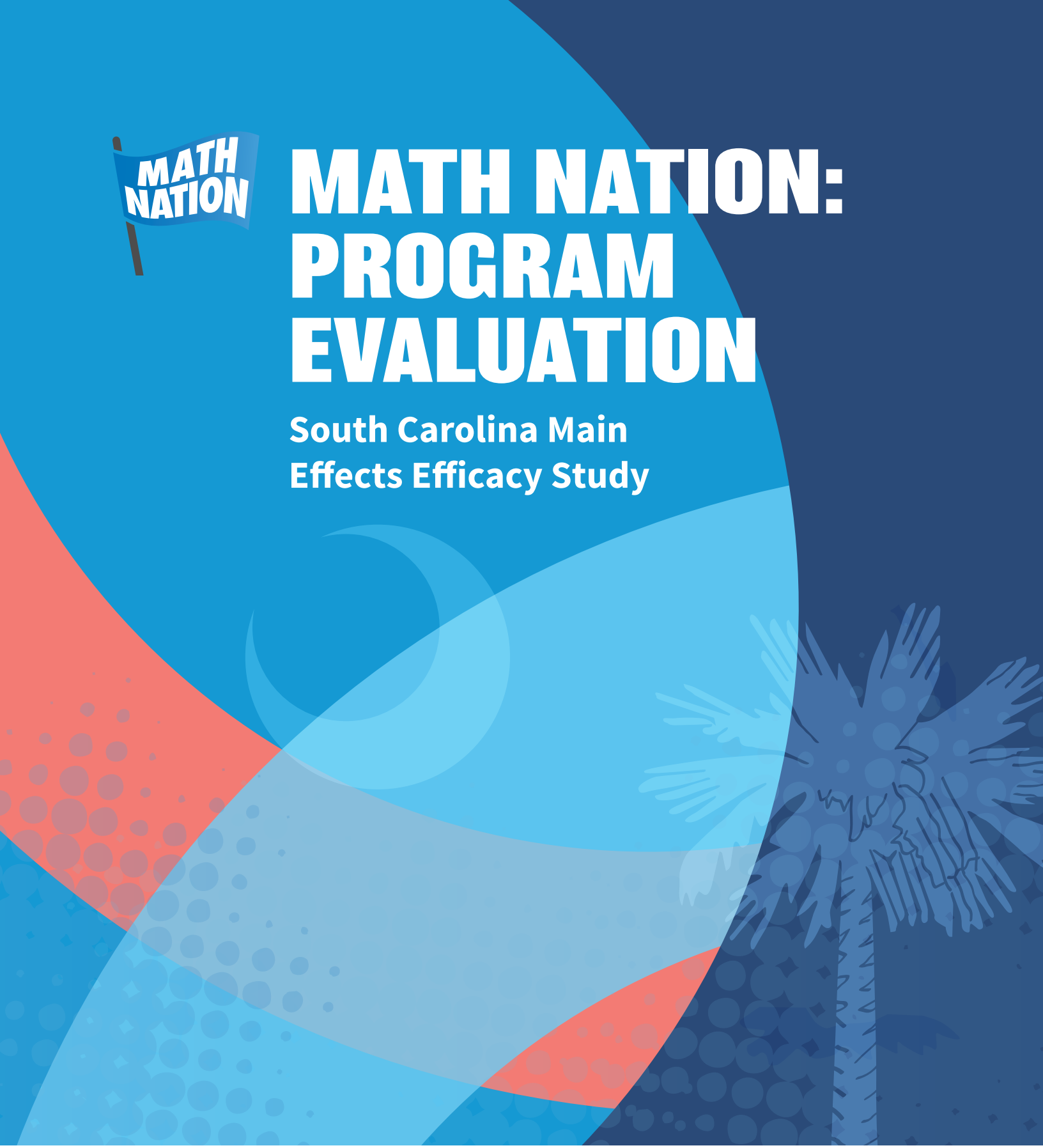
MATH NATION: PROGRAM EVALUATION

South Carolina Main Effects Efficacy Study



AccelerateLEARNING
THE LEADER in STEM EDUCATION

FEBRUARY 2025

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

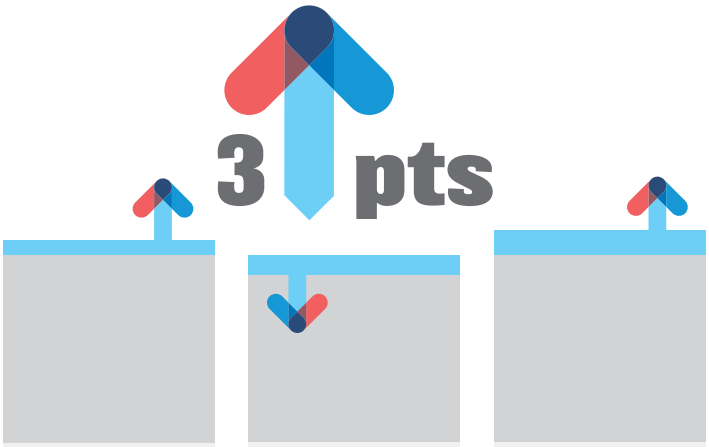
EXECUTIVE SUMMARY

This report presents the evidence that the Math Nation program is effective at raising student achievement on the End-of-Course (EOC) Algebra exam in South Carolina. We used a post facto quasi-experimental design (QED) with a matched control group to evaluate potential associations between Math Nation usage and EOC achievement for algebra students in South Carolina. QEDs with matching attempt to overcome the barriers of "non-random" assignment. The report presents four rigorous studies using diverse methodologies that provide strong evidence of the curriculum's effectiveness in improving student and school achievement while demonstrating its equity in serving a diverse student population.

Study 1: How does Math Nation usage impact math achievement?

Study 1 examines if schools using Math Nation outperformed non-Math Nation schools in Algebra End-of-Course (EOC) exams. To do this, we compared test scores from 120 schools—some that used Math Nation and some that did not. Schools were matched on key variables, such as school size, previous EOC math performance, and demographic factors to ensure the Math Nation and non-Math Nation schools included in the study were as similar as possible. Similarity is important to ensure a fair comparison; we want to make sure that the only real difference between the groups is the factor that we are specifically interested in. In other words, we want to ensure that any difference between Math Nation and non-Math Nation schools are due to Math Nation itself, rather than pre-existing differences between the two groups.

Our analysis showed that **students in Math Nation schools scored almost 3 points higher on average than those in schools using other math programs**. Moreover, in Math Nation schools also had:



4% more students reached the highest proficiency level (Level A).

6% fewer students fell into the lowest proficiency level (Level F).

7% more students met the state proficiency benchmark (Level A or B).

Study 2: How does the impact of curriculum usage differ across student subgroups?

Study 2 focuses on performance differences among subgroups of students at Math Nation schools compared to non-Math Nation schools.

For **Black/African American students,** Math Nation had a strong impact:

- Average test scores were almost **3 points higher** than their peers in non-Math Nation schools.
- The percentage of students meeting the state benchmark **increased by 6.5%**.
- There was a **10% decrease** in students scoring at the lowest level (Level F).

For **White/Caucasian students,** Math Nation significantly improved performance:

- Average test scores were almost **6 points higher** than peers in non-Math Nation schools.
- There was an **11% significant increase** in students scoring at the highest level (Level A).

While improvements for **female students** were not statistically significant, results showed promising trends:

- Female students in Math Nation schools scored nearly **3 points higher** on average than those in non-Math Nation schools.
- The percentage of female students at the lowest proficiency level was nearly **6% lower**.
- More female students reached higher proficiency levels, with a **5.4% increase** in those meeting the state benchmark.

While improvements for **students in poverty and English language learners** were not statistically significant, proficiency rates slightly improved for schools using Math Nation.

Study 3: How does the impact of Math Nation differ by school profile clusters?

To better understand how schools with different characteristics perform, we grouped schools into four categories based on three main factors:

1. **Community Income Level** (low, middle, or high)
2. **Location** (urban or rural)
3. **School Performance Rating** (assigned by the South Carolina Department of Education)

This grouping helped us compare similar schools more fairly when looking at student achievement results. By analyzing schools in groups based on location, income, and ratings, we ensure that the curriculum functions effectively across diverse school contexts. This approach helps us assess its equitable impact and ability to support historically marginalized or underperforming schools.

Each school fell into one of four clusters:

1. **Cluster 1**: Rural, middle-income, "Good" rating
2. **Cluster 2**: Rural, lower-income, "Average" rating
3. **Cluster 3**: Urban, higher-income, "Excellent" rating
4. **Cluster 4**: Urban, lower-income, "Average" rating

For each cluster, we analyzed test scores in Math Nation versus non-Math Nation schools.

For schools in Cluster 1, Math Nation led to significantly higher test scores and more students achieving higher proficiency levels:

- Math Nation schools had slightly higher scores on the EOC.
- There was an **8% increase** in students achieving Level B.
- There was a **17% decrease** in students at the lowest proficiency level (Level F).
- Math Nation's impact was demonstrated by moderate to high effect sizes, indicating that the program could help close achievement gaps in schools serving underserved populations.

Improvements in scores and achievement levels were noted for Math Nation users in all other clusters. particularly in Cluster 3, where fewer students scored at the lowest proficiency level.

Study 4: What are the most influential components of the curriculum in predicting math achievement?

Study 4 seeks to identify patterns that help explain which activities are most important for student success. We looked at student engagement with three key curriculum activities:

- Check Your Understanding (CYU) Questions – Short questions designed to help students check their understanding of concepts.
- Study Expert Videos – Instructional videos that explain key math topics.
- Test Yourself – Practice questions that allow students to apply what they have learned.

We compared student performance while accounting for their past scores to understand how these activities contribute to improvement. The goal was to find the most important factors influencing student outcomes by using a regression tree.

A regression tree is a type of decision tree used for predicting a continuous outcome variable (e.g., state test scores). A decision tree is a machine learning technique that recursively splits the data into subsets based on the values of input features. We can think of a regression tree as a flowchart or series of questions that helps you make predictions. Each question (or split) refines your prediction until you reach a specific outcome (in this case, different levels of proficiency on the state test). Regression trees allow us to break down a complex problem into simpler, more manageable steps. The tree "learns" how to predict the target variable (here, the state test score).

The strongest predictor of success was the number of CYU questions completed. Schools where students answered more CYU questions saw greater improvements in performance.

These findings suggest that students benefit most from actively engaging with practice questions, particularly "Check Your Understanding" questions. Schools and educators may consider encouraging students to complete more of these exercises to improve learning outcomes.

Conclusions

Overall, the evaluation findings indicate that Math Nation is an effective and engaging tool for enhancing students' math learning and performance. Across multiple subgroups of students, those using Math Nation consistently outperformed their peers. These findings support the potential for Math Nation as an effective tool in helping students, especially those in underserved groups, improve their math performance.

