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The Impact of Universally Accelerating Eighth Grade Mathematics Students on Participation and Achievement

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THE IMPACT OF UNIVERSALLY ACCELERATING EIGHTH GRADE MATHEMATICS STUDENTS ON PARTICIPATION AND ACHIEVEMENT

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INTRODUCTION

In New York State, one of the requirements for graduating with a Regents Diploma is earning a passing score on the Algebra I Regents. Most schools in New York State offer this first-year high school course in eighth grade to only their top students who are selected by using a combination of the student's prior academic achievement and school recommendation. Students in this track are considered "accelerated" and are on a direct path to take calculus as a senior in high school. The other students in the cohort take the Algebra I course in 9th grade and can only progress to a pre-calculus course by senior year.

This sorting of students into tracks by ability may disproportionally affect minority students and students of low socioeconomic status, since these students are, on average, overrepresented in the "lower" tracks (Braddock, 1990; Oakes et al., 1990). Black students make up 15% of the eighth-grade student body in the United States, but only 10% of students enrolled in eighth grade Algebra I nationwide. Similarly, a quarter of eighth graders are Latino, but only 18% of the students enrolled in eighth grade Algebra I are Latino (Patrick et al., 2020).

To increase equity and access for all students, some schools have adopted universal acceleration policies, assigning all students in eighth grade to the Algebra I curriculum. A perceived benefit to the policy of universal acceleration is that it ensures equal access to a challenging curriculum for all students, regardless of race, socioeconomic status, or prior achievement. However, a perceived drawback is the possibility that weaker students may not be developmentally ready to take Algebra in 8th grade and stronger students' progress might be hindered by having lower achieving peers in their classes.

"…sorting of students into tracks by ability may disproportionally affect minority students and students of low socioeconomic status…"

Using student level data from one Long Island, New York school district, this study analyzes the impact of a universal acceleration policy on the timing of when students took the Integrated Algebra Regents Exam and their subsequent achievement on the Integrated Algebra Regents Exam among the general student population and among racial/ethnic subgroups.

BACKGROUND

Worthy (2010) (as cited in Bolick & Rogowsky, 2016) found that students in high-tracked classes experienced a faster paced, more challenging workload, compared to students in low-tracked classrooms, where the focus was on basic literacy skills and test preparation, with low-level materials. Combine that with the fact that minority students and students of low socio-economic status are often over-represented in the lower tracks (Braddock, 1990; Oakes et al., 1990), it can appear that a students' educational experience is often a result of the track they are placed into. In this model, the gap in opportunity and access to higher level courses and scholastic achievement for minority students and students of

poverty can be magnified by the track placement. In other words, education can function to emphasize and exacerbate the differences in the class system by maintaining the classes of the ruling class and the working class and thus promoting social inequalities (Samkange, 2015). This Marxist perspective on education is founded on the belief that the education system maintains the capitalist system and the class struggle.

Universal acceleration is one response to tracking and the large racial inequities in access to a high-quality curriculum (Patrick et al., 2020). Tyson (2011) outlined how separating students for instruction, by ability or prior achievement, often leads to segregated classrooms. The higher-level classes are often filled with predominantly white students, while the lower-level standard classes contain a disproportionate number of black and minority students. This can impact the self-perception and academic trajectory of black and Hispanic students. A universal acceleration policy, if implemented reliably, removes racial access gaps, and ensures that all eighth-grade students are enrolled in Algebra I. However, there is an open question of whether all students will succeed when faced with more challenging coursework.

Sociocultural learning theory suggests students learn best when they are pushed right outside of the area of the things they currently know and are provided with supports and interventions to promote learning. Vygotsky developed the concept of the Zone of Proximal Development (ZPD) as: "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peer" (Shabani et al., 2010, p. 238). This zone is vastly different for all students; therefore, one might argue that universally accelerating students may not lead to academic success for students who are not developmentally prepared for the coursework or do not receive sufficient supports in advanced courses. As well, it is possible that heterogeneous grouping practices might hinder academic process, because of the challenges that come with having such an academically diverse classroom.

