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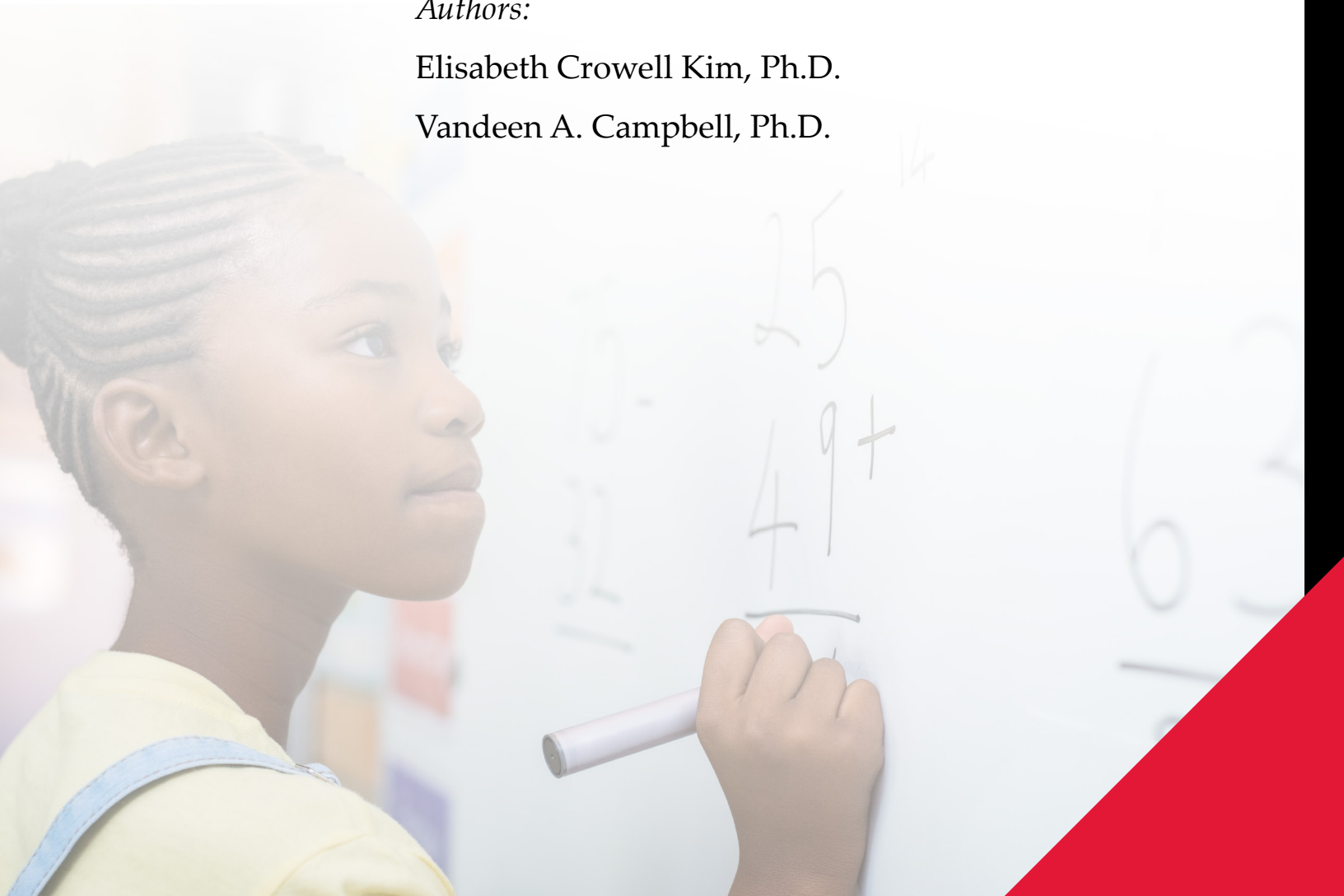

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Executive Summary

This report presents findings of a study of mathematics course-taking in middle and high schools in the state of New Jersey between 2016 and 2020. Science, technology, engineering, and mathematics (STEM) careers can lead to rewarding postsecondary options. Increasing participation and access to STEM fields is a national priority in addition to reducing inequality in access. A basic point of entry to STEM, middle and secondary mathematics course enrollment has been a pothole in STEM pathways because of persistent disparities by racial, socioeconomic, language, and disability backgrounds. This report tracks mathematics course-taking trends in the state for school years 2016-2017 through 2019-2020 using publicly available school-level data from the New Jersey Department of Education's (NJDOE) School Performance Reports.

Findings focus on rates of enrollment in the standard math sequence – Algebra I, Geometry, and Algebra II – and high-leverage, advanced coursework – Pre-Calculus, Calculus, and Statistics – often favored in admission to selective post-secondary institutions and many mathematics-related majors. Disparities in enrollment in STEM courses have been along racial and economic lines so this report disaggregates trends by racial and socioeconomic composition of students in schools. Results are further broken down to show cross-sectional mathematics course-taking trends by grade level to depict students' likely trajectory through high school. The report also focuses on mathematics course-taking in schools with varying proportions of English Learners (ELs) and Students with Disabilities (SWD). Lastly, the report features schools with trends which are positive outliers from the average pattern.

Overall, we find that students in segregated schools (90%+ minority and/or 50%+ economic disadvantage) do not have the same levels of enrollment in high-leverage coursework in mathematics as those in non-segregated schools. This disparity starts in middle school and worsens as students move to the later years of high school. We find some similar patterns for schools with the highest EL and SWD enrollments.

Middle School Mathematics Course-taking

In grades 6-8, students in schools segregated racially and economically (53%) have far lower rates of access to Algebra I than those in mixed enrollment schools (93%).

Freshman Year Mathematics Course-taking

Students in mixed enrollment schools have an 11-percentage point advantage in the proportion of students who are taking Geometry in 9th grade (29% v. 18% of students in schools segregated economically or both racially and economically).

Sophomore Year Mathematics Course-taking

In racially and economically mixed schools, nearly one-third (31%) of students have moved on to take Algebra II in 10th grade compared to 22% in racially and economically segregated schools.

Junior Year Mathematics Course-taking

That trend continues in 11th grade when proportionally fewer students in racially and economically segregated schools enroll in Pre-Calculus (16%) than in non-segregated schools (26%).

Senior Year Mathematics Course-taking

In schools segregated racially and economically, 14% of seniors took either Calculus or Statistics while 45% did so in mixed enrollment schools, reflecting the same 11-percentage point gap we saw among sophomores.

Mathematics Course-taking by Schools' English Learner Composition

In schools with high concentrations of English Learners, by 12th grade, proportionally fewer seniors enroll in Statistics and Calculus as compared to schools with low EL enrollment (8% v. 18% for Statistics and 17% v. 23% for Calculus).

Mathematics Course-taking by Schools' Student with Disabilities Composition

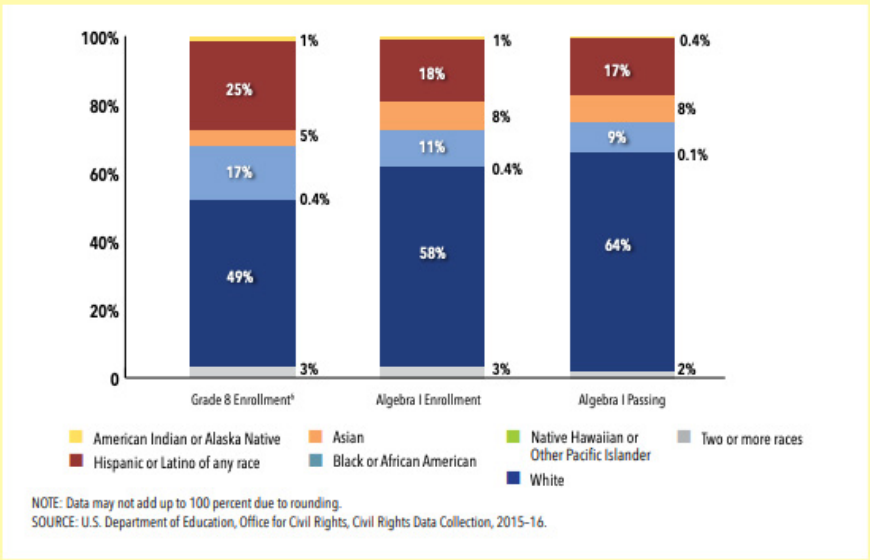
Schools with high percentages of Students with Disabilities (SWD) also have lower enrollment in high-leverage courses along the high school trajectory so that by 12th grade 26% of seniors in schools with high SWD are taking a higher-level course compared to 43% of seniors in schools with low percentages of SWD.

Introduction and Background

Mathematics has long been considered essential to success in many post-secondary careers and in a labor market increasingly reliant on 21st century skills (Aughinbaugh, 2012; Kim et al., 2015). Furthermore, an understanding of complex math and problem-solving skills is critical to citizenship as math illiteracy can serve as a barrier to both full participation in democracy and the realization of one's life aspirations (Moses & Cobb, 2002; Allen, 2011). Taking advanced math courses in middle and high school improves math achievement (Long et al., 2012; Stein et al., 2011) and increases the likelihood of college enrollment (Byun et al., 2015) and access to science, technology, engineering, and mathematics (STEM) fields (Warne et al., 2019).

A typical high school math course sequence would start with Algebra I and continue with Geometry, Algebra II, Pre-Calculus, and Calculus. For academically prepared students, enrolling in Algebra 1 before high school—typically 7th or 8th grade—gives an advantage in increasing students' likelihood of later enrolling in higher level math courses such as Calculus and Advanced Placement (AP) math courses during high school. However, when eligible students do not have access to Algebra I in middle school their likelihood of experiencing this enrichment is decreased. Nationally, only 59% of schools that serve eighth graders offer Algebra I and 24% of all eighth graders are enrolled in the course (USDOE, 2018). Black and Latinx students are less likely to have access to Algebra I in middle school, especially when they attend segregated schools. Despite being 15% and 25% of the overall eighth-grade population, Black and Latinx students make up only 10% and 18% of students enrolled in eighth grade Algebra 1 (Patrick et al., 2020).

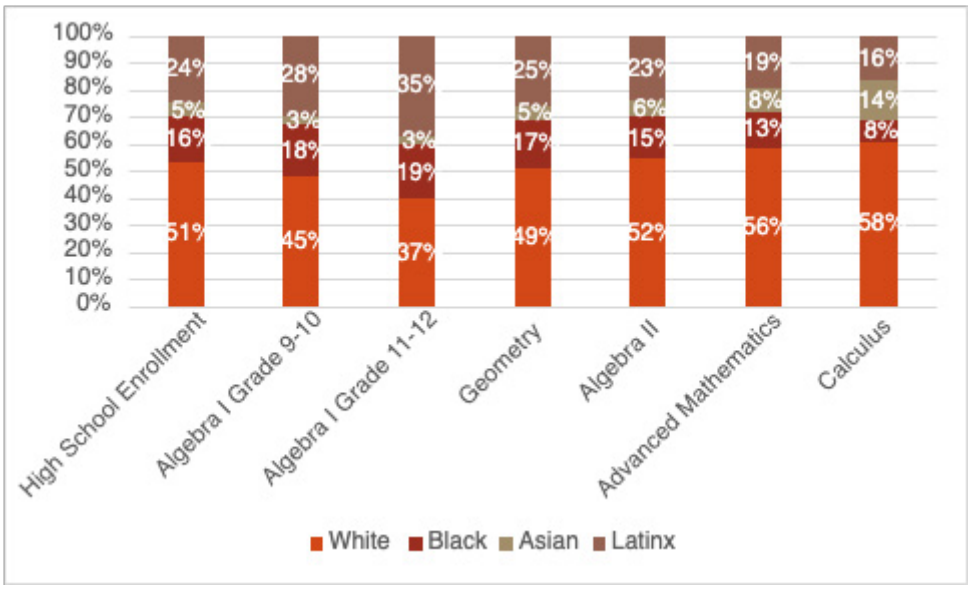
Figure 1: Nationally, Percentage Distribution of Grade 8 Students Enrolled in and Passing Algebra I, by Race, 2015-2016



Source: US Department of Education, Office for Civil Rights, Civil Rights Data Collection, 2015-16.