DATA SOURCES

Data for this study came from two sources. First, schools that used Math Nation for the 2023-2024 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.

Second, school demographic data and school performance on the South Carolina EOC were accessed through the official South Carolina Department of Education (DOE) data website. We used the South Carolina Algebra 1 End-of-Course exam spring 2024 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 2022-2023 school performance on the South Carolina Algebra 1 EOC exam from the South Carolina DOE data website.

We also downloaded 2023-2024 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).

Finally, school geographic location, poverty data, and additional demographic data were retrieved from the U.S. Department of Education (USDOE) website. See Table 1.

Table 1. Data Retrieved from SCDOE and USDOE Websites

Data Type	Source	Description
2023-2024 Math Nation Usage data	Math Nation Data Platform	Number of logins, number of videos watched, number of Test Yourself questions completed, and number of Check Your Understanding questions completed per school.
2023-2024 South Carolina Algebra End-of-Course exam results	South Carolina Department of Education	Algebra 1 EOC scale scores and proficiency rates.
2022-2024 South Carolina Algebra End-of-Course exam results	South Carolina Department of Education	Algebra 1 EOC scale scores and proficiency rates.
South Carolina Department of Education School, District, and State Poverty Index 2024	South Carolina Department of Education	School-level income-to-poverty ratio (IPR) estimates are indicators that reflect the percentage of family income that is above or below the federal poverty threshold.
2023-2024 Enrollment data	South Carolina Department of Education	District and school data by grade and subgroup.
2023-2024 Accountability data	South Carolina Data	Performance rating for each school and district based on established criteria regarding student achievement, individual student growth, graduation rate, and participation rate.
Education Demographic and Geographic Estimates Program (EDGE)	U.S. Department of Education	The NCES locale framework is classified into four types (city, suburban, town, and rural). Classification is based on population size and proximity to urban areas.

Data Preprocessing

All datasets were transformed, cleaned, and organized to make them suitable for analysis. Data from multiple sources had to be integrated to ensure consistency and unity among datasets. The values of variables such as poverty rates, school accountability ratings, and usage calculations were normalized to similar ranges so they would have comparable magnitudes and preserve the relationships between data points. Additionally, some categorical variables were converted into a numerical format to make them suitable for analysis. To mitigate the impact of outliers, two-step transformation to normality was used to normalize Math Nation usage variables.

Missing Data

As a measure of privacy, state data does not include a numeric value for any variable to which fewer than 10 students contributed data. This led to missing data (by design—meaning 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 imputations 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 size were used in both matching analyses.

Propensity Score Matching

Propensity score matching is a method used in research to make sure that when comparing two groups (i.e., Math Nation vs. non-Math Nation schools), they are as similar as possible. Similarity is important to ensure a fair comparison; we want to make sure that the only real difference between the groups is the factor that we are specifically interested in. In other words, we want to ensure that any difference between Math Nation and non-Math Nation schools is due to Math Nation itself, rather than pre-existing differences between the two groups. In order to match students as closely as possible, they were matched across demographic and achievement variables, including 2023 EOC algebra scores, school size, economic status, ELL status, race/ethnicity, and school.

To match schools based on the data available from the South Carolina DOE data website, we matched as closely as possible across various school demographic and achievement variables, including 2023 South Carolina EOC algebra scores, school size, the percentage of students that were classified as economically disadvantaged, the percentage of ELL students, and the percentage of students in a school across race/ethnicity categories (i.e., Asian, Black/African American, Latino/Hispanic, White/Caucasian, and two or more races/ethnicities).

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 more robust to both multiple covariate usage and correlated covariates. Finally, using Mahalanobis Distance in Match-it has the added benefit of enabling the researcher to 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.

RESULTS

What are the characteristics of the schools and students included in this study?

Math Nation Usage

During the 2023-2024 school year, the overall number of schools in South Carolina that used Math Nation in algebra grade was 546. There was missingness in all publicly available state files (see Missing Data section); this number is the number of schools that submitted data but not necessarily scores. See Table 2.

Table 2. Math Nation Usage Descriptive Statistics

Variable	Maximum	Mean (SD)
Videos	271,950	10,021.13 (38,544.35)
Test Yourself questions completed	9,684	368.55 (1,279.66)
Check Your Understanding questions completed	33,125	721.25 (4,275.81)

Algebra EOC Assessment Data

During the 2023-2024 school year, 524 public schools submitted assessment data for the Algebra 1 EOC exam. Of these, 452 did not have any missing data for score reports for all students. Table 3 provides descriptive statistics of 2024 EOC performance by student subgroup, while Figure 1 illustrates the distribution of scale scores for all students. Note that EOC scale scores are normalized to range from 0 to 100. Distributions of scores for all demographic subgroups are provided in the appendix. See Table 3.

Figure 1. Distribution of 2024 EOC Scores for All Students

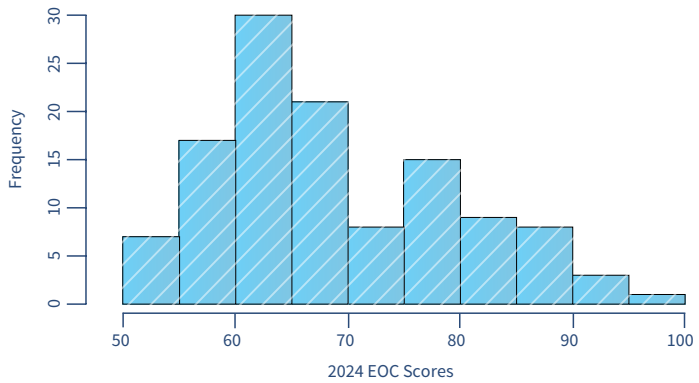


Table 3. 2024 EOC Performance by Student Subgroup

Variable	EOC Scale Score Mean (SD)	% Level A (SD)	% Level B (SD)	% Level C (SD)	% Level D (SD)	% Level F (SD)
All Students	68.71 (10.46)	10.67 (16.63)	14.27 (13.57)	20.96 (10.31)	22.64 (10.79)	31.47 (23.54)
Black/African American Students	61.47 (5.87)	1.71 (2.90)	6.16 (8.02)	17.07 (9.69)	27.16 (9.03)	47.90 (19.99)
Female Students	68.64 (10.19)	9.76 (17.55)	13.55 (12.70)	22.60 (12.07)	23.71 (11.55)	30.38 (23.38)
Male Students	65.73 (5.89)	5.20 (5.17)	10.35 (8.59)	22.72 (8.72)	27.41 (9.15)	34.32 (17.68)
Latino/Hispanic Students	67.30 (10.38)	10.24 (17.23)	11.83 (11.64)	19.65 (9.96)	22.70 (10.35)	35.59 (23.31)
Students in Poverty	63.56 (7.14)	3.51 (6.45)	8.92 (10.99)	19.03 (10.13)	26.00 (9.31)	42.55 (21.45)
White/Caucasian Students	70.63 (10.62)	13.33 (18.91)	15.81 (13.00)	22.20 (11.42)	21.41 (11.27)	27.25 (22.24)

Income-to-Poverty Ratio

For poverty level, school-level income-to-poverty ratio (IPR) estimates were grouped into ranges to create an IPR range indicator. Income-to-poverty estimates are indicators that reflect the economic condition of a population. The IPR, calculated by the United States Census Bureau, is the percentage of family income that is above or below the federal poverty threshold. See Table 4.

Table 4. Poverty Thresholds for 2024 by Size of Family and Number of Related Children under 18 Years (in Dollars)

Size of Family Unit	Related children under 18 years								
	None	One	Two	Three	Four	Five	Six	Seven	Eight or More
One Person (unrelated):									
Under 65 years	16,320								
65 years and over	15,045								
Two People:									
Householder under 65 years	21,006	21,621							
Householder 65 years and over	18,961	21,540							
Three People	24,537	25,249	25,273						
Four People	32,355	32,884	31,812	31,922					
Five People	39,019	39,586	38,374	37,436	36,863				
Six People	44,879	45,057	44,128	43,238	41,915	41,131			
Seven People	51,638	51,961	50,849	50,075	48,631	46,948	45,100		
Eight People	57,753	58,263	57,215	56,296	54,992	53,337	51,614	51,177	
Nine People or More	69,473	69,810	68,882	68,102	66,822	65,062	63,469	63,075	60,645

Source: U.S. Census Bureau, 2025

The 2024 IPR estimates associated with South Carolina schools were downloaded from the NCES EDGE website. The federal poverty threshold used to calculate IPR estimates is based on the size of the family living in a household. For example, the 2024 federal poverty threshold for a family of four is $31,200 and the IPR estimate is 100%. The IPR estimate for a family of four with a household income of $53,000 would be 170% (53,000/31,200 = 1.70, 1.70*100 = 170). See Table 5.

Table 5. Income to Poverty (IPR) Estimate Ranges for South Carolina Schools

IPR Estimate Range	Income Range	IPR Indicator	Frequency
<100	< $31,200	1	0%
100-199	$31,200 - $62,399	2	22.50%
200-299	$62,400 - $93,599	3	44.17%
300-399	$93,600 - $124,799	4	18.33%
400-499	$124,800 - $155,999	5	8.33%
>500	>$156,000	6	8.67%

The IPR estimate datapoint ranges reflect the income distribution for the state of South Carolina (Table 5). The first range, IPR estimates below 100, captures schools located in neighborhoods with household incomes below the federal poverty level (FPL) of $31,200. The IPR range of 100 to 199 $31,200–$62,399) captures households with incomes above the FPL, the median income for South Carolina in 2024 (i.e., $66,818) (U.S. Department of Justice, 2024), and incomes for households with children that are eligible for Medicaid and the Children's Health insurance Program (CHIP). The IPR range of 200 to 299 ($62,400–$93,599) captures households with incomes that are typically not eligible for public assistance. The IPR range of 300 to 399 ($93,600–$124,799) captures households with incomes that are above the state median but not typically high enough to be classified as affluent, often representing middle-income families with more stable financial resources than lower-income households, but without the higher levels of wealth seen in the upper ranges. The IPR range of 400 to 499 ($124,800–$166,999) represents households with higher-than-average incomes, often above the median, and is associated with more affluent communities. Finally, the IPR range of 500 and above ($167,000 and higher) represents the highest-income households, typically found in high-income areas with a concentration of families that are financially secure and may have access to greater resources and opportunities. The final IPR range includes schools with IPRS 300 or above and represent 35.33% of schools in the study. See Figure 2.

To create a more balanced distribution, the IPR was recoded into three values, detailed in Table 6.

