RESEARCH BRIEF

Preparing the Littlest Learners:

Four-Year-Old Kindergarten Enrollment and Kindergarten Readiness in MMSD

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Madison Education Partnership

The Madison Education Partnership (MEP) is a research-practice partnership between the University of Wisconsin – Madison School of Education's Wisconsin Center for Education Research and the Madison Metropolitan School District. MEP provides a context for collaborative problem identification, jointly designed empirical research to address problems of practice, development of educational interventions, and the creation of mutually beneficial lasting relationships across the UW and MMSD. The partnership serves as a conduit to establish new research within the district, enhances research use for the district, and creates mechanisms for the dissemination of new knowledge in Madison and beyond.

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Executive Summary

This report explores the association between enrollment in four-year-old kindergarten in the Madison Metropolitan School District (MMSD) and the literacy and socioemotional learning skills of students entering kindergarten in the district. Building on our previous report documenting enrollment patterns in MMSD's four-year-old kindergarten program (hereafter, "4K"), this report addresses the following questions:

1. Is MMSD 4K enrollment associated with higher levels of kindergarten readiness (as measured by literacy and socioemotional skills)?
2. Do the associations between MMSD 4K enrollment and kindergarten readiness vary across racial/ethnic groups, free/reduced lunch participation or parental education?
3. Is 4K site type (school-based or early care and education sites) associated with varying levels of kindergarten readiness?
4. How does the association between 4K enrollment and kindergarten readiness in MMSD compare to Milwaukee Public Schools (MPS), a peer urban district in Wisconsin?

We begin this report by describing how we measure school readiness among entering kindergarteners. Next, we use data from five cohorts of MMSD kindergarten students to describe the associations between MMSD 4K enrollment and school readiness among kindergarteners. We then describe variation in 4K readiness association by student and family characteristics, including student race/ethnicity, family income, parental education and among sites (distinguishing between school-based and early care and education locations). Next, we compare the association between 4K enrollment and kindergarten literacy skills for students who enroll in kindergarten in MMSD and MPS. Finally, we offer some conclusions and recommendations for next steps for MMSD. We hope that this descriptive report will help inform MMSD and others as we work together to better understand and improve the quality of 4K and the transition into kindergarten.

Based on our descriptive analyses, we arrive at the following conclusions:

- **Students who enroll in 4K have slightly stronger literacy skills at kindergarten entry and are slightly more likely to have strong classroom behavior skills** than otherwise similar children who do not enroll in 4K.
- **4K may improve equity among students at the start of kindergarten.** Students of color, students from low-income households and students of parents that did not attend college and who enroll in MMSD 4K enter kindergarten with appreciably stronger literacy skills than otherwise comparable students who do not enroll in 4K.
- **Students who enroll in 4K in school-based sites show similar levels of early literacy skills as those who enroll in early care and education sites.** However, students who enroll in school-based 4K sites are slightly more likely to consistently engage in prosocial behavior in kindergarten than those who enroll in early care and education sites.
- **Students who enroll in MMSD's 4K program experience substantially less growth in their early literacy skills than children who enroll in Milwaukee Public School's 4K program.** The difference between districts in the association between 4K enrollment and kindergarten literacy skills is consistent across students by race/ethnicity and family income.

How Do We Measure Kindergarten Readiness and Which Students Do We Study?

As of 2016, 28 states employed a kindergarten entry assessment (REL Northwest, 2016[1]). Many of these assessments are designed to measure multiple domains, including social and emotional development, approaches to learning, and physical health in addition to the academic domains of literacy and numeracy. This emphasis on the whole child is consistent with the Wisconsin Model Early Learning Standards, but Wisconsin does not currently have a statewide kindergarten entry assessment. Currently, MMSD does not systematically collect data across these domains at kindergarten entry and does not have a publicly available vision or goals for what four-year-old kindergarten should contribute to a child's development beyond general preparation for kindergarten. In this report, we rely on the measures available in MMSD administrative data that most closely reflect the Wisconsin Model Early Learning Standards.

We measure school readiness using data on kindergarten literacy and socioemotional learning skills collected by MMSD. To measure early literacy skills, we use fall kindergarten Phonological Awareness Literacy Screening (PALS) total scores and restrict our analyses to children who complete PALS in English (91% of all children who complete PALS). PALS measures several dimensions of early literacy including letter recognition, concept of word, letter sounds, rhyme awareness, sound awareness, and spelling (see Table 1). We use PALS scores for students who were in kindergarten from the 2013-2014 school year (when PALS scores became available) through 2016-2017 (the most current year available). For a more detailed description of English language PALS scores, see Appendix A.

Table 1. PALS Subscales Descriptions

Subscale	Task	Maximum Score	Mean	Standard Deviation
Letter Recognition	Name all lowercase letters in the alphabet	26	17.7	8.5
Concept of Word	Identify words through rhyme, use context to identify words in text, and identify words not in text	10	2.5	3.4
Letter Sounds	Produce letter sounds of upper-case letters	26	12.9	7.9
Rhyme Awareness	Identify pictures whose objects rhyme	10	8.0	2.7
Sound Awareness	Identify pictures whose objects have the same beginning sound	10	7.7	2.9
Spelling Inventory	Spell consonant-vowel-consonant words (phonetically correct substitutions are acceptable)	21	8.1	6.2
TOTAL	*Sum of subscales*	*103*	*56.9*	*26.6*

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[1] Citation: REL Northwest. (2016). National Snapshot: Kindergarten Readiness Definitions & Assessments. Retrieved 12/14/2017 from https://ies.ed.gov/ncee/edlabs/regions/northwest/pdf/50-state-scan-kindergarten-readiness.xlsx.

Prior MMSD reports have focused on whether or not children meet a benchmark on PALS (set at a total score of 29 points for the English language tests). This benchmark helps teachers decide which students need additional instructional resources to catch up to their peers. However, focusing on benchmarks obscures the great diversity in phonological skills of entering kindergarteners.[2] Examining benchmark performance can focus disproportionate attention on the subset of students whose scores are at or near the benchmark. Since the goal of this report is to understand variation in the literacy skills of *all* children beginning kindergarten, the main body of this report focuses on the full range of PALS scores. We report models estimating the probability of meeting the PALS benchmark in Appendix B for readers interested in comparing this research brief to reports released by MMSD in the past.

Although MMSD administers PALS in both Spanish and English, we report only on English language results in the main body of this report. In addition to the fact that the range of Spanish PALS scores is different from that of English PALS, we are not aware of any psychometric work that puts the two assessments on a common scale. Furthermore, MMSD offered the Spanish language version of PALS to kindergarten students only in the last two of the four years of data available to us. About 730 MMSD students took a Spanish language version of PALS subtests in the 2015-2016 and 2016-2017 school years. We include model estimates with Spanish PALS in Appendix C for interested readers. Those results are essentially identical to the results discussed in this report.

We measure socioemotional learning skills using student report cards in the second semester of kindergarten. As part of regular classroom assessments, teachers rate students' frequency of exhibiting certain behaviors or attitudes along a three-point scale (1-Rarely, 2-Sometimes, and 3-Most of the time). From the 13 items rating socioemotional learning skills, we create two scales: *Prosocial Classroom Behavior* and *Classroom Effort* (Table 2). "Prosocial Classroom Behavior" describes the ways children positively interact with classmates and teachers, while "Classroom Effort" describes the ways children positively and productively engage in the work of school. We construct scales by averaging across all non-missing items in each scale. We use only report card data from the 2011-2012 to 2015-2016 school year. In 2016-17, the district redesigned the report cards in a way that made comparison to previous years impossible. See Appendix D for further details on these measures. A glossary of technical terms used in this report can be found in Appendix E.