Nationally, this disparity in access to Algebra I in middle school extends into the high school grades. Most high schools offered Algebra I (86%), Geometry (84%), and Algebra II (80%). However, advanced mathematics and Calculus were offered at fewer schools: 65% and 50%, respectively (CRDC, 2018). Further, these courses were offered at a lower rate (55%, 38%) among the approximately 5,000 high schools with high Black and Latinx enrollment (defined in that report as schools with more than 75% Black and Latinx student enrollment). This difference is greatest with respect to advanced mathematics and Calculus (CRDC, 2018).[1] In terms of enrollment, nearly 75% of the total high school student population was enrolled in Algebra I, Geometry, Algebra II, advanced mathematics, and/or Calculus. Schools with high Black and Latinx enrollment are far less likely to offer advanced math courses like Calculus compared to all secondary schools and even when they do, they often do not gain access to Algebra 1 until secondary school and are therefore not positioned to take advantage of advanced math courses (CRDC, 2018). Of high schools with high Black and Latinx student enrollment, 38% offer Calculus compared to 50% of high schools nationwide.

Figure 2: Nationally, Percentage Distribution of Students Enrolled in High School Mathematics Courses, by Race, 2015-2016



Source: US Department of Education, Office for Civil Rights, Civil Rights Data Collection, 2015-16.

1 In the CRDC (2018) study, advanced mathematics courses cover the following topics: trigonometry/analytic geometry, trigonometry/mathematics analysis, analytic geometry, mathematics analysis, mathematics analysis/analytic geometry, probability and statistics, and pre-calculus.

Along these lines, English Learner (EL) students are far less likely to enroll in higher-level math courses than their English proficient counterparts. In 2015-16, ELs represented 6% of the high school population but only 2% of students enrolled in Calculus or beyond and 4% of students enrolled in Algebra II (CRDC, 2018). These students are often placed in lower math tracks due to their language status (Gamoran, 2017), restricting access to higher-level content (Callahan, 2018). ELs are often pulled away from academic learning opportunities to receive English as a Second Language (ESL) instruction (EdTrust, 2020).

Similarly, students with disabilities under the Individuals with Disabilities Education Act (IDEA) are less likely than their counterparts to enroll in higher-level math courses. Students with disabilities accounted for about 12% of the student population in secondary school but they represented only 2% of Calculus enrollment in 2015-16 (CRDC, 2018). Further illustrating the disparities apparent in STEM fields, high school students with disabilities acquire an approximately proportionate number of credits in English as other students but far fewer credits in math or science than their counterparts (Schneiderwind & Johnson, 2020). Insufficient curricular and instructional adjustments to recognize and address the needs of students with disabilities often renders higher-level math course content inaccessible (Moon et al., 2012).

The disparities in math access and achievement along the K-12 continuum are apparent in the postsecondary period for students who make it to the point of college enrollment, and this fact points to an urgent need for informed policies and early interventions. While advanced course enrollment can lead to increased postsecondary access, there are significant disparities. In one study, students who took an advanced academic math curriculum in high school (Algebra II, Pre-Calculus, Trigonometry, Calculus) were found to be about 17 times more likely to go to college and 20 times more likely to start college at a four-year institution by age 21 compared to those students whose highest math class was Algebra I or Geometry (Byun et al., 2015). Black and Latinx students are assigned to remedial math courses at a higher rate than their White peers in college (Chen & Simone, 2016; Preston 2017). At public two-year institutions, 78% of Black students and 75% of Latinx students took remedial courses compared to 64% of White students, while at public four-year institutions, 66% of Black students and 53% of Latinx students took remedial courses compared to just 36% of White students (Chen & Simone, 2016; Preston 2017). (It should be noted that remedial placement policies often vary across institutions and states.)

The reality is that math preparation in the earlier grades is not consistently effective so that students are not prepared to take higher-level content in middle and high school. A study using data from a large urban district found that racial inequality in access to Algebra in 8th grade is also due to prior opportunities to learn particularly for predominantly Latinx schools such that students did not receive the necessary preparation in elementary school to be successful in higher-level math courses in middle and high school (Morton & Riegle-Crumb, 2019). Thus, weighing the implications of evidence of enrollment gaps at the secondary level requires accounting for earlier disparities in preparation and achievement (Watt et al., 2014).

The New Jersey Context

In NJ, districts may handle the transition to high school in different ways. The K-7 standards contain the prerequisites to prepare students for Algebra I by eighth grade, and the standards are designed to permit districts' existing policies concerning Algebra I in 8th grade (NJDOE, 2020). The successful completion of Algebra I became a high school graduation requirement for all New Jersey students in 2012 with Geometry being added in 2014. There is also a requirement for a third year of mathematics that builds on the concepts and skills of the previous two courses, preparing students for college and 21st century careers. These account for a minimum of 15 out of the 120 credits mandated for state graduation (see Table 1). Districts can choose what the third course entails.

Table 1: New Jersey State Minimum Graduation Requirements- Mathematics (N.J.A.C. 6A:8-5.1)

	15 credits including:
Mathematics	• Algebra I or the content equivalent
	• Geometry or the content equivalent
	• Third year of math that builds on the concepts and skills of Algebra and Geometry and prepares students for college and 21st century careers

Source: https://www.nj.gov/education/cccs/grad.pdf

Findings: Mathematics Course-Taking Trends by School Segregation in New Jersey

Defining Segregation

To show disparities in high-leverage math coursework, we categorized NJ secondary schools based on race/ethnicity of students enrolled and the economic status of their families. To operationalize the idea of "segregation," we consider a school racially segregated if the percentage of White students is lower than 10%. In NJ, these are predominantly schools with majority Black and Latinx students. On the other hand, if the percentage of White students is equal to or greater than 90%, the school is considered 'White isolated'. Schools that do not belong to these two categories are considered 'racially mixed.' If the percentage of economically disadvantaged students is equal to or greater than 50%, the school is considered 'economically segregated'. Our analysis focuses on three categories which cover most schools: 1) Schools that are non-segregated or mixed in terms of race and economic status; 2) schools that are segregated both economically and racially; 3) schools that are segregated economically (see Table 2).

School Category	Racial/Ethnic and Socioeconomic Composition	Number of High Schools, 2018-2019
1. Non-segregated/mixed enrollment	>10% and <90% White <50% economic disadvantage	239
2. Segregated - Race (Students of Color) and economic disadvantage/poverty	90%+ Black and Latinx 50%+ economic disadvantage	49
3. Segregated - economic disadvantage/poverty	50%+ economic disadvantage	37

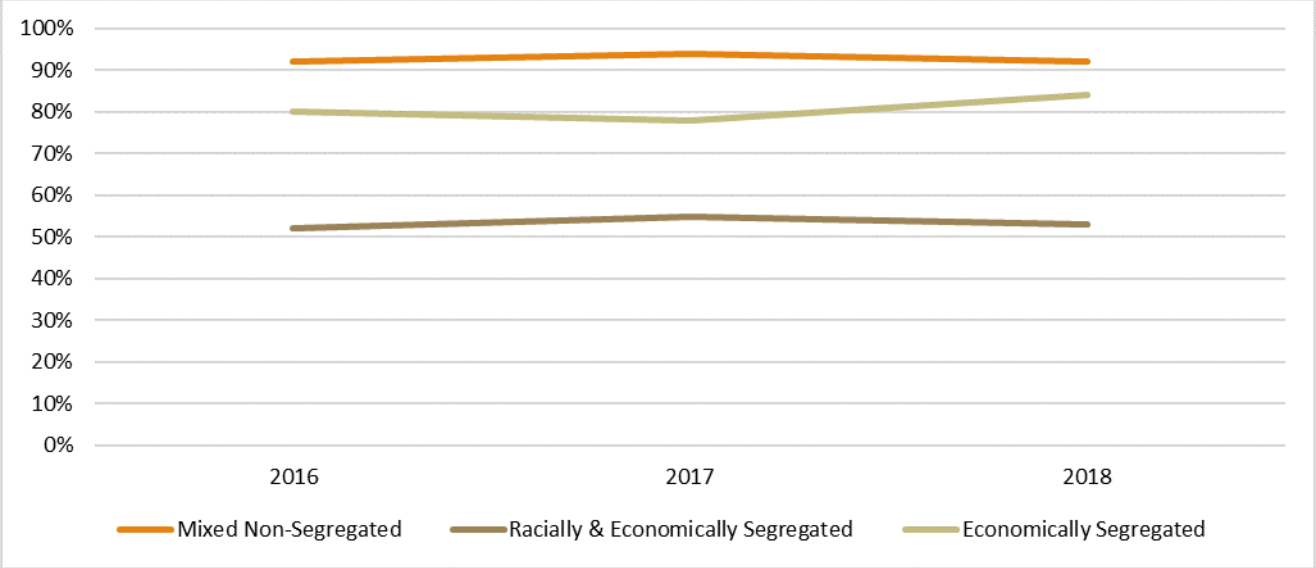
Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download. *Note: Three additional categories had very small numbers of high schools: White isolated, n=7; White isolated and economic disadvantage, n=0; Segregated – Race (Students of Color), n=7.*

Mathematics Course-taking Trends in Middle School

In 6th-8th grade, students in racially and economically segregated schools in NJ have far lower rates of access to Algebra I (measured by zero enrollment) than those in other schools (see Figure 3). As of 2019, of racially and economically mixed schools with the middle grades, 93% and 81% of economically segregated middle schools offered the course. However, among schools segregated racially and economically, only 53% offer Algebra I in the middle grades. This is consistent with the research literature on the national level finding a similar disparity (Peters & Carter, 2021). While we cannot examine specific middle to high school transition patterns, such as whether students from segregated middle schools will subsequently enroll in segregated high schools, we assume that since school segregation is largely (though not entirely) driven by neighborhood segregation, many students will enroll in high schools that are similarly

segregated. In the remaining sections we present math course enrollment patterns in high schools which show persistent disparities in advanced course enrollment. We hypothesize that at least some of the disparities are related to gaps in access to Algebra I earlier in the middle grades.