Figure 2. Distribution of IPR Estimates for Math Nation and Control Schools

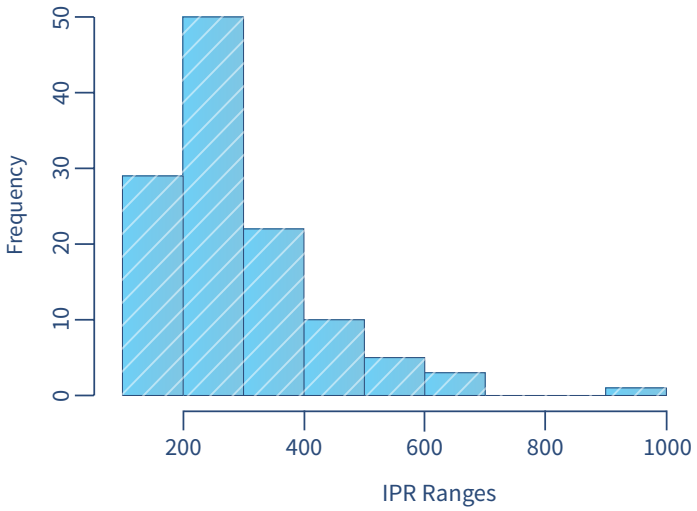


Table 6. Recoded IPR Values for the Current Study

IPR Indicator	Income Range	Frequency
2	$26,500-$52,999	22.50%
3	$53,000-$79,499	44.17%
4	>=$79,500	33.33%

Locale Classifications

The National Center for Educational Statistics (NCES) locale framework is classified into four types—city, suburban, town, and rural—and classification is based on population size and proximity to urban areas. See Table 7. For this study, city and suburban were reclassified as urban areas, while rural and town were reclassified as rural areas. The indicators for urban and rural were recoded as zero and one, respectively. See Table 8.

Table 7. National Center for Educational Statistics Locale Classifications

NCES Locale Number	NCES Locale Label	Description	Frequency
12	Rural, Distant	Rural areas that are located far from a metropolitan area and have fewer than 2,500 people in a population center.	5.83%
13	Rural, Remote	Rural areas located in sparsely populated regions that are far from any metropolitan area with fewer than 2,500 people in a population center.	5.83%
21	Suburb, Large	An urban fringe area or suburban area within a metropolitan area of 250,000 or more people.	16.67%
22	Suburb, Mid-size	A suburban area within a metropolitan area with populations between 100,000 and 249,999.	6.67%
23	Suburb, Small	A suburban area within a metropolitan area with fewer than 100,000 people.	1.67%
31	Town, Fringe	A town located outside a metropolitan area but within a population center of 10,000 to 49,999 people.	3.33%
32	Town, Distant	A town located outside a metropolitan area but within a population center of 2,500 to 9,999 people.	8.33%
41	City, Large	A central city within a metropolitan area with a population of 250,000 or more people.	30%
42	City, Mid-size	A central city within a metropolitan area with a population between 100,000 and 249,999 people.	20.83%
43	City, Small	A central city within a metropolitan area with fewer than 100,000 people.	0.83%

Table 8. Reclassification of Locale Indicator

Locale Indicator	Description	Frequency
0	Urban	76
1	Rural	44

Table 9. Accountability Ratings for South Carolina Schools in 2024

Accountability Rating	Description	Frequency
1	Unsatisfactory	3.33%
2	Below average	20%
3	Average	28.33%
4	Good	17.50%
5	Excellent	29.17%
9	Not rated	21.67%

Accountability Data

The South Carolina Accountability System assigns a performance rating of 1–5 for each school and district based on established criteria regarding student achievement, individual student growth, graduation rate, and participation rate. The school accountability numbers are defined in Table 9 above.

STUDY 1: HOW DOES MATH NATION USAGE IMPACT MATH ACHIEVEMENT?

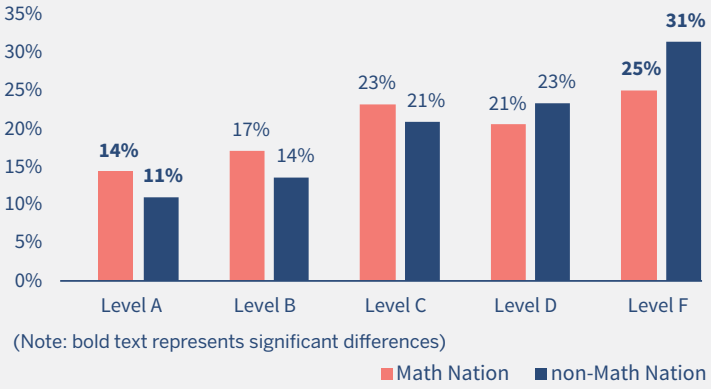
To examine the effectiveness of Math Nation to increase End-of-Course (EOC) algebra passing rates, we conducted multiple regression analyses using structural equation modeling. Our main analyses compared EOC performance in algebra students at schools using Math Nation versus schools using non-Math Nation programs in a matched sample of 120 schools. Secondary analyses compared EOC performance in Math Nation versus non-Math Nation schools across various student demographic subgroups.

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. 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 that may impact math performance. As a stringent test of the effects of Math Nation, we include multiple covariates in all analyses, including baseline 2022 FSA math average scores, school size, and percentages of economically disadvantaged students, Black/African American students, Asian students, and Latino/Hispanic students.

The main effect of Math Nation on average scale scores was significant, with Math Nation schools (M = 71.51, SD = 10.44) showing a near 3-point increase in scores compared to non-Math Nation schools (M = 68.77, SD = 10.63): ß = 0.02, p < .001, d = 0.26. There were also significant improvements in the percentages of students achieving Levels A and F at Math Nation schools. In Math Nation schools, nearly 4% more students achieved Level A proficiency, and this difference was significant: ß = 0.05, p = .003, d = 0.20; Math Nation: M = 14.28%, SD = 17.26%; non-Math Nation: M = 10.94%, SD = 15.90%. Additionally, there was a significant reduction of 6% in the percentage of students at Level F at in schools using Math Nation (M = 25.01%, SD = 22.74%) compared to non-Math Nation schools (M = 31.30%, SD = 24.36%): ß = 0.05, p = .02, d = 0.27. Last, schools using Math Nation had significantly more students achieving the state benchmark, that is, achieving Level A or B proficiency. Specifically, approximately 7% more students achieved the state benchmark at Math Nation schools (M = 31.30%, SD = 26.23%) compared to non-Math Nation schools (M = 24.56%, SD = 27.27%): ß = 0.05, p = .1, d = 0.25.

For all other levels, there were mean improvements for Math Nation schools, although these differences did not reach statistical significance. See Figure 3 and Table 10.

Figure 3. Proficiency Levels for Students at Math Nation vs. Non-Math Nation Schools



(Note: bold text represents significant differences)

Table 10. Comparison of Matched Math Nation and Non-Math Nation EOC Performance

Score	Math Nation Mean (SD)	Non-Math Nation Mean (SD)	Mean Difference	ß	p-value *p < .05 **p < .001	Effect Size
Average Scale Score	**71.51 (10.44)**	**68.77 (10.63)**	2.73	0.02	< 0.001**	0.26
% Level A	**14.28 (17.26)**	**10.94 (15.90)**	3.33	0.05	0.003*	0.20
% Level B	**17.02 (11.53)**	**13.62 (13.78)**	3.40	0.01	0.68	0.27
% Level C	**23.19 (10.44)**	**20.86 (9.55)**	2.33	0.02	0.26	0.23
% Level D	**20.50 (10.47)**	**23.28 (11.47)**	2.78	0.02	0.09	0.25
% Level F	**25.01 (22.74)**	**31.30 (24.36)**	6.28	0.05	0.02*	0.27
% Above Benchmark	**31.30 (26.23)**	**24.56 (27.27)**	6.73	0.05	0.01*	0.25

STUDY 2: HOW DOES THE IMPACT OF CURRICULUM USAGE DIFFER ACROSS STUDENT SUBGROUPS?

Black/African American Students

Our matched sample of Black/African American students comprised 54 schools. Schools using Math Nation had significantly higher average EOC scale scores for Black/African American students (M = 64.93, SD = 7.86) compared to Black/African American students at non-Math Nation schools (M = 62.05, SD = 6.79): ß = 0.02, p = .02, d = 0.39. There was also a significant 6.5% increase in Black/African American students achieving the state benchmark for schools using Math Nation (M = 15.07%, SD = 17.18%) compared to non-Math Nation matched peers (M = 8.54%, SD = 12.89%): ß = 4.34, p = .004, d = 0.43. Notably, there was a significant 10-point reduction in the percentage of Black/African American students achieving the Level F proficiency rate at Math Nation schools: ß = -0.09, p = .02, d = 0.44; Math Nation: M = 36.69%, SD = 22.24%; non-Math Nation: M = 46.83%, SD = 23.65%).

For all other proficiency levels, Black/African American students at Math Nation schools outperformed peers at non-Math Nation schools. Although these differences did not reach statistical significance, they boasted moderate to high effect sizes ranging from d = 0.10–0.42. See Figure 4 and Table 11.

Figure 4. Proficiency Levels for Black/African American Students at Math Nation vs. Non-Math Nation Schools

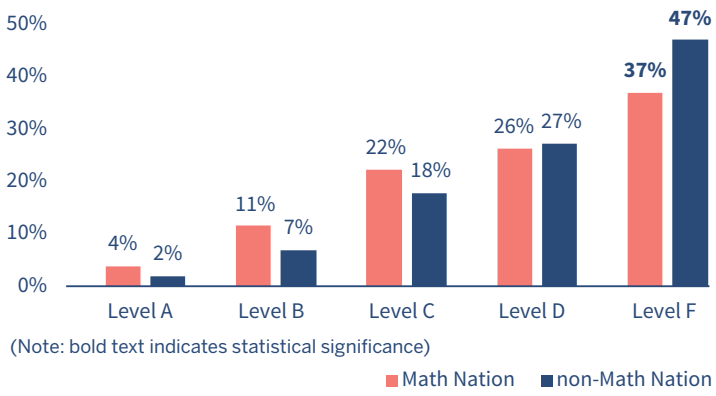
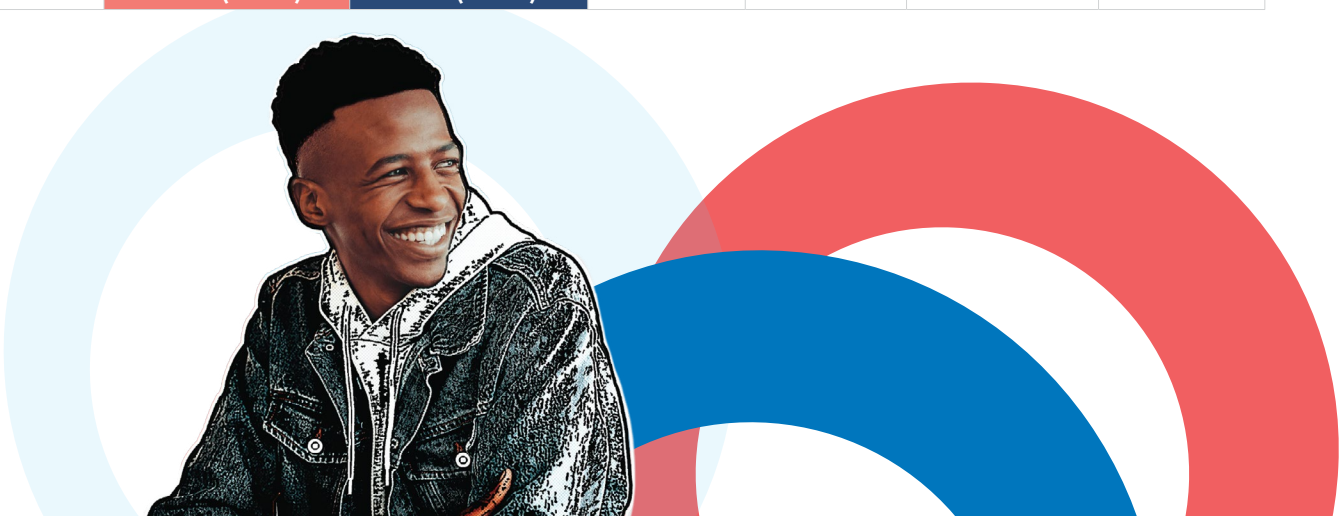


