Trends in MMSD Middle School Math Performance from 2015-16 to 2023-24

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Executive Summary & Key Findings

Working with Madison Metropolitan School District (MMSD) and University of Wisconsin-Madison research partners, the Madison Education Partnership set out to better understand the current state of math achievement in MMSD to inform an upcoming middle school math tutoring pilot. Using administrative data from both summative and formative exams, we explored overall patterns of achievement, comparing MMSD's results to other districts. Then, we examined patterns of achievement across middle school grades and student demographic groups and within the specific math areas of numeracy and algebraic function. Overall, we find that MMSD middle school students are outperforming or keeping pace with peers in comparable, urban Wisconsin districts on the Forward exam; however, across districts, students are more likely to perform at below basic level than they are to perform at or above the threshold of proficient. When looking just at MMSD middle school results, we find inequities in student performance by demographic groups like race/ethnicity and family income. Overall, we believe these results point to the need for MMSD and those who support it to invest in strengthening math instruction, achievement and support.

Introduction

The Madison Education Partnership (MEP) is working with the Madison Metropolitan School District (MMSD) Teaching & Learning and Engagement, Equity, Diversity & Inclusion departments to develop and pilot a new tutoring intervention for middle school mathematics. Recent research has shown high-intensity tutoring as a promising way to move student achievement, and MMSD expressed interest in using this particular intervention for middle school math.[1] MEP began conversations with district partners in summer 2023 to explore the possibility of partnership around tutoring, and will pilot this new tutoring intervention in the 2024-25 school year.

As part of that work, MEP, MMSD and UW needed to better understand the current state of math achievement in MMSD. In February 2024, the district shared an update with the Board of Education on 4K-12 mathematics, including a review of achievement data, curriculum, professional learning and coursework options. They also shared some strategies to address challenges in data trends in middle school, including tutoring and course sequence alignment. Our descriptive report below builds on that foundation by providing a brief review of mathematics achievement and growth, focusing on the middle school years in MMSD between 2015-16 and 2023-24.

In this report, we pose two key research questions:

1. What are the trends in MMSD performance pre- and post-pandemic using summative data?
    a. How do MMSD students' math achievement across all grades compare to student in other, similar districts?
    b. What are the trends in MMSD middle school math performance across years and by students' race/ethnicity and family income?
2. How can we understand MMSD middle school math performance using formative data, especially related to key domains like algebra and numbers and operations?
    a. How does MMSD middle school math achievement look overall and by students' race/ethnicity and household income?
    b. How does MMSD middle school math growth look overall and by students' race/ethnicity and family income?

To answer these questions, we summarize trends in math standardized test scores for students in grades 6-8 over time and across different subgroups, notably by race, grade, and family income. First, we discuss the expectations for student learning in middle school math based on Wisconsin state standards. This discussion helps ground the later achievement data in the learning context for students. Then, we present descriptive results for two different standardized tests: 1) Forward, the exam Wisconsin employs to monitor achievement on state

[1] Kraft, Matthew A. and Grace T. Falken. 2021. "A Blueprint for Scaling Tutoring and Mentoring across Public Schools." AERA Open 7:23328584211042858. https://journals.sagepub.com/doi/abs/10.1177/23328584211042858

standards (in compliance with Federal requirements), and 2) iReady, an assessment MMSD administers at least two and up to three times per year to evaluate student learning in middle school math. We use iReady in particular to access test scores across several domains. The specificity and periodicity of the iReady assessment helps us understand (1) mathematics learning over the course of the academic year and (2) variation in achievement and growth for specific domains of mathematics knowledge. iReady assessments are also vertically equated across grades, meaning that gains in scores are comparable within and between grade levels. We consider trends in Forward test scores over time (pre- and post-COVID) and across selected urban districts in Wisconsin to situate MMSD in the broader Wisconsin context. We then focus only on the two most recent years of data available for iReady to take a deeper dive into current patterns of achievement in the domains of mathematics that will be the focus or a tutoring intervention. We describe both assessments in more detail below. After presenting results for each assessment, we then provide some discussion and implications.

Background: Expectations for Student Learning in Middle School Math

Over the course of middle school, students in Wisconsin are expected to apply concepts from their math classes to describe the world around them.[2] As an example, they should begin translating word problems or real-life situations into mathematical models, knowing which tools to use, learning how to identify patterns, and persevering in solving problems.

In sixth grade, students are specifically expected to begin to understand and apply concepts of ratios, division and multiplication of fractions, factor numbers, and translate word problems into algebraic expressions; the latter includes writing expressions where some variables are unknown.[3] Students will also be exposed to more advanced concepts, like geometry and statistics. In terms of geometry, sixth grade students should feel comfortable calculating the areas and volumes of 2-D and 3-D shapes, including squares, rectangles, pyramids, and trapezoids, as well as drawing and graphing them. Basic statistics skills include plotting data on graphs and describing trends and observation counts.

By the time students complete middle school (grade eight), they should have a solid knowledge of working with ratios, fractions, and factorization, and are expected to increasingly focus on complex algebraic expressions, advanced geometry concepts, and plotting and interpreting datasets. For example, eighth graders will work with exponents, irrational numbers, and be able to solve systems of two equations. Geometric concepts include knowing the Pythagorean Theorem and how to apply it to find the distance between two points, understanding properties of polygons and lines, and being confident in calculating areas and

[2] Wisconsin Department of Public Instruction. 2021. "Wisconsin Standards for Mathematics." Madison: Wisconsin Department of Public Instruction. https://dpi.wi.gov/sites/default/files/imce/math/files/DPI-WI-Mathematics-Standards.pdf

[3] For example: Suppose a car moves at 65 miles per hour. Let x represent the number of hours traveled and y represent the total distance traveled. Can you (i) write an equation relating hours and distance and (ii) graph what this relationship looks like?

volumes. Students will continue plotting bivariate data, but also be able to give linear approximations that fit the data and summarize trends.