Table 2. Prosocial Classroom Behavior and Classroom Effort Scales

Prosocial Classroom Behavior	Mean	Standard Deviation
1. Accepts responsibility for own behavior	2.77	0.50
2. Demonstrates listening skills	2.65	0.54
3. Demonstrates self-control	2.65	0.57
4. Follows oral directions	2.73	0.50
5. Respects rights, diversity, and feelings of others	2.83	0.42
6. Solves conflicts appropriately	2.71	0.52
7. Works cooperatively with others	2.80	0.44

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[2] We do not use the "Summed Score" provided in the PALS data due to differences in the measure of some domains across observations. Because PALS administrators can score students using either group or individual assessments, depending on each child's need, the Summed Score measure is confounded by student's skill levels. In order to accurately analyze the PALS scores while retaining this variability we take scores from identically administered subscales in the PALS assessment, favoring group over individually administered assessments when both are available, and sum across the six subscales.

Table 2 (Cont.) Prosocial Classroom Behavior and Classroom Effort Scales

Classroom Effort	Mean	Standard Deviation
1. Completes assignments on time	2.71	0.54
2. Organizes materials and time	2.67	0.57
3. Participates in classroom activities	2.83	0.41
4. Persists in tasks until completion	2.76	0.50
5. Takes positive risks in learning and social situations	2.75	0.49
6. Works independently	2.68	0.57

Note: Item scores range from 1 (Rarely) to 3 (Most of the time)

Relatively few teachers rate students in their classroom as rarely engaging in either prosocial behavior or classroom effort. In fact, about 53% of students were rated by their teachers as engaging in both prosocial behaviors and classroom effort most of the time across all constituent items, as shown in Figure 1. Teachers rated an additional 41% of kindergarteners as engaging in such behaviors some or most of the time. Only about 6% of kindergarten students in MMSD were rated as engaging in problematic behaviors with sufficient regularity to be marked as 'rarely.'

With cooperation from Milwaukee Public Schools (MPS), we are able to compare associations between 4K enrollment and kindergarten literacy skills between MMSD and MPS using data from the Wisconsin Department of Public Instruction (DPI). The data from DPI lack some of the detail available to us in MMSD (including parent education) and are more limited in their temporal coverage. We chose to use MPS as a peer district to provide context for MMSD results. As urban districts in Wisconsin, MMSD and MPS both serve diverse populations in terms of race/ethnicity and socioeconomic background. They are also among the largest districts in the state. The two districts are also different in many ways, including the size of the cities and student populations they serve, their levels of funding and the complexity of their organizational structures. MPS serves a population appreciably more disadvantaged than that of MMSD in terms of free/reduced lunch program participation and parental education. Readers should bear these differences in mind when considering the comparative analyses we offer. Ideally, we would have compared MMSD to a range of districts, but bureaucratic barriers to data access limit the districts we could include in this report.

Figure 1. Kindergarten Distribution of Teacher Ratings on Socioemotional Scales
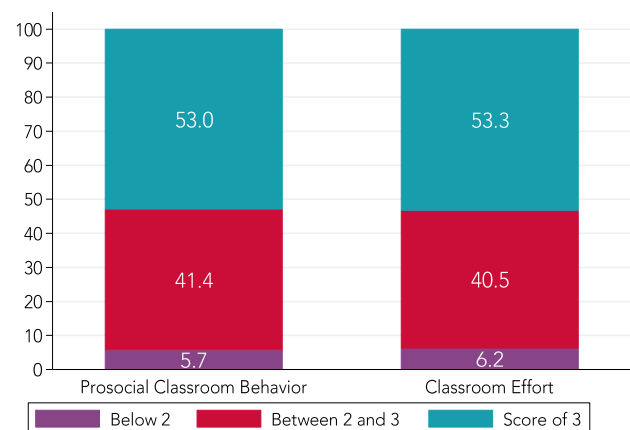
Throughout this report, we not only explore average associations between 4K enrollment and kindergarten readiness; we also consider the degree to which those associations vary by race/ethnicity[3] and socioeconomic status (as measured by parental education and participation in the free/reduced price lunch program). These are the fundamental axes of social inequality in Wisconsin and the country

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[3] We distinguish among African American, non-Hispanic white, Latinx and Asian/Pacific Islander students. A more careful analysis of variation by race/ethnicity might further distinguish by nativity and among subgroups of Asian students given the heterogeneity in the experiences of students within some of these groups. For reasons related to both substantive focus and statistical power we have chosen not to do so in this report.

as a whole, strongly shaping the educational experiences of children and their economic and occupational prospects as adults. Given MMSD and MEP's focus on equity, we want to understand not only the association between 4K enrollment and readiness more generally, but also between 4K enrollment and equity. If 4K enhances equity, we would expect 4K enrollment to have a stronger association with readiness for children of color and children from disadvantaged families.

What Methods Do We Use To Analyze the Data?

To answer Question 1, we use a statistical model (ordinary least squares regression) to estimate the association between 4K enrollment and average PALS test scores, net of differences in student race/ethnicity, parental education, family income[4], disability status and English language learner (ELL) status. We present estimates from this model as the percent of students a child with a particular characteristic would be expected to out-perform on the fall Kindergarten PALS assessment, if that child were similar to other children on all other characteristics we studied. As a point of reference, the average student scores better than half of his or her peers on PALS. For this report, groups in which students outperform more than 50% of their peers are considered "advantaged" and groups in which fewer than 50% of students outperform their peers are considered "disadvantaged." For example, students of parents with a master's degree are expected on average to score higher than 70% of students whose parents have a high school diploma and are otherwise similar in race, family income, age, etc.

To explore the association between 4K enrollment and socioemotional learning skills, we estimate the probability that a child was rated by his or her teacher as engaging in prosocial classroom behavior or appropriate classroom effort most of the time. Each model controls for differences in students' race/ethnicity, participation in the free or reduced price lunch program (referred to as 'low-income'), parental education, ELL status, special education status and age (in months) at kindergarten entry. Results in this report are based on data across cohorts of children entering kindergarten between 2013 and 2016.

To answer Question 2, we estimate the degree to which the association between MMSD 4K enrollment and school readiness varies by race/ethnicity, family income and parental education.

In Question 3, we explore differences in the association between 4K enrollment and kindergarten readiness across school-based and early childcare education (ECE) sites. We first describe the share of variation in school readiness within and between 4K sites, excluding from our analysis students who did not attend 4K in the district. This analysis quantifies the limit of the contribution of site differences (including site type) to variation in school readiness among students. If none of the variation in readiness were across 4K sites this would imply that sites were engaging in practices that had very similar associations with kindergarten readiness. On the other hand, if most of the variability in readiness were associated with sites, this would imply that the average level of readiness across site were highly variable and characteristics of sites potentially important in accounting for differences among children in school readiness. We then estimate the extent to which these between-site differences are attributable to observable differences in the students served by those sites. After documenting the share of within-site and between-site variation in readiness, we consider the degree to which average levels of readiness differ between children in school-based and ECE sites.

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[4] Our measure of family income is whether or not a child is participating in the free or reduced price lunch program. Unfortunately, this is the only measure of family income available to us. Students are eligible for free or reduced price lunch by virtue of living in a household with income levels at or below 185% of federal poverty guidelines. In 2016-17 the poverty threshold was $24,300 for a household of four; therefore students living in households earning less than $44,955 annually would qualify for free or reduced price lunch.

In Question 4, we employ the same strategy we use to answer Question 1 (described above). However, because we rely on data from the state's longitudinal data system, we are more limited in the cohorts we can include in the analyses and in the background measures available to us. On the other hand, we go beyond Question 1 to look descriptively at the literacy skills of children at the beginning and end of their time in 4K in both Milwaukee and Madison schools.