Table 11. Comparison of Matched Math Nation and Non-Math Nation Performance for Black/African American Students

Score	Math Nation Mean (SD) n = 27	Non-Math Nation Mean (SD) n = 27	Mean Difference	ß	p-value *p < .05 **p < .001	Effect Size
Average Scale Score	**64.93 (7.86)**	**62.05 (6.79)**	2.88	0.02	0.02*	0.39
% Level A	**3.68 (7.51)**	**1.79 (3.39)**	1.89	0.01	0.14	0.33
% Level B	**11.38 (11.75)**	**6.75 (10.41)**	4.64	0.02	0.18	0.42
% Level C	**22.15 (12.49)**	**17.56 (10.46)**	4.59	0.02	0.31	0.40
% Level D	**26.09 (9.0)**	**27.07 (11.20)**	0.98	0.01	0.71	0.10
% Level F	**36.69 (22.24)**	**46.83 (23.65)**	10.14	-0.09	0.02*	0.44
% Above Benchmark	**15.07 (17.18)**	**8.54 (12.89)**	6.53	4.34	0.004*	0.43



Female Students

Our matched sample of female students included 88 schools. While there were no significant findings, the mean proficiency rates were superior for schools using Math Nation compared to non-Math Nation schools.

Notably, the percentage difference of students at the Level F proficiency level was approaching significant, p = .06. There was a near 6% reduction in female students at the Level F proficiency level for Math Nation schools versus non-Math Nation schools: ß = -0.05, p = .06, d = 0.32; Math Nation: M = 23.42%, SD = 19.56%; non-Math Nation: M = 30.61%, SD = 25.21%.

While all other comparisons were nonsignificant, female students at Math Nation schools consistently scored higher than female students at non-Math Nation schools. Female students at schools using Math Nation scored almost 3 points higher (M = 71.37, SD = 10.28) than their peers at non-Math Nation schools (M = 68.74, SD = 10.48). Moreover, proficiency rates were higher at Math Nation schools for Levels A, B, and C. Over 4% more female students achieved Level A at Math Nation schools (M = 13.74%, SD = 22.04%) compared to non-Math Nation schools (M = 9.49%, SD = 16.30%). Overall, there was a 5.4% increase in female students meeting the state benchmark at Math Nation schools (M = 28.79%, SD = 27.44%) compared to their non-Math Nation peers (M = 23.40%, SD = 27.23%). See Figure 5 and Table 12.

Figure 5. Proficiency Levels for Female Students at Math Nation vs. Non-Math Nation Schools

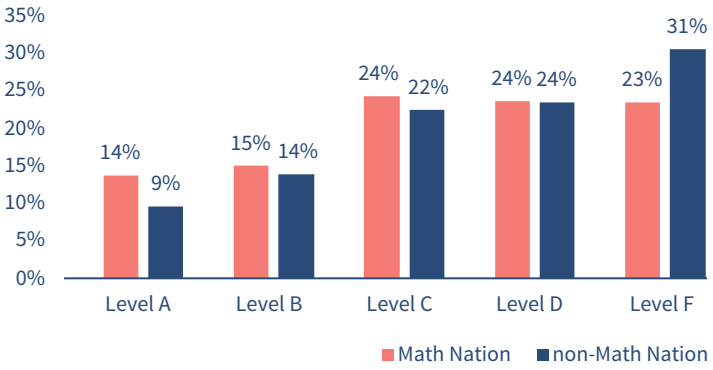


Table 12. Comparison of Matched Math Nation and Non-Math Nation Performance for Female Students

Score	Math Nation Mean (SD) n = 27	Non-Math Nation Mean (SD) n = 27	Mean Difference	ß	p-value	Effect Size
Average Scale Score	**71.37 (10.28)**	**68.74 (10.48)**	2.63	0.10	.23	0.25
% Level A	**13.74 (22.04)**	**9.49 (16.30)**	4.25	0.02	.47	0.22
% Level B	**15.06 (10.47)**	**13.90 (13.92)**	1.15	-0.001	.97	0.09
% Level C	**24.21 (11.40)**	**22.49 (11.70)**	1.72	0.01	.56	0.15
% Level D	**23.58 (11.95)**	**23.50 (12.05)**	0.08	0.02	.21	0.01
% Level F	**23.42 (19.56)**	**30.61 (25.21)**	7.19	-0.05	.06	0.32
% Above Benchmark	**28.79 (27.44)**	**23.40 (27.23)**	5.40	1.06	.65	0.20

THE MEAN PROFICIENCY RATES WERE SUPERIOR FOR SCHOOLS USING MATH NATION COMPARED TO NON-MATH NATION SCHOOLS

White/Caucasian Students

The matched sample of White/Caucasian students represented 94 schools. A series of independent samples t-tests revealed statistically significant differences between EOC scale scores and Level A proficiency rates for White/Caucasian students at Math Nation and non-Math Nation schools. Scale scores of White/Caucasian students at schools using Math Nation were nearly 6 points higher (M = 77.05, SD = 10.91) than their matched peers at non-Math Nation schools (M = 71.23, SD = 10.83): t(46) = 2.60, p = .01, d = 0.54. Notably, over 11% more students achieved Level A at schools using Math Nation (M = 24.65%, SD = 23.99%) compared to non-Math Nation schools (M = 13.61%, SD = 17.83%): t(46) = 2.53, p = .01, d = 0.52. Likewise, there were nearly 10% less students at the Level F proficiency rate for Math Nation schools (M = 15.53%, SD = 17.49%) compared to non-Math Nation schools (M = 25.48%, SD = 23.09%): t(46) = 2.45, p = .02, d = 0.49. See Figure 6.

The observed effect sizes (d = 0.54, 0.52, and 0.49, respectively) indicate a medium-to-large impact of the curriculum, suggesting meaningful differences in outcomes between schools that implemented Math Nation and those that did not. At the school level, such an effect size is relatively large because aggregated data typically dampen variability compared to individual-level data. This underscores the potential impact of the curriculum at a broader, institutional level. While the effect size is substantial, it is important to consider that school-level data may reflect underlying differences in demographics, resources, or prior performance that were not fully accounted for in this analysis. These results highlight the potential for meaningful curriculum impacts but warrant further investigation using multilevel modeling to account for school-level clustering and other contextual factors.

However, structural equation modeling (SEM) (which controlled for the percentages of Black/African American students, Asian students, female students, "Two or more" races/ethnicities students, and White/Caucasian students, as well as total school enrollment, EOC 2023 math scores, and enrollment for grades 6 through 12) indicated that these differences were not statistically significant (see Table 13). This suggests that the observed group difference in the t-tests may be influenced by confounding variables.

Figure 6. Proficiency Levels for White/Caucasian Students at Math Nation vs. Non-Math Nation Schools

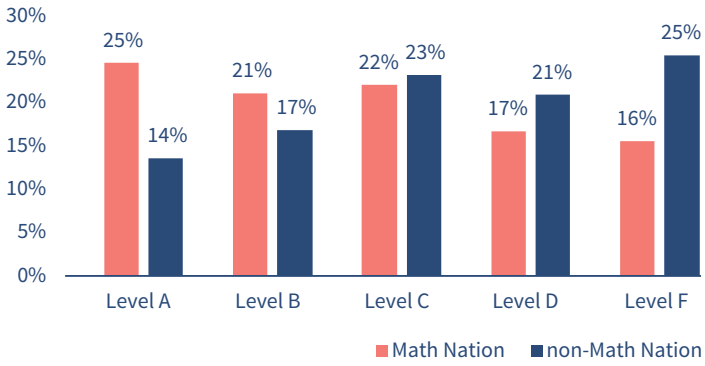


Table 13. Comparison of Matched Math Nation vs. Non-Math Nation Schools Performance for White/Caucasian Students

Score	Math Nation Mean (SD) n = 47	Non-Math Nation Mean (SD) n = 47	Mean Difference	t-test		SEM		Effect Size
				t-value	p-value	ß	p-value	
EOC Scale Score	**77.05 (10.91)**	**71.23 (10.83)**	5.82	2.60	.01*	0.01	.14	0.54
% Level A	**24.65 (23.99)**	**13.61 (17.83)**	11.04	2.53	.01*	0.04	.05*	0.52
% Level B	**21.08 (12.54)**	**16.76 (14.30)**	4.32	1.56	.12	0.01	.79	0.32
% Level C	**22.04 (10.83)**	**23.16 (10.78)**	1.12	0.50	.62	0.02	.32	0.10
% Level D	**16.70 (12.11)**	**21.00 (11.26)**	4.30	1.78	.08	0.001	.94	0.37
% Level F	**15.53 (17.49)**	**25.48 (23.09)**	9.94	2.35	.02	0.03	.20	0.49
% Benchmark	**45.72 (31.39)**	**30.36 (29.42)**	15.36	2.45	.02	3.53	.16	0.51

Students in Poverty

The matched sample of students in poverty included 74 schools. While there were no significant findings, the mean proficiency rates were slightly improved for schools using Math Nation compared to non-Math Nation schools, with slightly higher rates of students achieving Levels A, B, and C, and slightly lower rates of students achieving Levels D and F. See Figure 7 and Table 14.