Sixth grade students are assessed on skills like translating word problems to equations, working with changes in units and ratios, and having a good understanding of operations with both, whole numbers and fractions. Below is an example question from a sixth grade Forward practice exam:

A fish tank is filled 3/4 full of water. The tank measures 18 1/2 inches long, 16 inches wide, and 12 1/2 inches high. What is the volume, in cubic inches, of the water in the tank?
A. 2,592
B. 2,775
C. 3,700
D. 3,952

Eighth grade students are expected to evidence skill in working with irrational numbers and simplifying exponents, with a focus on geometry and interpreting charts and figures of data. Below is an example question from an eighth grade Forward practice exam:

Thomas has a cup shaped like a cone and a cup shaped like a cylinder.
- *Both cups have the same height.*
- *The circular tops of the two cups have the same radius.*

Thomas completely fills the cone cup with water twice and empties it into the cylinder cup. Which fraction of the volume of the cylinder cup is filled with water?
A. 1/3
B. 1/2
C. 2/3
D. 1

Understanding the Landscape: Trends in Math Performance Pre- and Post-Pandemic Using Summative State Data

In this section, we set out to understand the landscape of math achievement in MMSD based on the Wisconsin Forward Exam, the state-required, summative assessment. First, we describe the data we use. Then, we answer some descriptive questions to contextualize MMSD achievement overall and in middle school.

What Summative Data Did We Use and What Can It Measure?

First administered in Spring 2016, the Forward exams assess Wisconsin students on English and Language Arts, Mathematics, Science, and Social Studies. The state mandates that students in middle school complete the Forward exam annually in mathematics. The tests are a

combination of multiple choice and free response questions, and include sections with and without calculator use.

The exams help identify academic strengths of students as well as their opportunities for growth, communicate learning expectations, and inform stakeholders about how schools and districts are progressing toward meeting educational standards. Based on cut points that were set in 2016, students' mathematics skills are summarized as *Below Basic*, *Basic*, *Proficient*, or *Advanced*. As students progress through schooling, they are expected to master more complex material (see the section, "Background: Expectations for Student Learning in Middle School Math" for more details about what topics are covered, example questions, and exam format).

How do MMSD students' math achievement across all grades compare to other, similar districts in Wisconsin?

Although we cannot situate the performance of MMSD's middle school students relative to their peers across the state, we can use publicly available data from the Department of Public Instruction to contextualize the math performance of students in the District as a whole relative to students in other districts. Figure 1 illustrates the share of students whose performance is categorized as Proficient or Advanced on the Forward exams and Figure 2 illustrates the share of students whose performance is categorized as Below Basic. Both figures compare students in the Madison Metropolitan School District to those in the Milwaukee, Kenosha, and Green Bay public school districts. The figures illustrate patterns for the 2015-2016 school year through the 2022-2023 school year; no data were compiled at the advent of the COVID-19 pandemic during the 2019-2020 school year.

Over the years, MMSD has had a larger share of higher-performing students than the other comparison districts we present, as illustrated in Figure 1. MMSD reached a high point of 40% of students proficient or advanced in the 2018-2019 school year before dropping to a post-pandemic low of around 35% in the 2021-2022 school year. All districts experienced a drop in the fraction of students whose performance is Proficient or Advanced between the 2018-2019 school year and the 2020-2021 school year. The proportion of students at these ranges recovered slightly in the post-pandemic years, albeit slowly.

Figure 1

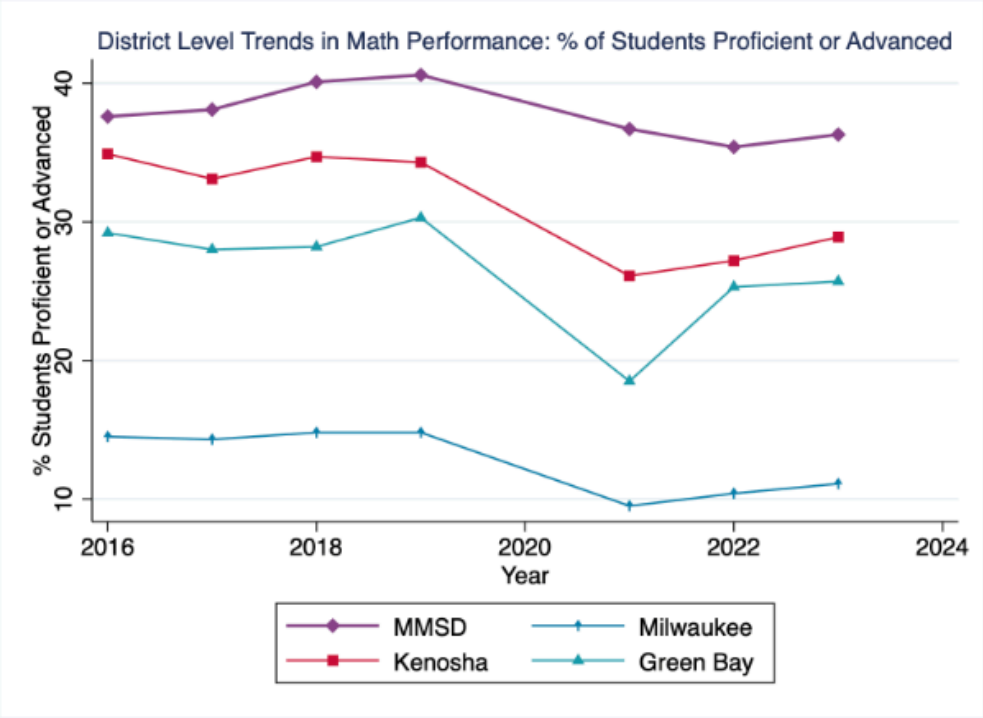
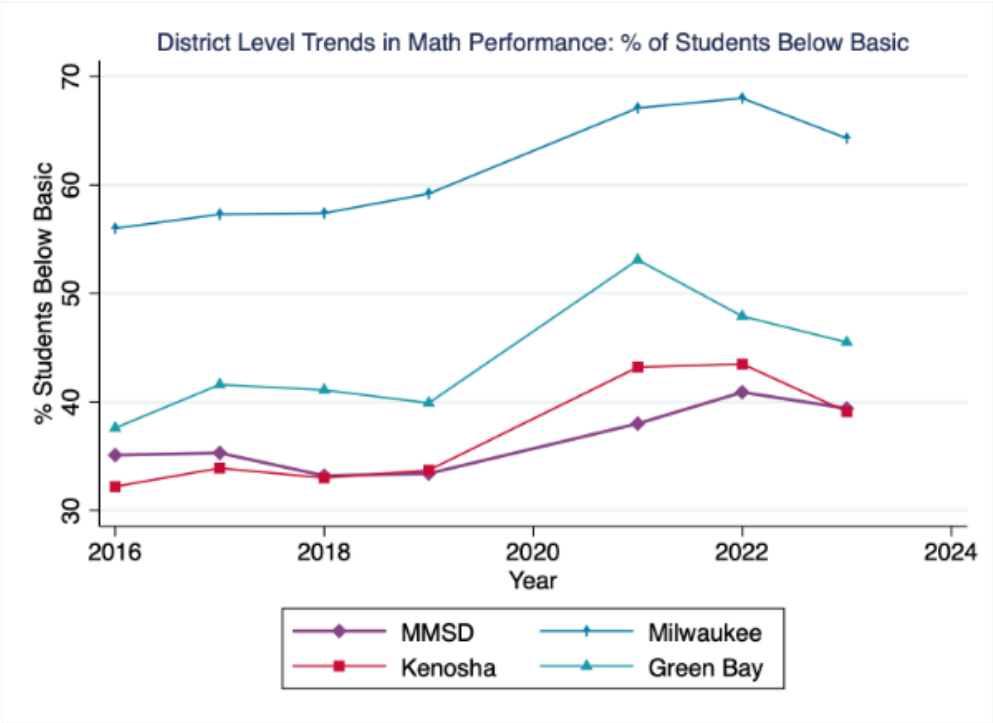