Figure 3: Access to Algebra I in New Jersey's Middle Schools: Percentage of Schools with Middle Grades Having Enrollment in Algebra I in Grades 6-8 by School Segregation



Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

Mathematics Course-taking Trends in 9th Grade

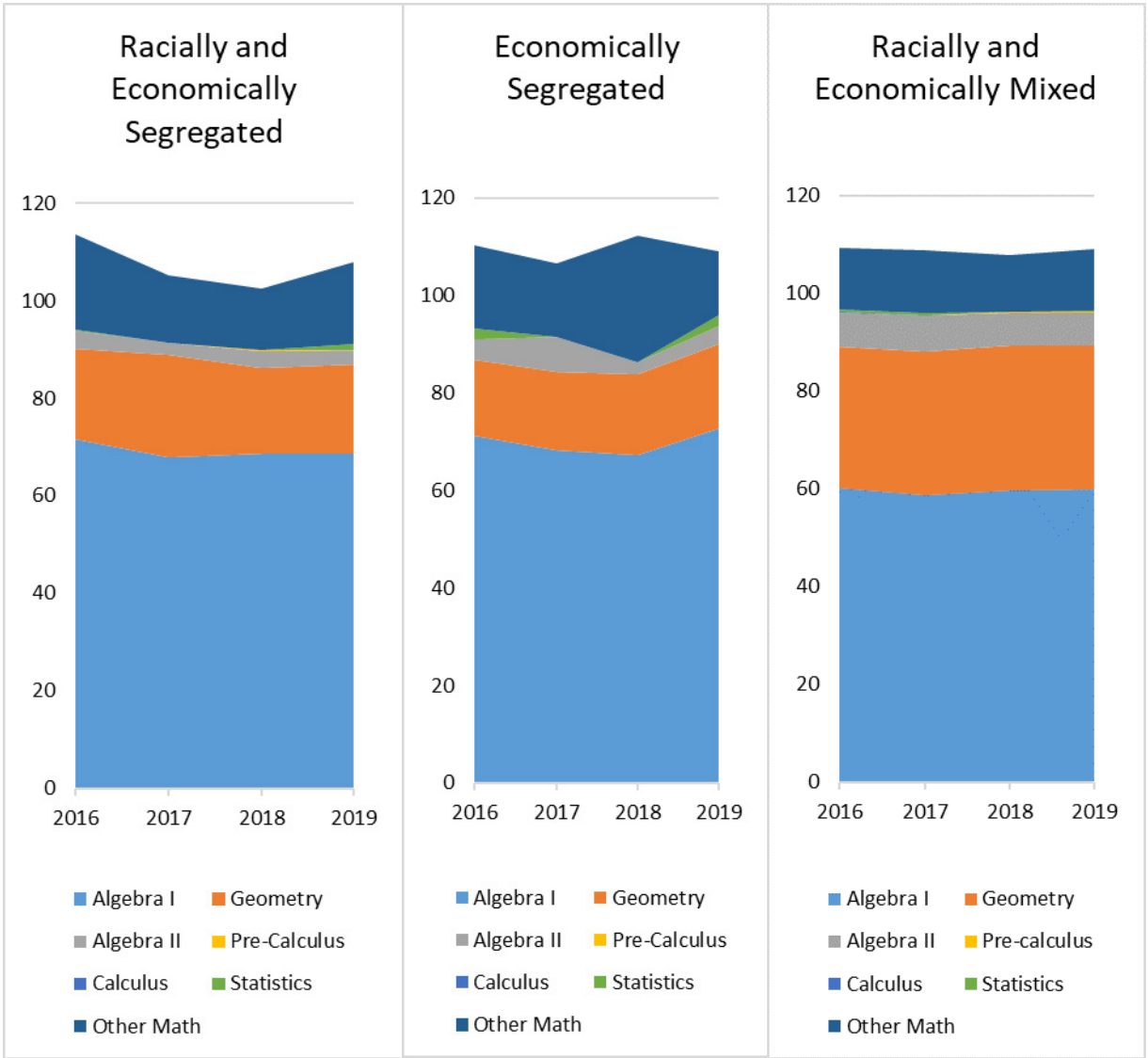
With math course enrollment rates exceeding 100% each year[2], we can infer that some students are taking multiple math courses freshman year across the three school types. The highest rates of 'Other Math' enrollment during freshmen year are found in schools segregated racially and economically. One limitation is that we cannot tell the extent to which this reflects innovative course-taking versus remedial course-taking.

Nonetheless, the differences in 9th grade Algebra I enrollment rates tell a story of advantage for students in mixed enrollment schools (see Figure 4, pg. 13). Proportionally more students in mixed enrollment schools are further along in the math sequence. Freshmen in mixed enrollment schools are taking Geometry, the next course in the math sequence, at higher rates than freshmen in both segregated school categories (11 percentage point difference). In both types of segregated schools, less than 20% of 9th graders are enrolled in Geometry (about 18% for both) compared to 29% at mixed enrollment schools.

2 According to NJDOE School Performance Reports Reference Guides, students are counted in each course in which they are enrolled. Therefore, if students are taking multiple math courses, then the total percent of students enrolled in math will exceed 100%.

As of 2019, while 69% of students in schools segregated racially and economically and 73% in schools segregated economically are taking Algebra I in 9th grade, only about 60% of students in mixed enrollment schools are doing so. Although the disparity in Algebra I and Geometry course enrollments provides important insight, we do not know what courses are included in 'Other Math' and how this may improve or worsen the conclusions. As of 2019, 'Other Math' enrollment was 17% in schools segregated racially and economically, 13% in schools segregated economically, and 13% in mixed enrollment schools.

Figure 4: Math Enrollment in 9th Grade by School Segregation

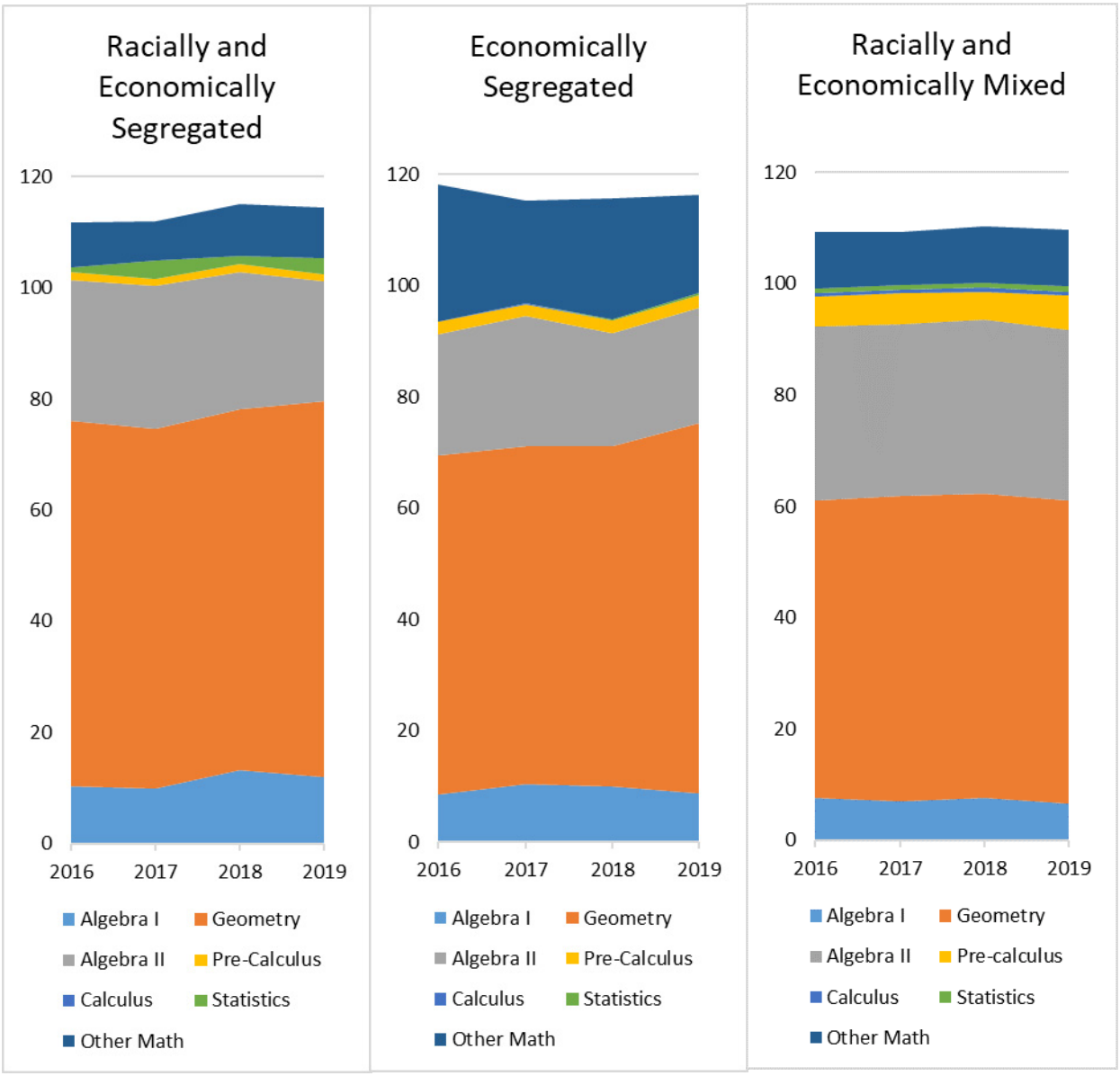


Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

Mathematics Course-taking Trends in 10th Grade

In 10th grade, the 10-point gap remains in taking more advanced math courses between the two types of segregated schools and mixed enrollment schools (see Figure 5, pg. 15). In racially and economically mixed schools, over half of students take Geometry (54%) while nearly one-third (31%) of students have moved on to take Algebra II. In racially and economically segregated schools (68%) and economically segregated schools (67%), proportionally more 10th graders are enrolled in Geometry and only about 20% are enrolled in Algebra II. Taking Algebra II in 10th grade would signal some acceleration in the math sequence and here, the gap remains at 10 percentage points. Again, how 'Other Math' impacts this finding is unknown but worth further study. In schools segregated economically, there seems to be a reliance on the 'Other Math' category reflected by the 18% of students enrolled, though the proportion has decreased over time.

Figure 5: Math Enrollment in 10th Grade by School Segregation



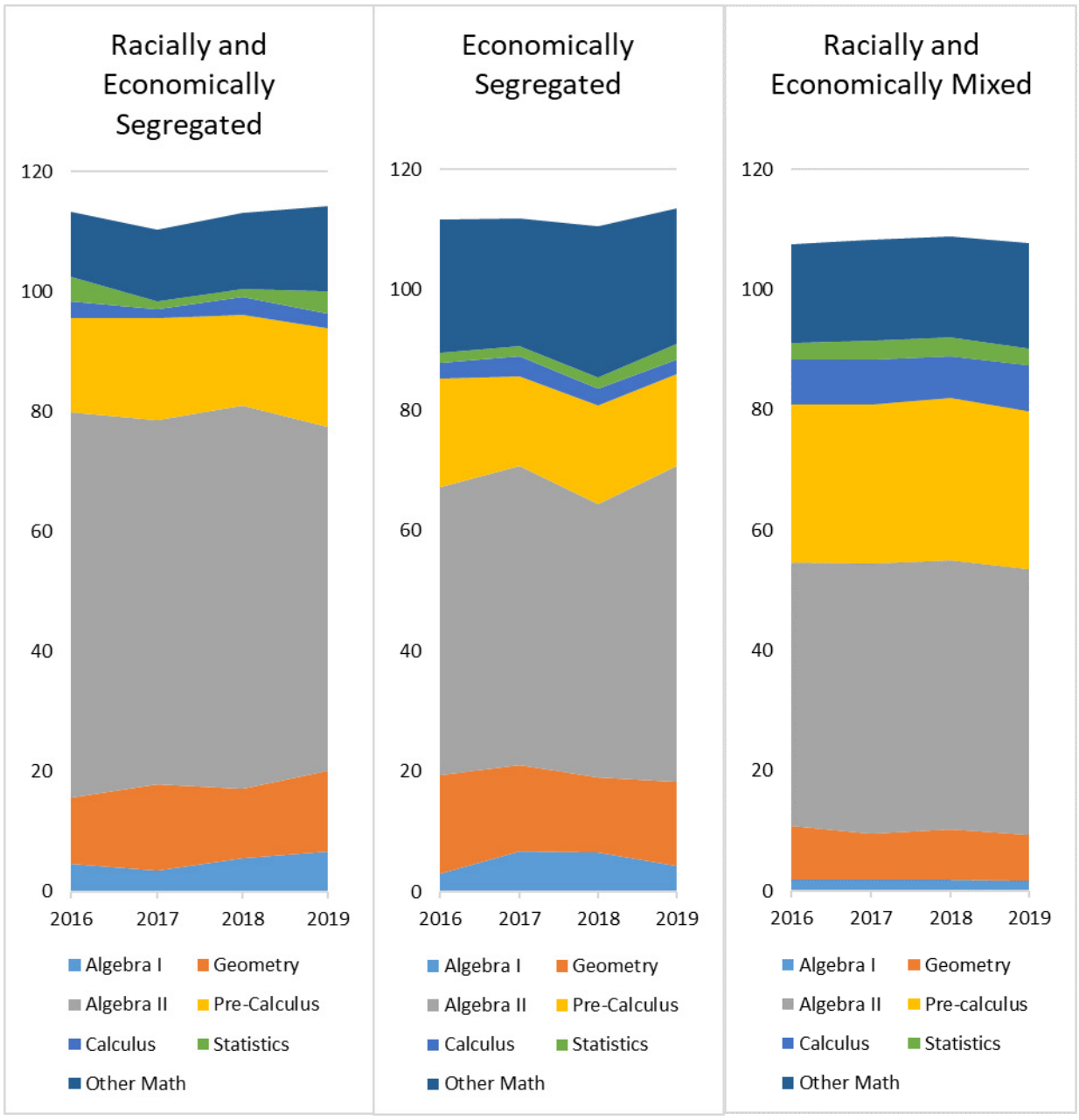
Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

