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February 22, 2024 **Efficacy Research**

COMPARING 2023 FAST MATH SCORES FOR MATH NATION AND NON-MATH NATION SCHOOLS IN FLORIDA

Background

The current report focuses on evidence that the Math Nation program is effective at raising 6th – 8th grade student achievement on the math Florida Assessment of Student Thinking (FAST) test in Florida. We used a post-facto quasi-experimental design (QED) with a matched control group to evaluate potential associations between Math Nation usage and FAST match achievement for 6th – 8th graders in Florida. QEDs with matching attempt to overcome the barriers of "non-random" assignment. In this case, the schools that chose to use Math Nation may be different in some ways (e.g., serve different student populations) than the schools that chose to not use Math Nation during the 2022-2023 school year.

Our main analyses focus on whether schools using Math Nation outperformed non-Math Nation schools on the math section of the FAST, as evidenced by average scores and proficiency rates. Follow-up analyses focused on grade-level findings.

Results

To examine the impact of Math Nation on FAST math performance, we compared FAST math performance in schools using Math Nation compared to schools using other math programs. To examine the effectiveness of Math Nation to increase FAST passing rates, we conducted multiple regression analyses using structural equation modeling. Our main analysis compared FAST math performance in 6th – 8th grade in Math Nation schools versus non-Math Nation schools in a matched sample that included 111 schools. Secondary analyses compared performance at each grade level. Our 6th grade matched sample included 24 schools. Our 7th grade matched sample included 63 schools. Lastly, our 8th grade matched sample included 25 schools.

Combined Sample

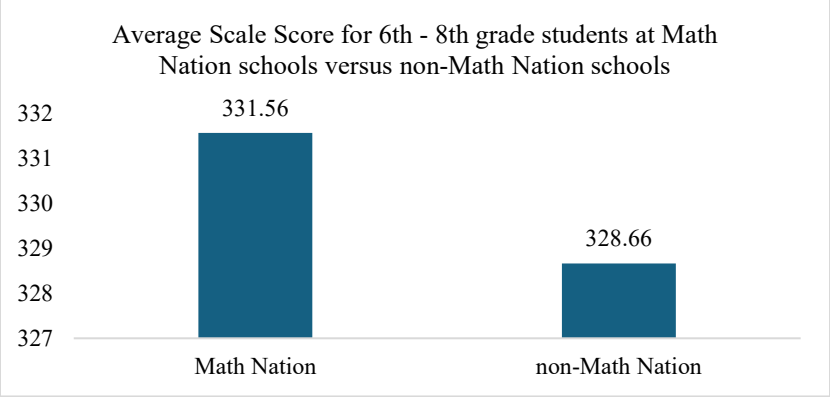

Figure 1

The main effect of Math Nation on average scale scores was significant (non-Math Nation: M = 328.66, SD = 12.24; Math Nation: M = 331.56, SD = 11.60; b = 0.03, p = 0.04, d = 0.24) (see Figure 1). Schools using Math Nation had a 2.9-point increase in average scale scores on the math FAST compared to non-

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Math Nation schools, and a 2.87-point increase compared to the statewide average (State: M = 328.69, SD = 15.43; t(1555) = 1.92, p = 0.06, d = 0.19). Math Nation usage also significantly increased Level 5 proficiency rates by 2.6% (non-Math Nation: M = 9.88%, SD = 9.03%; Math Nation: M = 12.48%, SD = 10.54%; b = 0.02, p = 0.04, d = 0.27). See Figure 2.