Given the data available to us and lacking a strong strategy for identifying causal effects, we want to make clear that *none* of these results tell us the causal impact of 4K on kindergarten readiness. The association between 4K enrollment and readiness may be caused by factors we have not measured. For example, the association we observe might merely reflect differences in the characteristics of students and families who do and do not participate in 4K rather than the causal effect of 4K enrollment. Another possibility is that the children who enroll in 4K are substantially less advantaged than those who do not (net of FRL participation and parental education) or that those who do not attend 4K attend more academically rigorous childcare settings instead. Both of these conditions could lead us to observe a negative association between 4K enrollment and readiness even if 4K enrollment were substantially enhancing the skills of the students it serves. Despite these limitations, we offer these estimates in the hopes of contributing to discussion and further research aimed at enhancing the efficacy of 4K programming in MMSD.
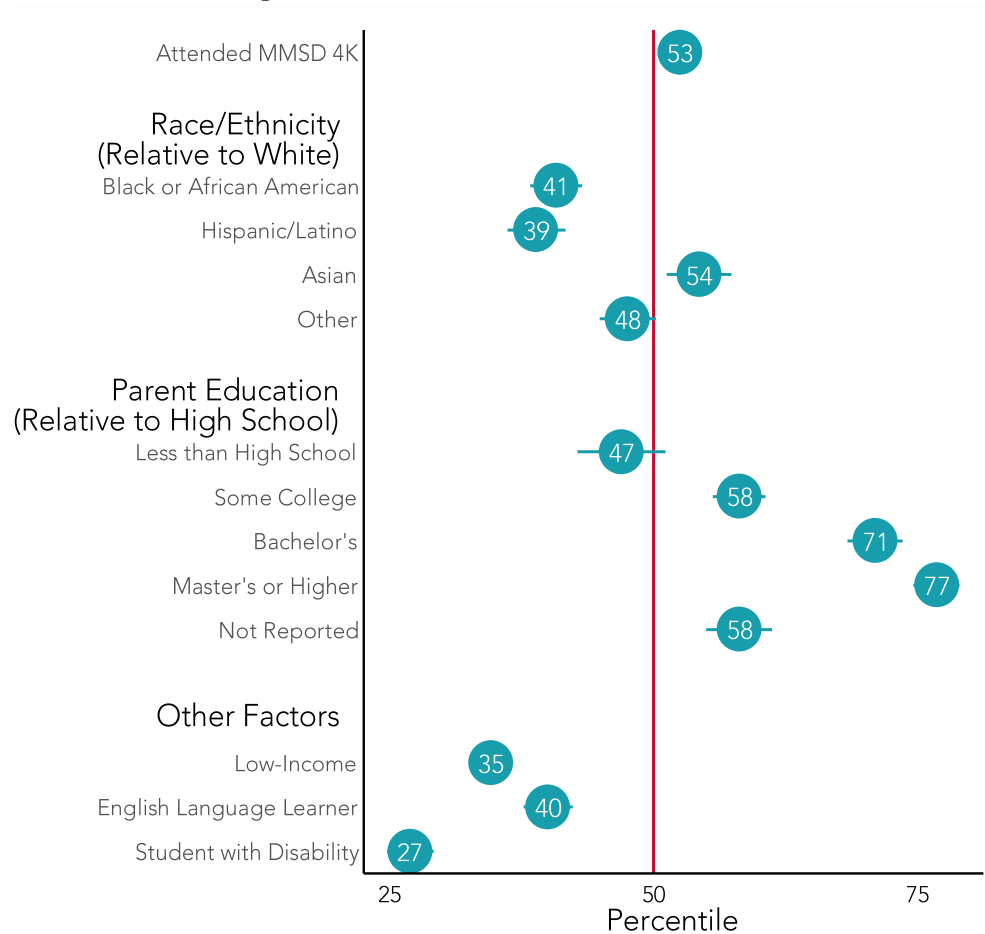
Question 1: Is MMSD 4K enrollment associated with higher literacy and socioemotional skills in kindergarten?

Overall, MMSD 4K enrollment is associated with a modest increase in early literacy skills, as measured by the total PALS score. The average 4K student scored higher on t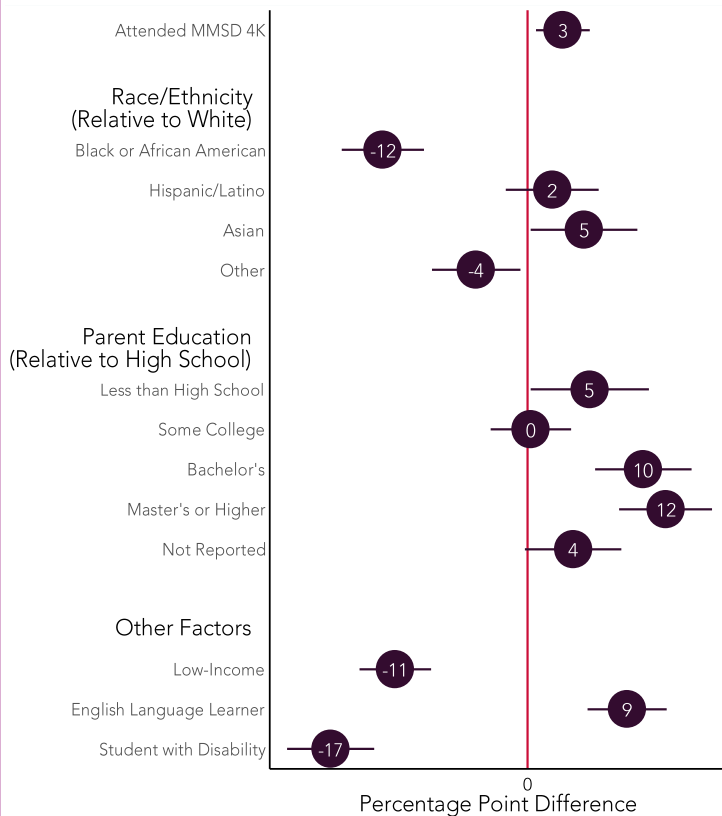he fall kindergarten PALS than 53% of incoming MMSD kindergartners who did not enroll in the district's 4K program, accounting for other characteristics (Figure 2). Consistent with other research on inequalities in school readiness (e.g., [Fryer and Levitt 2006](#); [Kaushal, Magnuson, and Waldfogel 2011](#); [Duncan and Magnuson 2005](#); [Reardon and Portilla 2016](#)), we find differences in readiness across racial/ethnic groups and by levels of parental income and education. African American and Latinx students are, on average, appreciably less prepared to read than otherwise comparable non-Hispanic white students at kindergarten entry, all else equal. Levels of pre-literacy skills increase sharply across parental education, with the typical child of parents with a graduate or professional degree scoring on average higher than 77% of children whose parents have a high school diploma. Finally, the average student from a low-income household begins kindergarten scoring better than about a third of more economically advantaged peers in literacy skills.

Figure 2. Predicted Percentile Rank Difference in PALS Scores

Figure 3. Probability of Consistently High Prosocial Classroom Behavior

Students who enroll in 4K are slightly more likely to demonstrate consistently high prosocial behavior than other similar children who do not enroll. Enrollment in the 4K program is associated with a three-percentage point increase in the probability of engaging in prosocial classroom behavior most of the time (Figure 3). African American students are 12 percentage points less likely to be rated as engaging in prosocial classroom behavior most of the time and Asian students five percentage points more likely to be rated as engaging in prosocial classroom behavior most of the time than otherwise comparable non-Hispanic white students, all else equal. Latinx students are about as likely as non-Hispanic white students to consistently engage in prosocial behavior net of other observed differences among students. Students from college-educated families were more likely to engage consistently in prosocial classroom behavior than those whose parents had a high school education and students from low-income families less likely to do so than those from more economically advantaged homes.

Kindergartners who enrolled in 4K are also two percentage points more likely to be reported as engaging in appropriate levels of classroom effort most of the time, all else equal, but this difference is not sufficiently reliably estimated to give us confidence that it is real rather than due to chance (Figure 4). Similar to the patterns of prosocial classroom behavior described above, African American and low-income students, as well as students from less educated families, are less likely engage in appropriate levels of classroom effort most of the time than their peers according to teacher reports.