District Level Trends in Math Performance: % of Students Proficient or Advanced
% Students Proficient or Advanced
10
20
30
40
2016
2018
2020
2022
2024
Year
MMSD
Kenosha
Milwaukee
Green Bay

Figure 2 shows that MMSD also has a smaller percentage of students who are lower performing (categorized as Below Basic) relative to the other districts. The share below basic in MMSD increased from around 33% just prior to the pandemic to almost 41% in 2021-2022. During the 2015-2016 school year and 2016-2017 school year, it exceeded Kenosha School District in the share of students with Below Basic math performance. The proportion of students at these ranges are level with Kenosha in the following two years, but dip below it (and remain below Green Bay and Milwaukee) in the post-pandemic years.

Figure 2



Digging Deeper: Understanding Middle School Math Achievement Using Formative Data

The preceding section helps contextualize math achievement - and specifically middle school math achievement - over the last nine years. In this section, we dig deeper into formative data (iReady) for fall 2022 through spring 2023 to understand skills and abilities of MMSD middle schoolers in specific domains of mathematics. We focus our attention on performance and growth in the domains of algebraic thinking and number and operations. Achieving proficiency in the skills measured under these domains is foundational to further student progress in mathematics and in the natural sciences later in high school. First, we describe the data we use. Then, we answer some descriptive questions.

What Formative Data Did We Use and What Can It Measure?

Each fall and spring, middle school students complete a second set of mathematics assessments called iReady that, in contrast to the Forward exam (a comprehensive assessment), allows us to observe test scores across several domains and is administered up to three times in a school year. The specificity and periodicity of the iReady assessment help us understand (1) mathematics learning over the course of the academic year and (2) variation in achievement and growth for specific domains of mathematics knowledge. iReady assessments are vertically equated across grades, meaning that gains in scores are comparable within and between grade levels.

iReady assessments measure achievement in the following domains : (i) Algebra and Algebraic Thinking, (ii) Geometry, (iii) Measurement and Data, and (iv) Number and Operations. A composite score is calculated for each student, reflecting their performance across domains. In addition to a scaled test score for each domain, student performance is also categorized on whether it meets the expectations for each grade. In order from lowest to highest performance categories, a student's score can take on one of the five following classifications: (i) three or more grades levels below, (ii) two grade levels below, (iii) one grade below, (iv) early on grade level, and (v) mid, late, or above grade level. Categories (iv) and (v) correspond to being at or above grade standards, while the first three correspond to performing below the expectations for a grade. The cutoffs increase as students progress across grades. For example, scoring a 430 on Algebra and Algebraic Thinking in grade two corresponds to being early on grade level; achieving the same score in grade four corresponds to being two grade levels below expectation.

We begin by reporting the raw scaled scores for fall iReady assessments in Algebra and Algebraic Thinking as well as Number and Operations. As noted above, scores can be compared across the different grades. Given the very modest changes in student performance across 2022 and 2023, we combine these years in our analyses; see Appendix Table 1 for a comparison of student achievement in fall of 2022 and 2023.

We also take advantage of the fact that iReady is administered at least two times a year: in the fall and the spring. Using the fall and spring assessments, we can construct a measure of test score growth within each domain area that is specific to each student. If Charlie receives a score of 50 on the fall Geometry iReady assessment and a score of 75 on the spring assessment, his score has grown by 25 points. In sections that follow, we summarize trends in test score growth for students and document how this differs across student groups.

How does MMSD middle school math achievement look overall and by student race/ethnicity and family income?

Figure 3 and Table 1 display summary statistics of the iReady test scores for (i) Algebra and Algebraic Thinking and (ii) Number and Operations separately for each middle school grade. The boxes in Figure 3 displays scores at the 25th percentile, 50th percentile (or median), and 75th percentile; the caps at the end of each vertical line above and below the boxes show the maximum and minimum scores, excluding outliers.The median score (the middle line of each box) is the score of the typical student; the 75th percentile score is the score above which only 25% of students fall and below which 75% of students fall. The box reflects scores for the middle 50% of students. To the side of each box we show a smoothed histogram to convey the underlying shape of the distribution of achievement in each domain.

Algebra and Algebraic Thinking test scores have a dashed outline (shown on the left of each pair of figures) and Number and Operations test scores have a solid outline (shown on the right). Grade level standards provided by iReady overlay the test score distributions in color. Score ranges that are highlighted in salmon correspond to performance two or more grade levels below the standard; scores highlighted in peach correspond to performance one grade below the standard; finally, scores highlighted in light green mark performance at or above the grade-level standard. We chose to combine those at and above grade level due to the small numbers of students in MMSD who score above grade level. Table 1 gives the average fall test scores by domain and grade, with standard deviations in parentheses.

Regardless of the grade, the performance of students in MMSD middle schools remains consistent with respect to grade level standards. The typical middle school student scores near the upper end of two grades below their grade level, meaning roughly half of middle school students in the district are two or more grade levels behind in algebra, numbers and operations, or both. Conversely, roughly one in four students are at or above grade level in algebra, numbers and operations, or both. Scores for the middle 50% of students rise across grade levels, as one would hope; however, students through the middle school grades show no progress in increasing their share at or above grade level.