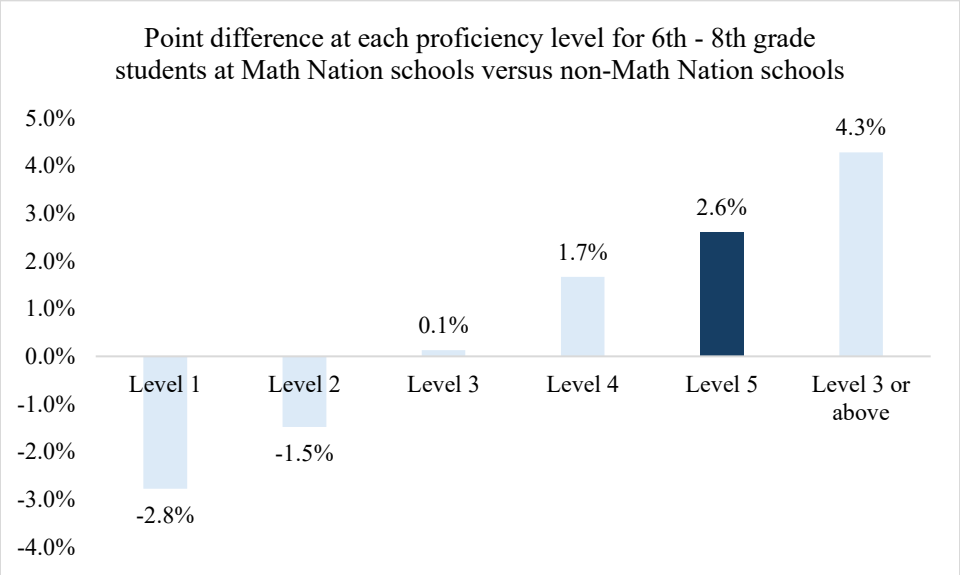

Figure 2
Note: Dark blue bars indicate significant findings, p < .05

Sixth Grade

In 6th grade, the main effect of Math Nation was not significant. Math Nation schools had slightly increased percentages of students reaching Level 3 (Math Nation: M = 24.08%, SD = 6.11%; non-Math Nation: M = 22.96%, SD = 6.25%) and Level 5 (Math Nation: M = 11.52%, SD = 10.09%; non-Math Nation: M = 10.96%, SD = 11.58%), however, these differences were not statistically significant. However, schools using Math Nation had significantly higher percentages of students reaching the Level 3 (Math Nation: M = 24.08%, SD = 6.11%; Statewide: M = 21.97%, SD = 9.41; t(1456) = 2.32, p = 0.002, d = .27)

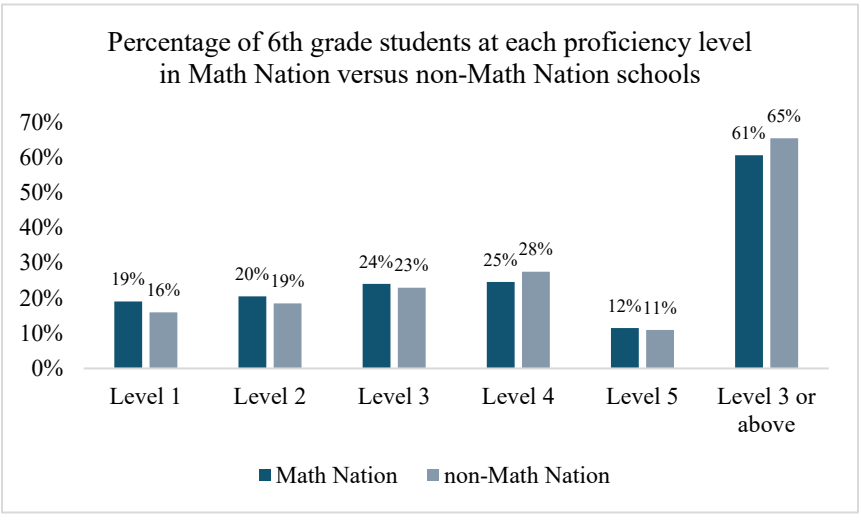

Figure 3

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and Level 4 proficiency rates (Math Nation: M = 24.58%, SD = 9.42%; Statewide: M = 21.80%, SD = 12.76%; t(1456) = 2.25, p = 0.02, d = 0.25) compared to the statewide averages.