Figure 4: Probability of Consistently High Classroom Effort
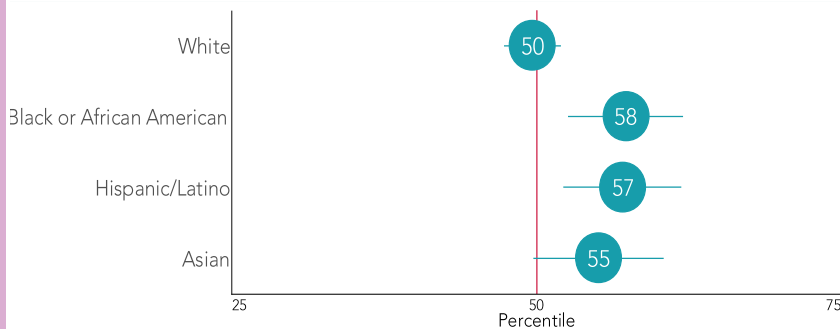
Question 2: Do the associations between MMSD 4K enrollment and kindergarten readiness vary across racial/ethnic groups, levels of free/reduced lunch participation or parental education?

We find that students of color, students from low-income households and students of parents who did not attend college who participate in 4K have higher levels of literacy in kindergarten than similar non-participating peers. In separate models, we explore variation in the association between 4K enrollment and PALS scores by race/ethnicity and socioeconomic background. Overall, estimates from these models suggest that the small average association between 4K enrollment and pre-literacy skills shown in [Figure 2](#) masks substantial variation in associations among subgroups.

We present key results from separate models in Figures 5, 6 and 7. On average, African American and Latinx students who enroll in MMSD 4K achieve PALS scores higher than 58%, and Asian students achieve PALS scores higher than 55%, of otherwise similar students in their racial or ethnic group who did not enroll in 4K (Figure 5).

Figure 5. Percentile Rank Differences in PALS Score for 4K Attendees over Non-Attendees, by Race

Typical low-income students who enroll in 4K the year prior to kindergarten have higher PALS scores than 58% of students from low-income homes who do not enroll in 4K (Figure 6). The more advantaged students in each of these analyses who enroll in 4K score about as well on PALS as comparable students who do not enroll in 4K, outscoring about half of non-participating students.

Figure 6. Percentile Rank Differences in PALS Score for 4K Attendees over Non-Attendees, by Family Income
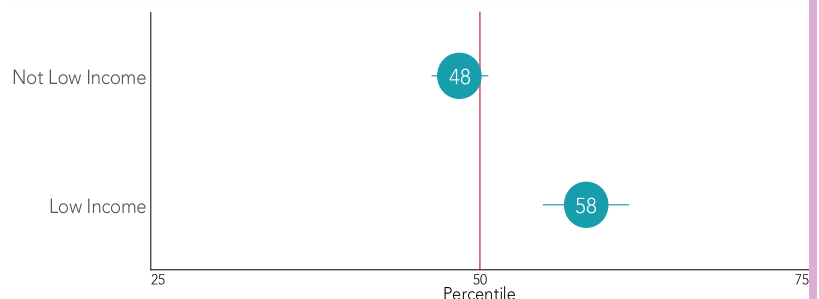
Figure 7. Percentile Rank Differences in PALS Score for 4K Attendees over Non-Attendees, by Parental Education
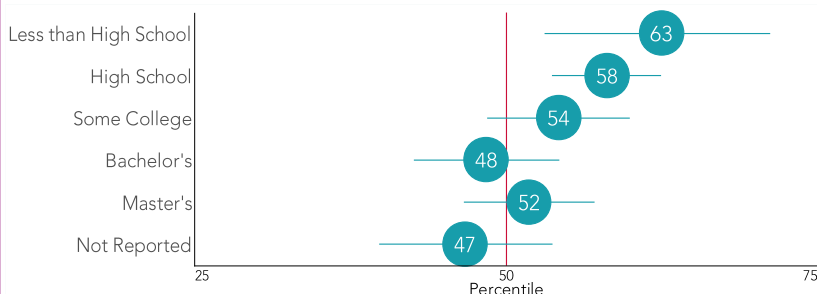
Figure 7 shows that 4K children of parents who did not complete high school outscore 63% of otherwise comparable children who did not attend 4K. The association between 4K attendance and early literacy skills declines across levels of parental education such that kindergarten literacy scores of 4K children whose parents attended college are not statistically distinguishable from the literacy scores of comparable children who did not enroll in 4K. Whether this results from differentiated effects of 4K favoring less advantaged children or stronger literacy development opportunities in early childhood settings for white, economically advantaged students outside of 4K is unclear.

In contrast to our results for early literacy skills, *we found no evidence of differential associations between 4K enrollment and socioemotional skills across racial/ethnic groups, family income or parental education.*

Question 3: Is 4K site type (school-based or early care and education) associated with varying levels of MMSD kindergarten readiness?

Figure 8 displays the share of variation in PALS scores we observe between 4K sites and the share we observe among students enrolling at the same sites. The more variation between sites we observe, the greater the likelihood that attributes of sites, such as whether or not they are located in schools, contribute meaningfully to differences in readiness among students. The pie chart on the left in Figure 8 shows that about a quarter of the variation in PALS kindergarten scores is potentially attributable to site differences while just over three-quarters of the variation is found among children within sites. However, almost all of the variation we observe across sites is attributable to differences among the students served by those sites, as reflected in the pie chart on the right in Figure 8.

After accounting for student and family characteristics, 97% of the variation in PALS scores is within sites and 3% is between sites. This leaves almost no room for differences across sites in kindergarten readiness independent of differences among the children who attend 4K at those sites. If there are differences in the average literacy skills of children participating in different 4K programs, those average differences are very small relative to differences among children from the same 4K programs. Relatedly, we find no meaningful differences between school-based or ECE sites in terms of their impact on kindergarten PALS readiness, and

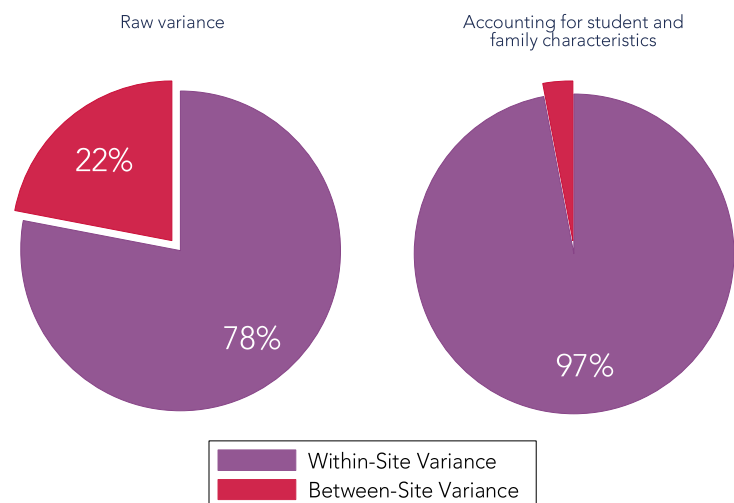**Figure 8. Shares of Variance in PALS Scores among 4K Attendees**

Raw variance

Accounting for student and family characteristics

Within-Site Variance
Between-Site Variance

Figure 9. Probability of Consistently High Prosocial Classroom Behavior by Type of 4K

Percentage Point Difference from Non-4K Children
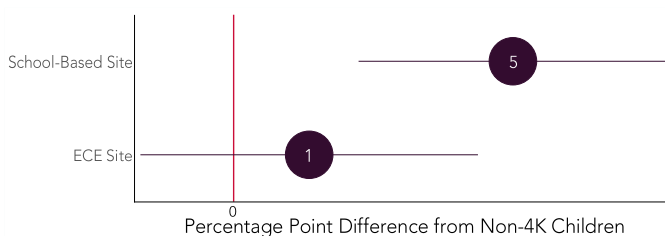
Figure 10. Probability of Consistently High Classroom Effort by Type of 4K

Percentage Point Difference from Non-4K Children
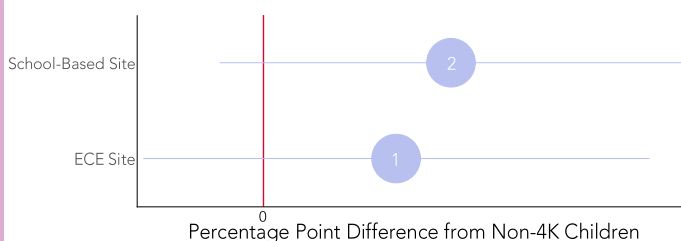
therefore do not discuss those null results.