Mathematics Course-taking Trends in 11th Grade

A clear gap in taking advanced math courses is solidified by 11th grade when around 26% of students in mixed enrollment schools are taking Pre-Calculus while 16% in schools segregated racially and economically and 15% in schools segregated economically are doing so (see Figure 6, pg. 17). Less than half (44% as of 2019) of students in 11th grade take Algebra II in non-segregated schools. Thus, the roughly 10-point gap in taking more advanced math courses along the trajectory remains. Considering Pre-Calculus and Calculus together, the gap is 15 points. In mixed enrollment schools, 34% of juniors are taking either Pre-Calculus or Calculus compared to 19% in schools segregated racially and economically and 18% in schools segregated economically.

Instead, students in schools segregated racially and economically appear to take the standard math sequence described earlier with little acceleration. A little more than half (57%) enrolled in Algebra II in 11th grade. Some also seem to be a step behind the standard sequence with 20% of juniors taking either Algebra I or Geometry. The same is true in schools segregated economically – 52% of juniors are taking Algebra II and 18% are still taking Algebra I or Geometry.

Figure 6: Math Enrollment in 11th Grade by School Segregation



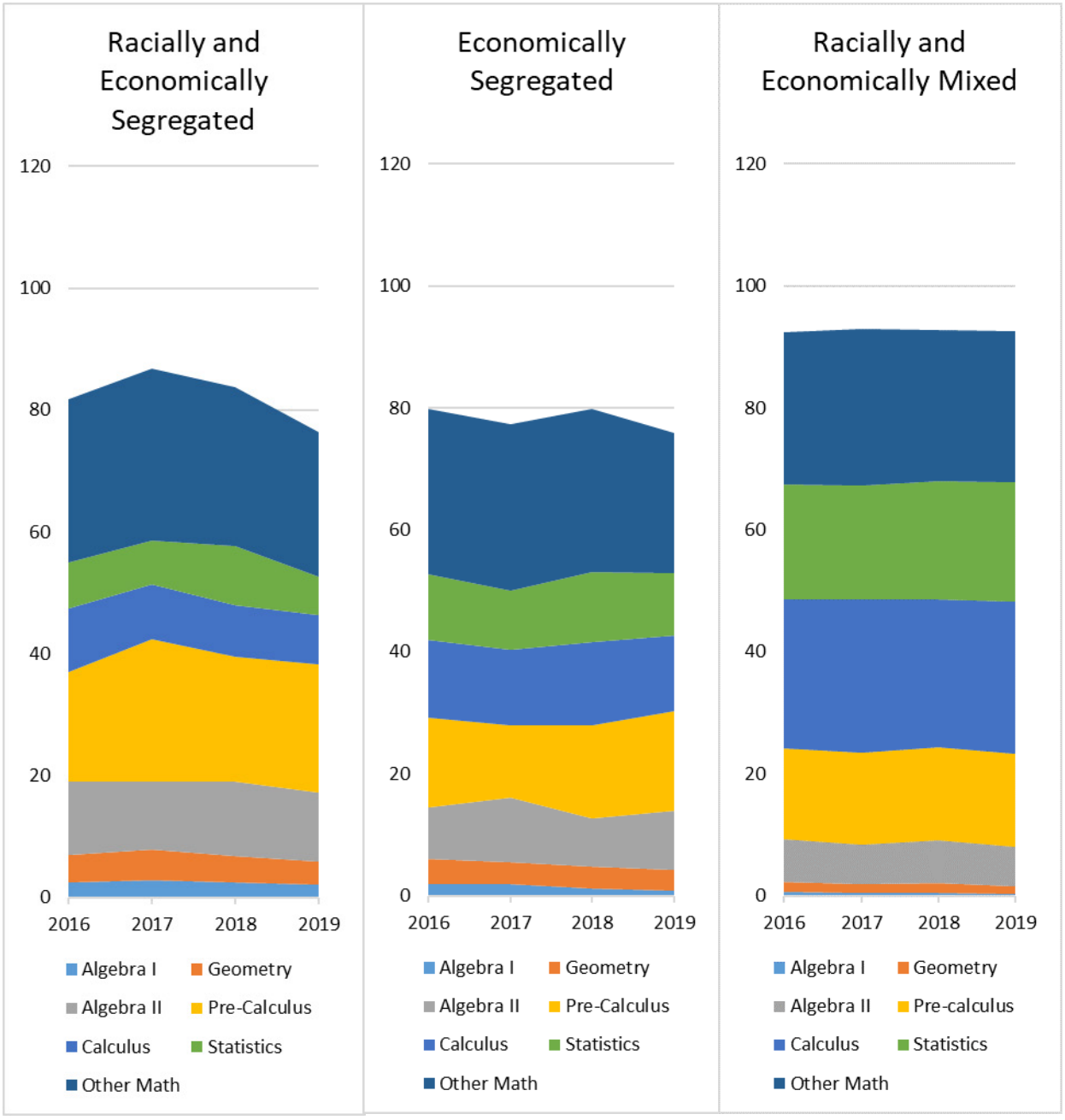
Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

Mathematics Course-taking Trends in 12th Grade

Research has demonstrated that taking a fourth year of math is associated with success in college and with higher earnings (Poulsen, 2019), though a causal relationship is not established. Overall, math enrollment is high during 12th grade in NJ, with rates ranging from 76% to 93% across the three school types shown, but a 17-point gap in taking advanced courses persists between the two segregated school categories and non-segregated schools (See Figure 7, pg. 19). Rates of math course-taking in more advanced courses such as Pre-Calculus and Calculus in the two segregated school categories do not appear to catch up to those in non-segregated schools. In schools segregated racially and economically, 35% of seniors take Pre-Calculus, Calculus, or Statistics; 39% do so in schools segregated economically, and 60% in mixed enrollment schools, reflecting a gap as wide as 25 percentage points. Looking only at the measure of Pre-Calculus or Calculus enrollment, 29% of seniors in schools segregated economically or both racially and economically took either course while 40% did so in mixed enrollment schools.

Therefore, with persistent math course-taking disparities from 8th grade through 12th grade, we have reason to believe that an advantage is solidified for students in non-segregated schools. Still, the proportion of students in segregated schools taking advanced math opportunities is not insignificant (e.g., 29% taking Pre-Calculus or Calculus in 12th grade) and this should encourage a drive towards closing the gaps.

Figure 7: Math Enrollment in 12th Grade by School Segregation

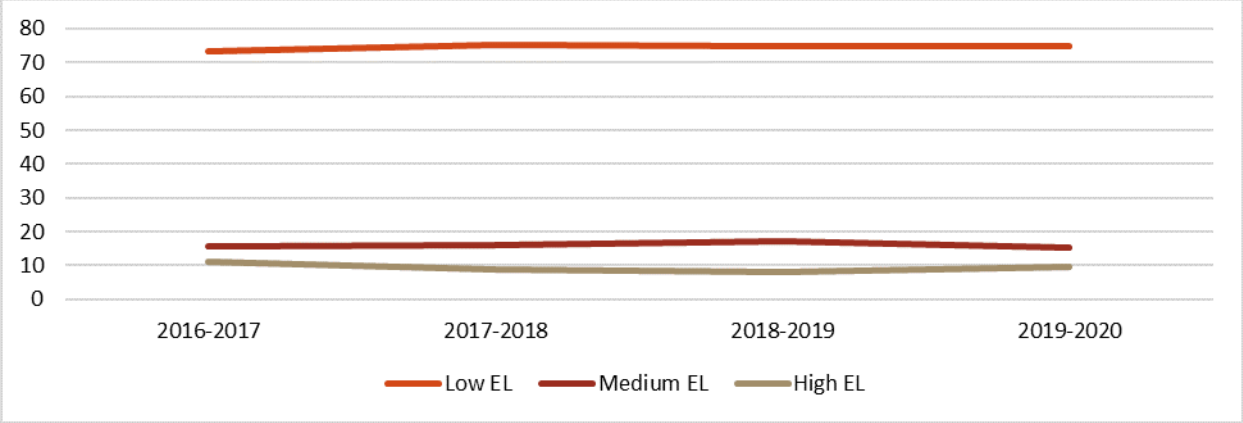


Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

Mathematics Course-taking Trends by English Learner Composition in Schools

This section of the report considers mathematics course-taking trends in schools by composition of English Learners (ELs). The national average of public-school students in the US classified as ELs in 2018 was 10.2%, or 5 million students (NCES, 2021). In this analysis, we use the work of the USDOE (2022) as a guide such that schools with a high percentage of ELs are defined as those with above 20%, schools with a medium percentage of ELs are defined as those with 5 to 20%, and schools with a low percentage of ELs are defined as those with below 5%. In New Jersey, as of 2019-2020, about 75% of schools are considered to have low concentrations of ELs, 15% medium concentrations of ELs, and 10% high concentrations of ELs (see Figure 8).

