

# The Impact of NBA Math Hoops on Students' Math Achievement: A Randomized Controlled Trial

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# Executive Summary

Student math scores have fallen over the past decade. Because math continues to serve as a gatekeeper to advanced high school course-taking and career opportunities, it is essential to identify effective approaches to accelerating learning for elementary and middle school students who are not meeting grade-level standards. This study evaluates one promising program: NBA Math Hoops.

NBA Math Hoops, developed by the nonprofit Learn Fresh in partnership with the NBA and WNBA, is a math learning program that uses an interactive board game built around real player statistics. The game aims to build students' fluency in arithmetic, fractions, decimals, percentages, and data analysis—while also developing skills in critical thinking, problem-solving, and collaboration. The program operates in classrooms, after-school programs, community centers, and summer learning sites and has reached more than 1.4 million students across all 50 states since its launch in 2012.

## About This Study

WestEd conducted a 2-year randomized controlled trial (RCT) during a free summer enrichment camp in an urban Southern school district. Rising 4th, 5th, and 6th graders were randomly assigned to either NBA Math Hoops or the district's business-as-usual STEM enrichment instruction. The final analytic sample included 256 students, fewer than half of whom were performing at or above grade level in math. Because the study used an RCT design with low differential attrition, the positive effects can be confidently attributed to the program.

## Key Findings

**Math Achievement: NBA Math Hoops students significantly outperformed peers in math—the equivalent of an 8-percentile-point gain.**

Students in NBA Math Hoops classrooms scored, on average, 0.19 standard deviations higher than their peers in STEM enrichment classrooms—equivalent to a student moving from the 50th to the 58th percentile.

**Social–Emotional Learning (SEL): NBA Math Hoops students had significantly lower SEL levels—but they still scored at moderately high levels on the SEL measures.**

Students in NBA Math Hoops classrooms scored, on average, 0.21 standard deviations lower on the composite SEL measure. However, the predicted post-study mean for the treatment group

remained above the midpoint of the scale, indicating that, on average, students reported moderate-high levels on key SEL measures.

**Fidelity of Implementation: NBA Math Hoops was implemented with high fidelity—most teachers completed nearly all lessons and played games regularly.**

- On average, teachers implemented NBA Math Hoops components on 12 of the 14 or 15 potential days of instruction.
- Teachers completed an average of 8.31 of the 10 lessons.
- The majority of treatment classrooms (71%) saw teachers play more than 10 NBA Math Hoops games over the course of summer camp.
- NBA Math Hoops fostered higher levels of participation, deeper cognitive engagement, and greater retention of mathematical concepts than did control classrooms.

**Variation in Impact by Student Characteristics: NBA Math Hoops produced greater gains for students with stronger incoming math scores.**

- Students who entered the program with stronger math scores benefited even more from NBA Math Hoops than did students with lower incoming math scores.
- The program's effects did not vary significantly based on gender, IEP status, or incoming SEL scores.

**Program Costs and Cost-Effectiveness: NBA Math Hoops can be implemented at low cost.**

Learn Fresh makes NBA Math Hoops free for participating educators and students—covering the costs for the board games, player cards, and shipping and handling.

- Assuming that NBA Math Hoops is integrated into typical summer programming, the cost-effectiveness is \$92.99 per pupil (for the analytic sample) and \$59.23 per pupil (for the study sample) to produce an increase of 1 standard deviation in student math learning.

## Implications

The findings from this study are encouraging for researchers, practitioners, and policymakers focused on accelerating math learning outside of the school day.

- **The impacts on students' math learning are robust.** In roughly 15 days of instruction, students with NBA Math Hoops as their core summer curriculum significantly outperformed comparison students on a rigorous test of math learning.
- **NBA Math Hoops is cost-effective.** An investment of less than \$20 per student beyond normal summer programming costs, such as teachers' salaries, was required for an



increase in math achievement of 0.19 standard deviations. The program could be even more cost-effective for programs that select the virtual option.

- **The program is easy for teachers to use.** With only a few hours of training, coupled with 90-minute blocks of instructional time during the summer, it is feasible for other districts and schools to incorporate NBA Math Hoops into their summer programming.
- **Students consistently enjoyed the experience.** The qualitative data indicate that students consistently enjoyed playing a game that requires mathematical operations and problem-solving. This has implications for game designers—it is possible to carefully design learning experiences for students that are both engaging and educative.