Schools using Math Nation had 2.11% more students scoring at the Level 3 proficiency rate, and 2.78% more students scoring at the Level 4 proficiency rate compared to the statewide average. Although non-Math Nation schools also had slightly higher percentage of students reaching the Levels 3 (M = 22.96%, SD = 6.25%, t(1369) = 0.51, p = 0.61, d = 0.12) and Level 5 proficiency rates (M = 10.96%, SD = 11.58%, t(1369) = 0.76, p = 0.45, d = 0.19) compared to the statewide averages, the increase was not significant.

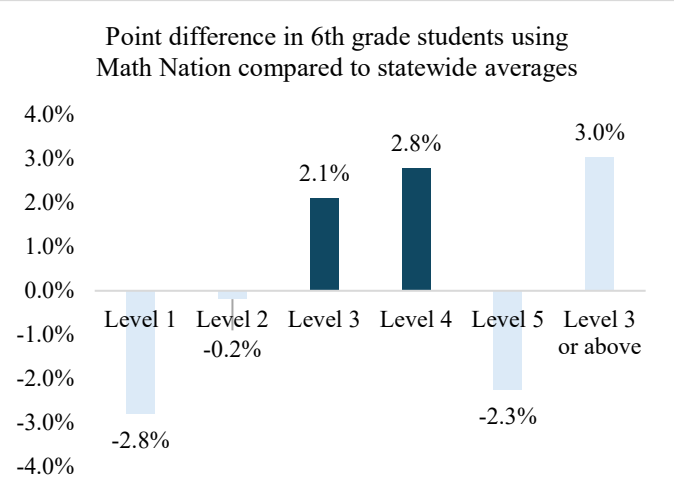

Figure 4
Note: Dark blue bars indicate significant findings, p < .05

Seventh Grade

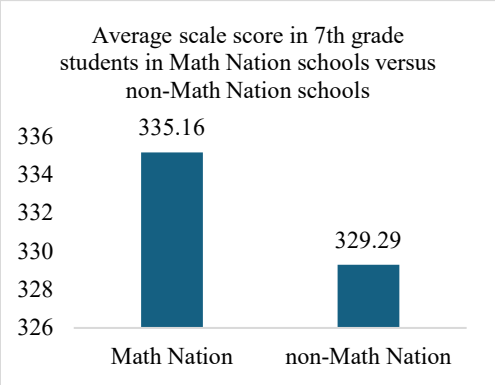

Figure 5

In 7th grade, the main effect of Math Nation on average scale scores and all proficiency rates except Level 3 and Level 4 were significant at the .05 level. Additionally, the main effect of Math Nation on the number of students reaching the Level 4 proficiency rate was marginally significant (p = 0.06). Effect sizes for all tests ranged from 0.38-0.46. See Table 1.

Notably, 7th graders at schools using Math Nation scored nearly 6 points higher than 7th graders at schools that did not use Math Nation (see Figure 5). Additionally, schools using Math Nation had 6.11% and 3.25% less students at the Levels 1 and 2 proficiency levels, respectively. Conversely, schools using Math Nation had more students achieving higher proficiency levels, with 3.38% more 7th grade students at the Level 4 proficiency level, and 5.90% more students at the Level 5 proficiency level. Math Nation schools had nearly 10% more students at Level 3 or above. Finally, Math Nation schools had significantly more 7th grade students achieving Level 5 proficiency (M = 15.06%, SD = 14.58%) than the statewide average (M = 6.63%, SD = 10.30%), t(1212) = 6.17, p < .0001, d = 0.67. Notably, this effect was coupled with a high effect size (d = 0.67). Although non-Math Nation schools also had more students achieving Level 5 (M = 9.16%, SD = 11.63%) than the statewide average, the increase was not significant: t(1212) = 1.89, p = 0.06, d = 0.23.