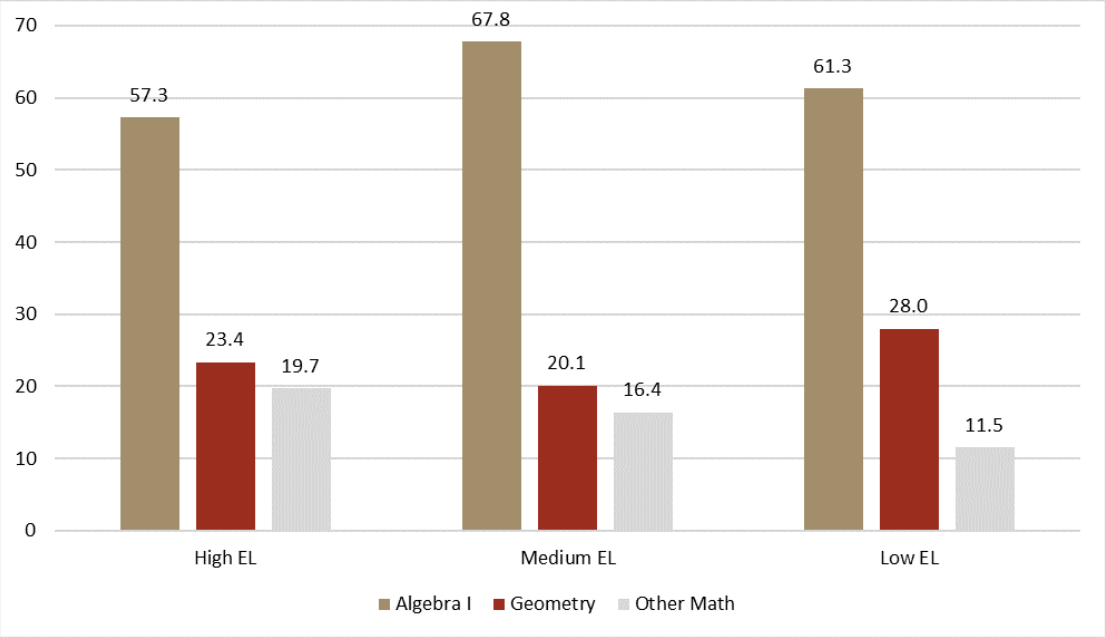
Figure 8: Percentage of New Jersey Schools having Low, Medium and High EL Enrollment



Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

When comparing freshman year math course-taking trends across the three EL composition school types, all tend to enroll students in Algebra I, but there are subtle differences (Figure 9). In high EL schools, proportionally fewer students enroll in Algebra I (57%) than medium (68%) and low EL (61%) schools. Less than a quarter of students are enrolled in Geometry in high and medium EL schools suggesting modest rates of accelerating students in contrast to low EL schools in which nearly 30% of freshmen are enrolled in Geometry indicating greater tendency for students to accelerate in these schools. The trends for low EL schools mirror the trends for racially mixed schools. Interestingly, nearly 20% of students are enrolled in 'Other Math' in high EL schools. This will be important to study further because, as the literature shows, there's a tendency for EL students to be enrolled in remedial math courses in high school (Gamoran, 2017).

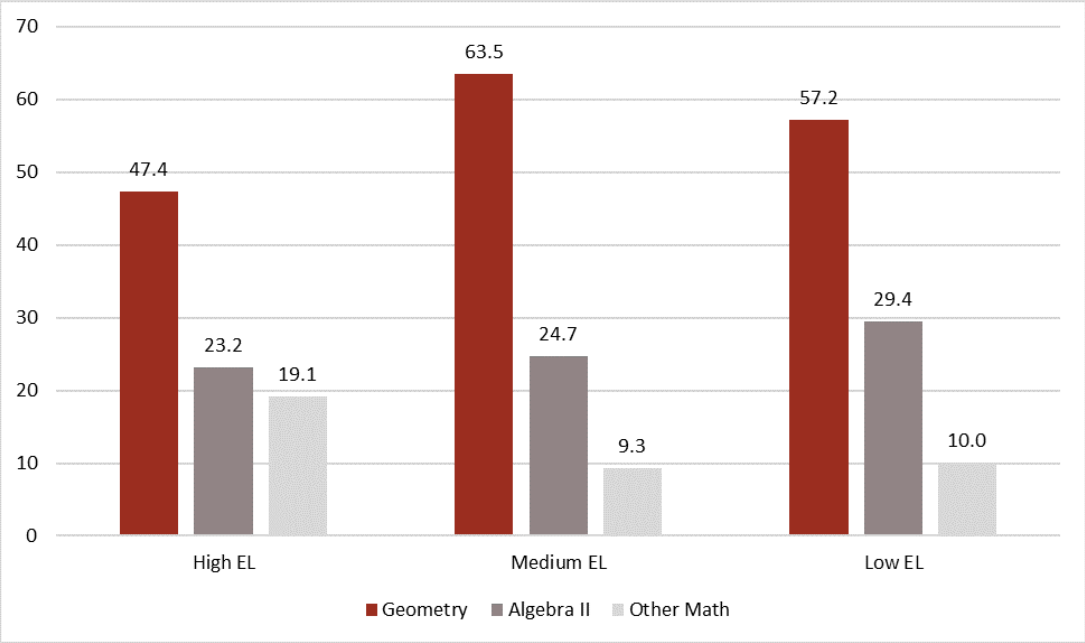
Figure 9: Rates of Enrollment in Algebra I, Geometry, and 'Other Math' in 9th Grade by English Learner Composition, 2019-2020



Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

At 10th grade, a similar lag between high EL and low EL schools shows up when investigating Geometry and Algebra II enrollment (Figure 10). Respectively, for Geometry, the enrollment rates are 47% compared to 57%; for Algebra II 23% compared to 29%. Concurrently, enrollment in 'Other Math' for high EL schools is 19% compared to 10%. The differences in enrollment rates between medium and low EL schools are smaller, though present. The general takeaway is that higher EL composition seems associated with either a standard math course-taking sequence (medium EL) or possibly a lagged or unclear math course-taking (high EL).

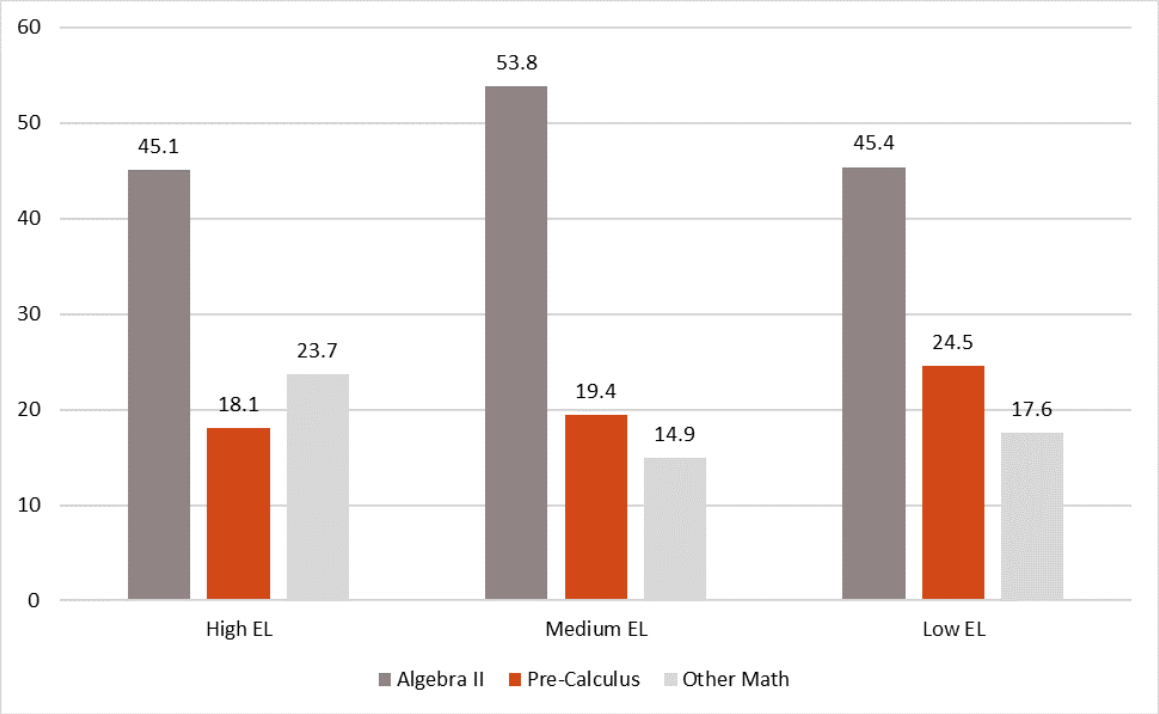
Figure 10: Rates of Enrollment in Geometry, Algebra II, and Other Math in 10th Grade by English Learner Composition, 2019-2020



Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

For juniors, where medium EL schools appear to enroll students in a standard math sequence, and low EL schools lean toward acceleration, the pattern in high EL schools is more ambiguous. Less than half of juniors in high EL schools are taking Algebra II (45%), the standard course in the sequence for 11th graders. On the other hand, about 24% are taking 'Other Math.' Still, indicating acceleration in at least some schools and a smaller gap between medium and low EL schools, 18% of juniors in high EL schools are enrolled in Pre-Calculus. Math enrollment for juniors in medium EL schools is standard to advanced, with a majority of students taking Algebra II (54%) or Pre-Calculus (19%). In low EL schools, math enrollment is also standard to advanced but proportionally more students are on an advanced track taking the Pre-Calculus (25%).

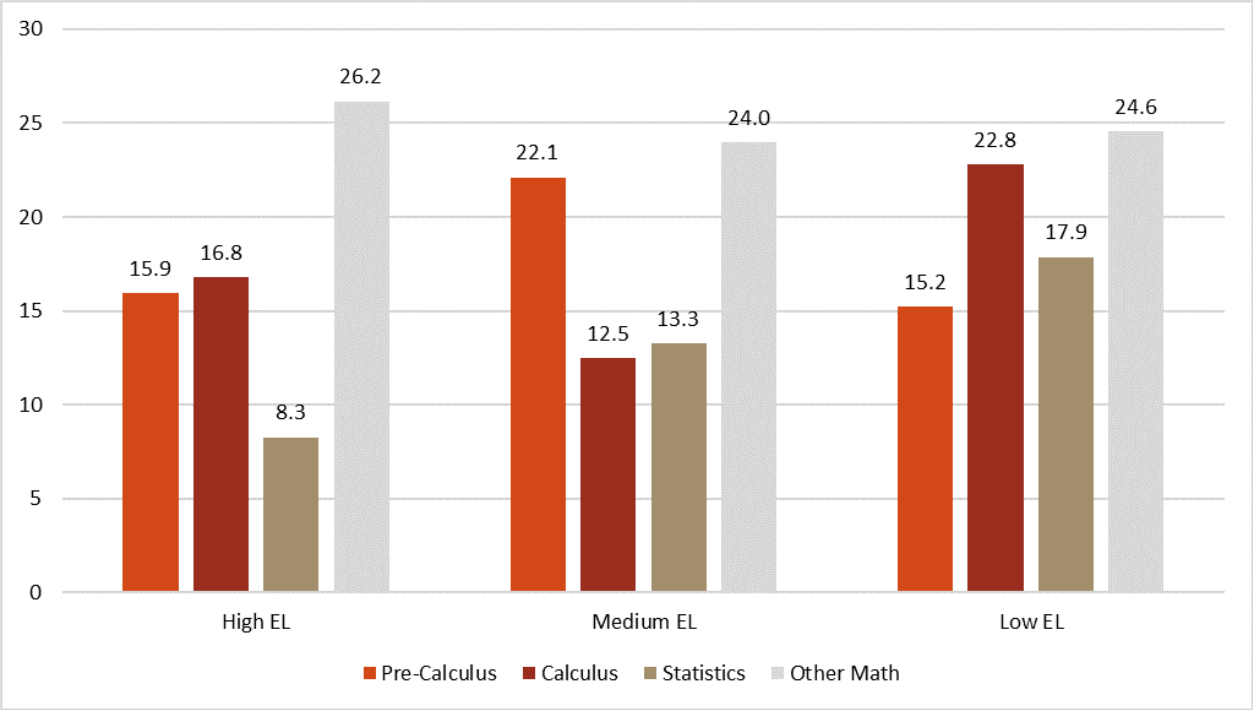
Figure 11: Rates of Enrollment in Algebra II, Pre-Calculus, and Other Math in 11th Grade by English Learner Composition, 2019-2020



Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

Low EL schools have a clearer tendency to enroll seniors in more advanced math course-taking with 56% of seniors taking either Pre-Calculus, Calculus, or Statistics compared to 48% in medium EL and 41% in high EL doing the same. Between low and high EL, the gap is 15 percentage points. Proportionally, far more students in low EL schools are taking Calculus by senior year – 23% compared to 17% in high EL and 13% in medium EL – and Statistics – 18% in low EL schools compared to 13% in medium EL and 8% in high EL schools. Still, despite the 9-11th grade math course-taking patterns in high EL schools, these schools manage to enroll proportionally more students in Calculus in 12th grade than medium EL schools – a 4 percentage point difference.