Figure 7. Proficiency Levels for Math Nation vs. Non-Math Nation Students in Poverty

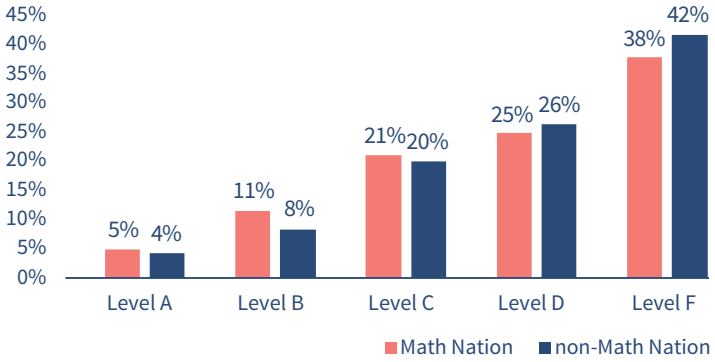


Table 14. Comparison of Matched Math Nation and Non-Math Nation Performance for Students in Poverty

Score	Math Nation Mean (SD) n = 37	Non-Math Nation Mean (SD) n = 37	Mean Difference	ß	p-value	Effect Size
Average Scale Score	**65.25 (7.50)**	**64.01 (7.97)**	1.24	0.01	.39	0.16
% Level A	**4.92 (7.68)**	**4.10 (8.63)**	0.82	0.02	.12	0.10
% Level B	**11.38 (11.50)**	**8.27 (9.87)**	3.10	0.02	.48	0.29
% Level C	**21.08 (10.51)**	**19.87 (10.79)**	1.21	0.01	.67	0.11
% Level D	**24.85 (8.99)**	**26.23 (10.16)**	1.38	0.02	.29	0.14
% Level F	**37.78 (21.57)**	**41.53 (23.04)**	3.75	0.01	.66	0.17
% Above Standard	**16.29 (16.33)**	**12.37 (17.87)**	3.92	2.72	.23	0.23

English Language Learner Students

The matched sample of English Language Learner students represented 10 schools. With only 5 observations per group, the statistical power is very low, making it harder to detect significant differences even if they exist. Moreover, the small sample might lead to imprecise estimates of the mean and variance. Therefore, we provide descriptive statistics using the unmatched sample. The unmatched sample provides a larger dataset, which increases statistical power and may yield more precise estimates. Without matching, observed differences may reflect underlying group differences unrelated to the Math Nation program. See Table 15.

Table 15. Comparison of Matched Math Nation and Non-Math Nation Performance for English Language Learner Students

Score	Math Nation Mean (SD) n = 57	Non-Math Nation Mean (SD) n = 5	Mean Difference
EOC	**62.34 (4.87)**	**62.36 (5.66)**	0.92
% A	**3.18 (3.91)**	**1.91 (2.98)**	1.27
% B	**7.13 (5.84)**	**8.70 (6.70)**	1.56
% C	**17.85 (9.00)**	**19.30 (10.41)**	1.45
% D	**25.92 (7.58)**	**26.07 (5.16)**	0.15
% F	**45.92 (16.25)**	**44.02 (21.27)**	1.90
% Benchmark	**10.32 (8.17)**	**10.61 (7.76)**	0.30

STUDY 3: HOW DOES THE IMPACT OF MATH NATION DIFFER BY SCHOOL PROFILE CLUSTERS?

All schools (Math Nation and non-Math Nation) were classified into four clusters based on school poverty level, urban/rural designation, and school accountability rating using k-means cluster analysis. K-means is a partitioning method that divides data into a prespecified number of nonoverlapping clusters by iteratively assigning each data point to the nearest cluster centroid (central points or coordinates that represent the center of each cluster) and recalculates the centroids based on the mean of the points in each cluster. Because this clustering method cannot learn the number of clusters from the data, the number of clusters are manually entered along with the number of iterations. Once the selected variables undergo a predefined number of iterations and are assigned to a predefined number of clusters, the results are examined to determine if data points in each cluster are as similar as possible (intra-class similarity) and dissimilar enough from data points in other clusters (inter-class similarity). If this is not the case, then combinations of cluster numbers and interactions are re-entered until data are clustered appropriately with the least number of iterations.

To assess whether Math Nation was more effective among certain types of student populations, school profiles were established by grouping schools based on similarities in the income level of the surrounding population, school location (i.e., urban or rural), and school accountability ratings assigned by the South Carolina DOE (see Table 16).

Table 16. Cluster Classifications Based on School Characteristics

	Clusters			
School Profile Characteristics	**1**	**2**	**3**	**4**
	n = 33	n = 20	n = 27	n = 11
IPR Indicator	3	2	4	2
Locale Indicator	1 (Rural)	1 (Rural)	2 (Urban)	2 (Urban)
Rating	4 (Good)	3 (Average)	5 (Excellent)	3 (Average)

The profile for schools grouped in **Cluster 1 (n = 33)** consists of schools with students in households with incomes between 1.77 and 2.65 times above the federal poverty level. For example, a family of four with a household income between $53,000 and $79,499 would fall into the category. Schools in this cluster are mostly in rural areas of the state and most have an accountability rating of 4 (good).

Cluster 2 (n = 20) consists of schools with students in households with incomes 0.88 and 1.77 times the federal poverty level. For example, a family of four with a household income between $26,500 and $52,999 would fall into this category. They are also mostly in rural areas of the state but most have an accountability rating of 3 (average).

Cluster 3 (n = 27) consists of schools with students in households with incomes 2.65 times above the federal poverty level. For example, a family of four with a household income above $79,500 would fall into this category. The schools in this cluster are mostly in urban areas and have accountability ratings of 5 (excellent).

Cluster 4 (n = 11) consists of schools with students in households with incomes 0.88 and 1.77 times the federal poverty level. They are mostly in urban areas and mostly have accountability ratings of 3 (average).

Independent samples t-tests were performed to assess if the differences in mean EOC scores and proficiency rates between Math Nation and non-Math Nation schools assigned to similar profile clusters were significant.

Cluster 1: Rural, middle-income, "Good" rating

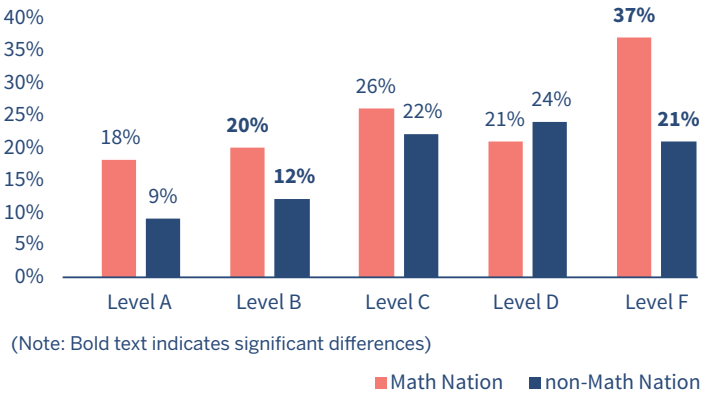
For School Profile Cluster 1, schools using Math Nation had significantly higher EOC scale scores (M = 0.74, SD = 0.09) than non-Math Nation schools (M = 0.68, SD = 0.11): t(2) = 2.24, p = .03, d = 0.68.

Additionally, Math Nation schools in Cluster 1 had significantly higher percentages of students achieving Level B proficiency (M = 0.20, SD = 0.11) compared to non-Math Nation schools (M = 0.0.12, SD = 0.12): t(2) = 2.19, p = .03, d = 0.68. Last, Math Nation schools had significantly less students at the Level F proficiency level. Over 17% less students were at Level F at Math Nation schools (M = 0.16, SD = 0.15) compared to non-Math Nation schools (M = 0.33, SD = 0.25) in Cluster 1: t(2) = 2.78, p = .01, d = 0.84.

Notably, the observed effect sizes (d = 0.68, 0.68, and 0.84, respectively) indicate a substantial improvement, signifying that the curriculum has a pronounced and positive influence on student achievement, exceeding benchmarks commonly associated with impactful educational interventions. In comparison to typical educational programs, which often achieve effect sizes closer to 0.40, Math Nation's results are exceptionally promising, underscoring its potential to elevate educational outcomes significantly.

While all the other comparisons did not reach statistical significance, there were mean improvements at every level for schools using Math Nation. See Figure 8 and Table 17.

Figure 8. Proficiency Levels for Math Nation vs. Non-Math Nation Cluster 1 Schools



(Note: Bold text indicates significant differences)

These results demonstrate positive impact on student achievement in rural, underserved schools. Math Nation has been associated with significant improvements in student achievement in rural schools with middle-income families (Cluster 1). These schools, which often face resource constraints and higher levels of student need, had a marked increase in EOC scale scores compared to non-Math Nation schools. The effect size of 0.68 suggests a substantial benefit from using Math Nation, indicating that the curriculum could help close achievement gaps in schools serving underserved populations.

Table 17. Independent Samples T-Tests for Cluster 1 Schools

Variable	Math Nation User Mean (SD) (n = 19)	Control Mean (SD) (n = 22)	Mean Difference	t-value	p-value *p < .05 **p < .001	Effect Size
EOC 2024	**0.74 (0.09)**	**0.68 (11)**	0.07	2.24	.03*	0.68
% A	**0.18 (0.20)**	**0.09 (0.15)**	0.08	1.47	.15	0.47
% B	**0.20 (0.11)**	**0.12 (0.12)**	0.08	2.19	.03*	0.68
% C	**0.26 (0.07)**	**0.22 (0.11)**	0.05	1.68	.10	0.51
% D	**0.21 (0.13)**	**0.24 (0.11)**	0.03	0.89	.38	0.28
% F	**0.16 (0.15)**	**0.33 (0.25)**	0.17	2.78	.01**	0.84
% Benchmark (A+B)	**0.37 (0.27)**	**0.21 (0.27)**	0.16	1.92	.06	0.60

MATH NATION HAS BEEN ASSOCIATED WITH SIGNIFICANT IMPROVEMENTS IN STUDENT ACHIEVEMENT IN RURAL SCHOOLS WITH MIDDLE-INCOME FAMILIES

Cluster 2: Rural, lower-income, "Average" rating

For School Profile Cluster 2, there were no significant differences between schools using Math Nation and schools using other programs. However, Math Nation schools observed slight mean improvements across all levels. Notably, the observed effect size when comparing Level D proficiency rates for Math Nation versus non-Math Nation schools in Cluster 2 was moderate-to-large at d = 0.42. See Figure 9 and Table 18.

