in a math or science course actually decreases grade performance and the number of same-subject courses taken in later years.

Carrel et al (2009) exploit the random assignment of both students and faculty that is unique to the Air Force Academy. They find that high ability female students who have their introductory STEM courses taught by a female instructor perform better in these and additional courses and are more likely to receive a degree in a STEM field. However, when examining all female students, they find that having a female instructor in a STEM course increases performance in that course but has no significant effect on performance in subsequent courses and no effect on graduating in a STEM field. Due to the unique nature of the university where the data for this particular study comes from, the results may not generalize to other academic institutions.

Bettinger and Long (2007) use a more representative sample, including all public 4-year universities in the state of Ohio, to examine the effect that female instructors have on female students in STEM fields. They look at whether having a female instructor for a course in a particular field increases the probability of taking additional courses in that field and receiving a degree in that field. To address differential selection into courses, they instrument for having a course taught by a female instructor with a measure of the fraction of courses within a department taught by female instructors. They find mixed results of the effect of female STEM faculty on female students. For example; female faculty have a positive effect on female students taking additional courses in mathematics and geology fields but a negative effects in the fields of biology and physics. Results of these more recent studies, then, indicate that in general that there are short term benefits for female students who have courses taught by female faculty, but it remains inconclusive as to whether these short term results translate into the outcome of interest, which is remaining in a STEM field major and receiving a degree in a STEM field.

Additional studies have examined the effect that minority teachers have on the academic outcomes of minority students in elementary and secondary school. Ehrenberg & Brewer (1995) use data from the mid 1960’s and find evidence that black high school teachers are associated with higher test gains for black high school students. With more recent data, Ehrenberg, Goldhaber, and Brewer (1995) show that a teacher’s racial characteristics have no effect on how much students learn between the 8^{th} and 10^{th} grades. Using data from Texas High Schools, Klopfenstein (2005) finds that increasing the percentage of black math teachers has a significant effect on the probability that black students in a geometry class will enroll in more advanced math classes. Using data from Tennessee's Project STAR, Dee (2004) uses the random assignment of students and teachers to classes and finds that having an own-race teacher significantly increases the math and reading test scores of black students. In addition, teachers are more likely to give higher ratings to students who are of the same race as themselves (Ehrenberg et al. 1995, Dee 2005). While there is documented evidence for a positive effect in elementary and secondary school, the relationship that exists between professor and student may be quite different at the college level. There has not been any research on the effect of having a same-race teacher for college students.

This study contributes to the existing literature of the effects of own-race and own-gender instructors on academic outcomes of STEM majors in two ways. First, it is the first quasi-experimental study that identifies the own race instructor effect on persistence in STEM field. Second, it re-examines the effect that female instructors have on the decision of college students to persist towards a degree in a STEM field in a different manner than previous studies. It changes the level of analysis from course-student level to student-semester level. This allows me to simultaneously control for other courses that the student enrolls in within a given semester. Additionally, this study uses variation in the number of black and female instructors assigned to teach STEM courses within an institution over time to identify the causal effect of an own-race or own-gender instructor on persistence.

III. Data

The data for this study comes from the Ohio Board of Regents, which collects data from all public universities within the State of Ohio. One strength of such a data set is that it is large enough to have sufficient power to separate the sample into small groups based on race and gender and detailed enough to match students to the instructor of each course in which they enrolled. The data consist of first-time freshmen who enrolled in one of the 13 public 4-year universities in the state of Ohio between 1998 and 2002. Three sources of student-level data are included in the present analysis: (1) information the school receives when the student first enrolls, including gender, race, age, standardized test score (ACT or SAT) and state of residence; (2) information the school records each term, such as term grade point average and intended major field of study, and (3) the courses in which each student enrolled for each term up to six years after initial enrollment. In addition there is information on each faculty member, such as race, gender, tenure status, rank, and highest degree earned which I can match with each course taught. This allows me to match each student with the instructor of every course in which they enrolled.

