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School Discipline, Race–Gender and STEM Readiness: A Hierarchical Analysis of the Impact of School Discipline on Math Achievement in High School

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Abstract
While research on school suspensions and its impact on students is not new, scholars have not yet explored whether there is a link between school suspensions and high school students' preparation for success in STEM. Using nationally representative data, this study explored the relationship of suspensions to math outcomes while considering race–gender intersections and school social control. Our findings confirm that both in and out-of-school suspensions significantly lower math achievement in high school even after controlling for a host of individual and school factors. More so, the effect of suspensions on math achievement persists over time. The analysis reveals that suspended students scored lower in math 2 years after the suspensions occurred after controlling for individual and school characteristics, and prior math achievement. The study also found an overrepresentation of racialized students among those suspended. The paper concludes with a discussion and implications for policies, practice and research.

Keywords Suspensions · Math · Race–gender · STEM · Social control · High-school · Intersectionality

Introduction

Despite greater investments in STEM education, U.S. students still underperform in math, an academic subject that is foundational to all STEM fields, relative to those in other industrialized countries (PISA) (Barshay 2016). Policymakers and private corporations have realized that the nation's ability to achieve a sufficient workforce

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in the areas of science, technology, engineering and math (STEM) relies on increasing the STEM readiness and persistence of racialized and gendered populations. As of the last census, whites and Asian-Americans are overrepresented in STEM, constituting 70.8% and 14.5% of the workforce, respectively, while being just 73% of the working age population. Contrariwise, Hispanics and African Americans are underrepresented with only 6.5% and 6.4%, respectively, having careers in STEM fields (American Community Survey 2011; National Science Foundation 2013), and their underrepresentation has not changed much in the last 14 years (Bidwel 2015; National Science Foundation 2016).

Women too are underrepresented in STEM. Although women make up 48% of the total U.S. labor force, they account for only 24% of the STEM workforce (American Community Survey 2011). When gender disparities are considered along with race, we find that shortfalls in STEM representation are greatest for particular race–gender groups (Reeves and Halikias 2017; National Science Foundation 2018). For example, the overrepresentation of men within STEM does not apply to men of color, with Hispanic and African American men making up just 4% and 3% of scientists and engineers in the workforce (National Science Foundation 2017). The corresponding figure was 2% for Hispanic and African American women (National Science Foundation 2017). While the reasons for this underperformance have often addressed the dispositions and interests of students (McLeod 1992; Kilpatrick et al. 2001; Liu and Koirala 2009; Beyers 2011), content of STEM curricula (PCAST 2010) and social dynamics such as stereotype threat and implicit bias (Martin 2009; Brewley-Kennedy 2005; Reed and Oppong 2005; McGee 2013; McGee and Pearman 2015) within STEM classrooms, little to no attention in research has been given to the disparate impact school approaches to student discipline have had on the STEM preparedness of particular race–gender groups (Jabbari and Johnson, forthcoming). Consequently, inequalities in occupational status, and the nation's security and international competitiveness, are unlikely to improve unless educational institutions expand access to STEM fields for the same race–gender groups that they disproportionately discipline (Hirschfield 2008; Kupchik 2010; Perry and Morris 2014; DeNisco 2015).

While scholarly work has established the impact of school suspensions on individual students in what is known as the 'school-to-prison pipeline'(Skiba et al. 2002; Morrison and Skiba 2001; Gregory et al. 2010; Cuellar and Markowitz 2015; Mizel et al. 2016) research has yet to explore the association between school suspensions and students' preparation for STEM fields. To address the void in knowledge, we utilized a nationally representative sample of high school students from the Educational Longitudinal Study (ELS) of 2002 to explore the impact of school suspensions on math achievement, a key subject in STEM preparation.

Our findings confirm that both in-school and out-of-school suspensions significantly lower math achievement in high school over time, even after controlling for a host of individual and school factors. Further analysis reveals that suspended students scored lower in math 2 years after the suspensions occurred, suggesting that opportunities to recover from the effects of suspension on students' learning are rare in subsequent years of schooling. This study also finds that, among non-demographic factors, suspensions have the highest impact on math achievement for high school students. Finally, and consistent with previous research that reveals an overrepresentation of racialized students among those suspended, we find Black and Hispanic students are roughly 28% of the whole sample, but nonetheless received about 45% of all in-school suspensions and 43% of all out-of-school suspensions. We conclude this study with a discussion of its implications for policy and research.

Literature Review

Since the late 1980s, schools across the country have adopted formal social control practices mirroring the criminal justice system's approach to dealing with adolescents' perceived misbehavior (Hirschfield 2008; Kupchik 2010; Welch and Payne 2010). Theoretically, social control is a concept that recognizes the social forces that allow a society, culture, or organization to internally regulate the behavior of its members (Durkheim et al. 1961; Hughes 1946; Janowitz 1975). Following this concept, discipline in schools seeks to maintain social order and reduce misbehavior that could potentially disrupt the learning environment. However, some schools have modeled their social control methods after the 'tough on crime' approaches to policing that characterized the 1980s (Garland 2001). Therefore, many scholars have argued that social control in schools has shifted in emphasis toward a punitive ideology and focuses less on rehabilitation (Hirschfield 2008; Simon 2007).

Today, most of the nations' schools are characterized by uniformed police officers, surveillance cameras, and 'zero-tolerance' policies that automatically suspend students for certain behaviors (Noguera 2003; Perry and Morris 2014). These social control practices and policies might be one of the reasons why school suspensions have doubled since the 1970s (Losen 2011) and in 2015–16, nearly 2.7 million students received at least one or two out-of-school suspensions (U.S. Department of Education 2018). Others might contend that increases in school suspension merely reflect rates of student misbehavior. Yet, a precipitous decline in rates of victimization (Butts 2000), teacher reports of having been threatened or physically attacked by their students (Fox and Burstein 2010), and school-associated deaths and homicides (Robers et al. 2014; CDC 2008) has been well documented to have occurred since the early 1990s. This inconsistency between actual rates of student misconduct on one hand, and suspensions on the other, implores us to understand the impact the latter may have on important policy priorities, namely correcting the underrepresentation of racial/ethnic groups, females, and their intersections in STEM.