Existing studies of universal acceleration find somewhat mixed results. Burris and Welner (2005) investigated how one suburban school raised achievement levels for all students by de-tracking and universally accelerating all eighth-grade students into Algebra. Prior to universal acceleration (between 1995 and 1997), black and Hispanic students were overrepresented in lower tracks and only 23% of these students passed the Algebra Regents exam, while 54% of white and Asian peers passed the exam. After universally accelerating students in heterogeneously grouped classrooms, 90% of all students passed the Regents examination, including 75% of all black and Hispanic students and 98% of white students. These students were also more likely to pursue higher-level math coursework, to earn higher grades in those courses, and to earn their Regents Diplomas (Burris & Welner, 2005, p. 598).

Dougherty et al. (2015) studied a district that implemented a targeted enrollment strategy for accelerated algebra and found that there were increases in enrollment and access to the advanced mathematics course under the new policy. The district used a prediction model to assign students to advanced coursework, rather than leaving the choice to individual school recommendation. Within two years of policy implementation, there was a 30 percentage point increase in middle school students in accelerated math, from 40 percent to nearly 70 percent. As well, students who otherwise would have been omitted from Algebra in 8th grade were now being selected in a fairer way. Their findings showed that the new assignment rule substantially diminished income and race gaps in course assignment, compared to the prior discretionary policy of determining acceleration. They also found that middle school math acceleration improved college readiness scores and college aspirations, increasing the fraction of students intending to enroll in four-year colleges by over 20%.

Not all instances of universally accelerating students in mathematics yielded overwhelmingly positive results, however. Allensworth et al. (2009) explored the impact of the Chicago Public Schools' implementation of a policy that required Algebra for all ninth-grade students, eliminating all remedial coursework beginning in 1997. They found that an increase in Algebra I enrollment by 20 percentage points resulted in a 10% increase in students' earning Algebra credit in 9th grade. Math failure rates increased among low-ability students and average-ability students, and students were not more likely to take advanced math classes beyond Algebra II post-policy. The policy did not have statistically significant effects on math scores on the first year of policy implementation. (Allensworth et al., 2009).

Domina et al. (2014) studied the effect of a district's effort to intensify its 8th grade mathematics curriculum and increase the number of students in Algebra I. Between the 2004-05 and 2007-08 school years, the proportion of 8th graders in the district taking Algebra I increased from 32% to 84%. Findings showed that universal acceleration had a strong impact on course selection. Prior to implementation, a hypothetical student had a 43% chance of enrolling in Algebra in 8th grade, compared to a 94% chance after this curricular intensification. However, even as the district implemented a universal acceleration policy, mathematics achievement growth between 6th and 10th grade slowed, and the achievement advantages associated with 8th eighth grade Algebra declined.

When analyzing the efficacy of a universal acceleration policy, how the school groups students for instruction should be looked at as well. Atteberry, et. al. (2019) analyzed one Long Island, New York school district's de-tracking effort and the impact it had on participation in advanced courses and overall student achievement. As a result of moving to heterogeneous grouping, they found that there was increased participation in their International Baccalaureate (IB) courses following their de-tracking efforts, particularly among students with lower PSAT scores. As well, they found that de-tracking was not associated with lower mean mathematics scores for any group in the study. Similarly, Leonard (2001) found that low-achieving and middle-achieving students scored significantly higher in mixed ability groups than students in homogeneous groups. Boaler (2011) conducted two longitudinal research studies that found students in heterogeneously grouped mathematics classrooms achieved at significantly higher levels than those in tracked settings. Boaler found the group that benefitted most from the change in grouping policy was higher achieving students, which she hypothesized was a result of having them explain concepts to their less able peers, strengthening their own understanding.

Research also shows that grouping students homogeneously can yield positive results when done in the right setting. Collins and Gan (2013) found a positive, statistically significant relationship between the sorting variable and math score/gain score, indicating that sorting is beneficial to students. To test for the possibility that grouping students only improves outcomes for higher achieving students at the expense of lower achieving students, Collins and Gan found only slightly higher effects for high achieving students, and the estimates for the two groups are not statistically significantly different from each other. Robinson (2008) showed that LM/P (Language Minority students whose first language at home is not English) Hispanic children, when grouped by ability for kindergarten reading instruction, noticed significantly greater benefits compared to other students. However, this benefit faded during the summer and first grade, unless grouping continued in first grade, signaling the benefit of the grouping strategy.