Figure 3

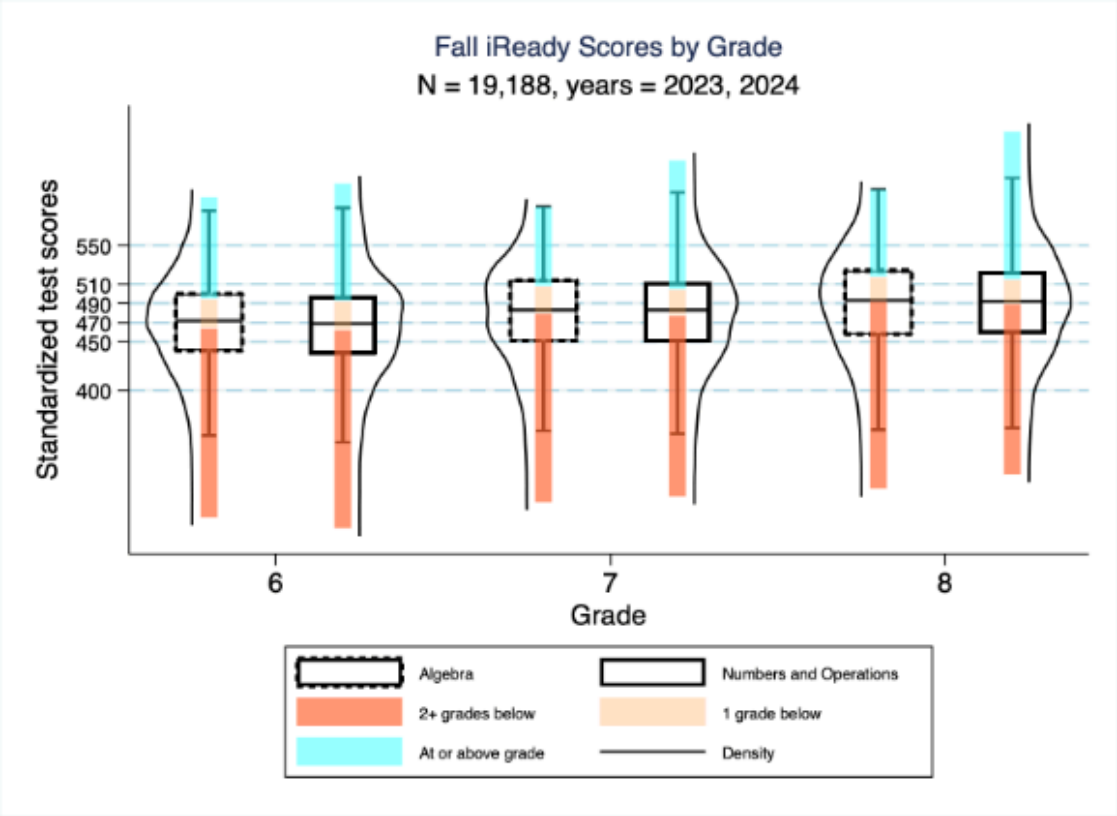


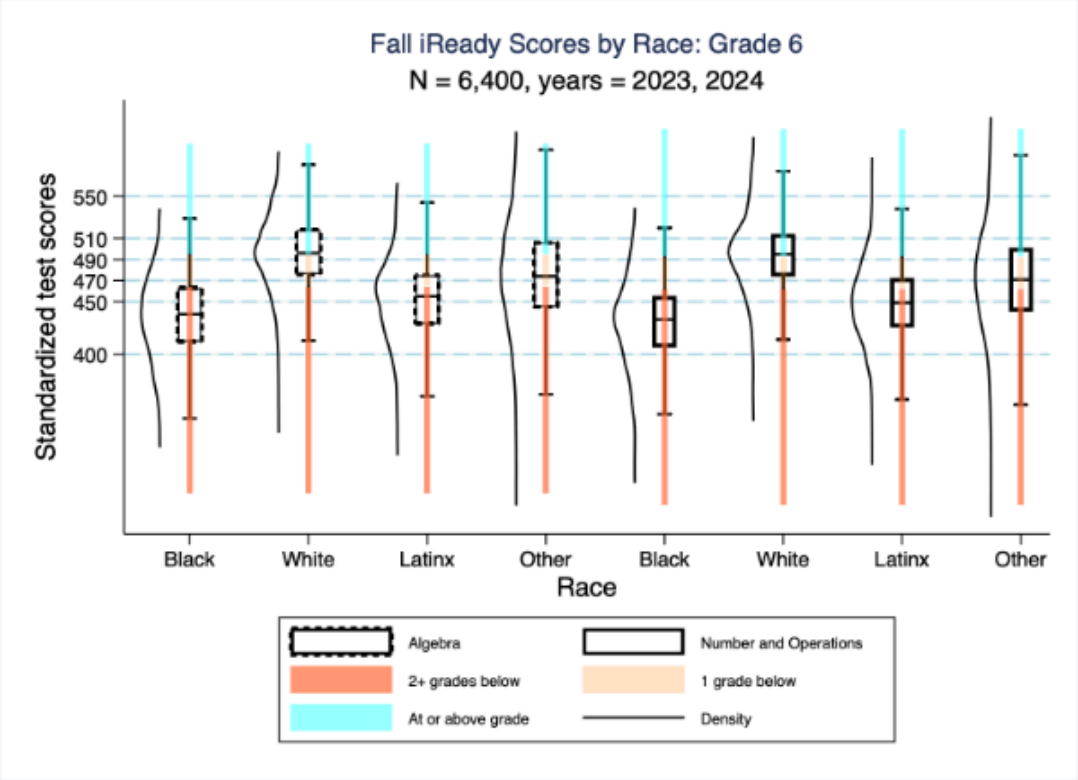
Figure 4 only considers sixth grade standardized test scores, but summarizes the distributions separately by domain (with algebra to the left and numbers and operations to the right) and by students' race/ethnicity.[4] There are noticeable inequities in achievement across racial and ethnic subgroups. Students who identify as White not only have the highest scores on average; they also have the lowest level of inequality (or within-group variation) as measured by the standard deviation (34, compared 37 for students who identify as Black and 47 for student who identify as a race/ethnicity other than White, Black or Latinx). Though not displayed in Figure 9, average test scores continue to increase with grade of enrollment and standard deviations (within-group inequality) generally increase within each racial/ethnic group over time.