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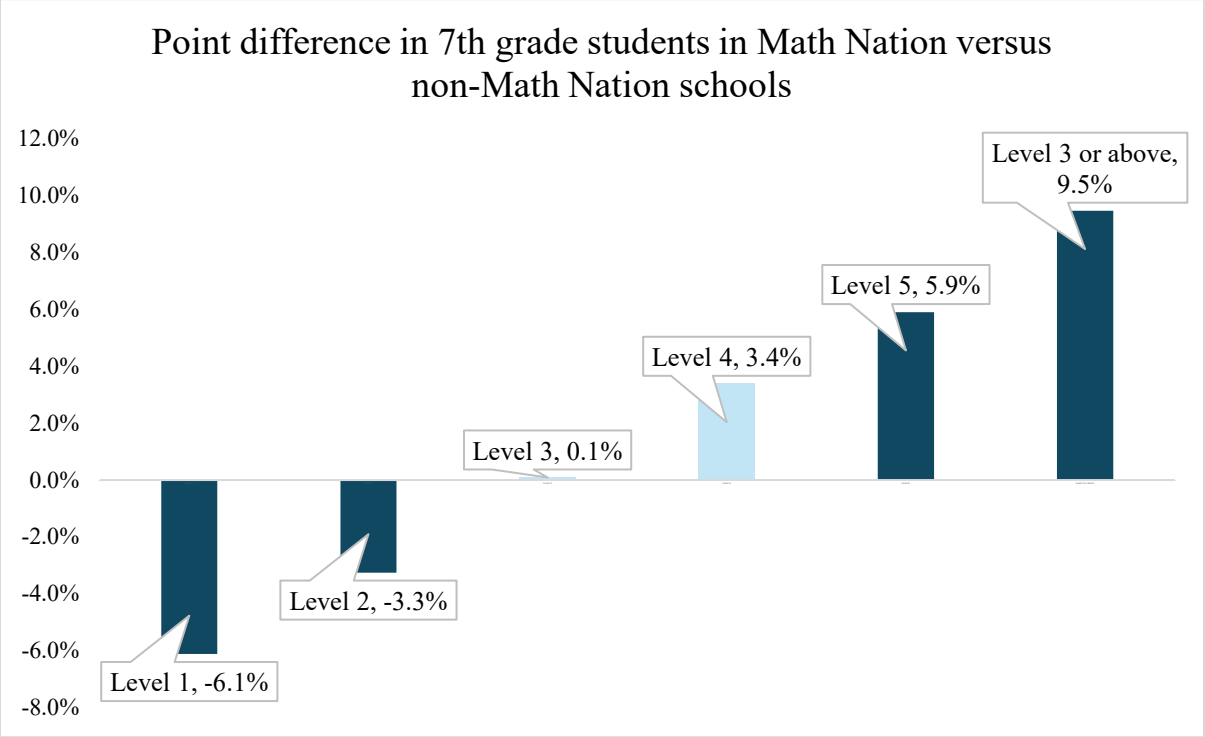

Figure 6
Note: Dark blue bars indicate significant findings, $p < .05$

Table 1. *Comparison of matched Math Nation and non-Math Nation 7th grade performance*

	Math Nation *Mean (SD)*	**Non-Math Nation** *Mean (SD)*	**Mean Difference**	**β**	**p-value**	**Effect size**
Average Scale Score	335.16 (12.40)	329.29 (13.22)	5.87	0.06	0.01	0.46
Level 1	18.83% (14.05%)	24.94% (16.21%)	-6.11%	-0.04	0.03	0.40
Level 2	17.97% (7.77%)	21.22% (9.34%)	-3.25%	-0.03	0.04	0.38
Level 3	27.41% (8.05%)	27.32% (9.84%)	0.10%	-0.01	0.57	0.01
Level 4	20.70% (9.32%)	17.32% (13.32%)	3.38%	0.03	0.06	0.29
Level 5	15.06% (14.58%)	9.16% (11.63%)	5.90%	0.05	0.01	0.45
Level 3 or above	63.22% (20.22%)	53.76% (24.14%)	9.46%	0.06	0.02	0.42