Figure 12: Rates of Enrollment in Pre-Calculus, Calculus, Statistics, and Other Math in 12th Grade by English Learner Composition, 2019-2020



Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

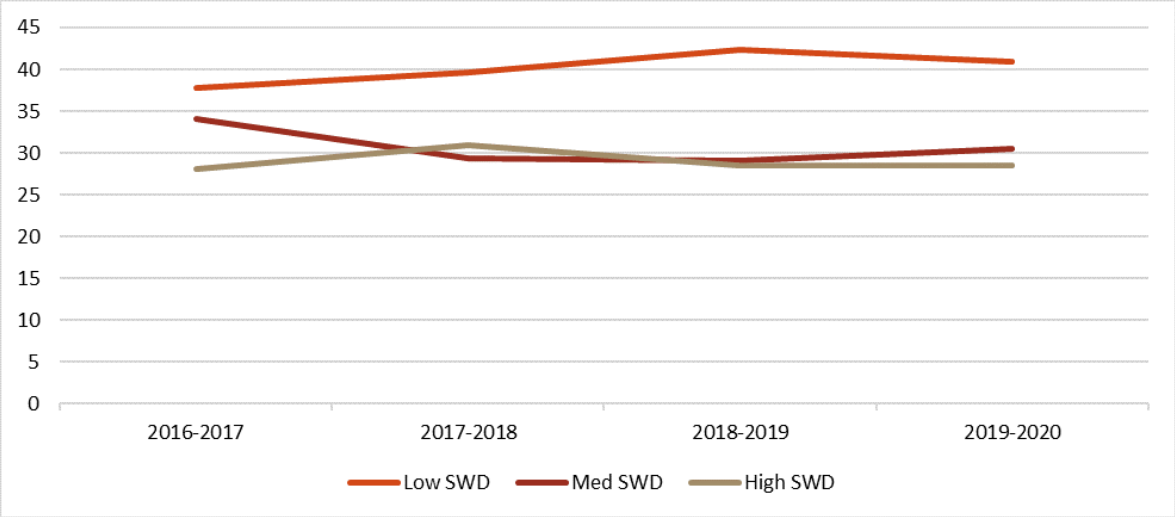
In sum, when considering the EL composition in schools, low EL schools mirror the patterns in racially and economically mixed schools in that they both appear to accelerate about one-third or more of their students each grade. In contrast, while some acceleration is observable in low and medium EL schools (about less than 20% to 25% each grade), students in medium EL schools seem to follow a standard math sequence and those in low EL schools enroll in a mix of standard courses and courses outside of the established sequence, i.e., 'Other Math'. This leaves an open question as to whether those 'Other Math' courses reflect remediation or innovative mathematics experiences. Unfortunately, we cannot know the courses that EL students are actually taking from these school-level data.

Mathematics Course-taking Trends by Students with Disabilities Composition in Schools

In this section we review math course-taking trends by school composition of students with disabilities (SWDs). In 2019–20, the number of students aged 3–21 who received special education services under the Individuals with Disabilities Education Act (IDEA) was 7.3 million, or 14% of all public-school students across the country (NCES, 2021). In New Jersey, 22,7963 students or 17% received special education services in public schools in 2020 (NJDOE, 2020). In this analysis we use

the work of the Pew Research Center (2020) as a guide such that schools with a high percentage of SWDs are those with more than 18%, schools with a medium percentage of SWDs are those with 14-18%, and schools with a low percentage of SWDs are those less than 14%. As seen in Figure 12, as of 2019-2020, more New Jersey schools have low percentages of SWDs (41%) while there is an even number of schools with medium (31%) and high percentages of SWDs (29%).

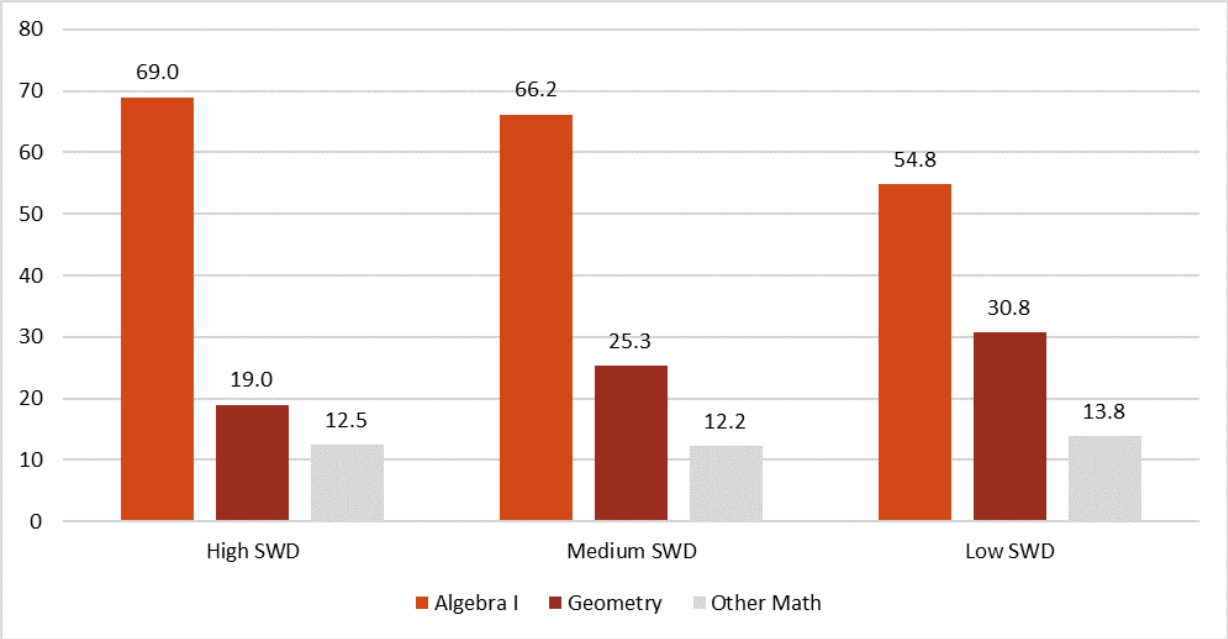
Figure 13: Percentage of New Jersey Schools having Low, Medium and High Student with Disability (SWD) Enrollment



Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

We found that for 9th grade, as SWD composition decreases, enrollment in an advanced math sequence becomes more likely - 31% of freshmen in low SWD schools are already taking Geometry compared to 25% in medium SWD and 19% in high SWD schools (see Figure 13). In schools with high percentages of SWDs, almost three quarters of students are enrolled in Algebra I (69%) but less than a quarter in Geometry (19%), suggesting a standard math course-taking approach in these schools. The trends for medium and low SWD schools mirror the trends by schools segregated economically or both racially and economically.

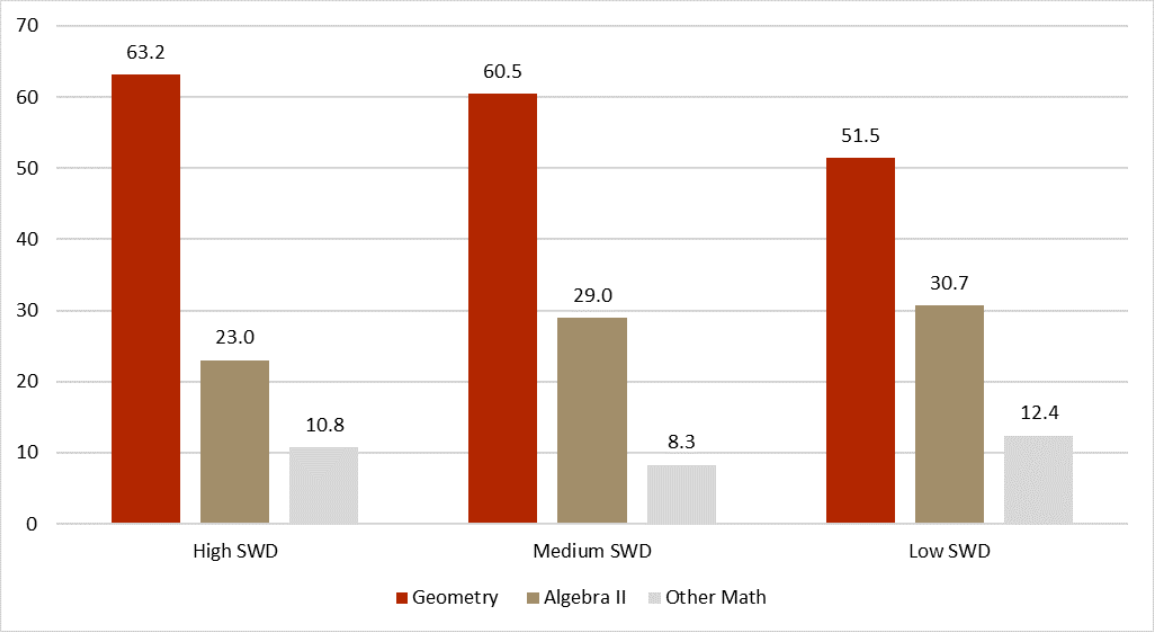
Figure 14. Rates of Enrollment in Algebra I, Geometry, and 'Other Math' in 9th Grade by Student with Disabilities Composition, 2019-2020



Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

In 10th grade, schools with high percentages of SWDs are almost as likely to enroll in Geometry (63%), the standard course for 10th grade, as are medium SWD schools (61%) (see Figure 14). The difference is in the percentage of students which have moved ahead to take Algebra II – 23% in high SWD schools compared to 29% in medium SWD schools and 31% in low SWD schools. With 86% of 10th graders in high SWD schools taking Geometry or Algebra II and 90% doing so in medium SWD schools, tenth grade math course-taking is standard to advanced. The same is true for low SWD schools, though these schools lean toward a more advanced sequence with another 7% of tenth graders taking Pre-Calculus (not shown in Figure 14).