The differences in raw standardized test scores across groups translate to huge differences in the shares of students that meet grade-level math standards, which you can see in Figure 8 below. For example, about 54% of sixth graders who identify as White are at or above their grade level in performance,with 31% of them being one grade below standards, and the remaining 15% being two or more grades below. Students who identify as Black or Latinx fare markedly worse: only 4% of students who identify as Black meet or exceed grade-level standards (10% of Latinx students); 19% of students who identify as Black are one grade level

[4] We focus on 6th grade for ease of exposition. Results for 7th and 8th grade are substantively identical to results in 6th grade.

below standards (28% of Latinx), and the substantial majority of students who identify as Black (77%) perform two or more grade levels below their standard (62% of students who identify as Latinx). In Number and Operations, 81% of students who identify as Black are two or more grade levels below their standard.

Figure 4



Figures 5A and 5B summarize the fall iReady test scores by student's family income (low vs. not low) and grade for Algebra and Algebraic Thinking and Number and Operations, respectively. As with Figure 7, the performance standards (specific to grade and domain) overlay the summary plots.

Inequities in mathematics achievement across levels of family income are pronounced. For example, among 6th grade students, students from low-income families have a median score of 450, compared to students from non-low-income families with a median score of 496. This difference of 46 points is just over one standard deviation. Put differently, if students average about 14 points of growth over the academic year (discussed below), this is a difference of over three years of learning at the typical pace of learning for algebra and algebraic skills among MMSD middle schoolers. These inequities persist across grades, other domains, and other statistics measuring test performance.

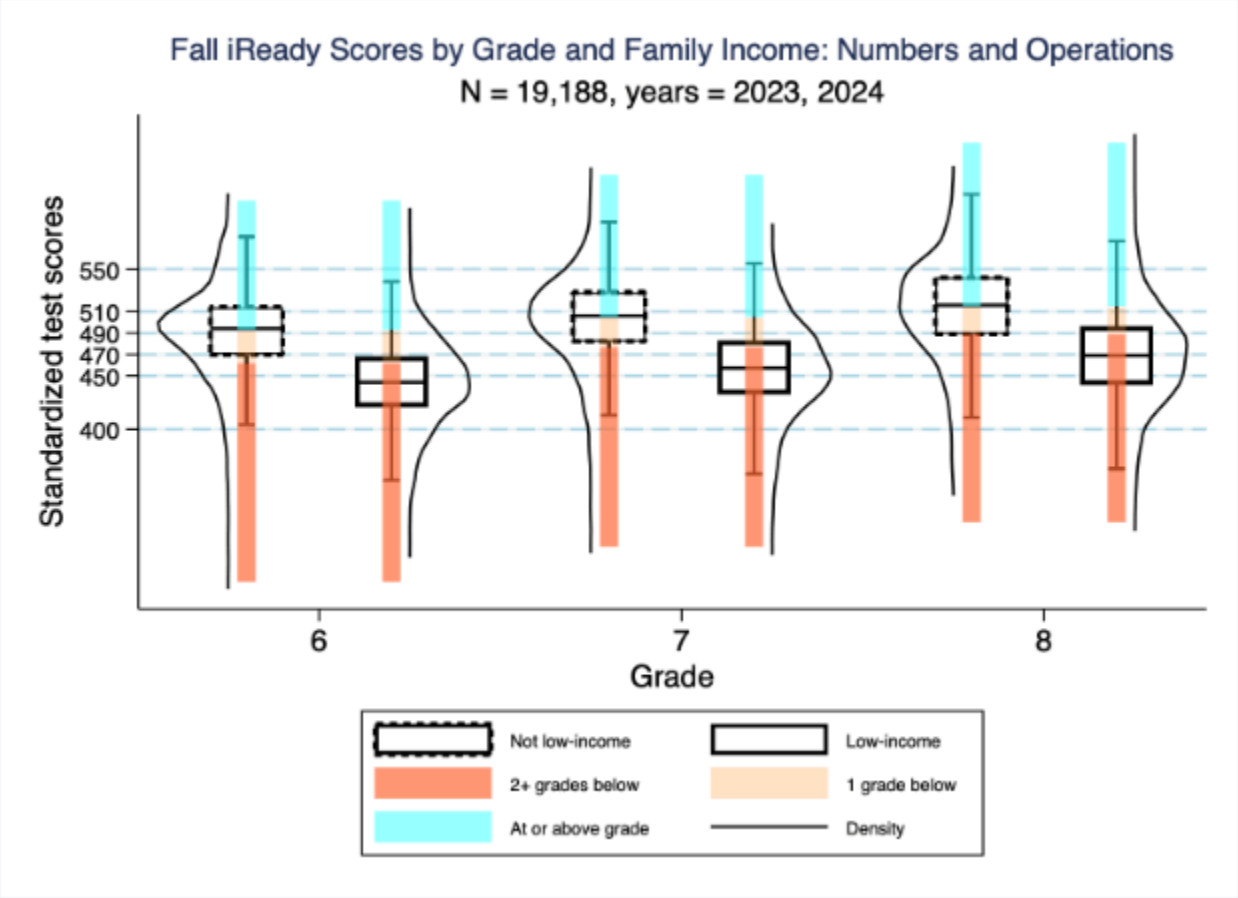
Given these large inequities in raw test scores, it's not surprising that students from low-income families lag behind their more affluent counterparts in terms of meeting grade-level performance standards. While the upper 50% of students who are not low-income perform at

or above their grade-level expectations, low-income students fare much worse: less than a quarter of low-income students perform at or above grade level expectations. At the bottom of the distribution, less than 25% of non-low-income students perform two grade levels or more below their enrolled grade, while closer to 75% of low-income students perform at this level. These patterns hold across both grades and test domains.

There are also differences in the variability or spread of test scores. As in Figures 3, 5A, and 5B illustrate, the standard deviation of test scores increases slightly with grade of enrollment for a given domain, but the widening of the distribution is larger for students from low-income families. Consider test scores for Algebra and Algebraic Thinking once again. For non-low-income students, the standard deviations of test scores are 38, 40, and 40 for grade 6, grade 7, and grade 8, respectively. For students from low-income families, the standard deviations are 38, 40, and 43 - slightly wider at the end of middle school than at the start.