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Eighth Grade

In 8th grade, the main effect of Math Nation was not significant. Schools using Math Nation had slightly higher scale scores (Math Nation: M = 328.24, SD = 10.15; non-Math Nation: M = 326.80, SD = 11.93), however, the difference was not statistically significant. Similarly, Math Nation schools had lower percentages of students scoring at the Level 1 (Math Nation: M = 19.68%, SD = 10.93%; non-Math Nation: M = 21.48%, SD = 13.87%) and Level 2 proficiency rates (Math Nation: M = 21.28%, SD = 8.36%; non-Math Nation: M = 22.52%, SD = 7.95%), however, the difference was not significant. Similarly, Math Nation schools had increased percentages of students reaching the Level 4 proficiency rates (Math Nation: M = 23.72%, SD = 10.18%, non-Math Nation: M = 21.64%, SD = 9.87%) and increase students at Level 3 or above (Math Nation: M = 59.08%, SD = 17.96%; non-Math Nation: M = 56.04%, SD = 20.18), though the increase was not significant.

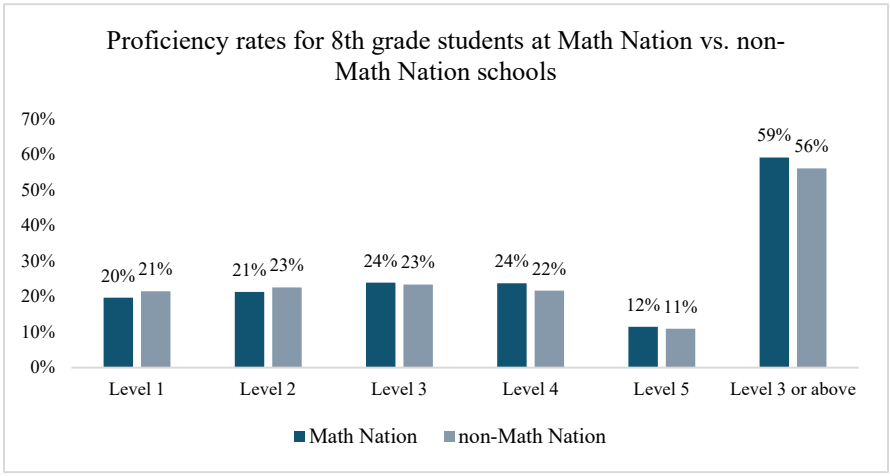

Figure 7

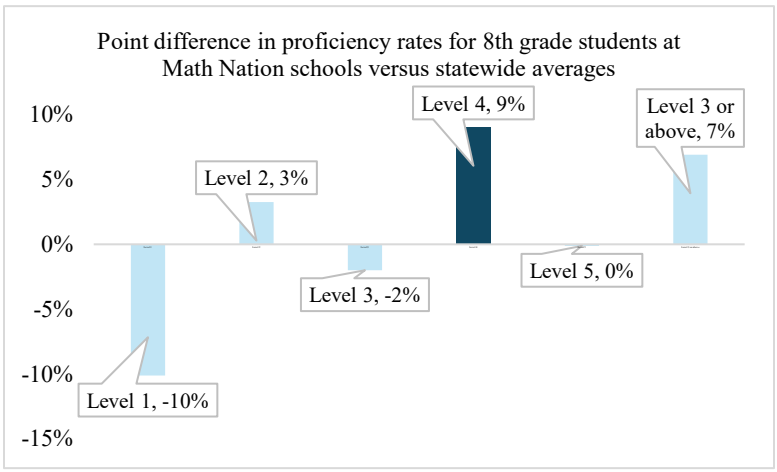

Figure 8
Note: Dark blue bars indicate significant findings, p < .05

However, Math Nation schools had significantly more students reaching Level 4 proficiency than the state average (Math Nation: M = 18.90%, SD = 7.82%; Statewide: M = 14.70%, SD = 9.43%): t(1181) = 2.21, p = 0.03, d = 0.48. See Figure 7.

Conclusions

This report provides evidence that schools that used Math Nation in the 2022-2023 school year had higher math achievement in 6th-8th grade. Schools that used Math Nation had significantly higher scores and significantly higher percentages of students achieving Level 5 proficiency.