Finally, even well intended de-tracking efforts can still promote inequities. Rubin (2008) analyzed three school districts with distinct student populations (one predominantly black and Hispanic, one predominantly white, and one racially diverse) and found that the

de-tracking efforts were implemented very differently depending on the school population. In the school containing mostly black and Hispanic students, the policy change was viewed from a position of deficit, and classroom practices provided students little opportunity to demonstrate competence. Comparatively, the de-tracking effort in the white suburban school spurred a creative curriculum, with faculty viewing students with high expectations and being college bound. In the racially diverse school, implementation focused on flexibility and personalization. It is important to note that the experience of de-tracking can differ from school to school.

The debate on which students should be granted access to accelerated mathematics courses is layered with complexities. Empirical studies provide mixed evidence as to whether tracking students leads to higher student achievement, making it difficult to reach a consensus about its benefits or consequences.

METHOD

DATA

This study used secondary data from students in the 8th grade cohorts beginning with the 2008-09 eighth grade cohort and ending with the 2013-14 eighth grade cohort from the Great Oaks School District (pseudonym). Universal acceleration first began in this district with the cohort of 8th graders in 2011-12, therefore this sample included three cohorts prior to universal acceleration and three cohorts post universal acceleration. All students were included in the sample, including special education students, to ensure a range of varying demographics, except for three students with unknown race and thirteen students who took the exam as 10th, 11th, or 12th graders. Students who re-took the exam a second time had only their first score included in the data and all subsequent scores were removed. Table 1 shows the demographic breakdown of the students included in this data set, by race/ethnicity.

Table 1

Race/Ethnicity of Students in Sample

Subgroup		Frequency	Percent
	White (non-Hispanic)	1183	73.4%
	Black	90	5.6%
	Hispanic	267	16.6%
	Asian	44	2.7%
	Multi-Race	28	1.7%
	Total	1612	100%

MODELS

To study the effect of the policy on the timing of students' Integrated Algebra course taking, I provide descriptive statistics of the students taking Integrated Algebra in 8th and 9th grade by cohort and subgroup. To estimate the effect of the policy on Regents exam performance, I estimated the following interrupted time series model:

$$regents_i = \beta_0 + \beta_1(t - t^*) + \beta_2(P_t) + \beta_3\,[(t - t^*)\,P_t\,] + e_t$$

In this model, $regents_i$ is the Regents score of student i; t is year (e.g., 2010, 2011); t^* is the year in which the policy was adopted; and, P_t is an indicator that the observation is from the post-period (after policy implementation). Therefore, β_1 is the trend in Regents scores prior to the implementation of the policy; β_2 is the "jump" in scores that occurred at the time of implementation of the policy change; and, β_3 is the "shift" in the trend in Regents scores after implementation. To understand whether the impact differs by subgroup, the model was estimated separately for each racial/ethnic subgroup and the coefficients from the model were compared.

Threats to Validity. The interrupted time series model hinges on the fact that there are no other significant changes occurring simultaneously during the time period within the study, and specifically the time at policy change. After policy implementation, New York State altered the Algebra curriculum in 2013-2014, moving to the Common Core Learning Standards. During the 2013-2014 school year, students in New York State had to sit for the Common Core Algebra I Regents but had the option of also taking the Integrated Algebra Regents as well. In this district, students in the 8th grade cohort in this district took both. For this study, only the results from the Integrated Algebra Regents Exam were used; however, the change in curriculum during the 2013-2014 school year may impact that results of the study and affect the estimated post-policy trend.

FINDINGS

CHANGES IN INTEGRATED ALGEBRA COURSE TAKING

Universal Acceleration led to significant increases in participation in 8th grade Integrated Algebra across the general population and for each racial/ethnic subgroup. Table 2 shows the percentage of students, by group, who took the Integrated Algebra Regents Exam in grade 8 versus grade 9 for the 2009 cohort through 2014. The district policy change of having all students take the Integrated Algebra Regents occurred first with the 2012 cohort.