Figure 5A

Figure 5B



How does MMSD middle school math growth look overall and by race/ethnicity and family income?

In this section, we summarize patterns in test score growth between the fall and spring iterations of iReady, across domains and subgroups. Figure 6 and Table 2 display summary statistics of the change in iReady scores for (i) Algebra and Algebraic Thinking and (ii) Number and Operations over the course of the academic year separately for each middle school grade.[5] The change is marked as the spring - fall iReady score for a given student in a particular academic year and for a particular domain. As there are no grade-level performance standards for test score growth, the figures that follow do not overlay any performance standards over the test score growth distributions (this aside, there are no other differences between the following figures and Figures 3 through 5).

Test score growth is fairly steady over time, at around 12 to 14 points a year, on average. The only exception to this pattern is the slightly higher average growth of about 19 points in

[5] For the 2022-2023 school year: we have 10,072 students total in grades 6-8; we have both spring and fall for 9,104 students (about 90% of students).

numbers and operations in grade six. Similar to the fall standardized test scores, though, the distribution of test score changes widens as grade increases for Algebra and Algebraic Thinking. The same pattern does not hold for the Number and Operations domain.

Figure 6

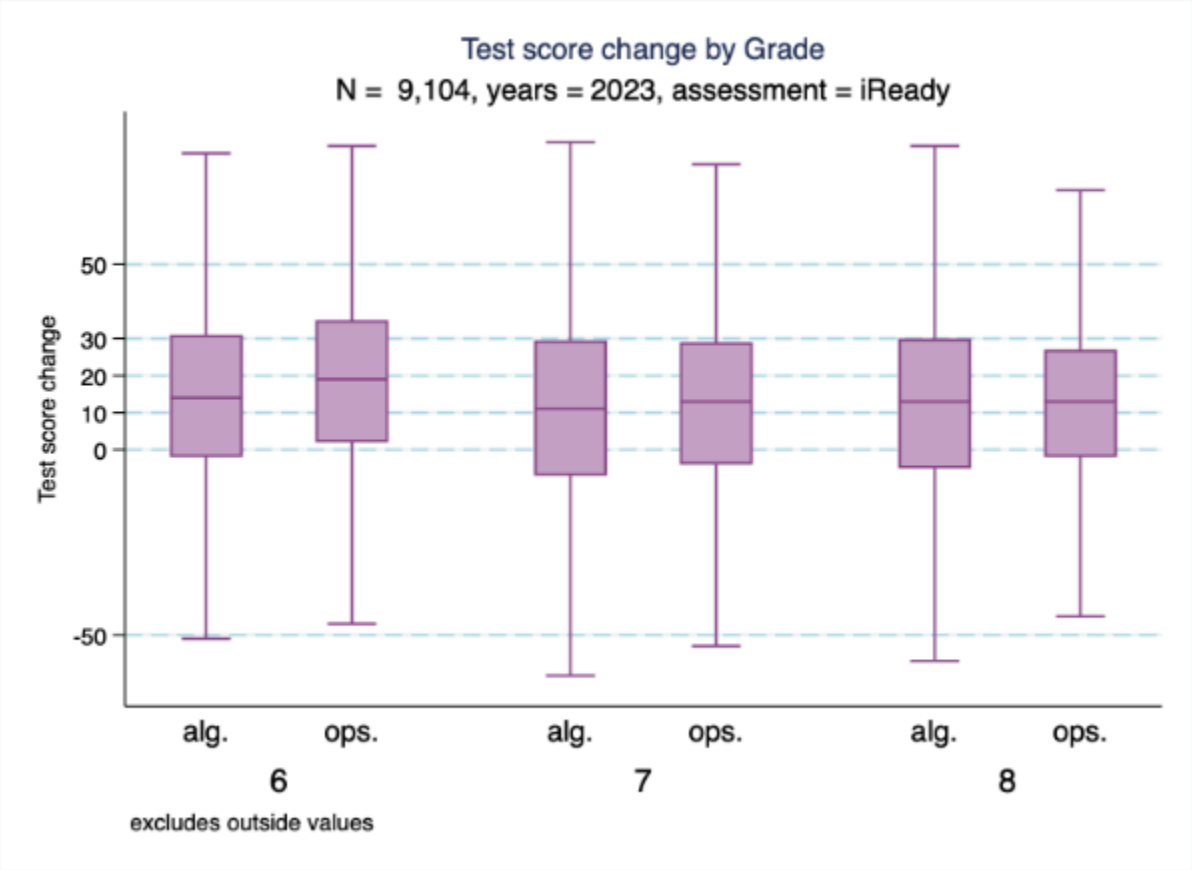


Table 2: Average annual growth (and standard deviation of growth) by grade and domain

Grade	Algebra and Algebraic Thinking	Number and Operations
6	14.0	18.5
	(27.6)	(25.6)
7	11.8	13.1
	(29.5)	(28.1)
8	13.2	13.4
	(30.5)	(27.3)

Figure 7 only considers grade six standardized test score changes, but separates growth by race/ethnicity. Middle school students who identify as White tend to experience greater test score growth than students who identify as Black, Latinx or another race/ethnicity, though the differences are modest (at around 2.8 points on algebra and one point on numbers and operations for middle school students who identify as White compared to those that identify as Black). Students who identify as White also tend to have smaller standard deviations in test score growth than students who identify as Black or Latinx, though for a few domains and grades, this is equal to or slightly larger than the standard deviation for students who identify as a race/ethnicity other than White, Black or Latinx.