One of the difficulties of examining the effect of minority instructors on academic outcomes is that many data sets have a small number of observations of either the number of minority students or minority faculty. The Ohio data used in this paper includes information on 14,448 black students and 1,613 black faculty, making it possible to estimate the effects of having a black instructor on academic outcomes for black college students. Another advantage of using data from Ohio is that the demographic characteristics of students who attend public 4-year universities in the state are similar to nationally representative samples.[2]

[2] For a more detailed argument of external validity see Bettinger (2007)

The five cohorts of first-time freshmen included in the data utilized in this analysis include over 157,000 students, of whom 22.4 percent initially intended to major in a STEM field. Throughout this study, I will aggregate subfields into a general STEM or non-STEM classification. Table 1 examines initial major choice and shows that female students initially constitute a lower percentage of STEM majors than non-STEM majors. Additionally, ACT scores are 2.4 points higher (≈90 SAT points) among STEM majors.[3] Significant differences arise when examining the fraction of students from a particular subgroup who initially declare a STEM major. Among men in the sample, 31.8 percent initially declare a STEM major compared to only 14.3 percent of female students. In terms of initial racial differences; 22.3 percent of white students initially declare a STEM field major compared to 20 percent of black students.

Faculty characteristics also differ between STEM fields and non-STEM fields. As shown in Table 2, about a third of STEM field faculty is female compared to nearly half of non-STEM fields. While the fraction of white faculty is similar between STEM and non-STEM fields, within STEM fields there is a lower fraction of black faculty and a higher fraction of Asian faculty than within non-STEM fields. STEM fields have a higher proportion of faculty who have earned doctoral degrees, are of higher academic rank, are tenured and are employed full-time.

Within STEM fields, there are significant gender and racial differences in faculty characteristics. As shown in Table 3, female faculty in STEM fields are less likely to have earned a doctoral degree, less likely to be an associate or full professor, less likely to have tenure, and more likely to work part-time. The racial differences in faculty characteristics are smaller, with

[3] The ACT is a college entrance exam similar to the SAT. A 21.7 on the ACT is approximately equivalent to a 1000 and a 24.1 is equivalent to a 1090 on the SAT.

black faculty less likely to have a Ph.D. or to be a full professor. These differences suggest that it is important to control for the observable characteristics of the faculty both between STEM and non-STEM fields and between the gender and race groups of faculty within STEM fields.

If the ultimate policy goal is to increase the number of female and minority students who major in a STEM field, then outcomes of interest should include indicators that are correlated with receiving a degree in a STEM field. Previous studies have examined grade performance and probability of enrolling in additional courses in a particular field as indicators for earning a degree (Hoffman & Oreopoulos, 2009; Carrell et al., 2009; Bettinger & Long, 2005). These outcomes may not provide the best measures of intent to earn a degree in a STEM field since enrolling in additional STEM courses may be the result of a general education requirement needing to be fulfilled and not necessarily due to interest in that field or intent to graduate in it. Whether the individual intends to major in a STEM field major is a better indicator that can be used to show progress toward the goal of receiving a degree in a STEM field. Therefore, the outcome which is of most interest in this study is whether a student who initially intends to major in a STEM field continues in a STEM field as his or her intended major in subsequent terms in which he or she enrolls.

IV. Patterns of Persistence

Upon enrolling in college, students declare a major in the field in which they intend to graduate. In this study, persistence is defined as continuing on in the field of the initial major during subsequent semesters that the student is enrolled in classes. The data for this measure is constructed from administrative records that contain the student's intended major for each term the student is enrolled. The focus of this analysis is on STEM fields in general; thus changing majors within STEM fields is counted as persisting in a STEM field (i.e. a student who initially declares a major in chemistry and then changes the following semester to a biology major is considered as persisting in a STEM field). The same is true among students who transfer within non-STEM field majors.

Lower persistence rates exist among those who initially enter STEM fields compared with those who initially enter non-STEM fields. Table 4 depicts a transition matrix of persisting in initial major, change majors, and dropping out of school. Among initial STEM majors, 90.4 percent remain STEM majors by the second semester of their freshman year. However, only 72 percent of initial STEM majors remain in a STEM field by the beginning semester of their sophomore year. Persistence rates for non-STEM majors are significantly higher, with 92.5 percent persisting in a non-STEM field after the first semester and 83.3 percent after the first year[4]. Also, a larger fraction of students in non-STEM majors drop out of college compared with students in STEM majors. Among those individuals who either change majors or drop out of school, 20 percent do so after the first semester, over 50 percent do so within in the first year of school, and 75 percent within the first two years.

In addition to differences in persistence rates across fields of study, there are significant differences in persistence rates between gender and racial groups within STEM field majors. The results in the top panel of Figure 1 indicate that even after the first semester, females who initially intend to major in a STEM field are less likely to persist than their male counterparts.