Prior to the policy, only about 30% of all students took Integrated Algebra in 8th grade. Post-policy, this jumped to 100%. Minority students showed the greatest change in participation in 8th grade Integrated Algebra based on the policy change. Table 2 shows the breakdown of the percentage of students taking Integrated Algebra in 8th grade based on race/ethnicity. Black and Hispanic students were less likely than white students to take the Integrated Algebra Regents Exam in 8th grade prior to the district's policy change. In the 2009-2011 8th grade cohorts, 32.9%, 31.5%, and 36.9% of white students took the exam in 8th grade, compared to 22.2%, 12.5%, and 15.4% for black students and 12.5%, 34%, and 17.5% for Hispanic students. The move to all students taking Integrated Algebra in 8th grade beginning with the 2012 yielded the biggest participation change among black, Hispanic, and Asian students.

Table 2

Percent of Students Taking the Integrated Algebra Exam in 8th or 9th Grade, by Subgroup

Cohort	All Students		White		Black		Hispanic		Asian		Multi-Racial	
	8th	9th	8th	9th	8th	9th	8th	9th	8th	9th	8th	9th
2009	28.6	71.4	32.9	67.1	22.2	77.8	12.5	87.5	20	80	0	100
2010	30.8	69.2	31.5	68.5	12.5	87.5	34	66	60	40	0	100
2011	32.4	67.6	36.9	63	15.4	84.6	17.5	82.5	14.3	85.7	0	100
2012	100.0	0.0	100	0	100	0	100	0	100	0	100	0
2013	100.0	0.0	100	0	100	0	100	0	100	0	100	0
2014	100.0	0.0	100	0	100	0	100	0	100	0	100	0

Note. The total sample included 1612 students. Numbers shown in table are percentages. Cohort is the spring of the Grade 8 school year.

CHANGES IN INTEGRATED ALGEBRA SCORES

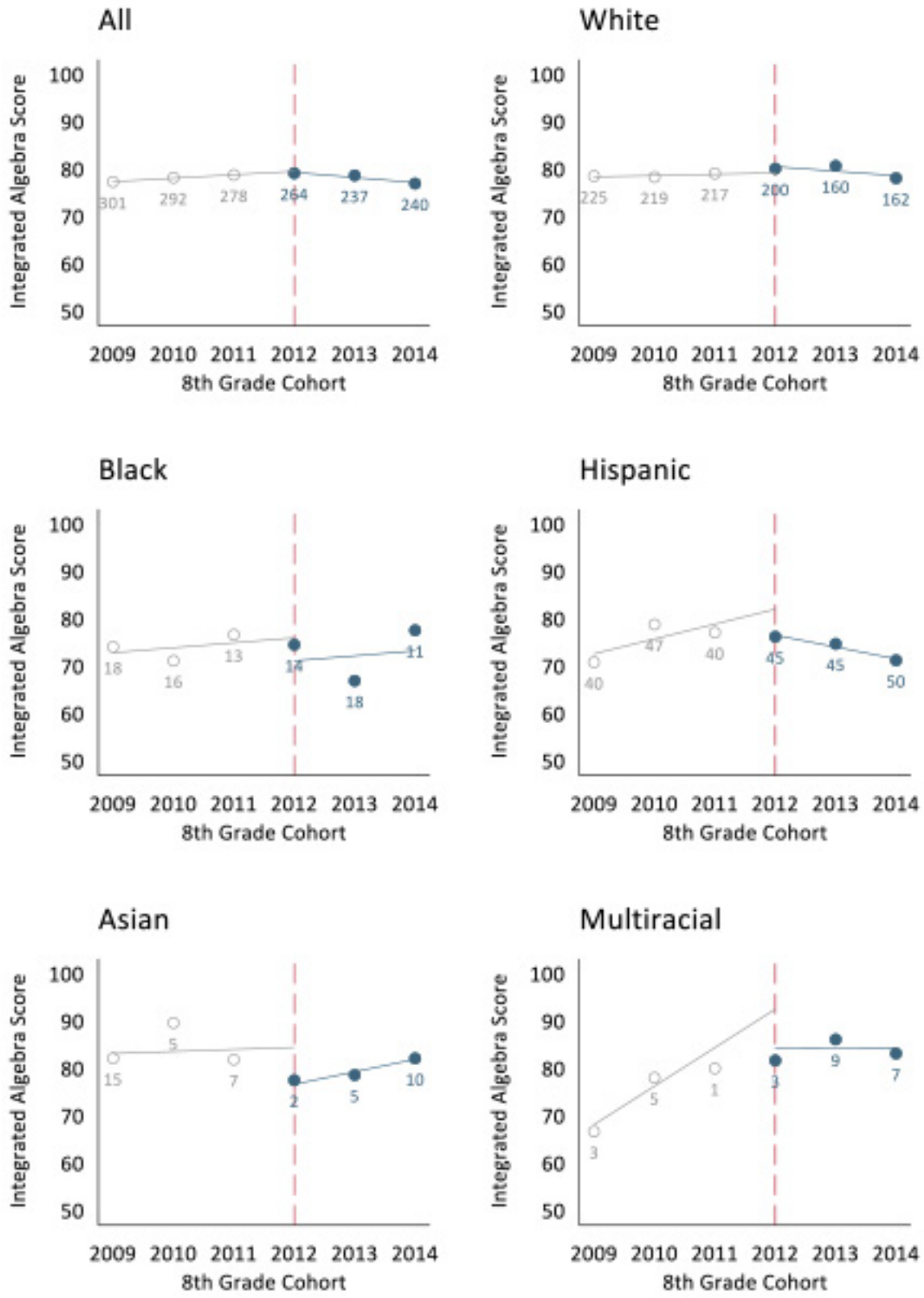
Across the general population, there was no significant change in scores upon policy implementation, however there was a small decrease in trend of scores post policy (Figure 1). Prior to policy implementation, the average Integrated Algebra score was approximately 79.5 points (see Appendix Table A1) and scores were not changing significantly ($\beta = .732$, $p = .093$). At the time of policy implementation, scores did not change significantly ($\beta = -.228$, $p = .839$); however, there was a significant change in the trend ($\beta = -1.814$, $p = .005$), suggesting that scores declined by about 1.082 points (trend prior plus trend after) on average each year for all students after implementation.