We find virtually no evidence of cross-site variability in socioemotional skills early in kindergarten and therefore do not report those results as we did for PALS in Figure 8. However, the association between 4K enrollment and prosocial classroom behavior does appear to be slightly stronger at school-based 4K sites than at ECE sites, net of observed differences among children. (Figure 9). Finally, we do not observe differences in the association between 4K enrollment and classroom effort between school based and ECE sites (Figure 10). The lack of variability in average levels of literacy and socioemotional skills across sites should not be taken as an indication that 4K does not matter. The uniformity of associations suggests that sites matter in similar ways; that, given the data we have, we cannot say with confidence that there are differences across sites in the associations between 4K enrollment and kindergarten outcomes.

Question 4: How does the association between 4K enrollment and kindergarten readiness in MMSD compare to Milwaukee Public Schools, a peer urban district in Wisconsin?

Figure 11 plots associations between kindergarten literacy skills, 4K enrollment and a number of attributes of enrolled children in MMSD (teal) and MPS (red). The plot is similar to Figure 2 but limited to two cohorts of students (2014-15 and 2015-16) and constrained to the indicators included in the state's longitudinal data system. Due to these sample differences, the MMSD results in this section differ slightly from the results in Figure 2.

The difference between districts in the association of 4K enrollment and kindergarten literacy skills is striking. *Where students enrolling in MMSD's 4K typically enter kindergarten with literacy skills better than 52% of otherwise similar students who do not enroll in 4K, students in MPS who participate in 4K on average score higher on early literacy skills than 76% of otherwise similar MPS kindergarten students who do not enroll 4K.*

In analyses not shown, we explored the possibility that gains in 4K varied across students' fall 4K scores and found little difference. Whether they entered 4K with relatively high or relatively low literacy skills, children enrolled in MPS 4K enjoyed appreciably greater gains in literacy skills than children enrolled in MMSD 4K. The more modest difference in associations shown in Figure 11 is due to the fact that kindergartners in MMSD who did not enroll in 4K have stronger kindergarten literacy skills on average than those who did enroll in 4K, while the opposite is true for MPS.

Figure 11: Kindergarten PALS Score Comparisons (Percentile Rank Difference)

To what extent are differences in the association between 4K enrollment and literacy skills in the fall of kindergarten attributable to differences in the skills of students that attend 4K in these two school districts? Figure 12 shows distributions of PALS scores at the beginning of 4K (on the left) and the beginning of kindergarten (on the right) for children who enrolled in 4K, with MMSD plotted in teal and MPS in red. *Differences in the populations of students MPS and MMSD 4K serve do not appear to contribute to differences in the association between 4K enrollment and kindergarten literacy skills discussed above.* In fact, children entering 4K in MPS on average score lower on 4K PALS than 66% of children entering 4K in MMSD. By the time they are assessed again in spring of 4K, children who enroll in 4K in MPS and MMSD achieve around the same average PALS score (49 points).

Figure 12. Distribution of PALS Scores in 4K and Kindergarten
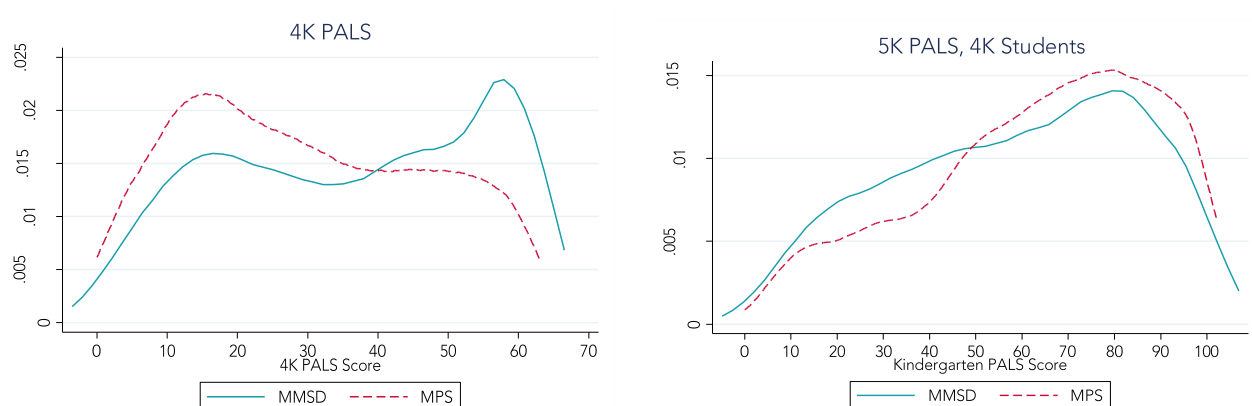
What drives the differences between MMSD and MPS? As with other questions, our analysis does not lead us to a definitive causal answer. We know there are structural differences between the programs that merit consideration. Table 3 on the following page compares 4K programs across the districts on characteristics available on the districts' web pages. Perhaps the most obvious difference is in the hours of service the respective programs offer. MMSD 4K is a part-day program while MPS is a full-day program. The extended time available to 4K teachers in MPS no doubt contributes to the stronger potential impact of 4K on kindergarten literacy skills. There could be additional programmatic factors that contribute to the MPS advantage, such as classroom practices, administrative structures, or other organizational factors.

In addition to these features of the 4K programs, however, the alternative venues for early childhood education available to parents across the districts may also contribute to the differences we observe. If non-4K ECE programs in MMSD do a better job of enhancing children's literacy skills than non-4K programs in MPS, then the difference in the 4K associations we observe may be due at least in part to the more beneficial experiences of children who do not enroll in 4K. Alternatively, it may be that some non-4K children are at home with a parent, relative or other caregiver, and that the home environments of such children in MMSD are more conducive to early literacy development than the home environments of such children in MPS.

Table 3. MMSD and MPS 4K Programmatic Components

Component	MMSD	MPS
Full Day/Half Day	Half-day only	Full-day only
Family Cost	$40 material fee; Tuition at ECE centers only for wrap around care outside of 437 4K instructional hours	Free
Enrollment Process	Online or in-person	Online or in person
Placement Process	Parents indicate top 3 choices in application, placement based in part on location and transportation needs	Parents indicate top 3 choices in application
Site Type	School-based and early childhood and education (ECE) centers	School-based programs only (includes neighborhood, neighborhood specialty, city wide specialty, and charter schools)
Developmental Bilingual Immersion Programs Offered	Yes	Yes
Curriculum Standards	All programs must align curriculum with WMELS standards; school based sites use Creative Curriculum	All programs are required to align curriculum with WMELS standards; use of worksheets in curriculum regulated
Assessments Used	PALS student assessment; GOLD assessment in school based sites	PALS student assessment; DECE Early Childhood Classroom Checklist for schools and teachers
Instructional Time Required	437 hours of instruction distributed through the regular school year	437 hours of instruction; 90 minutes of literacy instruction per day, dispersed throughout the day
Student-Teacher Ratio	1:18 (school based), 1:10 (ECE)	1:18 (school programs), 1:17 (Head Start)
Transportation Offered	Yes, for school sites if you live more than 1 1/2 miles from the site; offered for some ECE sites	Yes, all sites
3K Offered	No; birth to five-year-old Family Play and Learn program	Yes, at some sites
Head Start Offered	Yes	Yes