School Suspensions and Student Achievement

There is strong evidence that the risks of suspensions outweigh the benefits for suspended students both academically and behaviorally. Behaviorally, suspensions have been found to intensify anger, apathy and disengagement that might increase the likelihood of recidivism and school drop-out (Davis and Jordan 1994; Contenbader and Markson 1998; Jenkins 1997; Baker et al 2001; Cuellar and Markowitz 2015; States et al. 2015). More so, researchers have argued that suspensions can create volatile and socially disorganized environments contrary to the social order it was intended to create, negatively impacting suspended and non-suspended students alike (Perry and Morris 2014).

Studies have also shown that there is a strong connection between school suspensions and lowered achievement (Davis and Jordan 1994; Raffaele Mendez 2003; Skiba and Rausch 2004; Arcia 2006; Christie et al. 2004; Perry and Morris 2014; Lacoe and Steinberg 2018). Through the loss of instruction, suspensions perpetuate a cycle of failure putting students further behind with fewer opportunities to learn (Baker et al. 2001). Furthermore, high rates of suspension may produce collateral academic consequences for the overall student population (Perry and Morris 2014; Rausch and Skiba 2004). These concerns are shared by practitioners as well the American Association of School Administrators (AASA), for example, confirmed in their 2014 survey that 92% of superintendents believe that out-of-school suspensions are associated with negative student outcomes, including lost instructional time and increased disengagement, absenteeism, truancy, and high dropout rates. According to the Civil Rights Project (2000) report, more than 30% of sophomores who drop-out have been suspended in school.

Among the few studies that specifically investigates the association between suspensions and achievement in mathematics, Rausch and Skiba (2005) found that school usage of suspensions negatively influenced math scores on state accountability exams, even after accounting for socio-demographic factors. Similarly, Raffaele Mendez (2003) used data from Pinellas County, Florida, and found out-of-school suspensions in sixth grade were negatively related to student outcomes in reading and math in later years. In fact, students who were suspended failed to graduate on-time. More recent studies that utilized city (Lacoe and Steinberg 2018) and state (Morris and Perry 2016) level data explored the relationship between out-of-school suspensions and academic (reading and math) achievement for students in elementary, middle and high school. Consistent with the other studies, their results indicate that suspensions had significantly lowered students' performance in both subjects. Using these studies as foundational, this study extends the literature by investigating the short- and long-term impact of in and out of school suspensions on math achievement separately using a nationally representative data.

Suspensions Gap to the STEM Gap

Given research suggests that discipline lowers academic performance, racial/ethnic disparities in disciplinary rates could lead one to question whether the school discipline gap along racial lines might explain the STEM gap. It is well established in the literature that students of color are disproportionately targeted for discipline in school, are suspended at a higher rate (Gregory et al. 2010), and oftentimes disciplined more harshly than white students for similar mistakes (Rocque and Paternoster 2011; Ramey 2015). In fact, one in every six Black students has been suspended at least once (Losen and Gillespie 2012). Despite recent calls to reduce the use of exclusionary discipline, suspension rates for Black boys and girls actually went up in the 2015–2016 school year (Blad and Corey 2018). As a result, a recent study suggest that out-of-school suspensions account of about *one-fifth* of Black–white achievement gap in school (Morris and Perry 2016).

This analysis builds on those observations by considering how gender intersects with race and ethnicity to compound possible differences in the disciplinary experiences of adolescent students, and in mathematics in particular. For example, while one in six Black students has been suspended at least once, two in three Black boys have been suspended at some point in their K-12 education (Shollenberger 2015). While 6% of all students in K-12 received at least one out-of-school suspension in the 2013–2014 academic year, those figures were 20% for Black boys and more than 12% for Black girls (U.S. Department of Education 2014). In contrast, only 5% of white boys and 2% of white girls were suspended during the same period (U.S. Department of Education 2014). These figures suggest the disciplinary burden is disproportionately experienced by Black males and Black females, and other race–gender intersections less so.

This study views these race–gender disparities through the lens of intersectionality theory. An outgrowth of Black feminist and critical race theory, intersectionality recognizes that multiple systems of oppression, primarily those of race, gender, and social class simultaneously impact those individuals who hold those multiple identities (Collins 1990; Crenshaw 1991). Since its inception two decades ago, the concept has facilitated an understanding of how power is used (in this case, the coercive power of the state) by its primary institutions of socialization, to marginalize historically underrepresented populations. In sum, the empirical evidence supports the intersectional nature of school discipline administration, especially school suspensions (Skiba et al. 2002, 2003), the academic effects of which might explain, in part, why the same race–gender groups that are overrepresented in school suspensions are the least represented in STEM fields.

The intersectional nature of suspensions according to race–gender appear reinforced by other divergences in discipline, by special education services status in particular. For example, in a recent study using federal data, Black students with disabilities lost roughly three times as much instruction from discipline as did their white peers in both the 2014 and 2015 academic years (Losen 2018). When gender is considered along with race and disability, data show that almost 34 percent of Black boys with a disability were suspended in high school, twice the rate of white boys with a disability (Losen et al. 2015). This suggest that considering students' receipt of special education services along with adequate controls for socioeconomic status, as this study does, is essential to understanding race–gender intersections in suspensions.

The Present Study

Existing literature corroborates that school suspensions have been an area of longstanding interest and concern for social scientists. However, until recently, there was more focus on the extent of its use than the impact of suspension on youth's educational achievement. Therefore, research on the effect of suspensions on academic achievement is still limited, and to our knowledge we are not aware of studies that have looked at the impact of suspensions on student preparation for STEM achievement. The present study addresses this void in research in three ways. First, the few studies that have investigated the association between school suspensions and math achievement have used either state, county, or district level data (Raffaele Mendez 2003; Morris and Perry 2016; Lacoe and Steinberg 2018). The present study will extend the literature by using a nationally representative sample of high school students.