To determine if the policy change impacted students differentially by race/ethnicity, the data file was split to analyze the findings for each racial subgroup. There were no significant coefficients in the models for white students, Asian students, or black students, suggesting no effect of the policy for these subgroups. Although, it is important to note the small sample of black students, which may have been insufficient to determine significant effects.

Prior to the policy, the models show that multi-racial students' test scores were improving ($\beta = 8.125$, $p = .025$); no other coefficients were significant, likely due to the small sample size of students who identify as multi-racial. However, it does appear visually that the improvement prior to the policy did not continue post-policy (Figure 1). The results further showed that Hispanic students scores were increasing prior to the policy ($\beta = 3.138$, $p = .020$), but declining after by about 2.506 points per year (trend after plus trend prior). There were also a large, but only marginally significant drop ($\beta = -5.475$, $p = .098$), in the year of policy implementation. This suggests that the policy may have been slightly harmful for Hispanic students; a point I will revisit in the discussion.

Figure 1

Achievement on the Integrated Algebra Regents, by 8th grade Cohort



Note. The labels on the scatter indicate the number of students observed at that time point.

Discussion. The findings from this research indicate that prior to universal acceleration, fewer percentages of minority students took the Integrated Algebra Regents in 8th grade compared to white students. The policy was implemented effectively and 100% of students took the exam in 8th grade following policy implementation. There was not a significant change in Integrated Algebra scores pre-policy and at policy change overall, and most subgroups of students did not see a significant difference in exam scores at the onset of the policy. Post-policy, scores on the exam were decreasing, however it was a very small decrease and was mostly driven by one racial/ethnic subgroup, Hispanic students.

It is not surprising that a policy change to an accelerated mathematics curriculum for all students would initially yield lower test scores on average. Students who were not originally "on track" for the Integrated Algebra course would be taking the exam a year earlier than they might have otherwise, which means they may have missed out on an additional year of pre-algebra preparation. Moreover, it is also reasonable that achievement gains would take more than three years post policy to materialize; students, staff, and the community at large will take time to adjust to this policy change.

Focusing on Hispanic students, there is suggestive evidence that these students were negatively affected by the policy – evidenced by an immediate, albeit only marginally significant, drop in scores at policy onset and a decline in scores in the subsequent years. The decline in scores post-policy for Hispanic students is especially troubling in light of the increase in Hispanic students' scores prior to policy implementation. Understanding why Hispanic students were uniquely affected is important for this district as it strives toward equity goals.