Conclusion

Overall, we find that *enrollment in MMSD's 4K program is associated with higher literacy skills and socioemotional skills for students.* When we look at results for students of color, students from low-income families and children of parents with less than a college education, we see 4K associated with appreciably higher levels of literacy in fall of kindergarten, but not with levels of socioemotional skills. *Enrollment in MMSD's 4K program is thus associated with substantial reductions in inequality in literacy skills at the start of kindergarten.* When we look at difference between site types, we see *no substantial difference between school-based and ECE sites* in kindergarten readiness. Finally, we find that *MPS 4K students see substantially higher gains in early literacy than MMSD 4K students.*

> **Students Enrolled in MMSD 4K:**
>
> ➢ Have slightly higher literacy and socioemotional skills in kindergarten
>
> ➢ Students of color, low-income students and children of high school graduates have higher literacy skills in kindergarten
>
> ➢ No substantial difference in readiness between site types
>
> ➢ Have lower literacy gains in kindergarten than students enrolled in MPS 4K, net of student characteristics

How do these results align with the goals of the 4K program in MMSD? Answering that question is a bit challenging, in part because the explicit goals of MMSD 4K are not clear to us. Since all 4K programs employ the PALS assessment, we assume that 4K seeks to enhance literacy skills. One might also assume that increased socioemotional skills matter, given the attention to them on report cards. Yet without a clear definition of what school readiness is and measures of readiness closely aligned to that definition, the district will be unable to fully evaluate the contribution of 4K to the readiness of children entering kindergarten. MMSD is not alone in this situation; districts nationwide are struggling to define, measure and evaluate school readiness.

What are our recommended next steps for MMSD?

Based on our analyses of MMSD administrative data and our comparative analysis of MPS and MMSD, we offer the following recommendations:

1. We encourage MMSD to **explore how to define and measure school readiness**. Freed of the obligation to use PALS, the district has an opportunity to define what it regards as the key components of school readiness and to either find or design a measure that closely aligns with those components. This conversation is occurring across the country and will benefit not only the district, but potentially many other efforts in Madison, Dane County and Wisconsin.
2. The district should **consider creating a publicly available vision and goals for the 4K program**. Making explicit what students, families and staff should expect the program to achieve will help ensure that any analyses of program effects are fair and informative.
3. After acting on recommendations (1) and (2), the district should **gather detailed data on how curricular choices, teaching practices and organizational factors affect the capacity of the 4K program** to achieve its objectives.
4. We encourage **MMSD staff to work with MPS staff to learn more about their 4K programs**. For MMSD in particular, this may be a fruitful conversation, given the difference in program models and the associations we found here. We caution against a simplistic analysis attributing differences to the length of service (full versus half day) and encourage MMSD to consider the equity implications of any changes they consider to the 4K program. Of course, other districts beyond MPS may also offer guidance informed by research on their own 4K programs. For example, some of our colleagues in the National Network of Education Research-Practice Partnerships ([NNERPP](#)) are also doing work on four-year-old kindergarten and may have valuable insights about the components of more and less successful programs.

Figure A1 displays the distribution of scores across PALS subscales. Letter Recognition, Rhyme Awareness and Sound Awareness scores are highly left-skewed, indicating that many students scored high on these subscale tests. Concept of Word and Spelling Inventory scores are highly right-skewed, indicating that many students scored low on these subscales. Letter Sound scores are more or less distributed evenly across students.

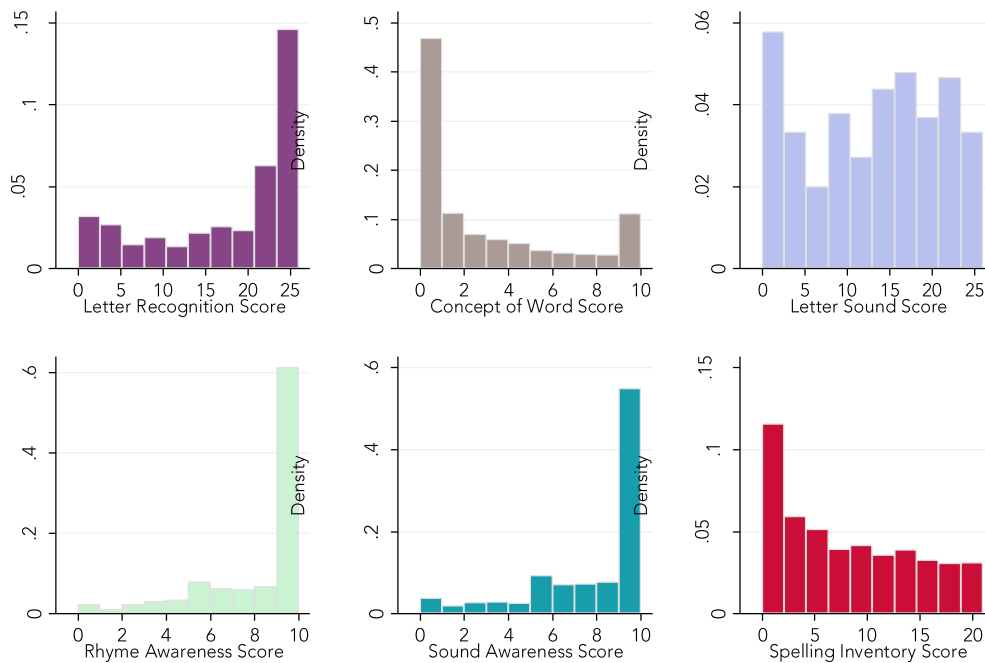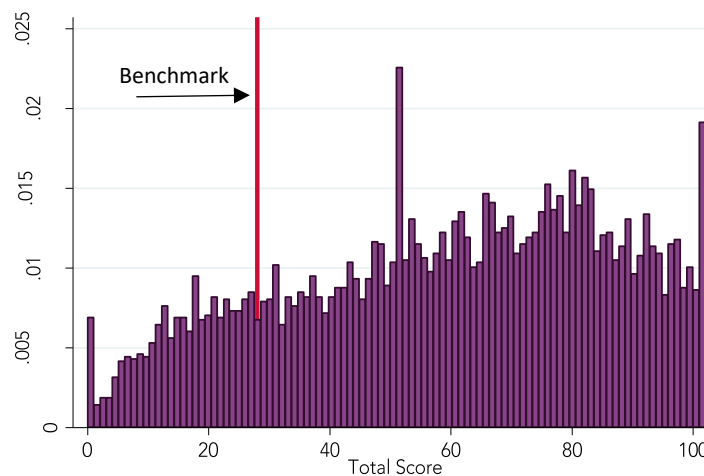### Figure A1. PALS Subscale Score Distributions

Figure A2 indicates that when students' scores are summed across the six subscales, the distribution of scores is more normally distributed than any of the individual subscale scores on their own.

Figure A2: Total PALS Score Distribution

We estimate a linear probability model to predict the probability that a student who attends MMSD 4K goes on to meet the kindergarten PALS benchmark. The coefficients from this model indicate the average change in probability of meeting the PALS benchmark after accounting for differences in other student characteristics. We display pooled results across cohorts and present results by year of kindergarten entry (Figure B1).

Attending MMSD 4K is associated with a four percentage point increase in the probability of meeting the PALS benchmark, all else equal. African American and Latinx students are 6 and 13 percentage points less likely to meet the PALS benchmark, adjusting for other characteristics. Asian students are not significantly more or less likely to meet the PALS benchmark than non-Hispanic white students, all else equal.

Consistent with results for average scores discussed earlier in this brief, we find that children of parents with less than a high school education are less likely to meet or exceed the PALS Kindergarten benchmark than children of parents who completed high school; while children of parents who had a college or graduate degree are appreciably more likely than children of high school graduates to meet or exceed the benchmark. Students from low-income households are ten percentage points less likely to meet the PALS benchmark than children from medium- or high-income households.