Second, our analysis presents a more comprehensive analysis to isolate the impact of suspensions with additional individual and institutional factors that have not been explored in the current literature. For example, the analysis in this study accounts for students' perception of school treatment/fairness, school engagement and motivation in addition to the frequently used demographic and social background characteristics. While our focus is not on the psycho-social contributors to suspension rates and math achievement, these variables strengthen this analysis relative to studies that feature less stringent modeling. Third, this research will also test whether the long term impact of social control on math extends beyond the initial academic year. Learning, especially mathematical content, is described as a continuum or process of moving students from simple ideas to a more sophisticated understanding within a subject area (National Research Council 2006; Nichols 2010). We therefore ask in this study, how sophomore year suspensions might impact senior-year math course taking for students who may not have mastered lower level math courses due to suspensions. These research aims are explored in the following research questions:

1. Are school suspensions associated with high school math achievement controlling for students and school characteristics?
2. Controlling for individual and school characteristics, how does the impact of suspensions on math achievement differ according to race–gender?
3. Controlling for 10th grade math test scores, does the effect of suspension at 10th grade affect math achievement at 12th grade?

Methods

Data

This research uses the restricted-use data from the Educational Longitudinal Study (ELS) of 2002 obtained through the National Center for Education Statistics (NCES). The ELS is a large nationally representative longitudinal study of 10th graders in 2002 and 12th graders in 2004 who were followed throughout secondary and post-secondary years. A total of 750 schools were randomly selected and about 25 students were randomly selected within each school that was sampled, the full sample was a total of 16,197. The selected students, their parents, administrators, librarians and math and English teachers of the selected students were asked to complete the survey. The ELS data is ideal for this kind of analysis as it contains a wide range of social control and school discipline variables from the facility checklist and administrators' survey which newer data like the High School Longitudinal Study (HSLS) do not contain.

The analyses in this paper utilized data from the first two waves, which included, base year (spring of 10th grade) and first-follow-up when the students were in 12th grade (spring of 2004). A total of 13,400 students had both base-year and 12th grade math test scores. Analytical subsamples of 11,050 for the first and second analyses and 9420 for the third analysis were created. The difference in sample size could be due to various reasons such as change of school, early graduates, dropouts or home schoolers (Ingels et al. 2007). However, with about 15% attrition rate, the samples remain comparable and with over 9000 observations.

Weights and Missing Values In this analysis, we used the sample weights that were provided by NCES to compensate for the unequal probabilities of selection of its sample participants, and to adjust for the effects of nonresponses (NCES 2004). Our use of panel weight (F1PNLWT) preserves the representativeness of the sample, making the study results generalizable to high school students who entered 10th grade in 2002 and matriculated to grade 12 in 2004. For independent measures that had values missing at random, we imputed those values using chained equations (MICE). The dependent variables were not imputed.

Measures

Dependent Variables

The three analyses in this study used *math standardized test scores*[1] as the dependent variable. In the first and second analysis, the dependent variable is the *base-year math standardized test scores* which were administered in spring of 2002 to 10th graders. The third analysis used math test scores which were administered 2 years later (in spring of 2004) when the students who completed the survey as 10th graders were in their senior year of high school. Math test scores were used as a measure of STEM readiness since mathematics is a foundational subject in STEM fields. The use of the math test scores from the spring semester also reduces concerns about reverse causation, that is, low academic performance leading to suspension (Morris and Perry 2016) since the suspensions happened prior to the testing (fall of 2001).

Independent Variables

As mentioned in the introduction, the main predictor variables of interest in this research are *in-school suspensions (ISS)* and *out-of-school suspensions (OSS)*. Both suspensions are binary measures (i.e. whether the student has been suspended at least once or never by 10th grade). In addition to the main predictors, several characteristics of individual students and schools are also included in the models. Individual characteristics included: *gender* (1 = female; 0 = male) and *race* measured in three categories and

[1] The standardized score provides a norm referenced measurement of achievement, that is, an estimate of achievement relative to the population (spring 2002 10th graders) as a whole. The standardized score is a transformation of the ability score, rescaled to a mean of 50 and standard deviation of 10 (NCES 2004).

dummy coded (1 = yes, 0 = no) for *White, African- American and Hispanic*. Additionally, we have created four race–gender variables, *Black female, Black male, Hispanic female* and *Hispanic male*, to examine the intersected stratification effects of race–gender on math achievement.

In addition, we included a number of individual level composites. The first composite is the number of *academic risk factors* in 10th grade. This composite variable indicates the number of academic risk factors among the following that a student has: (1) comes from a single-parent household (2) has two parents without a high school diploma (3) has a sibling who has dropped out of school (4) has changed schools two or more times (excluding changes due to school promotions) (5) has repeated at least one grade, and (6) comes from a household with an income below the federal threshold for poverty.

Students' *math self-efficacy* is a scale created by NCES through principal factor analysis and standardized to a mean of 0 and standard deviation of 1. Only respondents who provided a full set of responses were assigned a scale value (NCES 2004). The coefficient of reliability (alpha) for the scale is 0.93. The variable was created from the following set of Likert scale survey items: (1) I'm confident that I can do an excellent job on my math tests, (2) I'm certain I can understand the most difficult material presented in math texts, (3) I'm confident I can understand the most complex material presented by my math teacher, (4) I'm confident I can do an excellent job on my math assignments, and (5) I'm certain I can master the skills being taught in my math class.

School treatment is another composite created from a set of questions on students' perception of how fair school rules are enforced. The variables include: the school rules are fair; the punishment for breaking school rules is the same no matter who you are; everyone knows what the school rules are; and, school rules are strictly enforced. These variables were all Likert scale ranging from strongly agree to strongly disagree. We also include a *School engagement* composite constructed with a set of 9 school-sponsored extracurricular activities and indicates the number of these activities the respondent participated in during the 01–02 school year. The last composite, *school motivation* is created from a set of Likert scale statements that asked the sample member whether they agreed or not with the following statements: classes are interesting and challenging; education is important to get a job later; nothing better to do than school; school is a place to meet friends; teacher expects success in school; and, parents expect success in school. Finally, truancy measures such as *absences* and *skipping classes* were also added as control variables at the individual level.