While this study found that universal acceleration closed access gaps to high level math coursework and most students were unaffected by the policy, a move to a universally accelerated mathematics program entails significant changes for both students and staff. School leaders and teachers should continually monitor student achievement data to identify struggling students, so that interventions can be put into place. This study highlighted differential results for Hispanic students, which suggest that close attention needs to also be paid to how these types of policies affect racial/ethnic achievement gaps. Review of the mathematics curriculum in prior grades should be conducted to ensure that it supports future 8th graders' readiness for an Algebra course in 8th grade. School leaders should also regularly seek feedback from teachers, students, and families, so that they can have a holistic view of the progress of the implementation.

There were a number of limitations to this work. First, I was unable to control for other changes that occurred simultaneously with the policy change (e.g. new technology use in classrooms, a new principal being hired, etc.). Future research should use comparative interrupted time series between two similar school districts, one that adopted a universal acceleration policy and one that did not, to better control for unobserved changes during the policy period. Second, I did not have the data to study the effect of the policy on subgroups defined by prior achievement, socioeconomic status, or special education status. These factors may have helped to unpack the unique results for Hispanic students, as they may be correlated with race/ethnicity and achievement in this sample. Third, I was also unable to follow students throughout high school. Future research could be extended to observe how the universal acceleration policy in this district impacted the participation rates in higher level math courses down the road for students (Algebra II, Calculus, etc.) and the type of diploma they earn. Finally, I had data from only one suburban district in New York State. The sample was predominantly white (N = 1183) and Hispanic (N = 267), with few black (N = 90) Asian (N = 44) and multi-racial (N = 28) students. This limited the statistical power of the analyses that focused on these subgroups, as well as limits the generalizability of the results to similar districts.

Overall, a universal acceleration policy is a way for a district to ensure that all students, regardless of prior achievement, race, socioeconomic status, etc., have access to high level coursework with their peers. However, school leaders must be proactive

and anticipate which students are likely to struggle with this change and ensure that supports are in place to help those learners. Coordination with staff and aligning curriculum at the lower levels to help accommodate this change is essential to ensuring that the move to an Algebra for all program in 8th grade is successful, sustainable, and helps prepare students for high school level mathematics.

Appendix

Table A1

Coefficients of Multiple Regression Analysis on Student Achievement, All Students

	Unstandardized B
Intercept	79.536* (.950)
Trend Prior to Policy	.732 (.435)
Change in Policy	-.228 (1.120)
Change in Trend After Policy	-1.814* (.638)

Note. *p < .05. Standard error in parentheses. The sample included 1612 students.

Table A2

Interrupted Time Series Analysis for Student Achievement, Controlling for Race and Gender

	Integrated Algebra Regents Scores
Intercept	78.926* (.961)
Trend Prior to Policy	0.805 (.422)
Change in Policy	-0.122 (1.085)
Change in Trend After Policy	-1.854* (.620)
Black Indicator	-6.121* (1.109)
Hispanic Indicator	-4.187* (.689)
Asian Indicator	3.772* (1.561)
Multi-Race Indicator	2.309 (1.944)
Female Indicator	3.075* (.505)

Note. *p < .05. Standard error in parentheses. The sample included 1612 students.

Table A3

Coefficients of Linear Regression on Student Achievement by Racial Subgroup

	White	Black	Hispanic	Asian	Multi-Race	Non-White
Intercept	79.188* (1.005)	75.966* (5.020)	82.007* (-2.875)	84.445* (4.832)	92.500* (7.825)	80.472* (2.267)
Trend Prior to Policy	0.276 (0.463)	1.045 (2.226)	3.138* (1.336)	0.436 (1.973)	8.125* (3.388)	2.048* (1.020)
Change in Policy	1.328 (1.191)	-4.86 (5.830)	-5.475 (3.302)	-7.802 (6.921)	-8.149 (8.361)	-4.695 (2.630)
Change in Trend After Policy	-1.228 (0.691)	0.015 (3.324)	-5.644* (1.814)	2.207 (3.629)	-8.154 (3.992)	-2.791 (1.429)
Number of Students	1183	90	267	44	28	429

Note. *p < .05. Standard error in parentheses. Non-white includes all races in the table except for White.

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