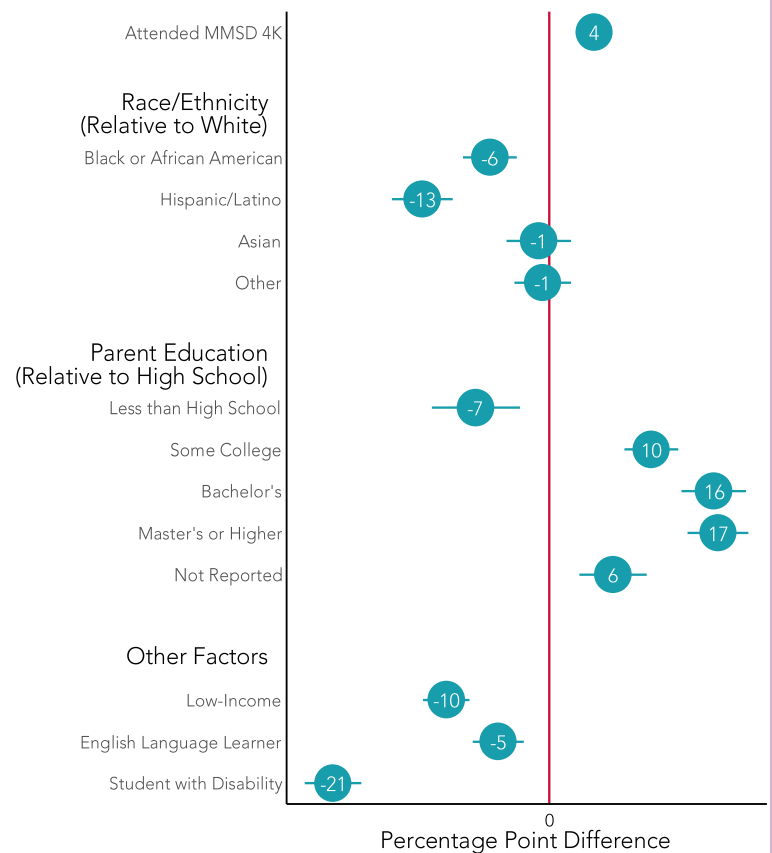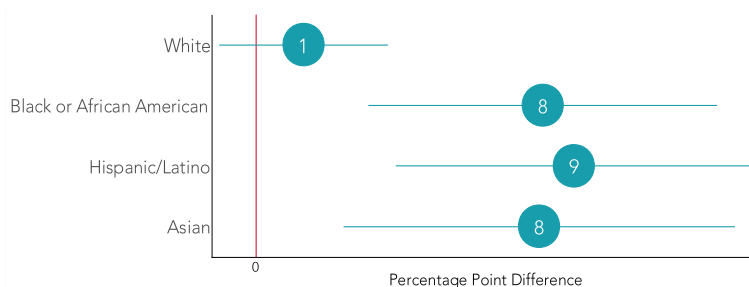**Figure B1. Probability of Meeting PALS Benchmark**

Figure B2: Probability of Reaching PALS Benchmark for 4K Attendees over Non-Attendees, by Race and Ethnicity

The association between 4K enrollment and the probability of meeting or exceeding the PALS benchmark varies by race/ethnicity and socioeconomic background, with 4K more strongly associated with adequate early literacy skills for less advantaged students than for more advantaged students. Figure B2 shows that the probability of meeting the PALS benchmark is about the same for white non-Hispanic children who do and do not enroll in 4K, while other children that participate in 4K enjoy an eight to nine percentage point advantage in their probability of meeting the fall Kindergarten PALS benchmark than otherwise similar (same race) children who do not enroll in 4K.

Likewise, Figure B3 suggests that students from low-income households that participate in 4K are eight percentage points more likely to meet the Fall Kindergarten PALS benchmark than low-income children who do not enroll in 4K. Finally, Figure B4 shows difference in the association between enrollment in 4K and meeting the 5K PALS benchmark by level of parental education. Consistent with results presented in the main body of this brief, we find that 4K children of parents with some college education or less are more likely to meet the PALS benchmark than otherwise similar non-enrolled children of parents with similar educational attainment. On the other hand, children of college-educated parents who enroll in 4K are about as likely to meet the fall kindergarten PALS benchmark as otherwise similar children who do not enroll in 4K.

Figure B3: Probability of Reaching PALS Benchmark for 4K Attendees over Non-Attendees, by Family Income
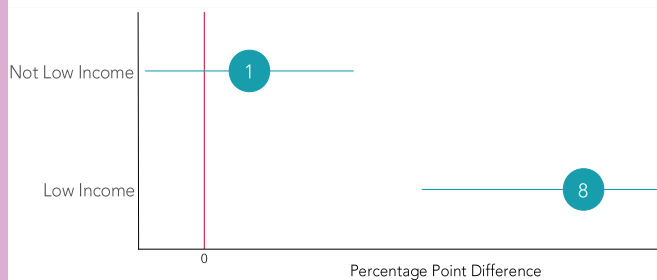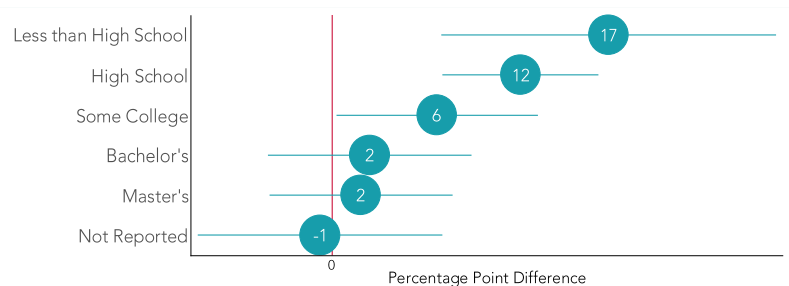

Figure B4: Probability of Reaching PALS Benchmark for 4K Attendees over Non-Attendees, by Parental Education

Kindergarteners in Spanish Dual Language Immersion or Developmental Bilingual Education classrooms in the 2015-2016 and 2016-2017 school years were offered Spanish language versions of the PALS assessment. Kindergarteners in prior years did not have this option. About 730 students took a Spanish version of a PALS subtest in the two most recent school years. The comparability of the Spanish and English versions of PALS sum of subscale scores is problematic because Spanish language test takers have more possible points to earn than English test takers. Our solution was to separate English and Spanish results, reporting on English results only in the main text of this report. Here, we report estimates based on the combined English and Spanish language PALS results. These results are essentially identical to the results presented in the main body of this report.