Figure 7

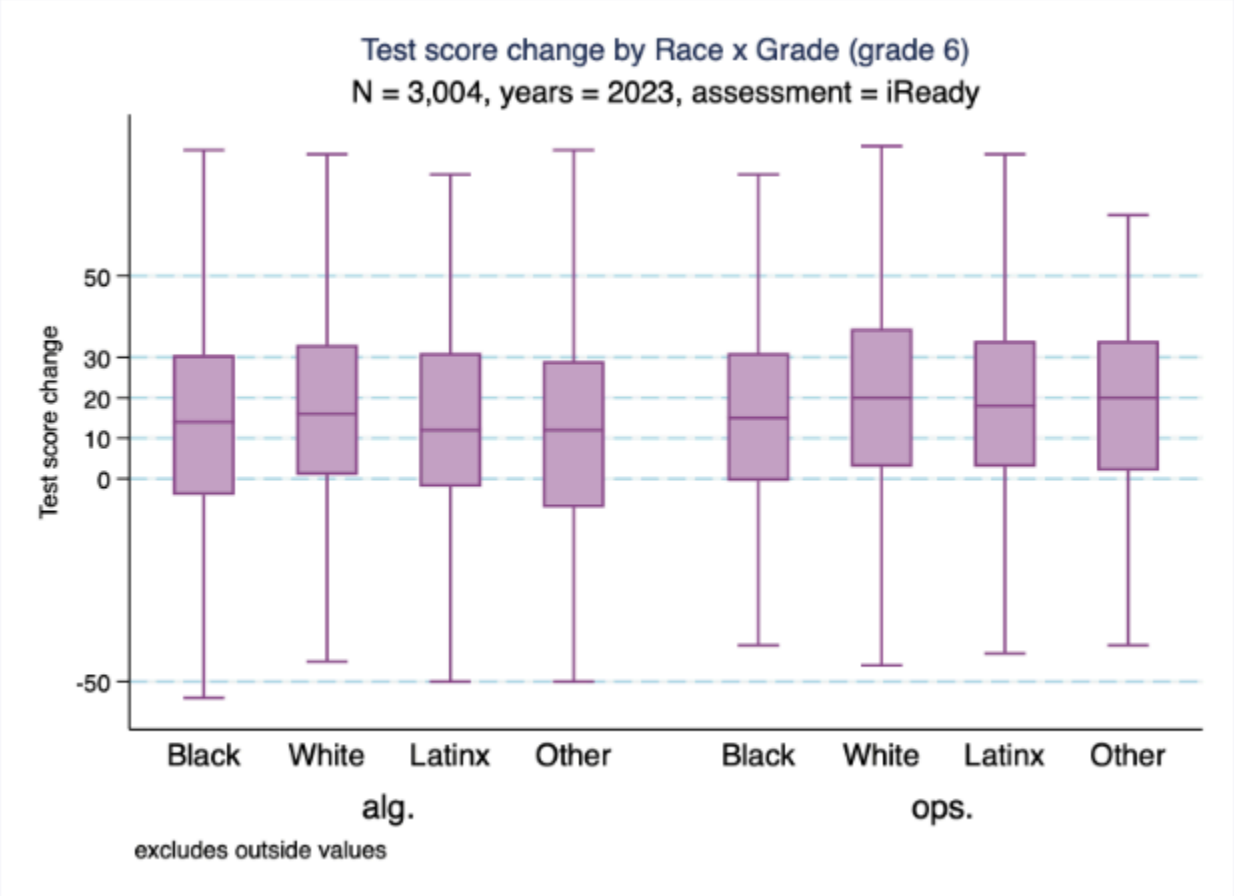


Figure 8 summarizes student growth in test scores by family income, domain, and grade. Though patterns are not as pronounced as in the graphs depicting average test scores, students from low-income households generally have slightly smaller test score gains within a given school year than students not from low-income households, evidenced by the lower medians for the blue box plots compared to the maroon ones. Although inequality in test score growth appears pretty similar across grade levels, inequalities in test score growth for students

from low-income households is always larger than for students not from low-income households.

Figure 8

Conclusion: Opportunities for Improvement in MMSD Middle School Math Achievement & Growth

Overall, we find that MMSD middle school students are outperforming or keeping pace with peers in comparable, urban Wisconsin districts on the Forward exam. As other districts did, MMSD saw declines in performance after COVID, with an uptick in results in later years. While these results appear satisfactory in some respects, we should think about the relative performance advantage MMSD enjoys over other urban districts in the state in light of the poor performance of MMSD and these comparators more generally. In MMSD, as in other districts, students are more likely to perform at the below basic level than they are to perform at or above the threshold of proficient. In MMSD, the share of students who are proficient has fallen since 2016—and the fall predates the pandemic, which may have exacerbated an already troubling trend.

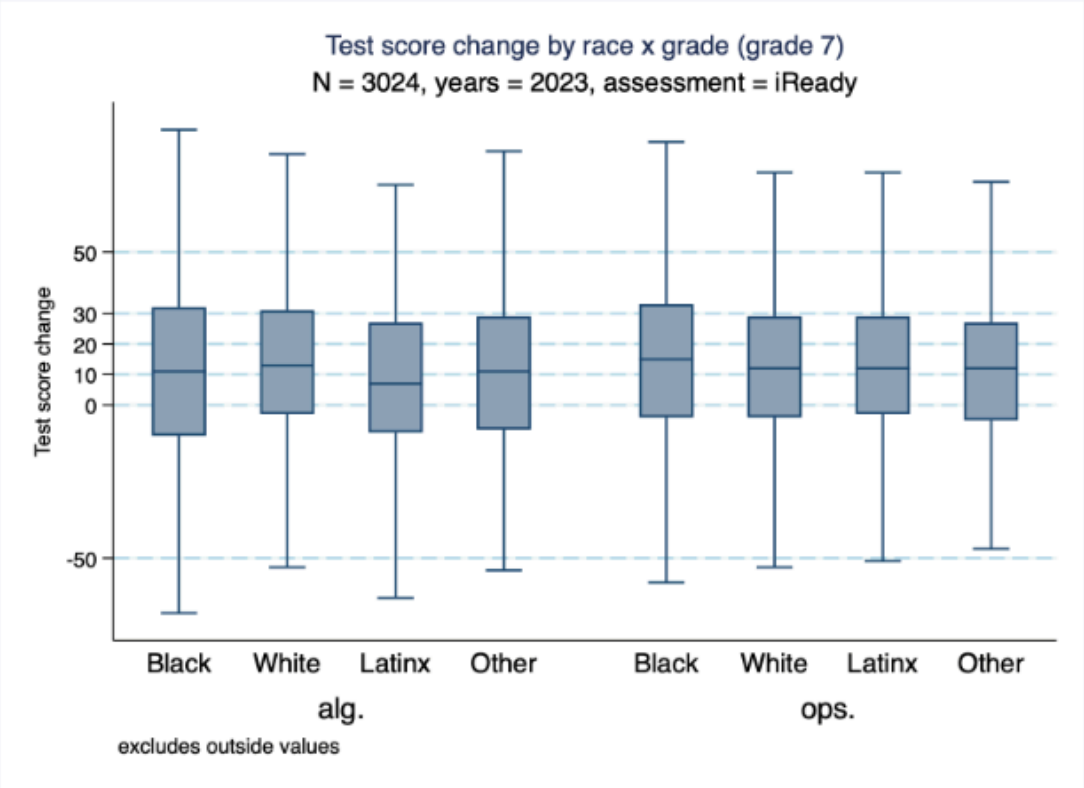
When we dig deeper on summative and formative exams, we find extreme inequities in performance by student demographic group and in specific content areas. For example, in 6th grade, the typical student from a low-income family is two or more grade levels behind in algebra and in numbers and operations while the typical student not from a low-income family is at the lower end of on grade level. The typical student who identifies as White in MMSD scores at or above grade level in 6th grade, compared to only four in one hundred students who identify as Black and ten in one hundred students who identify as Latinx.