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Specifically, Math Nation schools scored 2.90 points higher and had 2.60% more students who achieved Level 5 proficiency. Differences were also seen among each grade level. In 6th grade, schools using Math Nation had 2.11% more students scoring at the Level 3 proficiency level, and 2.78% more students scoring at the Level 4 proficiency level compared to the statewide average. The effects of Math Nation were particularly robust for 7th grade students. Specifically, schools that used Math Nation in 7th grade scored had a significant 6-point increase in scores, had significantly less students at Levels 1 and 2, and nearly 6% more students achieving the Level 5 proficiency. Moreover, almost 10% more 7th grade students achieved Level 3 or higher when using Math Nation, compared to their non-Math Nation peers. Effect sizes were medium to large based on field standards. Lastly, 8th grade students using Math Nation had 4% more students achieving Level 4 proficiency when compared to the statewide average, representing a significant increase. Taken together, these findings provide consistent support for the effectiveness of Math Nation.

Methods

Data Source

Data for this study came from two sources. First, schools that used Math Nation for the 2022-2023 school year were identified through the Math Nation analytics platform. Within the analytics reports, we used the unique number of videos watched and number of logins per student as a metric of use. If a school demonstrated at least 5 videos watched or logins per student, they were considered a Math Nation school. The usage criteria was determined from a previous internal study which demonstrated that when a school uses the platform 5 or more times in a given grade, this eliminated over 90% of cases that were out of grade level usage, thus ensuring that schools were appropriately included.

Second, school demographic data and school performance on the math FAST were accessed through the official Florida Department of Education (DoE) data website. We used the Florida Assessment of Student Thinking (FAST) spring 2023 results. We used average scale scores on the math section and the percentages of students who reached each proficiency level as a measure of math achievement. To control for previous year achievement on the math standardized test, we downloaded 2021-2022 school performance on the math Florida Standards Assessment (FSA) from the official Florida DoE data website.

We also downloaded 2022-2023 enrollment data, including enrollment by race/ethnicity, total enrollment, and enrollment of special populations including economically disadvantaged students, students with individualized learning plans (IEP), and English language learners. All count data was converted to percentage data by school (e.g., number of economically disadvantaged students/total number of students in a school). These variables were used to match Math Nation and non-Math Nation schools (see participants section below for details on matching).

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Participants

During the 2022-2023 school year, the overall number of public schools in Florida that used Math Nation in 6th-8th grade was 340. Math Nation is also used by numerous private and parochial schools in Florida. Overall, 1445 regular and/or public charter 6th – 8th grade schools may have contributed to the 2023 FAST data. There was missingness in all publicly available state files (see Missing Data section below); this number is the number of schools who submitted data but not necessarily scores.

Planned Analyses

We used Structural Equation Model (SEM) regression to determine if there were significant differences in scores of schools who used Math Nation and those who used other math programs using the Lavaan SEM package in R. We chose this analytic approach because the Lavaan SEM package includes estimation with full information maximum likelihood (FIML) to handle missing data. As a measure of privacy, state data does not include a numeric value for any variable where less than 10 students contributed data. FIML procedures to handle missing data estimation ensure that in the final analysis where we include covariates, the estimation is not biased. We describe how we address missing data in the sections below. Second, SEM allows us to investigate the direct and indirect relationships among variables in a complex system. This allows us to explore and uncover complex connections and interactions between different factors, including covariates which may impact math performance. As a stringent test of the effects Math Nation, we include multiple covariates in all analyses including baseline 2022 FSA math average scores, school size, percent of economically disadvantaged students, percent of Black/African American students, percent of Asian students, and the percent of Latino/Hispanic students.

Missing Data

As a measure of privacy, state data does not include a numeric value for any variable where less than 10 students contributed data. This led to missing data (by design—this means that we know what caused the missingness) with variables that included fewer than 10 students not reporting numbers. To account for missing data in the covariates, we used multiple imputation by chained equations (MICE). We use the 'mice' package in R (5 imputations, 20 iterations per imputation). Baseline math scores, race/ethnicity percentages, ELL percentages, and school sized were used in both matching analyses.