Figure 9. Proficiency Levels for Math Nation vs. Non-Math Nation Cluster 2 Schools

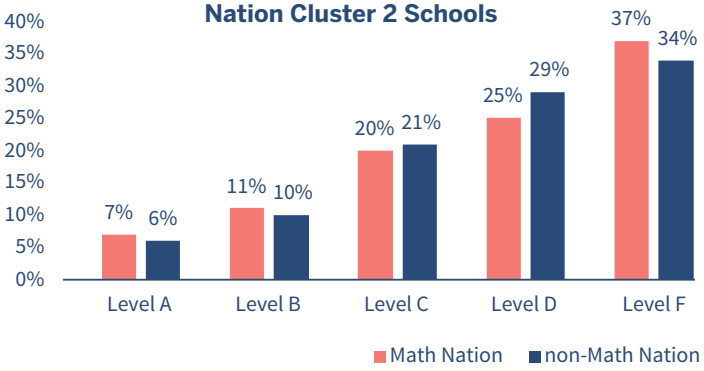


Table 18. Independent Samples T-Tests for Math Nation vs. Non-Math Nation Cluster 2 Schools

Variable	Math Nation User Mean (SD) (n = 14)	Control Mean (SD) (n = 16)	Mean Difference	t-value	p-value *p < .05 **p < .001	Effect Size
EOC 2024	**0.66 (0.09)**	**0.66 (0.08)**	0.001	0.02	.98	0.01
% A	**0.07 (0.14)**	**0.06 (0.08)**	0.02	0.44	.66	0.17
% B	**0.11 (0.09)**	**0.10 (0.13)**	0.01	0.22	.83	0.08
% C	**0.20 (0.11)**	**0.21 (0.09)**	0.02	0.50	.62	0.19
% D	**0.25 (0.08)**	**0.29 (0.11)**	0.04	1.17	.25	0.42
% F	**0.37 (0.22)**	**0.34 (0.21)**	0.03	0.40	.69	0.15
% Benchmark	**0.19 (0.22)**	**0.16 (0.21)**	0.03	0.36	.72	0.13

Cluster 3: Urban, higher-income, "Excellent" rating

For School Profile Cluster 3, there were no significant differences between schools using Math Nation and schools using other programs. However, Math Nation schools observed slight mean improvements across all levels. Notably, the observed effect sizes range from 0.25 to 0.49 (with the exception of Level A proficiency, d = 0.11), indicating a medium-to-large impact of the curriculum. The largest difference in mean scores was exhibited at Level F. Schools using Math Nation had over 10% less students at Level F (M = 0.16, SD = 0.21) compared to non-Math Nation schools in Cluster 2 (M = 0.26, SD = 0.25): t(2) = 1.24, p = .23, d = 0.43. See Figure 10 and Table 19.

Figure 10. Proficiency Levels for Math Nation vs. Non-Math Nation Cluster 3 Schools

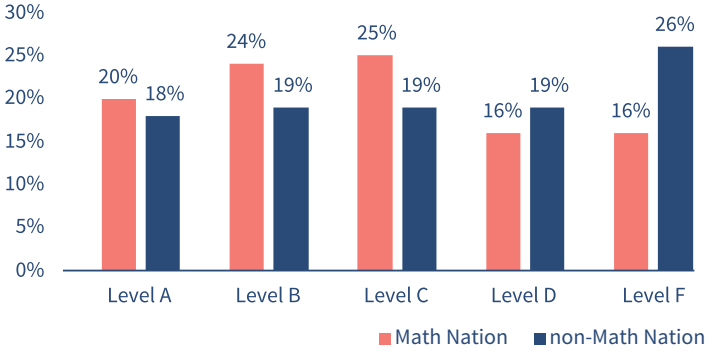


Table 19. Independent Samples T-Tests for Math Nation vs. Non-Math Nation Cluster 3 Schools

Variable	Math Nation User Mean (SD) (n = 16)	Control Mean (SD) (n = 17)	Mean Difference	t-value	p-value *p < .05 **p < .001	Effect Size
EOC 2024	**0.76 (0.10)**	**0.73 (0.12)**	0.04	-1	.33	0.35
% A	**0.20 (0.19)**	**0.18 (0.21)**	0.02	0.31	.76	0.11
% B	**0.24 (0.11)**	**0.19 (0.14)**	0.05	1.13	.27	0.39
% C	**0.25 (0.13)**	**0.19 (0.09)**	0.05	1.39	.18	0.49
% D	**0.16 (0.09)**	**0.19 (0.10)**	0.03	0.79	.43	0.28
% F	**0.16 (0.21)**	**0.26 (0.25)**	0.10	1.24	.23	0.43
% Benchmark	**0.44 (0.27)**	**0.36 (0.31)**	0.07	0.71	.48	0.25

Cluster 4: Urban, lower-income, "Average" rating

For School Profile Cluster 4 there were no significant differences between schools using Math Nation and schools using other programs. Math Nation and non-Math Nation schools scored fairly similar across all proficiency rates. See Figure 11 and Table 20.

Figure 11. Proficiency Levels for Math Nation vs. Non-Math Nation Cluster 4 Schools

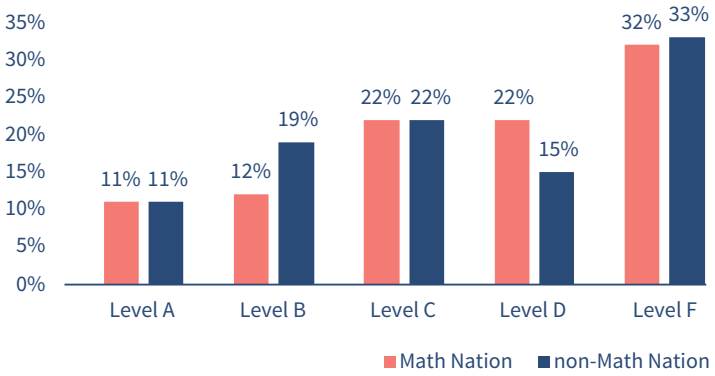


Table 20. Independent Samples T-Tests for Math Nation and Non-Math Nation Cluster 4 Schools

Variable	Math Nation User Mean (SD) (n = 9)	Control Mean (SD) (n = 4)	Mean Difference	t-value	p-value *p < .05 **p < .001	Effect Size
EOC 2024	**0.68 (0.08)**	**0.70 (0.15)**	0.02	0.21	.85	0.16
% A	**0.11 (0.10)**	**0.11 (0.13)**	0	0.001	.99	0.001
% B	**0.12 (0.08)**	**0.19 (0.20)**	0.07	0.70	.53	0.58
% C	**0.22 (0.08)**	**0.22 (0.11)**	0.01	0.09	.93	0.06
% D	**0.22 (0.08)**	**0.15 (0.11)**	0.07	1.18	.29	0.80
% F	**0.32 (0.21)**	**0.33 (0.38)**	0.003	0.01	.99	0.01
% Benchmark	**0.23 (0.18)**	**0.30 (0.33)**	0.07	0.42	.70	0.32

STUDY 4: WHAT ARE THE MOST INFLUENTIAL FACTORS IN PREDICTING MATH ACHIEVEMENT?

A regression tree was constructed to examine the relationship between curriculum usage metrics—Check Your Understanding questions answered, Study Expert videos watched per student, and Test Yourself questions answered per students—and End-of-Course performance scores and Level A proficiency ratings after accounting for previous year's performance.

EOC 2024 Regression Tree

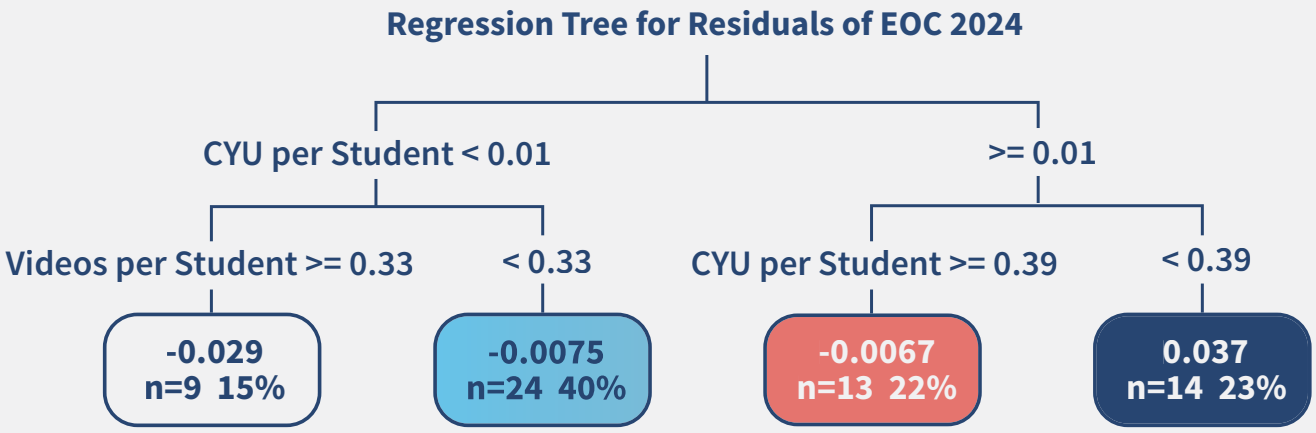
A regression tree analysis was conducted using residuals derived from a linear model that controlled for 2023 End-of-Course (EOC) scores. The regression tree was constructed with three predictor variables: Check Your Understanding (CYU) questions answered per student, Study Expert videos watched per student, and Test Yourself (TY) questions answered per student. Node splits were determined based on the minimization of within-node mean squared error (MSE), and variable importance was calculated by the reduction in residual variance at each split. To assess model generalizability, a 10-fold cross-validation procedure was employed.

The tree included 60 observations and resulted in three primary nodes. At the root node, the mean residual was approximately zero, with an initial MSE of 0.002. CYU per student emerged as the most influential predictor, followed by Study Expert videos watched per student and TY questions answered per student. The primary splits occurred at CYU < 0.01, TY < 0.004, and Study Expert videos < 0.007. Subsequent nodes exhibited varying residuals, with Node 2 capturing slight underprediction (mean residual = -0.01) and Node 3 capturing slight overprediction (mean residual = 0.02). Further splits at Nodes 6 and 7 highlighted additional differentiation, with Node 6 indicating underprediction (mean residual = -0.01) and Node 7 indicating overprediction (mean residual = 0.04).

Variable importance analysis confirmed that CYU had the highest impact (importance score = 45), followed by TY (33) and Study Expert videos (22). Complexity parameter (CP) analysis indicated that the tree was pruned to three splits, reducing the relative error from 1.00 at the root node to 0.70 at the final split. However, cross-validation errors increased slightly from 1.02 at the root node to 1.13 at three splits, suggesting potential overfitting. Additionally, the standard deviation of cross-validation errors increased slightly, underscoring the need for careful interpretation of the model's complexity.

Multicollinearity among predictors was assessed using variance inflation factors (VIF), all of which were below 2 (CYU: 1.12, TY: 1.54, Study Expert Videos: 1.60), indicating low levels of collinearity. Diagnostic checks for normality, homogeneity of variance, and cross-validation procedures further supported the model's validity. See Figure 12.