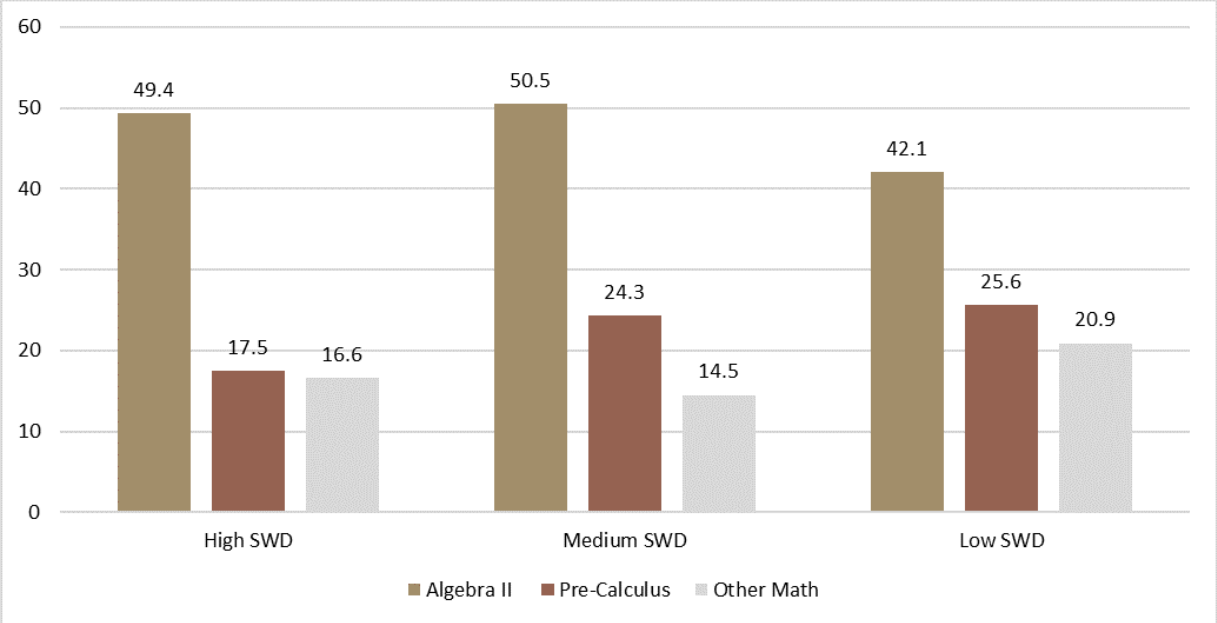
Figure 15. Rates of Enrollment in Algebra II, Geometry, and 'Other Math' in 10th Grade by Student with Disabilities Composition, 2019-2020



Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

The gap widens in 11th grade when schools with low percentages of SWDs are more likely to enroll in higher-level math courses than schools with medium and high percentages (see Figure 15). For example, in schools with low percentages of SWDs almost half are enrolled in Algebra II (43%), over a quarter in Pre-Calculus (26%) and almost 10% are enrolled in Calculus (not show in Figure 15). However, in schools with medium and high SWD schools, that slight shift to Calculus in 11th grade has not occurred (5% and 2% respectively).

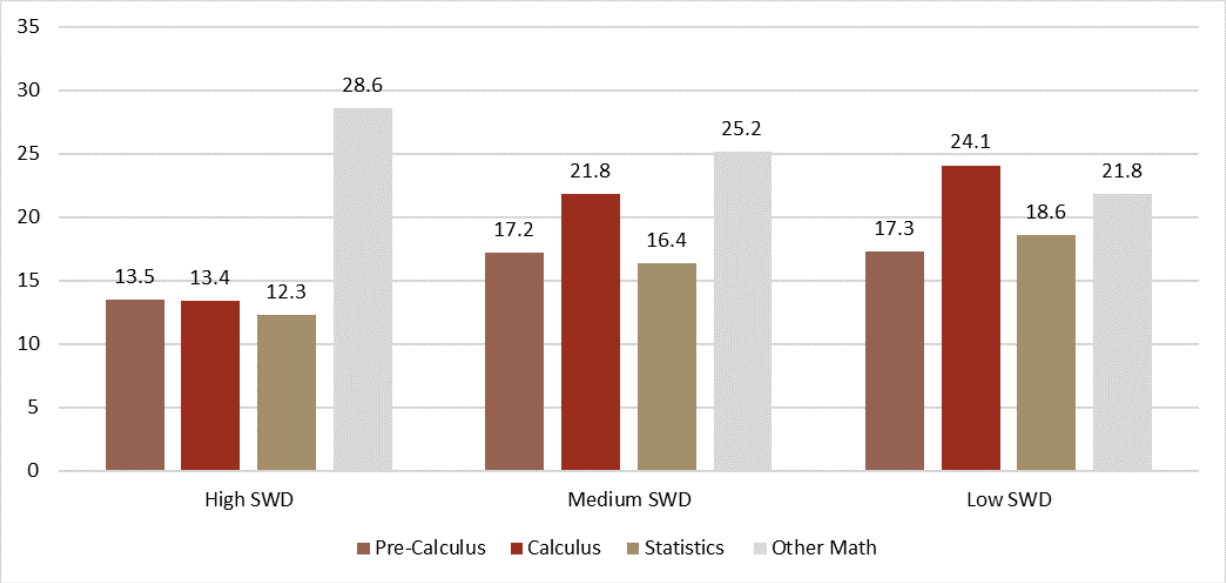
Figure 16. Rates of Enrollment in Algebra II, Pre-Calculus, and 'Other Math' in 11th Grade by Student with Disabilities Composition, 2019-2020



Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

Finally, in 12th grade, schools with low and medium percentages of SWDs continue the pathway to Calculus and Statistics but schools with high percentages of SWDs are more likely to enroll in 'Other Math' courses. For example, 43% of seniors in schools with low percentages of SWDs are enrolled in Calculus or Statistics and 38% in schools with medium percentages of SWDs, but less than a quarter (26%) in high SWD schools.

Figure 17. Rates of Enrollment in Pre-Calculus, Calculus, Statistics and 'Other Math' in 12th Grade by Student with Disabilities Composition, 2019-2020



Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

In sum, the course-taking patterns suggest that as the percentage of students with disabilities increases in high schools, it is less likely that those enrolled will be on accelerated math pathways. This pattern reflects the trend for schools segregated racially and economically so that by 11th and 12th grade, proportionally fewer students have shifted to advanced courses such as Pre-Calculus and Calculus. In contrast, students in low SWD schools appear to have a clear advantage. Again, unfortunately, we cannot know the courses that students with disabilities are taking from these data.

Positive Outliers

Despite the evident disparities in enrollment in high-leverage math courses in NJ, there are several positive outliers - segregated schools which enroll students in advanced math courses at rates much higher than the average for their category. A few positive outliers which are regular public schools with no special admission criteria or magnet program are highlighted here. These are schools which are managing to create advanced math learning opportunities in segregated conditions where students typically do not have the opportunity to participate. Note that for the purposes of this report we focus on math enrollment trends but the schools may not be positive outliers on other metrics. The four schools shown have enrolled more than 25% of their juniors in Pre-Calculus since 2016-17, on par with non-segregated schools (see Table 3).

Malcolm X Shabazz High School - a comprehensive school in the Newark Public Schools - and Hillside High School in Union County had 28% of their students enrolled in Pre-Calculus in their junior year in 2017. The other two high schools had slightly higher rates, enrolling more than 30% of their juniors in Pre-Calculus - Pennsauken High School (31%) and Dover High School (31%).

Table 3: Percentage of Students Enrolled in Pre-Calculus in 11th grade in Racially and Socioeconomically Segregated schools in 2016-17 and 2019-2020 (in parenthesis)

School	Economic Disadvantage	Latinx	Black	White	Asian	EL	SWD	% Enrolled in Pre-Calculus in 11th Grade
Pennsauken High School	69%	46%	32%	10%	12%	7%	19%	31% (31%)
Dover High School	69%	85%	5%	7%	2%	14%	9%	31% (28%)
Malcolm X Shabazz High School	61%	10%	89%	0%	0.7%	0%	24%	28% (28%)
Hillside High School	58%	21%	68%	9%	1%	7%	12%	28% (28%)

Source: Authors' presentation based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

Promising Practices, Policies, and Programs

Research points to opportunities within school culture for reducing disparities in enrollment in advanced mathematics courses. When students talk with parents and teachers about course selection, they are more likely to take and persist in advanced math courses, leading to reduction in the disparity (Irizarry, 2021). Further, a sense of belonging is critical in higher-level math courses but has been found to depend on students' perceived number of same race/ethnic peers in their math classes. Students of color are more likely to feel a sense of belonging when there are other students from their background in their classes (Morales-Chicas & Graham, 2021). The sense of belonging in 9th grade math was also stronger when students were enrolled in 8th grade Algebra I rather than for the first time in 9th grade. In addition to making students feel they belong, numerous reforms can be considered.

Algebra I Reforms

Algebra I is viewed as a gatekeeper to higher-level courses. Many districts across the country have instituted reforms to enroll more traditionally underrepresented students in Algebra I during middle school. The impact of these reforms has been mixed. Diverse remedies for Algebra I access have been proposed and some have been controversial. Districts would need to carefully study what would work for their population.

A study of middle schoolers in Wake County, North Carolina, found that accelerated math placement of relatively low-achieving middle schoolers contributed to an increase in the fraction of time students spent in accelerated math later on (13 percentage points) (Dougherty et al., 2015). In Chicago, many lower-achieving students were immersed in higher-level academic coursework for the first time due to an Algebra-for-All policy. As a result, lower-achieving students experienced a rise in the ability levels of their classroom peers. However, researchers have also found that simply requiring Algebra was not sufficient for improving outcomes, even though students may benefit from having higher achieving peers in their classrooms (Nomi & Raudenbush, 2014). Overall, taking Algebra instead of remedial math had no significant effect because students lacked sufficient skills to handle Algebra. Chicago subsequently implemented double-dose Algebra to address this problem, with research showing that this extension of instructional time and instructional supports to teachers was successful in improving Algebra learning for lower-achieving students (Nomi & Allensworth, 2009; 2010).

Intervention Programs

Instructional practices such as math labs (Bouck et al., 2019), flipped classrooms (Graziano & Hall, 2017), co-teaching (Ricci et al., 2019), and peer-mediated math interventions (Wexler et al., 2015) have been found to be effective at improving the performance of underserved students in advanced math courses. Math lab or an additional period of math provide additional interventions or supports to help students be successful in their regular mathematics class and also address gaps in their understanding and skills in mathematics (Bouck et al., 2019). This is also sometimes referred to as receiving a "double dose" of math content (Nomi & Allensworth, 2009, 2012). Flipped classrooms in which students are given reading to do at home so that they can focus on problem solving during class time can be effective particularly for English Learners. In one study, students in a "Newcomer" school (a school that offers educational assistance programs for students who are new to the English language and the United States and its school system) were found to be more engaged and motivated to learn Algebra and performed slightly higher than their peers that received traditional instruction (Graziano & Hall, 2017). Co-teaching as a part of an Urban Teacher Residency has been found to benefit students in math and other STEM subjects, particularly those with disabilities (Ricci et al., 2019). Peer-mediated instruction in which students of the same age tutor each other or work together as partners or in small groups to complete assignments has been found to be effective particularly for students with academic difficulties and disabilities. This is especially true when the intervention incorporated a structured feedback component (Wexler et al., 2015).

Culturally responsive mathematics teaching (CRMT) has made important contributions to both math achievement and sense of self-efficacy in students of color (Bonner, 2014). Relationships and trust are central to CRMT and communication patterns and various forms of knowledge mediate these relationships. CRMT provides students with access, which is mediated by culture and identity, to complex mathematical ideas. Culturally connected techniques such as chanting, storytelling, singing and movement help students access math content (Bonner, 2014). Students of color also gain support through "academic communities" or informal networks of parents, extended family members, neighbors, classmates, friends, teachers, and other school adults who support young people in mathematics (Walker, 2012). Through a "potential" rather than "deficit" model, Walker identifies three key principles for building math communities; (1) urban students "want" to be a part of academically challenging environments; (2) awareness that teachers and administrators can inadvertently create obstacles that thwart the mathematics potential of students; and (3) educators can build on existing student networks to create collaborative and non-hierarchical communities that support mathematics achievement.

In addition, research provides strong evidence that high-dosage tutoring can produce large learning gains for a wide range of students, including those who have fallen behind academically, particularly for older students in math (Robinson et al., 2021). Tutoring is most likely to be effective when delivered in high doses through tutoring programs with three or more sessions per week or intensive week-long, small group programs taught by talented teachers. Ensuring

students have a consistent tutor over time may facilitate positive tutor–student relationships and a stronger understanding of students' learning needs (Robinson et al., 2021). A study of an innovative tutoring program in New York City that trained Black and Latinx high school students to become math tutors found that tutees' math grades improved, and pass rates on the state's exams increased, especially for those who attended more sessions. The effectiveness of tutoring sessions depended on the quality of relationships among tutors, tutees, teachers, and graduate student advisors (Walker, 2012).