[4] The persistence rates between STEM and non-STEM majors is significantly different at the 1% level

Black students have significantly lower persistent rates than other racial groups. Much of the white-black persistence gap may be explained by differences in previous achievement of students, proxied with ACT test scores, who enter into these fields as measured by standardized test scores. Figure 2 shows that controlling for ACT test scores reduces the white-black persistence gap by over half. However, ACT test scores do not explain the difference in persistence rates between males and females as the male-female persistence gap is virtually unchanged when controlling for test scores.

V. Methods

The objective of this study is to test whether students who have their STEM courses taught by an instructor with similar racial or gender characteristics are more likely to persist in a STEM field major. To test this hypothesis, I focus on the first semester courses of students who initially declare a STEM major. The basic econometric model is represented with the following equation:

$$
\begin{aligned}
Persistence_{ijk} = {} & \beta_1 \cdot Number\ of\ black\ STEM\ instructors + \beta_2 \cdot Number\ of\ STEM\ courses + \\
& \beta_3 (Number\ of\ black\ Non-STEM\ instructors_{ijk}) + \beta_4 (Number\ of\ Non-STEM\ courses_{ijk}) + \\
& X_i + \theta_i + \delta_j + \delta_k + u_{ijt}
\end{aligned}
$$

where $Persistence_{ijk}$ is a binary outcome equal to one if student *i* at school *j* in cohort *k* is a STEM major in the second semester given that student i's initial major was in a STEM field. The key variable of interest is the number of black STEM instructors. X_i controls for student characteristics such as race, gender, ACT test score[5], and state of residence. Also included in the equation are controls for observable characteristics of instructors such as rank, tenure status, full-time, and graduate assistant. To account for structural differences between majors within STEM fields, θ is a set of dummy variables for the initial major of student i. There may also be specific programs implemented by individual universities that may affect a student's decision to remain in a STEM field major; thus I also include institutional fixed effects (δ_j), and cohort fixed effects (δ_k) to account for differences over time. This equation is estimated for white and black students separately to differentiate the effect that black instructors have on white and black students respectively. I also use this same model to estimate the own gender effect of instructors on persistence.

As in Hoffman and Oreopoulos (2009), I start by assuming that first semester courses are chosen independent of the characteristics of the instructors of the course. Based on this assumption, I use a fixed effects model to estimate the correlation between the number of STEM courses that are taught by female instructors and the outcome of persisting in a STEM field after the first semester. There reasons why the assumption that students randomly sort into classes in their first semester may not be a valid assumption. For example, although students sign up for classes before coming to campus, they can access information about potential instructors online or there may be opportunities to switch classes during the first week of school. Table 5 displays the correlation between the race of the instructor and the racial composition of the students in the course. A course taught by a black instructor has approximately 15 percent higher fraction of

[5] A dummy variable is included to account for the 16% of the sample who have missing ACT scores.

black students in the course, once including institutional and year fixed effects. This point estimate does not change once controlling for the field of the course or the observable characteristics of the instructor. Among STEM courses, a black instructor is correlated with a 10.5 to 11.2 percent increase in the fraction of the students who are black. Table 5 also shows similar selection into courses taught by female instructors.

To address this possible selection issue, I use the fraction of STEM courses taught by black instructors at an institution to instrument for the number of STEM courses taught by black instructors. Since institutional and cohort fixed effects are included in the model, the variation of the instrument comes from within institution changes over time in the number of courses taught by black faculty and the total number of courses offered. This variation can be driven by recent hires, course assignments, sabbaticals, job loss, or other within institutional factors. I also control for the total number of black STEM instructors at each institution in the first stage equation to proxy for time varying institutional factors that might be correlated with the type of instructors assigned to introductory courses and a student's decision to persist in a STEM field. I also use within institutional variation in the number of black faculty who are assigned to teach introductory courses in non-STEM fields to instrument for having a black instructor in a non-STEM course.

This instrument is similar to that used by Bettinger and Long (2005), but can be seen as an improvement because it aggregates fields to classify them as STEM versus non-STEM. Bettinger and Long conduct their analysis on more refined measures of field of study (i.e. physics, chemistry, biology, etc.) and use proportion of courses taught by female faculty to instrument for having a female instructor. While this controls for selection within a field, there may be selection across closely related fields of study based on faculty characteristics. For example the choice set may not just be sections of introductory chemistry courses, but it may include other physical science courses such as chemistry and physics. Thus aggregating to a higher level better accounts for the type of selection that occurs.