Figure C2: Percentile Rank Difference in PALS Score (Spanish Language Scores Included)
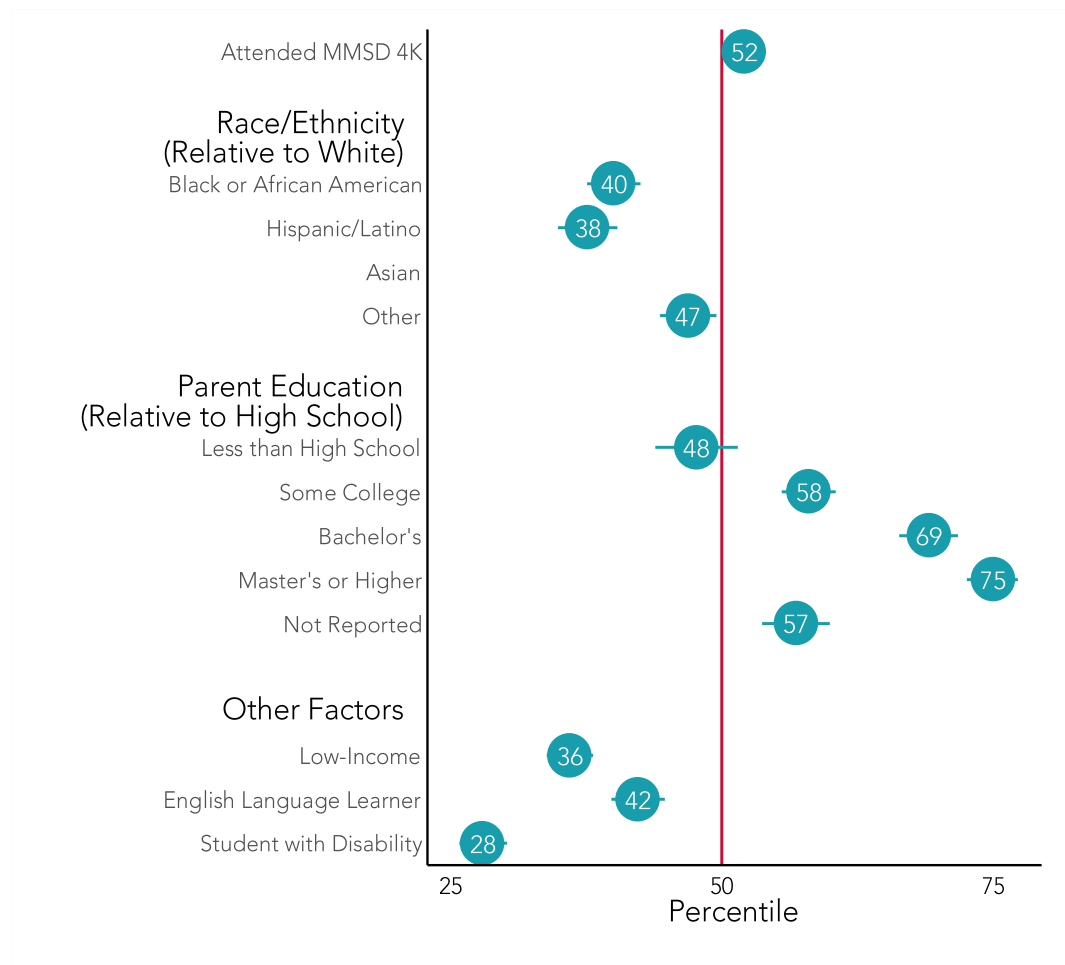
Appendix D: Socioemotional Learning Measures

Our measures of socioemotional learning (SEL) are from children's report cards in their second term of kindergarten. Though it would be preferable to report from earlier in the year, teachers do not report on these items in the first term of school. MMSD report cards include the 13 items we use under the heading "Child as Learner." Table D1 displays results from a principle components factor analysis of the 13 SEL items. The first two principal components have eigenvalues greater than one and capture 65% of the variance in item responses for the sample, while the next four components explain only 17% of the remaining variance. Therefore, we proceed by using two principal components in our analyses.

Table D1. Principal Components Analysis

Component	Eigenvalue	Difference	Proportion
1	7.02	5.62	0.54
2	1.40	0.58	0.11
3	0.82	0.22	0.06
4	0.60	0.15	0.05
5	0.45	0.05	0.03
6	0.40	-	0.03

N=8,219

Next, we use varimax rotation to score each factor. In this type of analysis, a larger factor loading indicates that the factor in question better explains variation in an item compared to other factors. Bolded results in Table D2 indicate that seven items load more highly on Factor 1, which we label *Prosocial Classroom Behavior* and six items load more highly on Factor 2, which we label *Classroom Effort*. Two items, "Listening Skills" and "Oral Directions", load similarly on both factors, but the loadings are slightly larger for Factor 1 than for Factor 2.

Table D2. Rotated Factor Results

Item	Factor 1	Factor 2	Uniqueness
Responsibility for Behavior	**0.72**	0.30	0.39
Listening Skills	**0.56**	**0.51**	0.42
Self-Control	**0.68**	0.37	0.41
Oral Directions	**0.55**	**0.53**	0.41
Respect for Others	**0.75**	0.19	0.39
Solving conflicts	**0.74**	0.28	0.37
Cooperation	**0.74**	0.28	0.37
Completing Assignments	0.20	**0.79**	0.33
Organization Skills	0.28	**0.75**	0.35
Participation	0.39	**0.50**	0.60
Persistence	0.29	**0.76**	0.33
Positive Risks	0.34	**0.50**	0.63
Independence	0.35	**0.69**	0.40

Rotation Method: Varimax. Bolded cells denote values over 0.40.

Given these results, we construct two scales by averaging students' scores across items within each scale. The *Prosocial Classroom Behavior* scale (alpha = .90) measures students' interactions in the classroom that are conducive to socialization and learning. The scale consists of seven items: Accepts responsibility for behavior; Demonstrates listening skills; Demonstrates self-control; Follows oral directions; Respects rights, diversity and feelings of others; Solves conflicts appropriately; Works cooperatively with others. The *Classroom Effort* scale (alpha = .87) measures the degree to which students are persistent, self-disciplined and exhibit a desire to learn. The scale consists of six items: Completes assignments on time; Organizes materials and time; Participates in classroom activities; Persists in tasks until completion; Takes positive risks in learning and social situations; Works independently.

Association or relationship of variables: Two variables can said to be associated or have a relationship when it appears that a change in one variable may be related to a change in the other variable. For example, if patterns in the data show that a change in 4K site type attended corresponds to a change in literacy scores on PALS tests for a certain group of students.

- *Caution:* When variables show a statistically significant relationship it does not necessarily mean there is a <u>causal</u> relationship. This relationship may still occur due to sampling error or because of the influence of other unmeasured circumstances or variables.

Coefficients: Represent the average change in an outcome variable (Y) expected for a one unit of change in a predictor variable (X), holding all other predictors in the model constant. For example, the average change in probability of a student meeting the PALS benchmark (Y) given enrollment in 4K (X), taking into account all other student and family characteristics.

Descriptive analysis: A statistical summary of patterns of associations among variables, such as program type and PALS scores, which does not identify causal relationships, but can serve to identify potential causal relationships for further analysis.

Factor analysis: A statistical method used to analyze relationships among a set of measures to identify groups of variables that reflect a common underlying phenomenon.

Kindergarten readiness: A test of skills children need to successfully transition into and through kindergarten. Some commonly used dimensions of kindergarten readiness are early literacy skills, math skills, social skills and motor skills. In this report, we have chosen to focus on components of which we have access to measurement data - basic literacy and social skills.

Linear probability model: A statistical model that predicts the association between a set of variables and the probability of an event. One example from this brief is the model of the relationship between participating in 4K and a student being rated by the teachers as engaging in classroom effort most of the time.

Longitudinal data system: A data system unified by a common element and collected over a long period of time. In this report, we use data from a state data system that collects scores from 4K literacy tests (the common element) over a series of years in multiple schools and multiple districts.

Ordinary least squares regression (OLS): A statistical method for estimating the strength of a relationship, or accuracy of the prediction of the relationship, between two variables. Using OLS can help minimize the amount of error in statistical predictions.

Pooled Data: In this report, we use pooled student data by combining data from students across years of kindergarten enrollment and perform analyses as though the year of kindergarten enrollment were the same.

Psychometric evaluations: Psychometric tests or evaluation tools are standardized tests that are designed to measure a person's mental capabilities or aptitude or behaviors.

Subset: A subset of data is a category of data which describes a particular group of data within the entire data set. For example, from the entire population of students enrolled in MMSD 4K, African American student scores can be analyzed as a *subset* of the whole population.

Temporal coverage: Refers to the time-period during which data was collected or observations were made.

Variation: Variation in data describes how far or close to the mean, or average, a particular data point falls. For example, variation can be used to describe how clustered or spread out student scores are from the average score.

Varimax rotation: A type of factor analysis used to simplify the identification of latent variables into just a few categories of latent variables, commonly referred to as "components" in factor analysis. Egin values are used to determine if results from this analysis pass a sufficient statistical threshold.