Matching

To match schools based on the data available from the Florida DoE data website, we matched as closely as possible across 16 school demographic and achievement variables including 2022 FSA math scores, school size, the percent of students that were classified as economically disadvantaged, the percent of ELL students, and the percent of students in a school across race/ethnicity categories (i.e., Asian, Black/African American, Hispanic/Latinx, White/Caucasian, and Two or more race/ethnicities).

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We used the "Match-it" package in R with Mahalanobis Distance matching. Mahalanobis Distance is designed to consider the multivariate space between numerous covariates when matching. Specifically, rather than propensity scores, Mahalanobis Distance (Gu & Rosenbaum, 1993) is used as the distance metric, and it is considered both more robust to multiple covariate usage and to correlated covariates. Finally, using Mahalanobis distance in Match-it has the added benefit wherein one can prespecify an allowable multivariate distance between matched school pairs. In this case, we used a multivariate distance of 0.10. By setting a pre-specified distance, the program will not return school pairs that are too dissimilar to a degree outside this distance. For all covariate variables (the variables used for matching) including baseline math performance, there were no significant differences between matched groups.

Baseline Equivalences

All analyses were conducted in R-studio. For all covariate variables (the variables used for matching) including baseline science performance, there are no significant differences between matched groups (see Tables 2-5). However, the WWC standards require that baseline differences greater than 0.05 must be controlled for statistically. Following the advice of Stuart, 2010, we include all covariates (apart from collinear variables, please see below) in the final analyses as a complementary approach to matching, and a more stringent test of effects. This also satisfies the WWC standard as several variables had effect sizes greater than or equal to 0.05.

Table 2. *Baseline comparison of matched Math Nation and non-Math Nation schools*

Variables	**Math Nation** *Mean (SD)*	**Non-Math Nation** *Mean (SD)*	**t-value**	**p-value**	**Effect size**
Baseline 2022 Math proficiency	324.53 (32.84)	326.37 (12.24)	0.55	0.58	0.07
School Size	858 (388)	791 (436)	1.21	0.23	0.16
Percent English language learner students	5.28% (8.13%)	4.64% (6.99%)	0.62	0.53	0.08
Percent of students receiving free/reduced lunch	69.53% (28.63%)	69.65% (31.55%)	0.03	0.98	0.004
Percent White/Caucasian students	40.75% (27.28%)	45.80% (27.81%)	1.36	0.17	0.18
Percent Black/African American students	15.37% (17.76%)	15.81% (19.59%)	0.17	0.86	0.02
Percent Asian students	2.09% (1.53%)	1.53% (4.68%)	0.86	0.39	0.12

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Table 3. *Baseline Comparison of matched Math Nation and non-Math Nation 6th grade students*

Variables	Math Nation *Mean (SD)*	Non-Math Nation *Mean (SD)*	t-value	p-value	Effect size
Baseline 2022 Math proficiency	326.5 (9.37)	327.83 (9.42)	0.49	0.63	0.14
School Size	977 (276)	1006 (267)	0.37	0.71	0.11
6th Grade Enrollment	329 (106)	322 (109)	0.21	0.83	0.06
7th Grade Enrollment	309 (105)	305 (114)	0.13	0.89	0.04
8th Grade Enrollment	306 (105)	306 (122)	0.004	0.99	0.001
9th Grade Enrollment	0	0	-	-	-
10th Grade Enrollment	0	0	-	-	-
11th Grade Enrollment	0	0	-	-	-
12th Grade Enrollment	0	0	-	-	-
Percent English language learner students	4.33% (3.26%)	3.65% (3.03%)	0.75	0.46	0.22
Percent of students receiving free/reduced lunch	0.07% (0.04%)	0.07% (0.05%)	0.18	0.86	0.05
Percent White/Caucasian students	43.69% (21.01%)	45.79% (20.55%)	0.35	0.73	0.10
Percent Black/African American students	16.36% (9.23%)	15.62% (15.55%)	0.20	0.84	0.06
Percent Asian students	2.39% (4.82%)	2.16% (2.39%)	0.21	0.84	0.06
Percent Latino/Hispanic students	30.90% (20.90%)	30.23% (21.45%)	0.11	0.91	0.03
Percent 'Two or more races/ethnicities' students	4.13% (2.30%)	3.13% (2.95%)	0.003	0.99	0.0008