Most of the focus of selection issues is targeted at the demand side, that is the students who enroll in STEM courses, yet there may also be selection on the supply side, or the type of individuals who become faculty in STEM fields. It may be the case that female faculty in STEM fields are systematically different than male faculty in these fields. To account for these differences, I include controls for the tenure status, rank, and highest degree earned of the faculty who teach introductory courses. There may still be other factors that differentiate male and female faculty that are not controlled for within these measures of faculty characteristics, but to identify these differences is not possible with the data.

VI. Results

Effect of Matching on Race

Results from fixed effects model suggest that additional black instructors are positively correlated with an increase in the persistence of black students in STEM fields. The third column of Table 6 shows that, controlling for the number of courses a student takes, black students are 4.5 percent more likely to remain a STEM major after the first semester for each additional STEM course that they take from a black instructor. This result is only marginally significant at the 10 percent level. Column two of the fixed effects model shows no statistical relationship between white students who have STEM courses taught by black instructors and persistence.

Limiting the sample to those individuals who enroll in courses in the second semester shows similar results[6]. Another specification examines whether the student had at least one STEM course taught by a black instructor since very few students had more than one black instructor in a STEM course.[7] As shown in Table 7, point estimates are similar as previous specifications and show a positive correlation of 3.4 percent. These specifications suggest that having a black instructor is associated with an increase in the persistence of black STEM majors of 3.4 to 4.3 percent. There is no significant correlation between enrolling in courses from black instructors and persistence in STEM fields for white students across the specifications.

As discussed in Section V, students sort into classes based on the race of the instructor. To address selection, I instrument for having a black instructor with the number of black instructors assigned to teach introductory courses. Controlling for the total number of courses in both STEM and non-STEM fields, first stage results in the bottom panel of Table 6 indicate that a higher fraction of introductory STEM courses taught by a black faculty increases the number of STEM courses that a student takes from a black instructor. The high F-statistic suggest that problems caused by weak instruments are not an issue in this analysis.

The second stage results suggest that the fixed effects model underestimates the true effect that black instructors have on black student persistence in STEM fields. By instrumenting for the number of courses taken from black instructors, Table 6 shows that for each additional STEM course taught by a black instructor increases the likelihood that a black student persists in

[6] Results from this specification is available upon request

[7] Of the black students who had at least one black STEM instructor during their first semester, 77% had only one black STEM instructor.

a STEM field by 38.5 percent points. As shown in Table 7, examining whether a student has at least one STEM course taught by a black faculty member indicates this large positive effet. Admittedly, this is a very large point estimate, but it is imprecisely measured as the standard errors are quite large. The important interpretation should be that it is positive in sign and statistically greater than zero. It does not seem to be the case that, after controlling for rank, tenure status, and degree, the results are being driven by unobservable characteristics that make black instructors more effective in encouraging all students to persist in STEM fields. As shown in the second column of Table 6, black instructors have a statistically insignificant effect on the persistence of white STEM majors. This insignificant effect is also evident in other specifications as exhibited in Table 7.

Effect of Matching on Gender

Results from the fixed effects model displayed in Table 8 suggest that for female students, each additional STEM course that is taught by a female instructor is correlated with a 2.1 percent decrease in the probability of a female student persisting in a STEM field after the first semester. While this estimation includes those who drop out, another specification limiting the sample to those who remain enrolled in school in their second semester yields similar results. Table 9 examines another specification using a binary measure of whether the student had at least one STEM course taught by a female faculty (76 percent of students who have at least one course taught by a female instructor only had one such course). Female students who have at least 1 STEM course taught by a female instructor are 1.6 percent less likely to persist. However, it is important to note that this analysis is based on the assumption that first semester instructors of courses are chosen at random by students.

Using the instrumental variable strategy discussed previously, the results from the first stage regression illustrate that the fraction of introductory STEM courses taught by female faculty is positively correlated with the number of courses that students take from female instructor in both STEM and non-STEM courses. The bottom panel of Table 9 presents the first stage, and shows that the F-statistics reveal that problems caused by weak instruments will not be an issue. Results from the second stage estimation indicate that female instructors have no statistically significant effect on the likelihood that a female student persists in a STEM field after the first semester. Limiting the sample to those who enrolled in the second and having at least one female instructor also show no relationship between having a STEM course taught by a female instructor and persistence. Another specification limited the sample to those who are in the 75th percentile of standardized test score, similar to Carrell et al (2009), but the results indicate no positive effect of own-gender instructors on persistence of female students. Male students who enroll in STEM courses taught by female instructors are equally as likely to persist had the courses been taught by a male instructor.