The second analysis examines the relationship between race–gender interactions and math achievement using the same predictor variables from the first analysis. In the third and final analysis, in addition to all the predictors in the first analysis, the 10th grade math test scores were added as a control variable.

School Variables

Since schools may vary in rates of suspension and their features influence those rates, we include school level predictors such as *the percent minority*, *percent of students receiving free/reduced lunch*, and the *percent of students receiving special* *education services*. To take into consideration possible teacher influences on our outcomes of interest, we have also included as variables the *number of full-time math teachers* and *average math teacher's expectation in a school*. One of our primary concerns is *school social control*, which we include as a composite indicator of several measures from the school administrator survey. These measures include the school requires students to pass through metal detectors each day; use one or more random dog sniffs to check for drugs; perform one or more random sweeps for contraband (e.g., drugs or weapons); and, require drug testing for any students.

Estimation

The focus of our analyses in this paper is to understand the relationship of suspensions to math outcomes while considering race–gender interactions and school social control. Using Stata 14, multivariate effects are modeled with multi-level mixed effect linear regression to appropriately accommodate the hierarchical nature of our data. Hence, the models have a two-level structure where level-one observations (students) are nested within level two (schools). The following expression reflects the combined equations in which, *i* corresponds to student (level one), and *j* corresponds to school (level two).

$$\mathrm{Yij} = \beta_0 + \beta_1 \mathrm{X}_{1ij} + \beta_2 \mathrm{X}_{2ij\ldots} + \beta_3 \mathrm{Z}_{3j} \cdots + \mathrm{u}_j + \mathrm{e}_{ij}$$

As an initial step, a multiple regression analysis was conducted to check for multicollinearity. With VIF values between 1.05 and 3.2, and tolerance statistics of 0.5 to 0.9, there was no concern for multicollinearity (Fields 2009). Additionally, normality tests of residuals were performed and the visual results confirmed a normal distribution. All assumptions for multilevel modeling and linear regression in each analysis were met. Results for each analysis are presented in Tables 1, 2, 3, 4, 5 and 6.

Results

Analysis 1: The Impact of ISS and OSS on Math Achievement at 10th Grade

As shown in the Table 1, the analysis contained a racial breakdown of about 13% African-American, 15% Hispanic, and 57% White. Other groups including Asians, Native Americans, Alaskan natives and more than one race made-up 15%. In terms of gender, males and females were equally distributed with about 50% of each group. The descriptive results suggest that 12% of students received ISS by the first-semester of their sophomore year and eight percent received OSS within the same time period. The mean 10th grade math test scores was 50.71 points. At the school level, about 34.35% of students were of underrepresented groups, 23.58% of students were receiving free/reduced lunch, and a little over 9% of students were enrolled in special education services.

Table 1 Sample description: 10th grade math achievement and school suspensions

Variable	Proportion	Mean (SD)
Individual level		
Sex		
Female	0.48	
Male	0.47	
Race/ethnicity		
Hispanic	0.15	
Black	0.13	
White	0.57	
Skip/cut classes	0.15	
Absences	0.26	
In-school suspensions	0.12	
Out-of-school suspensions	0.08	
Number of academic risk factors		1.02 (1.10)
Math self- efficacy		0.02 (1.00)
School engagement		1.00 (1.31)
School motivation		7.65 (1.97)
Perception of school treatment		11.15 (2.53)
Base-year math test scores		50.10 (10.06)
School level		
Percent free/reduced lunch		23.58 (24.96)
Percent special ed.		9.25 (9.06)
Percent minority		34.35 (31.20)
Number of full time math teachers		9.51 (6.10)
School social control		0.53 (0.74)
Math teacher's expectation		4.10 (1.47)

Table 2 Suspensions by race and gender

Variable	Percentage
Black_Female	6.6
Hispanic _Female	7.2
Black_Male	6.5
Hispanic_Male	7.3
Black * ISS	25
Black * OSS	24.5
Black_female * ISS	11.2
Black_Female * OSS	11.4
Hispanic-Female * ISS	7.8
Hispanic_Female * OSS	6
Black_Male * ISS	14
Black_Male * OSS	13
Hispanic_male * ISS	12.1
Hispanic_Male * OSS	12.4

Table 3 Mixed effects ML regression on the impact of student discipline on math test scores (10th grade test scores)

	Model 1a	Model 1b	Model 1c	Model 1d	Model 1e
Fixed effects: student level					
Gender: (1 = female)		− 1.42 (0.14)***	− 1.16 (0.14)***	− 1.06 (0.14)***	− 1.15 (0.15)***
Race: hispanic		−4.78 (0.28)***	−4.28 (0.27)***	−4.24 (0.27)***	−3.86 (0.29)***
Race: black		−5.36 (0.30)***	−5.06 (0.28)***	−5.20 (0.29)***	−4.83 (0.30)***
Race: white		0.23 (0.23)	0.46 (0.21)*	0.43 (0.22)*	0.27 (0.24)
# of academic risk factors		− 1.67 (0.07)***	− 1.43 (07)***	− 1.40 (0.06)***	− 1.32 (0.07)***
Math self-efficacy			2.14 (0.07)***	2.13 (0.07)***	2.10 (0.08)***
School engagement			0.99 (0.05)***	0.98 (0.05)***	0.96 (0.06)***
School treatment			0.20 (0.02)***	0.22 (0.03)***	0.23 (0.03)***
Motivation			0.02 (.04)	0.06 (0.04)	0.03 (0.04)
Classes skipped				−0.37 (0.16)***	−0.27 (0.09)**
Absences				−0.26 (0.19)***	0.26 (0.07)***
In-school suspension	−4.05 (0.26)***	−3.25 (0.24)***	−2.72 (0.24)***	−2.32 (0.24)***	−2.05 (0.26)***
Out-of-school suspension	−3.49 (0.29)***	−2.90 (0.28)***	−2.84 (0.27)***	−2.61 (0.28)***	−2.62 (0.30)***
Fixed effects: school level					
Percent free lunch					−0.01 (0.01)
Percent special ed.					−0.02 (0.01)
# of full time math teachers					0.10 (0.02)***
Percent minority					−0.02 (0.01)**
School social control					−0.26 (0.16)
Math teacher's expectation					3.02 (1.06)***
Intercept	51.42 (0.18)***	55.00 (0.26)***	50.97 (0.44)***	51.60 (0.0.46)***	39.05 (0.63)***
Random effects					
Random intercept variance	21.8 (1.39)***	12.42 (0.88)***	10.36 (0.76)***	10.10 (0.75)***	4.42 (0.44)***
Observations	11,046	11,046	11,046	11,046	11,046