Programs such as the Algebra Project were developed to address the need for high level math instruction for students of color. The Algebra Project is a national mathematics literacy effort for helping low-income and minority students attain mathematical skills required for college preparatory math classes in high school. They develop curriculum, train educators, and provide professional development and community activities for schools working towards systemic change in math education. Powell (2022) describes the pedagogical approach inherent in the Algebra project, beginning with an expanded purpose for learning mathematics namely "citizenship, solidarity, equity, curiosity and engagement, compassion, empathy, cultural values, physical and mental health, and social justice" (p. ii). Drawing on Caleb Cattegno's work, Powell further describes the process of 'subordination of teaching to learning' in the Algebra Project where the learning experience moves "deliberately and carefully from the details of students' cultural experience to the symbolic representation of the mathematical features of that experience" (p. v). One of the core viewpoints in this pedagogical approach is that students have natural "mental brilliance and intellectual and emotional agency" (p. vi). It is an asset-based pedagogical approach. A study of the seven cohorts of graduates (1991-1997) of the Founding Middle School in Cambridge, MA found that students in this well-implemented Algebra Project entered Geometry in Grade 9 at roughly twice the rate of non-Algebra Project peers (44% vs. 17% in 1992, and 92% vs. 47% in 1996) and that the program was especially effective for Black students (70% vs. 56%). Students also did well in Grades 10-12, with more than 60% passing Trigonometry by Grade 11 (West & Davis, 2006).

Similarly, the Young People's Project (YPP) aims to train, employ, and support high school students to become Math Literacy Workers (MLWs). MLWs are high school and college students who teach math-based activities to younger children in their neighborhoods and communities. The project aims to improve academic outcomes for elementary school students, opening paths to success that include college education, and removing institutional and systemic barriers. A study of a YPP program in Los Angeles found that the training program positively impacted youth participants' math literacy, problem solving, academic achievement, communication, organizing skills, leadership capacity, self-confidence, civic engagement, critical literacy, and self-identity. Participants shared that the program allowed them to achieve expertise in putting what they learned into practice (i.e., praxis) as they continuously reflected on their identities and the social significance of their experiences while taking direct action as facilitators of math literacy workshops (Farber, 2010).

Finally, the work of the Benjamin Banneker Association, Inc., We the People - Math Literacy for All Alliance, the Chicago Consortium for School Research, and the Charles A. Dana Center implementing the models developed by Dr. Uri Treisman are proven sources for insight into promising math interventions.

Conclusion

Overall, these findings suggest that students in segregated schools in New Jersey do not have the same level of enrollment in advanced mathematics coursework as those in non-segregated high schools. In addition, students in schools with large concentrations of English Learners and students with disabilities are taking high leverage math coursework at lower rates. Thus, part of the dialogue we hope to see in New Jersey is that of increasing access and enrollment in advanced math courses as well as better preparing and supporting students for success in those courses once enrolled.

The fact that there are several positive outliers suggests that increasing participation in higher-level math courses is a possibility for schools. The practices and policies in these schools can be shared with other schools and districts as those seeking to improve carefully consider options to leverage. Some promising practices such as high dosage tutoring, peer tutoring, extended instructional time, and teacher professional development to support students once enrolled in higher-level math coursework can be considered.

In further research, we will explore "Other Math" courses that are prominent particularly in segregated and high EL and SWD schools to determine what they comprise and if they do in fact meet graduation requirements and prerequisites for competitive postsecondary STEM majors.

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Appendix

Complete Data Tables:

Racially and Economically Segregated Schools* in 9th Grade

	Algebra I	Geometry	Algebra II	Pre-Calculus	Calculus	Statistics	Other Math	Total
2016	71.7	18.5	3.6	0.1	0.0	0.2	19.7	113.7
2017	67.8	21.0	2.6	0.0	0.0	0.0	13.9	105.3
2018	68.5	17.5	3.6	0.1	0.0	0.0	12.6	102.4
2019	68.5	18.3	3.0	0.0	0.0	1.3	16.9	108.0

Racially and Economically Segregated Schools* in 10th Grade

	Algebra I	Geometry	Algebra II	Pre-Calculus	Calculus	Statistics	Other Math	Total
2016	10.3	65.9	25.3	1.3	0.1	0.9	8.0	111.8
2017	9.9	64.7	25.7	1.4	0.0	3.2	7.2	112.1
2018	13.3	65.0	24.5	1.5	0.1	1.4	9.3	115.0
2019	12.0	67.7	21.6	1.2	0.1	2.9	9.1	114.5

Racially and Economically Segregated Schools* in 11th Grade

	Algebra I	Geometry	Algebra II	Pre-Calculus	Calculus	Statistics	Other Math	Total
2016	4.6	11.0	64.2	15.7	2.8	4.1	10.9	113.3
2017	3.5	14.4	60.8	16.9	1.5	1.4	11.9	110.3
2018	5.6	11.5	63.9	15.1	3.0	1.3	12.7	113.2
2019	6.8	13.3	57.5	16.3	2.6	3.6	14.3	114.3

Racially and Economically Segregated Schools* in 12th Grade

	Algebra I	Geometry	Algebra II	Pre-Calculus	Calculus	Statistics	Other Math	Total
2016	2.4	4.5	12.1	18.0	10.5	7.5	26.8	81.8
2017	2.9	5.0	11.1	23.5	9.0	7.2	28.1	86.7
2018	2.5	4.3	12.4	20.5	8.5	9.6	26.1	83.8
2019	2.1	3.8	11.4	21.1	8.1	6.2	23.7	76.3

*Racially and Economically Segregated Schools Definition:

School Category	Racial/Ethnic and Socioeconomic Composition	Number of High Schools, 2018-2019
Segregated - Race (Students of Color) and economic disadvantage/poverty	90%+ Black and Latinx 50%+ economic disadvantage	49

Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

Economically Segregated Schools* in the 9th Grade

	Algebra I	Geometry	Algebra II	Pre-Calculus	Calculus	Statistics	Other Math	Total
2016	71.2	15.7	4.1	0.0	0.0	2.3	17.0	110.3
2017	68.1	16.1	7.3	0.0	0.0	0.0	15.1	106.7
2018	67.2	16.7	2.5	0.0	0.0	0.0	25.9	112.3
2019	72.6	17.5	3.6	0.0	0.0	2.3	13.1	109.1

Economically Segregated Schools* in the 10th Grade

	Algebra I	Geometry	Algebra II	Pre-Calculus	Calculus	Statistics	Other Math	Total
2016	8.6	60.9	21.7	2.2	0.0	0.1	24.7	118.2
2017	10.3	60.9	23.4	2.0	0.1	0.1	18.4	115.2
2018	10.1	61.0	20.4	2.2	0.1	0.1	21.9	115.8
2019	8.8	66.5	20.6	2.4	0.1	0.3	17.5	116.2

Economically Segregated Schools* in the 11th Grade

	Algebra I	Geometry	Algebra II	Pre-Calculus	Calculus	Statistics	Other Math	Total
2016	3.1	16.3	47.8	18.1	2.6	1.6	22.1	111.7
2017	6.9	14.3	49.5	15.0	3.2	1.7	21.2	111.8
2018	6.6	12.4	45.3	16.5	2.8	1.8	25.0	110.5
2019	4.4	14.0	52.3	15.3	2.5	2.5	22.5	113.5

Economically Segregated Schools* in the 12th Grade

	Algebra I	Geometry	Algebra II	Pre-Calculus	Calculus	Statistics	Other Math	Total
2016	1.9	4.1	8.4	14.8	12.6	10.9	27.0	79.8
2017	2.0	3.5	10.6	11.9	12.3	9.8	27.2	77.2
2018	1.1	3.6	8.0	15.2	13.7	11.5	26.7	79.8
2019	0.8	3.5	9.7	16.3	12.4	10.1	23.1	75.9

***Economically Segregated Schools Definition:**

School Category	Racial/Ethnic and Socioeconomic Composition	Number of High Schools, 2018-2019
Segregated - economic disadvantage/poverty	50%+ economic disadvantage	37

Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

Racially & Economically Mixed Schools* in the 9th Grade

	Algebra I	Geometry	Algebra II	Pre-Calculus	Calculus	Statistics	Other Math	Total
2016	60.3	28.7	6.9	0.1	0.0	0.6	12.6	109.3
2017	58.7	29.3	7.3	0.2	0.0	0.5	12.8	108.9
2018	59.6	29.8	6.6	0.1	0.0	0.1	11.4	107.7
2019	59.9	29.4	6.7	0.2	0.0	0.2	12.6	109.0

Racially & Economically Mixed Schools* in the 10th Grade

	Algebra I	Geometry	Algebra II	Pre-Calculus	Calculus	Statistics	Other Math	Total
2016	7.5	53.6	31.1	5.5	0.7	0.8	10.0	109.3
2017	7.1	54.8	30.8	5.6	0.6	0.9	9.5	109.3
2018	7.6	54.7	31.3	4.9	0.8	0.9	10.1	110.4
2019	6.6	54.3	30.8	6.1	0.7	1.0	10.1	109.6

Racially & Economically Mixed Schools* in the 11th Grade

	Algebra I	Geometry	Algebra II	Pre-Calculus	Calculus	Statistics	Other Math	Total
2016	1.9	8.8	43.8	26.4	7.4	2.8	16.4	107.6
2017	1.9	7.6	45.0	26.4	7.5	3.1	16.7	108.2
2018	1.8	8.4	44.7	27.1	6.8	3.2	16.7	108.9
2019	1.6	7.6	44.2	26.2	7.7	2.7	17.4	107.7

Racially & Economically Mixed Schools* in the 12th Grade

	Algebra I	Geometry	Algebra II	Pre-Calculus	Calculus	Statistics	Other Math	Total
2016	0.7	1.6	6.9	15.0	24.4	18.9	24.8	92.3
2017	0.5	1.4	6.5	15.1	25.1	18.6	25.7	93.0
2018	0.4	1.7	7.0	15.2	24.3	19.3	24.7	92.8
2019	0.4	1.3	6.4	15.3	24.8	19.7	24.7	92.6

***Racially & Economically Mixed Schools Definition:**

School Category	Racial/Ethnic and Socioeconomic Composition	Number of High Schools, 2018-2019
Non-segregated/mixed enrollment	>10% and <90% White <50% economic disadvantage	239

Source: Authors' calculations based on data from New Jersey Department of Education School Performance Reports Database: https://rc.doe.state.nj.us/download.

The New Jersey State Policy Lab assists the State of New Jersey and its many communities in the design, implementation, and evaluation of state policies and programs by conducting rigorous evidence-based research that considers equity, efficiency, and efficacy of public policies and programs in holistic and innovative ways.

The lab leverages input from a robust network of multidisciplinary scholars, members of the community, and outside policy experts in New Jersey to craft innovative and equitable policy solutions that are sensitive to the needs of our state's diverse population.

By utilizing the combination of strong ties to New Jersey's diverse communities and significant expertise in collecting, cleaning, and analyzing data, the New Jersey State Policy Lab engages and collaborates with stakeholders such as community groups, the state government, and municipal governments to create high quality datasets and evidence that reflects our state's diversity and empowers state policy makers to address the needs of New Jersey communities more effectively, innovatively, and equitably.

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