Conclusions

This study examines the hypothesis that students who have STEM courses taught by an instructor of their own gender or race are more likely to persist in a STEM major. The empirical evidence provided in this study suggests that female students are no more likely to persist in a STEM field when they enroll in courses taught by female faculty. This finding is consistent with previous findings that, on average, female instructors do not have a significant effect on persistence of female students in STEM fields.

There also is significant evidence suggesting that black instructors increase the persistence of black students in STEM fields. While a positive effect of own-race teachers has been indicated in high school settings in previous research findings, this study is the first of its kind to indicate this effect in post-secondary institutions. Whereas a previous study shows that black teachers have a negative effect on academic performance of white students (Dee 2004), the results in this study indicate that black instructors in college do not have an impact on the persistence of white students in STEM fields. These results suggest that policies to increase the minority representation among faculty members might be an effective means of increasing the representation of minorities who persist and ultimately graduate within STEM fields.

One of the limitations to this study is that it is focused on factors that affect the decision to persist after one semester. About 20 percent of individuals who change majors from a STEM field to a non-STEM field do so after their first semester. However, most of the transition from STEM majors to non-STEM majors occurs at the end of the freshmen and sophomore academic years. Therefore, an extension of this research will examine the decision to persist at the end of each school year.

In addition, while of the line of research in the current analysis is designed to identify the effects of instructor characteristics; it does not seek to identify mechanisms causing these effects. To recommend specific policies to increase persistence of women and minorities it is essential to understand the mechanism which might be driving the results. Future research should explore possible mechanisms influencing why own race instructors have a positive effect and own gender instructors do not have a significant impact on persistence of students within STEM fields.

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Figure 1. Persistence in a STEM Major during Each Semester