Coefficients followed by standard error in parentheses

$^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$

Table 4 Mixed effects ML regression on the impact of Race_Gender on math test scores (10th grade test scores)

	Model 1a	Model 1b	Model 1c	Model 1d	Model 1e	Model 1f
Fixed effects: student level						
Black_Female	−7.39 (0.31)***	−6.26 (0.30)***	−6.09 (0.30)***	−5.81 (0.30)***	−5.86 ((0.30)***	−5.47 (0.32)***
Black_Male	−6.56 (0.31)***	−5.43 (0.30)***	−5.52 (0.31)***	−4.99 (0.31)***	−5.20 (0.31)***	−4.59 (0.33)***
Hispanic_Female	−6.39 (0.30)***	−5.57 (0.29)***	−5.19 (0.29)***	−4.99 (0.29)***	−4.85 (0.29)***	−4.42 (0.31)***
Hispanic_Male	−5.63 (0.30)***	−4.80 (0.29)*	−4.66 (0.29)***	−4.24 (0.30)***	−4.23 (0.29)	−3.69 (0.31)***
# of academic risk factors		−1.82 (0.06)***	−1.58 (0.06)***	−1.44 (0.06)***	−1.41 (0.06)***	−1.33 (0.07)***
Math self-efficacy			2.25 (0.07)***	2.23 (0.06)***	2.22 (0.07)***	2.18 (0.07)***
School engagement			0.95 (0.05)***	0.93 (0.05)***	0.92 (0.05)***	0.89 (0.05)***
School treatment			0.17 (0.02)***	0.20 (0.02)***	0.22 (0.03)***	0.24 (0.03)***
Motivation			0.02 (0.03)	0.04 (0.03)	0.09 (0.03)*	0.06 (0.04)
Classes skipped					−0.38 (0.08)***	−0.29 (0.09)**
Absences					−0.29 (0.06)***	−0.29 (0.07)***
In-school suspension				−2.62 (0.24)***	−2.20 (0.24)***	−1.94 (0.26)***
Out-of-school suspension				−2.79 (0.27)***	−2.55 (0.28)***	−2.56 (0.30)***
Fixed effects: school level						
Percent free lunch						−0.02 (0.01)
Percent special ed.						−0.01 (0.01)
# of full time math teachers						0.10 (0.01)***
Percent minority						−0.02 (0.00)***
School social control						−0.24 (0.15)
Math teacher's expectation						2.99 (0.20)***
Intercept	52.45 (0.16)***	54.07 (0.16)***	50.97 (0.40)***	50.50 (0.40)***	51.22 (0.43)***	38.75 (1.03)***
Random effects						
Random intercept variance	15.60 (1.03)***	12.62 (0.86)***	11.13 (0.80)***	10.34 (0.75)***	10.04 (0.74)***	4.41 (0.44)***
Observations		11,046	11,046	11,046	11,046	11,046

Coefficients followed by standard error in parentheses

*$p<.05$ **$p<.01$ ***$p<.001$

Table 5 Sample description: 12th grade Math achievement and school suspensions

Variable	Proportion	Mean (SD)
Individual level		
Sex		
Female	0.48	
Male	0.47	
Race/ethnicity		
Hispanic	0.15	
Black	0.13	
White	0.57	
Skip/cut classes	0.27	
Absences	0.84	
In-school suspensions	0.12	
Out-of-school suspensions	0.08	
Number of academic risk factors		1.02 (1.10)
Math self- efficacy		0.02 (1.00)
School engagement		1.00 (1.31)
School motivation		7.65 (1.97)
Perception of school treatment		11.15 (2.53)
Math test scores (10th grade)		50.71 (9.91)
Math test scores (12th grade)		50.66 (10.11)
School level		
Percent free/reduced lunch		23.58 (24.96)
Percent special ed.		9.25 (9.06)
Percent minority		34.35 (31.20)
Number of full time math teachers		9.51 (6.10)
School social control		0.53 (0.74)
Math teacher's expectation		4.10 (1.47)

The descriptive results in Table 2 also indicate there are disparities in suspensions across racial groups. Although Black students are only 13% of the sample, they received 25% of the total ISS and 24.5% of total OSS. Separating these results by gender, Black boys were suspended at a higher rate (14%) than were Black girls (11.15%). Hispanic students also account for a high percentage of the suspensions. In total, Hispanic students received 19.7% of all in-school suspensions. Hispanic boys were suspended at higher rate (11.9%) than Hispanic girls (7.8%).

Comparably, Black and Hispanic students received out-of-school suspension at a disproportionately higher rate. Again, Black students took the lead receiving 24.5% of total OSS with Black boys at (13%) and (11.4%) for Black girls. Hispanics students received 18.6% of all OSS, and Hispanic boys were suspended twice as much as Hispanic girls with suspension rates of 12.4% and 6%, respectively. In summary, Black and Hispanic students make up only about 28% of the whole

Table 6 Mixed effects ML regression on the impact of student discipline on math test scores (12th grade test scores)