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Table 4. *Baseline Comparison of matched Math Nation and non-Math Nation 7th grade students*

	Math Nation *Mean (SD)*	**Non-Math Nation** *Mean (SD)*	**t-value**	**p-value**	**Effect size**
Baseline 2022 Math Proficiency	331.83 (9.07)	329.90 (11.26)	1.05	0.29	0.19
School Size	890 (316)	827 (330)	1.08	0.28	0.19
6th Grade Enrollment	264 (133)	245 (141)	0.78	0.44	0.14
7th Grade Enrollment	255 (126)	235 (137)	0.88	0.38	0.16
8th Grade Enrollment	260 (131)	242 (143)	0.74	0.46	0.13
9th Grade Enrollment	12 (40)	11 (37)	0.09	0.93	0.02
10th Grade Enrollment	11 (37)	10 (35)	0.09	0.93	0.02
11th Grade Enrollment	10 (32)	9 (30)	0.12	0.90	0.02
12th Grade Enrollment	9 (30)	8 (27)	0.25	0.81	0.04
Percent English language learners	4.91% (4.95%)	5.07% (4.13%)	0.20	0.84	0.04
Percent of students receiving free/reduced lunch	65.83% (26.71%)	70.20% (29.68%)	0.87	0.39	0.16
Percent White/Caucasian students	46.84% (25.47%)	44.78% (24.72%)	0.46	0.65	0.08
Percent Black/African American students	14.64% (15.75%	16.27% (15.76%)	0.58	0.56	0.10
Percent Latino/Hispanic students	27.00% (20.41%)	26.95% (23.48%)	0.01	0.99	0.002
Percent Asian students	3.03% (7.05%)	2.81% (6.10%)	0.18	0.85	0.03
Percent 'Two or more races/ethnicities' students	3.40% (2.99%)	3.45% (3.25%)	0.08	0.93	0.02

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Table 5. *Baseline Comparison of matched Math Nation and non-Math Nation 8th grade students*

	Math Nation *Mean (SD)*	**Non-Math Nation** *Mean (SD)*	**t-value**	**p-value**	**Effect size**
Baseline 2022 Math Proficiency	329.24 (11.47)	329.20 (11.20)	0.01	0.99	0.004
School Size	970 (272)	918 (261)	0.70	0.50	0.20
6th Grade Enrollment	320 (112)	302 (113)	0.58	0.57	0.16
7th Grade Enrollment	302 (110)	286 (111)	0.51	0.61	0.14
8th Grade Enrollment	299 (109)	287 (106)	0.40	0.69	0.11
9th Grade Enrollment	0	0	-	-	-
10th Grade Enrollment	0	0	-	-	-
11th Grade Enrollment	0	0	-	-	-
12th Grade Enrollment	0	0	-	-	-
Percent English language learners	4.82% (3.67%)	5.20% (4.90%)	0.31	0.76	0.09
Percent of students receiving free/reduced lunch	0.07% (0.04%)	0.07% (0.05%)	0.33	0.74	0.09
Percent White/Caucasian students	43.51% (20.59%)	43.03% (23.19%)	0.08	0.94	0.02
Percent Black/African American students	16.48% (9.06%)	16.49% (16.10%)	0.002	0.99	0.0004
Percent Latino/Hispanic students	30.97% (20.46%)	32.12% (24.18%)	0.18	0.86	0.05
Percent Asian students	2.29% (4.74%	1.71% (2.88%)	0.53	0.60	0.15
Percent 'Two or more races/ethnicities' students	4.07% (2.27%	3.78% (3.43%)	0.35	0.73	0.10

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