Figure 12. Regression Tree for EOC Scores, Controlling for Previous Year's Performance



Level A Regression Tree

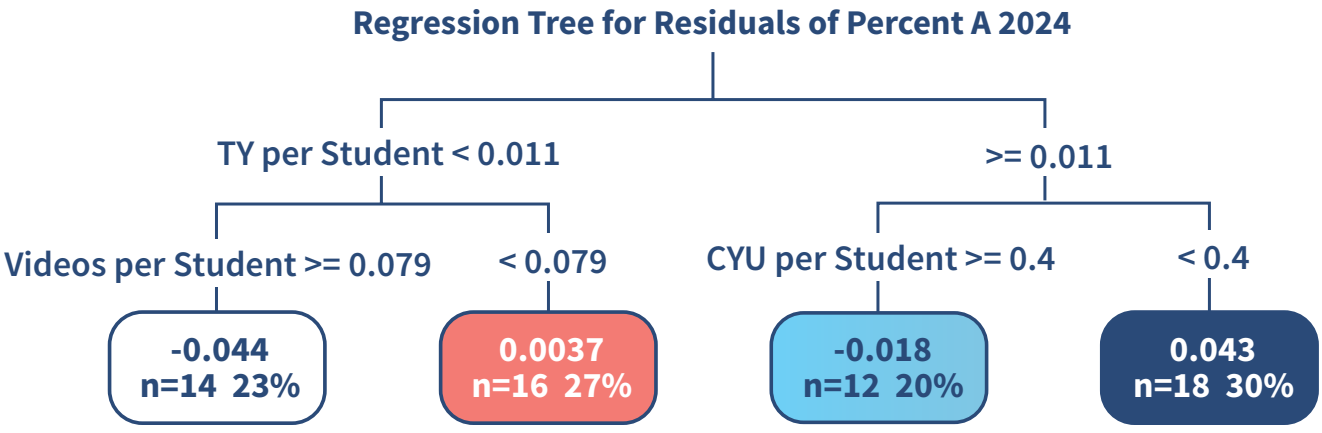
A secondary regression model was developed to predict the percentage of students achieving Level A, using the percentage achieving Level A in Year 2023 as a covariate, along with CYU, TY, and Study Expert videos as predictors. Residuals from this regression were analyzed using a regression tree to explore patterns of variability. The initial model included 60 observations, with residuals centered around zero and an MSE of 0.01.

Regression tree analysis for Level A achievement indicated that CYU, TY, and Study Expert videos were the most influential predictors, with CYU having the highest importance (40%), followed by TY (28%) and Study Expert videos (32%). Splits occurred at CYU < 0.01 and TY < 0.01, producing nodes with mean residuals ranging from -0.04 to 0.04 and MSE values between 0.00 and 0.01. Complexity parameter analysis suggested pruning to three splits, reducing relative error from 1.00 to 0.83. However, cross-validation errors increased from 1.05 at the root node to 1.34 after pruning, with standard deviations rising from 0.30 to 0.36, again indicating a risk of overfitting.

Variance inflation factors (VIF) for the predictors remained low (CYU: 1.12, TY: 1.54, Study Expert Videos: 1.60), confirming minimal multicollinearity. Diagnostic checks, including assessments of normality and homogeneity of variance, supported model validity.

The findings suggest that CYU is the most critical predictor of residual variation, with TY and Study Expert videos also contributing significantly. However, increasing cross-validation errors and small sample sizes in terminal nodes suggest potential overfitting. Future studies should validate these findings using independent data and explore alternative model specifications to improve generalizability and interpretability. See Figure 13.

Figure 13. Regression Tree for Residuals of Percentage of Students Achieving Level A Proficiency



THE MOST INFLUENTIAL MATH NATION FEATURE IN PREDICTING MATH ACHIEVEMENT—CHECK YOUR UNDERSTANDING QUESTIONS ANSWERED

CONCLUSIONS

The results of this study suggests that the Math Nation curriculum has a generally positive impact on student achievement in Algebra. The most significant improvements were observed in Black/African American students, who showed higher average test scores and a decrease in students performing at the lowest proficiency level. Female students also showed promising trends, although the results were less pronounced. These findings support the potential for Math Nation as an effective tool in helping students, especially those in underserved groups, improve their math performance.

The analysis of student engagement with curriculum activities highlighted the importance of "Check Your Understanding" (CYU) questions. Schools where students engaged more actively with CYU questions exhibited greater improvements in math performance. Other activities, such as watching "Study Expert" videos and completing "Test Yourself" questions, also contributed to success but were not as influential as CYU questions. The findings suggest that encouraging students to engage with these practice exercises could improve learning outcomes, although further research with larger student groups is needed to confirm these patterns.

In examining the relationship between school characteristics and curriculum effectiveness, the study revealed that rural schools with middle-income families and good performance ratings benefited most from using the curriculum. These schools had higher test scores, more students reaching higher achievement levels, and fewer students at the lowest proficiency levels. While other schools showed slight improvements, these results suggest that curriculum effectiveness may vary based on community context, with rural, middle-income schools showing the most significant gains. Further research is needed to explore whether these trends persist over time and across other types of schools.

Overall, the findings from these studies indicate that Math Nation is a valuable resource for improving student achievement in math, particularly for Black/African American students and those in rural, middle-income schools. However, the impact of curriculum engagement and school characteristics underscores the importance of context in determining the most effective strategies for educational success.

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APPENDIX

Descriptive Statistics

Figure 14. Distribution of 2024 EOC Scores for Black/ African American Students

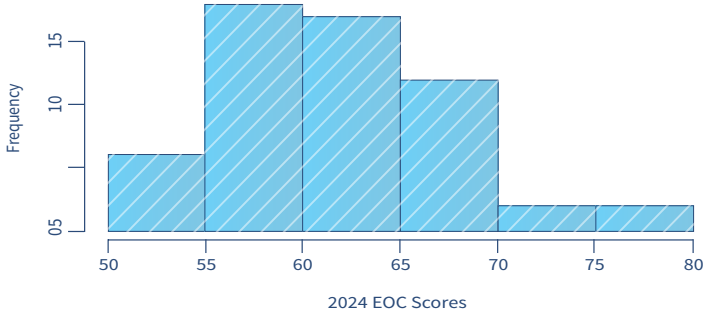


Figure 15. Distribution of 2024 EOC Scores for Female Students

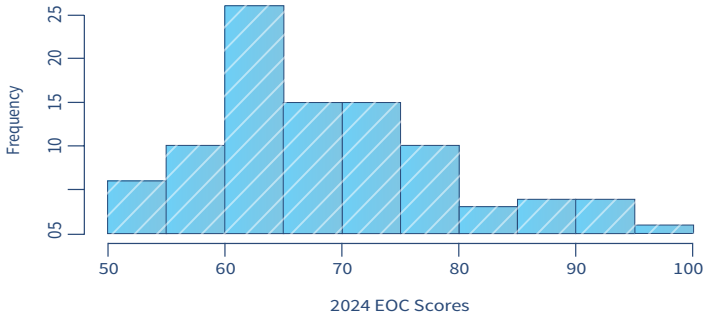


Figure 16. Distribution of 2024 EOC Scores for Male Students

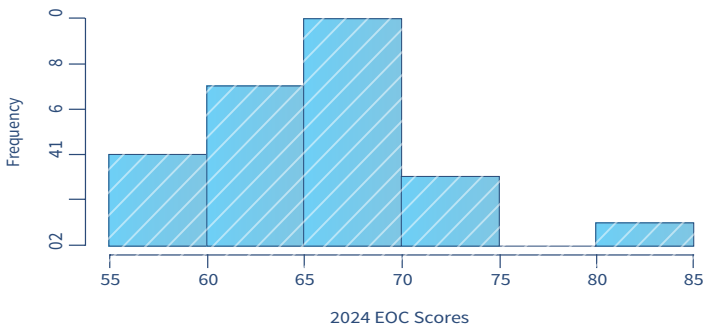


Figure 17. Distribution of 2024 EOC Scores for Latino/ Hispanic Students

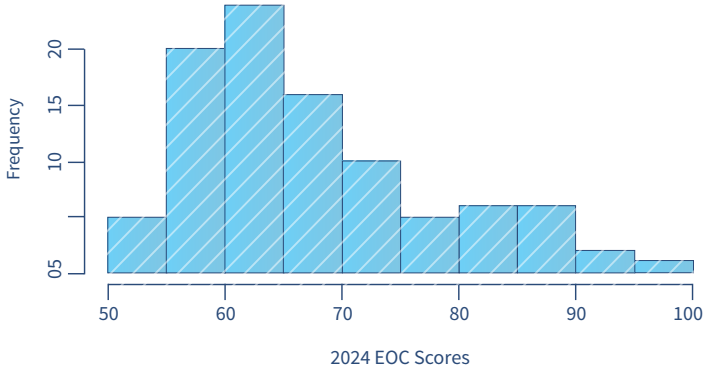


Figure 18. Distribution of 2024 EOC Scores for Students in Poverty

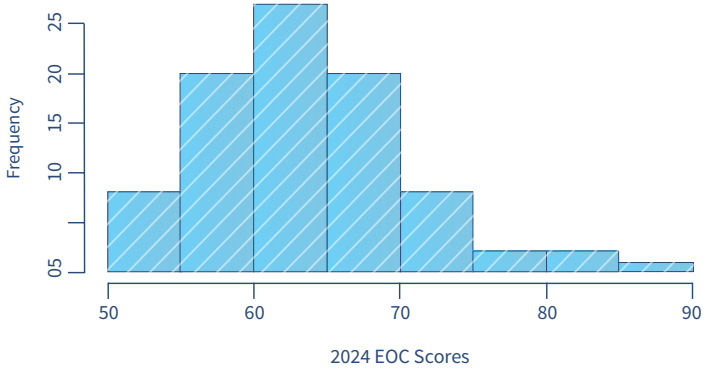


Figure 19. Distribution of 2024 EOC Scores for White/ Caucasian Students

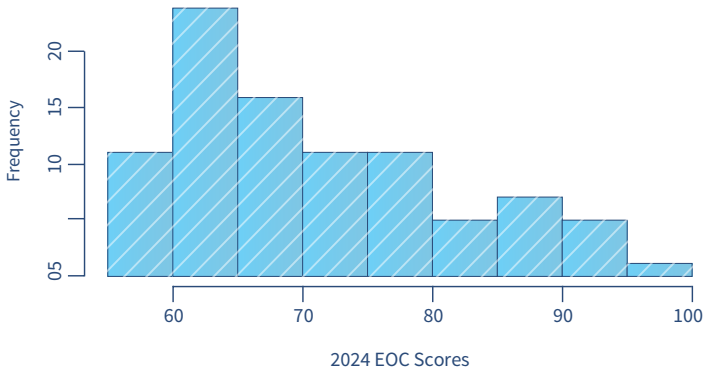
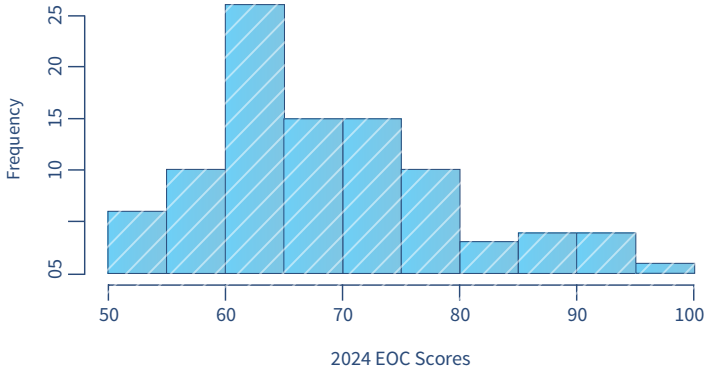