	Model 1a	Model 1b	Model 1c	Model 1d	Model 1e
Fixed effects: student level					
Gender: (1 = female)		−0.44 (0.08)***	−0.45 (0.08)***	−0.41 (0.08)***	−0.40 (0.08)***
Race: Hispanic		−0.65 (0.15)***	−0.59 (0.15)***	−0.53 (0.15)**	−0.44 (0.16)**
Race: black		−0.63 (0.16)***	−0.73 (0.16)**	−0.72 (0.16)***	−0.60 (0.17)**
Race: white		−0.47 (0.12)***	−0.45 (0.12)***	−0.41 (0.12)**	0.38 (0.13)**
# of academic risk factors		−0.30 (0.04)***	−0.30 (0.04)***	−0.28 (0.04)***	−0.22 (0.04)***
Math self-efficacy			0.45 (0.04)***	0.45 (0.04)***	0.42 (0.04)***
School engagement			0.28 (0.03)***	0.27 (0.03)***	0.25 (0.03)***
School treatment			0.04 (0.01)**	0.05 (0.01)**	0.06 (0.01)**
Motivation			0.02 (0.02)	0.04 (0.02)	0.02 (0.02)
Classes skipped				−0.10 (0.05)*	−0.09 (0.05)
Absences				−0.16 (0.04)***	−0.16 (0.04)***
In-school suspension	−0.96 (0.15)***	−0.94 (0.15)***	−0.90 (0.15)***	−0.84 (0.15)***	−0.78 (0.16)***
Out-of-school suspension	−0.86 (0.17)***	−0.86 (0.17)***	−0.89 (0.17)***	−0.81 (0.18)***	−0.71 (0.19)***
Base-year math test scores	0.89 (0.004)***	0.87 (0.004)***	0.85 (0.004)***	0.85 (0.004)***	0.85 (0.005)***
Fixed effects: school level					
Percent free lunch					0.01 (0.00)*
Percent special ed.					−0.02 (0.01)**
# of full time math teachers					0.00 (0.01)
Percent minority					−0.000 (0.02)
School social control					−0.05 (0.07)
Math teacher's expectation					0.80 (0.09)***
Intercept	4.90 (0.22)***	6.55 (0.28)***	6.52 (0.35)***	6.95 (0.36)***	4.18 (0.55)***

Table 6 (continued)

	Model 1a	Model 1b	Model 1c	Model 1d	Model 1e
Random effects					
Random intercept variance	0.87 (0.10)***	0.83 (0.10)***	0.80 (0.09)***	0.79 (0.09)***	0.40 (0.07)***
Observations	9416	9416	9416	9416	9416

Coefficients followed by standard error in parentheses

*$p < .05$ **$p < .01$ ***$p < .001$

sample but received about 45% of all in-school suspension and 43% of all out-of-school suspension.

Table 3 presents the results from the mixed effect linear regression of suspensions on math test scores. The analysis is sequentially modeled, adding an additional set of covariates at each model (models 1a -e). Starting with student level-variables, findings in model 1a with only ISS and OSS as predictors reveals that students who received ISS at least once scored four points less than their counterparts who were not suspended ($b = -4.05$; $p < .000$). Similarly, those who received OSS significantly scored lower than those who did not ($b = -3.49$; $p < .000$). The addition of socio-demographic variables including race, gender, and academic risk factors such as coming from single-parent household, having a sibling who dropped out of school, lower socio-economic status, and changing schools more than two times slightly reduced the impact of suspensions on math achievement for ISS ($b = -3.26$; $p < .000$) and OSS ($b = -2.88$; $p < .000$). The analysis also reveals racial stratification has the highest impact on math achievement for Black ($b = -5.37$; $p < .000$) and Hispanic ($b = -4.77$; $p < .000$) students.

In model 1c, math-self efficacy, student perceptions of school treatment, school engagement and school motivation were added to the model. With the exception of motivation, which was not significant, these additional variables were positively and significantly related to math achievement (Table 3, model 1c). This has further reduced the negative impact of ISS ($b = -2.71$; $p < .000$) and OSS ($b = -2.82$; $p < .000$) but their strong negative association remains. In model 1d, truancy variables at the student level were added to the model revealing classes skipped ($b = -0.37$; $p < .000$) and absences ($b = -0.26$; $p < .000$) have negative impacts on math achievement. Although both skipping classes and absences reduces student instruction time, their impact on math achievement is much lower than the impact of ISS ($b = -2.31$; $p < .000$) and OSS ($b = -2.59$; $p < .000$) within the same model. It is important to note that after accounting for math self-efficacy, student perception of school treatment, school engagement and motivation, OSS has slightly greater negative impact than ISS on math achievement.

In the full model (1e) school-level variables were added to the analysis. School socio-demographics, number of full-time math teachers, math teacher's expectations, and school social control variables were added to the model. With the exception of percent minority ($b = -0.01$; $p < .000$), all of the other school demographic factors were not significant. The composite indicator of school social control was also insignificant. Both number of full-time math teachers in the school ($b = 0.10$; $p < .000$) and math teacher's expectation ($b = 3.02$; $p < .000$) are positively and significantly related to math achievement. In summary, the magnitude of race continues to loom large along with the suspension effect, exceeding the effects of all other variables. It makes sense to look further to see for which race–gender groups are these effects most profound. Therefore, in our next analysis we include four race–gender variables.

Analysis 2: Math Achievement at the Intersection of Race and Gender

The second analysis in this article examines the effect of race–gender on math achievement, Table 4 displays the results of this analysis. In the first model (1a), with only race–gender, all the four dummy variables are negatively and strongly related to math achievement. Both Black girls ($b = -7.39$; $p < .000$) and boys ($b = -6.56$; $p < .000$) performed lower than Hispanic girls ($b = -6.39$; $p < .000$) and boys ($b = -5.63$; $p < .000$). Consistent with the first analysis, the number of academic risk factors added in model 1b lowers math achievement ($b = -1.82$; $p < .000$).

Model 1c shows that math self-efficacy ($b = 2.25$; $p < .000$), school engagement ($b = 0.95$; $p < .000$) and student perception of school treatment ($b = 0.17$; $p < .000$) are all positively related to math achievement. Accounting for these variables has also slightly reduced the race–gender effects for all categories (model 1c). School suspensions again account for the largest effect on math achievement after race–gender. In the full model (1f) all school level variables were added to account for potential confounding factors. The results show that large differences in math achievement remain between race–gender intersections followed in magnitude by OSS ($b = -2.56$; $p < .000$) and ISS ($b = -1.94$; $p < .000$). Black students appear to have the highest risk of lowered math scores with Black girls, in particular, facing the greatest point reductions ($b = -5.47$; $p < .000$) relative to Black boys ($b = -4.59$; $p < .000$), Hispanic girls ($b = -4.42$; $p < .000$) and Hispanic boys ($b = -3.69$; $p < .000$). That said, the addition of school level variables suggest that boys are more sensitive to school context than girls since for both Black and Hispanic boys, the effect of race–gender went down by more than a half point after controlling for school level variables (Table 4, model 1f).