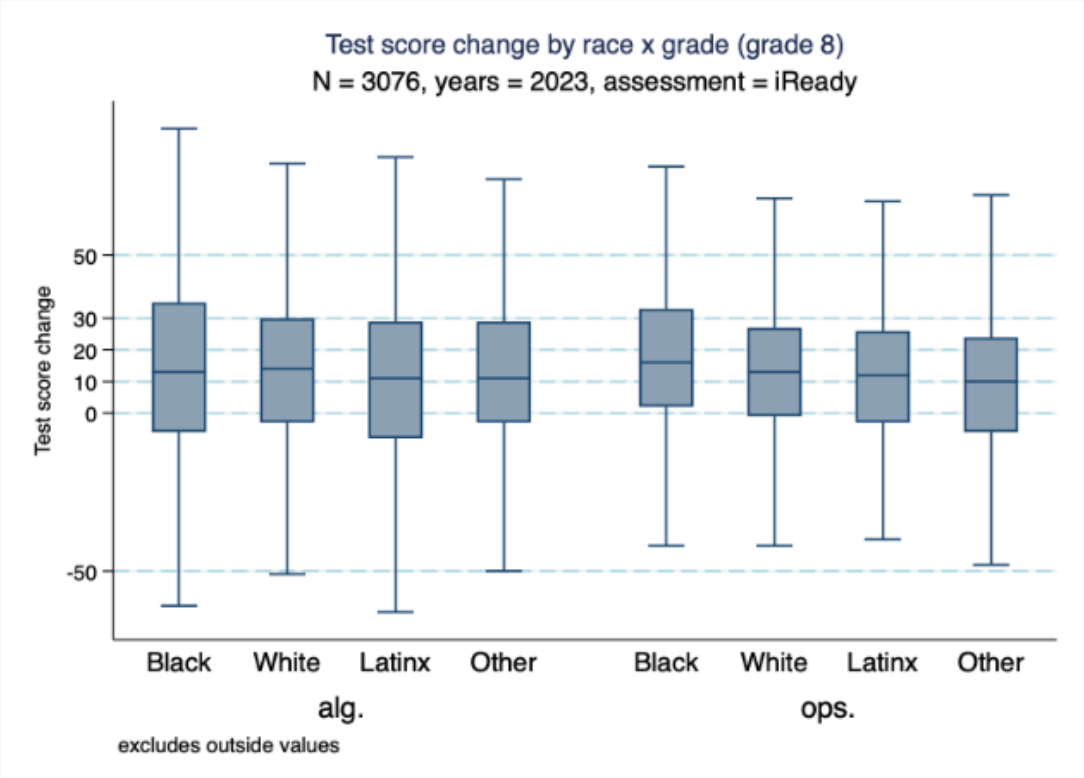
While MMSD trends are similar to those of other districts in the state, we still believe MMSD can raise growth and achievement in middle school math and recognize that MMSD has taken steps in that direction. The District implemented standards-aligned curriculum with supporting assessments; professional learning for educators and instructional coaches; K-5 implementation learning walks focused on identifying implementation of core resources and high-leverage instructional practices; and continued acceleration of learning opportunities in middle school grades. While the pandemic exacerbated inequities in mathematics achievement, the low levels of achievement, and declines in achievement, precede the pandemic. District leaders have taken steps to accelerate growth, including partnering with MEP and UW-Madison to implement a high-quality middle school tutoring;aligning middle school math course sequences across schools; and convening a math advisory committee driven by school-based and central office staff to set a vision for strong math instruction, identify levers for change and enact promising practices to raise achievement.

This report can identify the magnitude of this pressing challenge, but we cannot locate its source. To what extent do shortcomings in mathematics achievement predate middle school and what are the repercussions of below grade level middle school mathematics performance in subsequent grades? To what degree are these results due to administrative priorities, resource allocation decisions, curricular choices, and/or staffing decisions? Most importantly, what if anything can we do to improve the mathematics performance of students in MMSD, and what will we do?

As district partners and members of this community, we are ready to help MMSD take on this challenge. To begin, we have worked with MMSD to develop a middle school math tutoring intervention, set to pilot in the fall 2024. This tutoring intervention was motivated by recent research that highlights the potential impact of well-designed, high-quality tutoring, as well as the district's desire to think of ways to jumpstart improved results in middle school math. We will begin the tutoring by focusing on the domains that buttress students' understandings of ratios and proportions, specifically fractions, which are, themselves, foundational to algebraic reasoning - and where we have shown inequities exist across student demographics. By working with district leaders and educators to develop, implement and evaluate this program, we hope to increase math achievement in MMSD. This program is one step, and we are excited to see what other future research, policy and practice avenues we can explore with our MMSD partners to take on this challenge.

Appendix


Test score change by race x grade (grade 7)
N = 3024, years = 2023, assessment = iReady
Test score change
50
30
20
10
0
-50
Black
White
Latinx
Other
Black
White
Latinx
Other
alg.
ops.
excludes outside values


Test score change by race x grade (grade 8)
N = 3076, years = 2023, assessment = iReady
Test score change
50
30
20
10
0
-50
Black
White
Latinx
Other
Black
White
Latinx
Other
alg.
ops.
excludes outside values

Appendix Table 1

		Average Test Scores	
Subject	*Grade*	*Fall 2022*	*Fall 2023*
Algebra and Algebraic Thinking	6	472.2	468.2
	7	478.0	481.1
	8	490.9	488.5
Number and Operations	6	468.6	465.8
	7	478.5	480.4
	8	491.2	488.7