Figure 20. Distribution of 2024 EOC Scores for Female Students



Baseline Equivalencies

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 the following tables) 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 21. Baseline Comparison of Matched Math Nation and Non-Math Nation Students

Variable	Math Nation Mean (SD) (n = 60)	Non-Math Nation Mean (SD) (n = 60)	Mean Difference	t-value	p-value	Effect Size
Baseline 2023 EOC Algebra Scale Score	70.33 (12.06)	70.59 (11.87)	-0.27	0.14	.89	0.02
% Black/African American Students	0.39 (0.24)	0.37 (0.25)	0.01	-0.36	.72	-0.06
% American Indian/Alaskan Native Students	0 (0)	0 (0)	0.00	0.74	.46	0.12
% Asian Students	0.02 (0.02)	0.01 (0.02)	0.00	-0.28	.78	-0.05
% Female Students	0.49 (0.04)	0.49 (0.03)	0.00	-0.17	.87	-0.03
% Latino/Hispanic Students	0.13 (0.09)	0.13 (0.09)	0.00	0.10	.92	0.02
% Hawaiian/Pacific Islander Students	0 (0)	0 (0)	0.00	-1.17	.25	-0.19
% White/Caucasian Students	0.41 (0.22)	0.43 (0.23)	-0.02	0.45	.65	0.07
% Students in Poverty	0.64 (0.16)	0.64 (0.19)	0.01	-0.29	.77	-0.05
% “Two or More Races/Ethnicities” Students	0.05 (0.02)	0.05 (0.02)	0.00	-0.89	.38	-0.15
% Male Students	0.51 (0.04)	0.51 (0.03)	0.00	0.00	1.0	0.00
Total Enrollment	1,093.46 (959.5)	893.55 (546.99)	199.91	-1.56	.12	-0.26
PreKindergarten Enrollment	0 (0)	0 (0)	0.00			
Kindergarten Enrollment	5.74 (31.13)	3.92 (21.51)	1.82	-0.41	.68	-0.07
1st Grade Enrollment	6.3 (33.46)	4.19 (22.84)	2.11	-0.45	.66	-0.07
2nd Grade Enrollment	6.77 (34.5)	4.51 (24.32)	2.26	-0.46	.65	-0.08
3rd Grade Enrollment	7.8 (38.69)	4.64 (25.7)	3.16	-0.59	.56	-0.10
4th Grade Enrollment	8.49 (41.63)	4.81 (26.31)	3.68	-0.64	.52	-0.11
5th Grade Enrollment	9.15 (46.44)	4.85 (27)	4.30	-0.69	.49	-0.11
6th Grade Enrollment	85.77 (120.35)	78.47 (111.08)	7.30	-0.38	.70	-0.06
7th Grade Enrollment	112.45 (147.19)	97.38 (131.91)	15.07	-0.66	.51	-0.11
8th Grade Enrollment	116.28 (154.86)	96.19 (128.03)	20.09	-0.86	.39	-0.14
9th Grade Enrollment	210.81 (247.89)	170.28 (195.79)	40.53	-1.10	.27	-0.18
10th Grade Enrollment	192.65 (238.28)	154.54 (179.74)	38.11	-1.10	.27	-0.18
11th Grade Enrollment	169.36 (207.31)	136.59 (158.3)	32.77	-1.08	.28	-0.18
12th Grade Enrollment	161.89 (198.39)	131.89 (155.62)	30.00	-1.02	.31	-0.17

Table 22. Baseline Comparison of Matched Math Nation and Non-Math Nation Black/African American Students

Variable	Math Nation Mean (SD) (n = 27)	Non-Math Nation Mean (SD) (n = 27)	Mean Difference	t-value	p-value	Effect Size
Baseline 2023 EOC Algebra Scale Score	62.57 (8.36)	61.96 (6.84)	0.61	-0.29	.77	-0.08
% American Indian/Alaskan Native Students	0 (0.01)	0 (0.01)	0.00	-0.10	.92	-0.03
% Asian Students	0.01 (0.01)	0.01 (0.01)	0.00	0.55	.58	0.15
% Female Students	0.49 (0.04)	0.49 (0.03)	-0.01	0.66	.51	0.18
% Latino/Hispanic Students	0.09 (0.11)	0.13 (0.14)	-0.04	1.08	.29	0.29
% “Two or More Races/Ethnicities” Students	0.04 (0.03)	0.04 (0.02)	0.00	-0.24	.809	-0.07
Total Enrollment	672.15 (419.52)	884.04 (556)	-211.89	1.58	.120	0.43

Table 23. Baseline Comparison of Matched Math Nation and Non-Math Nation Female Students

Variable	Math Nation Mean (SD) (n = 44)	Non-Math Nation Mean (SD) (n = 44)	Mean Difference	t-value	p-value	Effect Size
Baseline 2023 EOC Algebra Scale Score	70.53 (11.76)	71.59 (11.06)	-1.07	0.47	.64	0.09
% Black/African American Students	0.51 (0.04)	0.51 (0.03)	0.00	0.62	.54	0.12
% American Indian/Alaskan Native Students	0.38 (0.25)	0.34 (0.22)	0.03	-0.71	.48	-0.14
% Asian Students	0 (0)	0 (0)	0.00	-1.16	.25	-0.23
% Latino/Hispanic Students	0.01 (0.02)	0.01 (0.01)	0.00	-0.19	.85	-0.04
% Hawaiian/Pacific Islander Students	0.13 (0.1)	0.13 (0.11)	0.00	0.21	.84	0.04
% White/Caucasian Students	0.05 (0.02)	0.05 (0.02)	0.00	0.24	.81	0.05
% Students in Poverty	0.43 (0.22)	0.46 (0.23)	-0.03	0.65	.52	0.13
% “Two or More Races/Ethnicities” Students	0 (0)	0 (0)	0.00	0.21	.83	0.04
% Male Students	0.49 (0.04)	0.49 (0.03)	0.00	-0.62	.54	-0.12
Total Enrollment	959.33 (534.39)	959.33 (594.07)	0.00	0.00	1.0	0.00
6th Grade Enrollment	76.73 (119.68)	79.25 (130.3)	-2.53	0.10	.919	0.02
7th Grade Enrollment	88.92 (132.59)	93.14 (140.94)	-4.22	0.16	.877	0.03
8th Grade Enrollment	87.71 (128.36)	94.2 (141.64)	-6.49	0.24	.809	0.05
9th Grade Enrollment	206.18 (205.36)	203.75 (222.18)	2.43	-0.06	.954	-0.01
10th Grade Enrollment	182.9 (178.85)	176.96 (187.28)	5.94	-0.16	.870	-0.03
11th Grade Enrollment	162.04 (161.62)	159.75 (180.17)	2.29	-0.07	.946	-0.01
12th Grade Enrollment	154.86 (157.88)	152.29 (166.31)	2.57	-0.08	.936	-0.02
5th Grade Enrollment	9.15 (46.44)	4.85 (27)	4.30	-0.69	.49	-0.11
6th Grade Enrollment	85.77 (120.35)	78.47 (111.08)	7.30	-0.38	.70	-0.06
7th Grade Enrollment	112.45 (147.19)	97.38 (131.91)	15.07	-0.66	.51	-0.11
8th Grade Enrollment	116.28 (154.86)	96.19 (128.03)	20.09	-0.86	.39	-0.14
9th Grade Enrollment	210.81 (247.89)	170.28 (195.79)	40.53	-1.10	.27	-0.18
10th Grade Enrollment	192.65 (238.28)	154.54 (179.74)	38.11	-1.10	.27	-0.18
11th Grade Enrollment	169.36 (207.31)	136.59 (158.3)	32.77	-1.08	.28	-0.18
12th Grade Enrollment	161.89 (198.39)	131.89 (155.62)	30.00	-1.02	.31	-0.17

Table 24. Baseline Comparison of Matched Math Nation and Non-Math Nation White/Caucasian Students

Variable	Math Nation Mean (SD) (n = 44)	Non-Math Nation Mean (SD) (n = 44)	Mean Difference	t-value	p-value	Effect Size
Baseline 2023 EOC Algebra Scale Score	75.18 (11.02)	70.95 (11.38)	4.23	-1.83	.07	-0.38
% Black/African American Students	0.25 (0.14)	0.2 (0.18)	0.05	-1.47	.15	-0.30
% Asian Students	0.01 (0.01)	0.01 (0.01)	0.00	-0.55	.58	-0.11
% Female Students	0.49 (0.04)	0.47 (0.06)	0.02	-1.77	.08	-0.37
% White/Caucasian Students	0.5 (0.16)	0.63 (0.21)	-0.13	3.36	.001	0.69
% “Two or More Races/Ethnicities” Students	0.06 (0.03)	0.05 (0.02)	0.02	-3.20	.002	-0.66
Total Enrollment	952.19 (515.86)	892.6 (921.3)	59.60	-0.39	.70	-0.08
6th Grade Enrollment	76.73 (119.68)	79.25 (130.3)	-2.53	0.10	.919	0.02
7th Grade Enrollment	88.92 (132.59)	93.14 (140.94)	-4.22	0.16	.877	0.03
8th Grade Enrollment	87.71 (128.36)	94.2 (141.64)	-6.49	0.24	.809	0.05
9th Grade Enrollment	206.18 (205.36)	203.75 (222.18)	2.43	-0.06	.954	-0.01
10th Grade Enrollment	182.9 (178.85)	176.96 (187.28)	5.94	-0.16	.870	-0.03
11th Grade Enrollment	162.04 (161.62)	159.75 (180.17)	2.29	-0.07	.946	-0.01
12th Grade Enrollment	154.86 (157.88)	152.29 (166.31)	2.57	-0.08	.936	-0.02

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