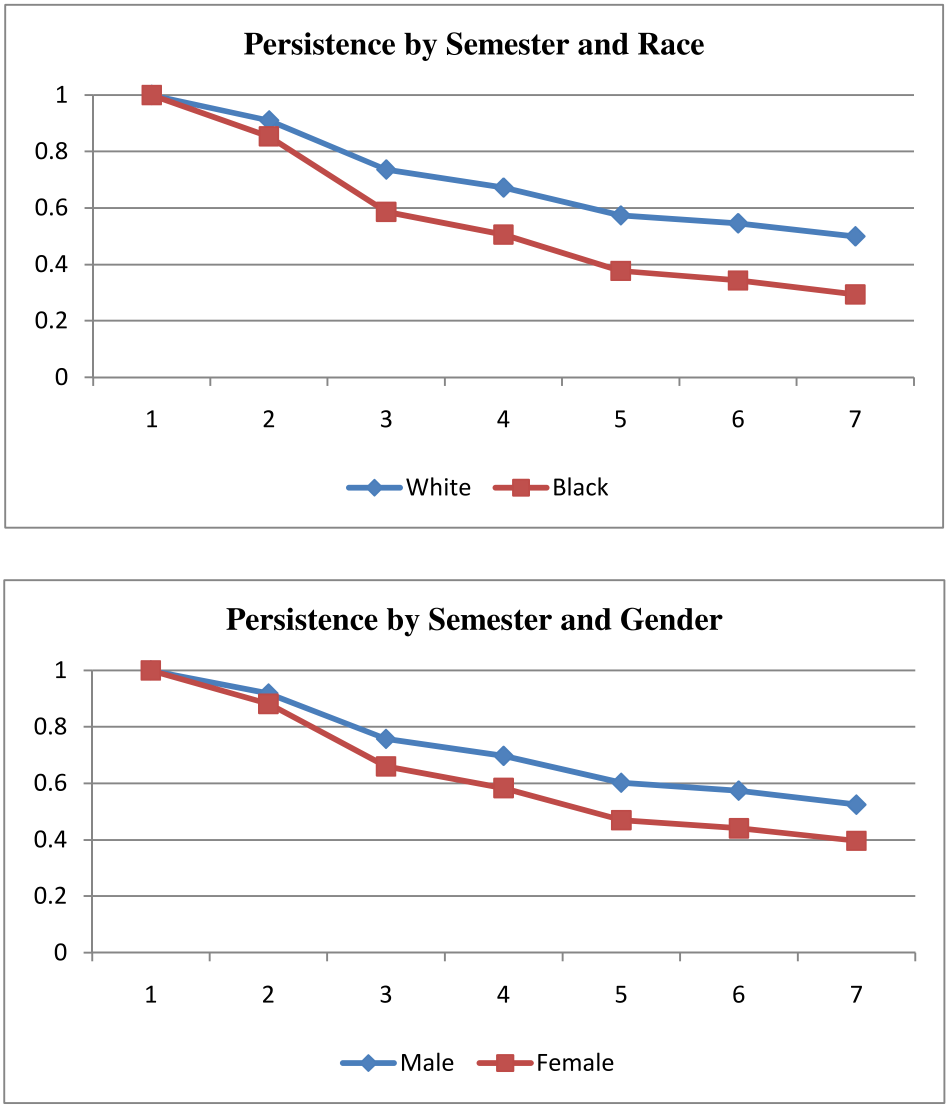
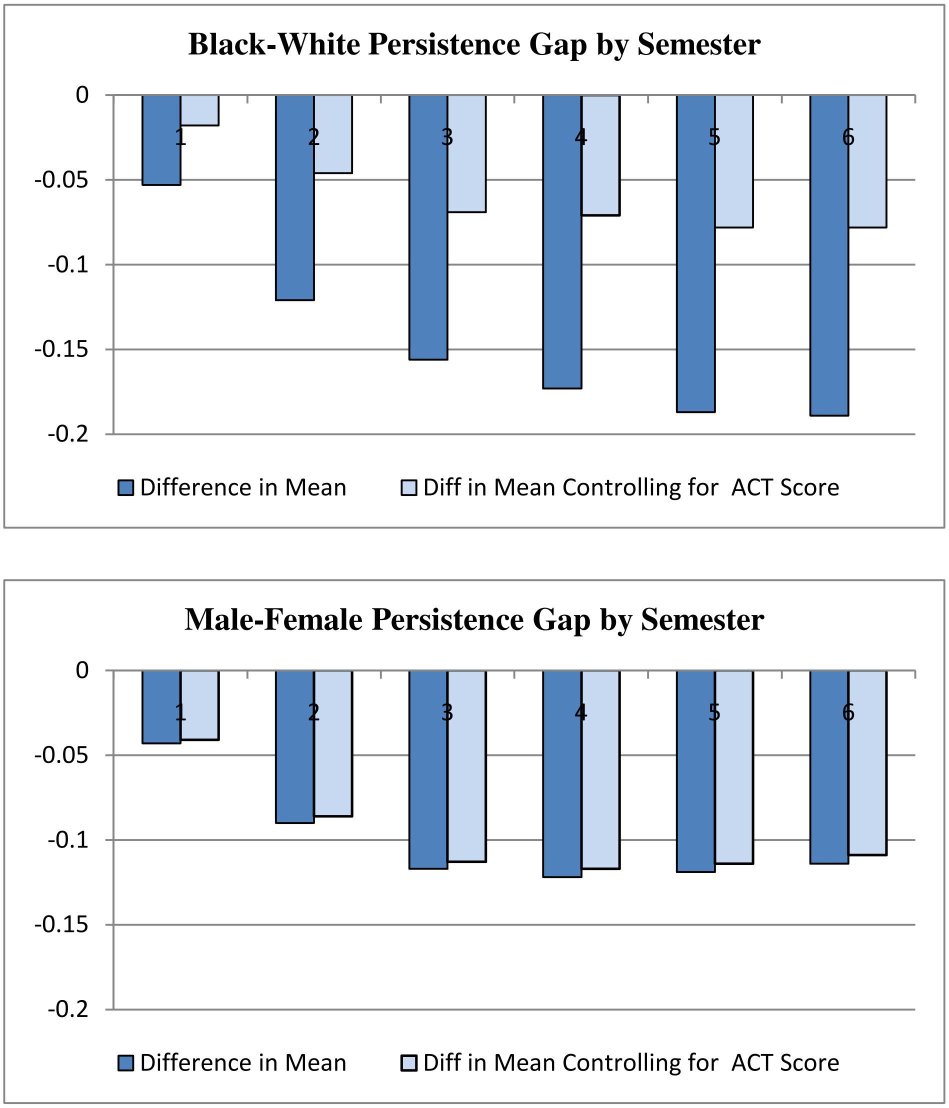


Figure 2. Racial and Gender Persistence Gap of Initial STEM Majors



Note: These figures are created by regressing persistence on a dummy varible for female. The coefficient on the dummy variable is the difference in mean that is presented. Next I include ACT score, and report the coefficient for the dummy variable of female. The same estimation is done with a dummy variable for black students. Institutional and cohort fixed effects are included in both estimations to look at within institution-year means.