Analysis 3: The Impact of 10th Grade School Suspension on Math Achievement at 12th Grade

This third analysis uses math test scores at 12th grade as the dependent variable, controlling for math test scores from 10th grade, while using all the independent variables from the first analysis. Similar to the first two analyses, this analysis is also sequentially modeled. The descriptive results are presented in Table 5. As shown in Table 5, the demographic composition of the sample remained very similar to that of the first analysis. The only new variable, which is math test scores from 12th grade level has also a very similar but slightly lower mean 50.66 points compared to the 10th grade math test scores that had a mean of 50.71 points.

Table 6 displays the results of the effects of school suspensions on math test scores in students' senior year of high school (spring 2004) while controlling for the base-year (spring 2002) math test scores. Model 1a has only ISS, OSS and the control variable, 10th grade math test scores. Both ISS ($b = -0.96$; $p < .000$) and OSS ($b = -0.86$; $p < .000$) are negatively and significantly related to math test scores. In model 1b, again demographic characteristics and academic risk factors were added to the model, which, were all significantly and negatively related to math achievement. The addition of these variables has slightly reduced the negative impact of

ISS ($b = -0.94$; $p < .000$) but the impact of OSS remained unchanged ($b = -0.86$; $p < .000$).

In model 1c, math self-efficacy ($b = 0.45$; $p < .000$), school engagement ($b = 0.28$; $p < .000$) and student's perception of school treatment ($b = 0.04$; $p < .001$) were added and found positively and significantly related to math achievement. The negative impact of ISS ($b = -0.90$; $p < .000$) consequently reduced, albeit marginally, as the impact of OSS increased ($b = -0.89$; $p <. 000$). Next, truancy variables (skipping classes and absences) were added to model 1d. Although skipping classes ($b = -0.10$; $p < .01$) and absences ($b = -0.16$; $p < .000$) are negatively and significantly related to math achievement, their effect sizes are considerably smaller than ISS ($b = -0.84$; $p < .000$) and OSS ($b = -0.81$; $p < .000$).

Finally, school level variables were added to the model (1e). The school percent free lunch ($b = -0.01$; $p < .000$) and percent receiving special education ($b = -0.02$; $p < .000$) are negatively related to math achievement but their effect size is very small. Math teacher's expectation ($b = 0.80$; $p < .000$) is positively and significantly associated with math achievement. The other school-level variables including the number full-time math teachers, percent minority and school social control have no significant effect. The addition of these school level variables has further reduced the effects of ISS ($b = -0.78$; $p < .000$) and OSS ($b = -0.71$; $p < .000$) but they still have the largest negative effect on math test scores. Moreover, unlike the 10th grade analysis, mean departures from the intercept are no longer greatest for race in grade 12. Instead, suspensions are the greatest determinant of math after prior math scores are considered.

Summary of the Analysis Results

Taken to together, our analyses have shown that there are large racial differences in 10th grade mathematics that do not go away after considering schools' level of social control and both types of suspension. Intersecting these racial/ethnic categories with gender revealed that females were the gender group within both racial/ethnic categories that had the greatest departure from mean achievement scores. In particular, Black girls appeared to perform less well in math than any other group. While both forms of suspension were large, they failed to rival the effects of race in 10th grade. In 12th grade however, the effects of OSS and ISS surpassed the effects of race/ethnicity. It is noteworthy that social control failed to achieve significance in all of our models while math teachers' average expectations of students' academic abilities was consistently the largest school level effect.

Moreover, the random components in our tables show that our modeling strategy reduced substantially between-school variation in test-scores. In the final model of analysis 1 the unexplained variance at the school-level is significant (4.42; $p < .000$) but nearly five times less than the first (21.85; $p < .000$). Similar reductions in the variance component occurred in the other analyses, but in all cases, significant between-school variation remained unexplained.

Discussion

In this study we tried to understand the relationship of suspensions to math outcomes while considering race–gender interactions and school social control. We began with the hypothesis that exclusionary school discipline lowers math achievement, a key subject that is foundational to all STEM fields. Consequently, students' preparation for STEM degrees and careers are lowered, especially for the race–gender groups that are increasingly exposed to school suspensions. Using social control and intersectionality as a guiding framework, we assessed the impact of in and out-of-school suspensions and race–gender on high school math achievement controlling for individual and school characteristics. The results of the analyses provide mixed support of our analyses. Overall, school suspensions significantly lowered math achievement, however, race–gender differences in mathematics remain after considering both the level of social control within schools and both forms of suspensions. Moreover, this effect does not only persist throughout the student's high school education, but suspensions eventually exceed race/ethnicity and become the greatest determinant of math achievement after controlling for prior math scores. In fact, out-of-school suspensions had twice the effect of other academic risk factors that students face such as lower socio-economic status, living in a single parent household, and having siblings who dropped out of school. Our results add to the evidence that school suspensions are harmful to students' academic achievement. More so, this might be a first step to identify that suspensions are barriers to students' preparation for STEM fields, and especially for particular race–gender groups that are over exposed to suspensions.

The most salient finding from our research is that the effect of suspensions on math achievement persist into subsequent years. Being suspended by the first semester of 10th grade substantially lowered senior year math scores, even after controlling for 10th grade math test scores. This finding is consistent with the recent work of Morris and Perry (2016), suggesting that this lasting effect might set a trajectory of lowered performance for the rest of the student's schooling. A potential explanation for this persistent effect could stem from the theory of *learning progression* that describes learning as process of moving students from simple idea to a more sophisticated understanding within a subject area (NRC 2006; Nichols 2010). Thus, students who missed some portion of math instruction in their sophomore year due to suspensions may have been excluded from the opportunity to acquire the background knowledge necessary to grasp more advanced math concepts that would be covered in other courses as they matriculate. As math sequences require students to complete successfully prerequisite courses, suspensions likely channel students to lower-level math courses, or stop their progression altogether, further reducing their access to math preparation and ultimately readiness for STEM degree programs.