Table 1. Summary Statistics

Variable	Mean	STEM Majors Mean	Non-STEM Majors Mean	Diff. in Means p-value
Female	0.539	0.345	0.595	0.000
White	0.832	0.829	0.833	0.065
Black	0.092	0.082	0.095	0.000
Asian	0.021	0.036	0.017	0.000
Other race	0.055	0.053	0.056	0.079
ACT score	22.29	24.18	21.73	0.000
		[0.013]	[0.024]	
Initial STEM Major	0.224			
Engineering	0.110			
Life/Physical Science	0.084			
Math/Technology	0.030			
Initial Non-STEM Major	0.7763			
Business	0.148			
Communication	0.050			
Education	0.098			
Humanity	0.195			
Social Science	0.086			
Vocational	0.095			
Unknown	0.103			
Observations	157,049	35,127	121,922	

Table 2. Characteristics of the Faculty

Variable	Full Sample Mean	STEM Mean	Non-STEM Mean	
Female	0.446	0.322	0.494	***
White	0.889	0.895	0.887	*
Black	0.055	0.033	0.064	***
Asian	0.035	0.059	0.026	***
Other race	0.020	0.014	0.023	***
Highest Degree				
Ph.D.	0.341	0.404	0.317	***
Masters	0.373	0.315	0.396	***
Other degree	0.286	0.282	0.288	
Rank				
Professor	0.121	0.158	0.107	***
Associate	0.125	0.147	0.117	***
Assistant	0.137	0.135	0.137	
Other rank	0.617	0.560	0.639	***
Tenure status				
Tenured	0.253	0.316	0.228	***
Tenre track	0.082	0.085	0.081	
Non tenure track	0.665	0.600	0.690	***
Apointment				
Full-time	0.251	0.276	0.241	***
Part-time	0.335	0.323	0.340	***
Grad assistant	0.204	0.165	0.219	***
STEM Field	0.280			
Engineering	0.046			
Life/Physical Science	0.097			
Math/Technology	0.133			
Non-STEM Field	0.854			
Business	0.032			
Communication	0.051			
Education	0.086			
Humanity	0.396			
Social Science	0.166			
Vocational	0.123			
Observations	29337	8200	21137	

Note: Asterisks represent significant difference in means, *** 1%, ** 5%, and *10%

Table 3. Racial and Gender Differences of Faculty within STEM Fields

Variable	White Mean	Black Mean		Male Mean	Female Mean	
Highest Degree						
Ph.D.	0.412	0.299	***	0.489	0.229	***
Masters	0.333	0.507	***	0.264	0.425	***
Other degree	0.255	0.194	***	0.246	0.346	***
Rank						
Professor	0.171	0.078	***	0.212	0.045	***
Associate	0.156	0.187	**	0.170	0.102	***
Assistant	0.134	0.153		0.135	0.137	
Other rank	0.539	0.582		0.484	0.716	***
Tenure status						
Tenured	0.342	0.321		0.389	0.166	***
Tenre track	0.080	0.116	**	0.087	0.080	
Non tenure track	0.578	0.563	*	0.523	0.754	***
Apointment						
Full-time	0.294	0.321	*	0.302	0.225	***
Part-time	0.340	0.362		0.281	0.403	***
Grad assistant	0.116	0.090	***	0.152	0.194	***
Observations	6427	268		5534	2626	

Note: Asterisks represent significant difference in means, *** 1%, ** 5%, and *10%

Table 4. Cummulative Transition Matrix by Initial Field of Study

Initial STEM Majors (N=35,127)

Semester	Fraction who Persist in a STEM field	Fraction Who Change to a Non-STEM field	Fraction Who Dropout
1	1		
2	0.906	0.064	0.030
3	0.724	0.176	0.101
4	0.658	0.213	0.129
5	0.557	0.266	0.178
6	0.528	0.274	0.198

Initital Non-STEM Majors (N=121,922)

Semester	Fraction Who Persist in a Non-STEM field	Fraction Who Change to a STEM field	Fraction Who Dropout
1	1		
2	0.925	0.032	0.044
3	0.833	0.040	0.127
4	0.794	0.045	0.160
5	0.740	0.044	0.216
6	0.717	0.044	0.239