Further, this study has used both ISS and OSS in the same analysis, producing separate effect sizes for each compared to previous studies that used only one of the suspensions to measure their effect on academic performances (Raffaele Mendez 2003; Morris and Perry 2016; Lacoe and Steinberg 2018). This is particularly important because our results suggest that ISS, which is commonly used at the discretion of school officials (Martin and Smith 2017; Perry and Morris 2014) for less serious infractions such as insubordination (Watanabe 2013), in the long-run may surpass the negative effects of OSS. Therefore, since more students are exposed to ISS, there is increased risk of losing students from STEM trajectories, especially students of racial minorities who are suspended at a higher rate.

This study also adds a critical dimension to the intersectionality theory as it conveys an empirical effect of race–gender interactions on math test-scores. The results reveal that the greatest manifestation of stratification in math performances is between race–gender groups. Black girls appear to be the least well prepared within this hierarchy, a possible effect of the double disadvantage of gendered and racialized stratification. These findings add to the recent call to the plight of African American girls in STEM that is often minimized and ignored in research (Martin and Smith 2017; Crenshaw 1993; Morris 2016) and the assumption that Black girls are just 'doing fine'. Equally, Hispanic girls performed less well than Hispanic boys.

Although it is not a focus of this study, our findings also suggest that the effects of suspensions on math result from more than the loss of classroom instruction. If a loss of instruction was the only effect of suspensions, then we might find similar effects in math related to skipped classes and absences. Although our models found significant negative effects for students' skipped classes and absences, the effect of ISS and OSS were nearly seven times that of classes skipped and almost ten times those of absences. After adding school level variables, the estimates for classes skipped and absences were smaller, while those for suspensions remained relatively large. This impact beyond instruction could be due to the ways in which students who are suspended are stigmatized and consequently bear the psychosocial provocations of suspensions such as anger, apathy and disengagement that further undermine math learning (Contenbader and Markson 1998; Davis and Jordan 1994; Jenkins 1997).

That said, we must admit that our analysis does not disentangle the relationship that skipped classes and absences have to suspensions because those norm violations may directly trigger suspensions. Even if this is the case, we would still argue that the impact of a suspension triggered by truancy far exceeds the loss of test-score points caused by the truancy related loss of instruction. In perplexing cases of educational policy such as these, the loss of instruction that triggers a suspension is punished with additional losses of instruction. This point could be made more forcefully in future analyses that allow researchers to adjust for the exact number of lost instructional days due to suspension or truancy and establish their relative equivalency.

The findings from this study have important implications for exclusionary school discipline policies and practices. It backs recent calls to seek alternative disciplinary methods to school suspensions. Although school suspension was initially conceptualized to maintain social order and reduce misbehavior that would disrupt the learning environment, evidence from the current and previous research suggests the unintended consequences are much more adverse especially on students' academic achievement. More so its long-term impact on math learning has severe implication for students' preparation for STEM fields. Considering these adverse effects on academic performance, the use of school suspensions need be reconsidered, and ISS should be totally eliminated. Since research shows most ISS are for subjective, minor rule infractions such as dress code violation, disobedience and tardiness, schools need to explore other options to deal with such misbehaviors instead of removing students from class. Likewise, the use of OSS should only be reserved for cases of serious threat or injury.

Research suggests restorative justice practices as alternative to the zero tolerance policies. As opposed to the zero tolerance policies, restorative justice approaches engage all parties including students, teachers, parents and administrators to resolve conflict (Gonzalez 2012; Anyon et al. 2014) as opposed to exclusion of offending students. Therefore, the aim of "restorative practice is to reintegrate the student into the school community, rather than removing the student and increasing the potential for separation, resentment, and recidivism" (Gonzalez 2012 p286). Since the restorative justice practice started, schools across the nations from Oakland, CA (Sumner et al. 2010) to Chicago Public Schools (Losen and Gillespie 2012) have reported decreases in suspension rates. Moreover, in the process of solving the problem through engagement, the restorative justice approach has the potential to build qualities that are necessary for math learning such as engagement and motivation in which other school social control methods inhibit as discussed earlier in the literature review.

Additionally, the conversation around the restorative justice table might build a better student–teacher relationship (Gregory et al. 2014) that might subsequently reduce the racial biases in discipline referrals that overwhelmingly affect students of color. However, although research on restorative justice has established a relationship between restorative justice practices and school suspensions, there is still little empirical evidence on the impact of restorative justice on the discipline gap. Hence, there is a need for more research as the current racial disparities in school discipline is startling.

Finally, while our findings are important addition to the knowledge base, we also acknowledge the limitation of our study. The only measure of suspensions in our data is from the 10th grade level, therefore, we do not know if these students were suspended in subsequent years and how that would have affected their math achievement.

Conclusions

These results demonstrate that suspensions have important consequences for students' math performances. This article adds critical evidence to the literature that school suspension is a major barrier in students' math learning. Although discipline and social order are necessary conditions for learning (Gregory et al. 2010), exclusionary discipline methods restrict students' opportunities to learn. More so, it breaks the learning process making it difficult for suspended students who missed basic concepts to progress to advance levels especially in key subjects like math.

Consistent with previous work, this study confirms racialized students are suspended at a higher rate. Higher rates of suspensions coupled with the alarming amount of race–gender stratification further reduces the opportunities of racialized students to succeed in math and prepare adequately for STEM majors. Recent reports indicated that the percentage of underrepresented groups in STEM workforce has either declined or stagnated since 2001 (Bidwel 2015; Matthews and Loftus 2014). Given the unequal suspension rates for different racial groups, school suspensions might be a contributing factor considering that high school is a crucial stage in student preparation for STEM majors. Therefore, disproportionately suspending students of color has far reaching implications for segments of populations who are already underrepresented in STEM. Although recent efforts to reduce school suspensions and introduce alternative discipline methods are encouraging, it is crucial to include strategies to close the racial punishment gap if the nation is to improve the status of the underrepresented groups in STEM workforce.

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