Table 5. Selection of courses based on race of instructor

Depedent Variable: Fraction of students in course who are black

	(1)	(2)	(3)	(4)	(5)	(6)
Instructor is Black	0.301***	0.156***	0.153***	0.151***	0.112***	0.105***
	[0.005]	[0.004]	[0.004]	[0.004]	[0.010]	[0.010]
Observatiuons	22778	22778	22778	22778	5060	5060
R-squared	0.14	0.53	0.54	0.54	0.58	0.59
Institutional FE	--	√	√	√	√	√
Year FE	--	√	√	√	√	√
Field FE	--	--	√	√	√	√
Faculty characteristics	--	--	--	√	--	√
Only STEM Courses	--	--	--	--	√	√

Dependent variable: Fraction of students in course who are female

	(1)	(2)	(3)	(4)	(5)	(6)
Instructor is Female	0.125***	0.123***	0.102***	0.106***	0.063***	0.055***
	[0.004]	[0.004]	[0.003]	[0.004]	[0.008]	[0.008]
Observatiuons	22778	22778	22778	22778	5060	5060
R-squared	0.05	0.06	0.18	0.18	0.29	0.29
Institutional FE	--	√	√	√	√	√
Year FE	--	√	√	√	√	√
Field FE	--	--	√	√	√	√
Faculty characteristics	--	--	--	√	--	√
Only STEM Courses	--	--	--	--	√	√

Table 6. Probability of Persisting in STEM Major into 2nd Semester

Second Stage Estimation

	All Students		White Students		Black Students	
	FE	IV	FE	IV	FE	IV
STEM courses taught by	0.01	0.214	0.003	-0.116	0.045*	0.385**
Black Instructors	[0.009]	[0.149]	[0.010]	[0.194]	[0.026]	[0.227]

First Stage Estimation

Fraction of STEM courses		1.284***		1.151***		2.592***
taught by black faculty		[0.115]		[0.121]		[0.547]
F-Statistic		77.26		58.65		23.53
Observations	35127	35127	29108	29108	2886	2886

Note: All regressions control for ACT scores, number of STEM and non-STEM courses, and faculty characterisics, instituional and cohort fixed effects.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7. Probability of Persisting in a STEM Maor into 2nd Semester

	All Students		White Students		Black Students	
	FE	IV	FE	IV	FE	IV
At least 1 STEM courses taught by Black Instructors	0.006	0.232	0.002	0.068	0.034	0.535**
	[0.009]	[0.169]	[0.010]	[0.202]	[0.030]	[0.304]

First Stage Regression for Instrumental Variable Estimation

Fraction of Intro STEM Courses Taught by Black Faculty		1.201***		1.115***		1.895**
		(0.103)		(0.111)		(0.423)
F-Statistic		73.96		56.48		21.77
Observations	35127	35127	29108	29108	2886	2886

Note: All regressions control for ACT scores, number of STEM and non-STEM courses, and faculty characterisics, instituional and cohort fixed effects.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8. Probability of Persisting in a STEM Major into 2nd Semester

First Stage Estimation

	All Students		Male Students		Female Students	
	FE	IV	FE	IV	FE	IV
STEM courses taught by	-0.009**	0.004	-0.003	-0.001	-0.021***	0.01
Female Instructors	[0.004]	[0.038]	[0.005]	[0.049]	[0.008]	[0.061]

First Stage Regression for Instrumental Variable Estimation

Fraction of Intro STEM Courses		1.170***		0.793***		1.808***
Taught by Female Faculty		[0.096]		[0.120]		[0.160]
F-Statistic		218.25		138.23		99.42
Observations	35127	35127	23002	23002	12125	12125

Note: All regressions control for ACT scores, number of STEM and non-STEM courses, and faculty characterisics, instituional and cohort fixed effects.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 9. Probability of Persisting in a STEM Major into 2nd Semester

Second Stage Estimation

	All Students		Male Students		Female Students	
	FE	IV	FE	IV	FE	IV
At least 1 STEM courses taught by Female Instructors	-0.013***	-0.082	-0.011**	-0.080	-0.016*	-0.055
	[0.004]	[0.075]	[0.005]	[0.049]	[0.008]	[0.052]

First Stage Regression for Instrumental Variable Estimation

Fraction of Intro STEM Courses Taught by Female Faculty		0.513***		0.454***		0.613***
		[0.069]		[0.086]		[0.115]
F-Statistic		180.05		117.03		77.84
Observations	35127	35127	23002	23002	12125	12125

Note: All regressions control for ACT scores, number of STEM and non-STEM courses, and faculty characterisics, instituional and cohort fixed effects.
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%