Despite the positive results, the study had certain limitations. It was conducted in one Southern school district with its typical summer student population, so the findings might not directly apply to other district contexts. It was also not practical to randomly assign teachers to NBA Math Hoops or STEM enrichment, so some of the effects could be attributed to the characteristics of teachers who taught each type of summer program. Future studies may be able to attend to these limitations and further strengthen conclusions.



# Introduction

Improving student math achievement has long been a focus of education reform. From 1990 to 2015, students showed steady gains on the National Assessment of Educational Progress (NAEP) math assessment, the Nation's Report Card. But for the past decade, exacerbated by the COVID-19 pandemic, scores have fallen to about where they were in 1990 (National Center for Education Statistics, 2025). Because math continues to serve as a gatekeeper to advanced high school course-taking and career opportunities, it is essential to identify effective approaches to accelerating learning for elementary and middle school students who are not meeting grade-level standards.

Learning acceleration strategies come in many forms, but most involve additional instruction time for the students most in need. Math intervention is a common supplemental approach used in schools during the school day. Students are placed in smaller groups and move in and out of the intervention period based on their specific learning needs and their progress meeting specific standards. High-impact tutoring programs, in which students get individualized, targeted support outside of core instruction, can also be implemented during the school day. Learning acceleration programs can also be delivered outside of the school day and take a variety of forms, from individualized tutoring to small-group and whole-class models.

The evidence base across these acceleration strategies is varied and still evolving, but there are some strong signals of promise. Although few supplemental math intervention programs have been subjected to rigorous independent evaluations, one notable exception is Zearn, a widely used product with a free version. Several independent studies have found positive effects on math learning for elementary students during in-school settings (e.g., Hashim, 2024; Pane et al., 2015, 2025), including a recent quasi-experimental study conducted by WestEd (Huang et al., 2026). The WestEd researchers found that elementary students who used Zearn at least three times a week over the school year performed significantly better on the Virginia state math assessment than a comparable set of students who did not use the product.

High-impact tutoring has perhaps the strongest evidence base for improving student outcomes in both attendance (e.g., Lee et al., 2025) and math learning. For example, a research synthesis found overall strong effects for tutoring on math achievement, with stronger effects seen from



programs led by a teacher or paraprofessional, administered during the school day, and targeted to earlier grades (Abdul Latif Jameel Poverty Action Lab, 2020). There is generally less evidence for learning acceleration approaches administered outside the school day.

This independent evaluation was designed to fill this gap. It focuses on a promising program, NBA Math Hoops, that is widely used in out-of-school time settings and that includes evidence-based design features related to game play and math learning. Learning math through a fun, active game can improve students' attitudes (Lipovsky & Brennan, 2022), help build students' mathematical reasoning and strategic thinking (Russo & Bragg, 2018), and foster healthy social interactions and interpersonal relationships (e.g., Fang et al., 2016; Xu et al., 2011). Math programs that provide students with opportunities to reinforce conceptual understanding, procedural fluency, and problem-solving have long been considered to have a much stronger design than math programs that focus on only one at the expense of the other two (e.g., Kilpatrick et al., 2001; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010; Siegler et al., 2010; Woodward et al., 2012).

As described in more detail in the following section, NBA Math Hoops attends to all three of these components of rigorous math learning. Student players delve into rational-number and data concepts, apply mathematical operations to build fluency, and think strategically in an active problem-solving environment. The game and supporting lessons also focus on the importance of teamwork and sportsmanship, providing opportunities for students to develop stronger interpersonal skills.

## NBA Math Hoops

NBA Math Hoops, developed by the national education nonprofit Learn Fresh in partnership with the NBA and WNBA, is a Science, Technology, Engineering, and Mathematics (STEM) learning program designed to transform students' relationship with math through basketball. As they play an interactive board game and complete associated lessons built around real NBA and WNBA player statistics, students have opportunities to build fluency in arithmetic, fractions, decimals, percentages, and data analysis while developing skills in critical thinking, problem-solving, and collaboration.

Since its national launch in 2012, NBA Math Hoops has reached over 1.4 million students across all 50 states and 13 countries. Learn Fresh uses a capacity-building model that trains and equips educators, coaches, and program leaders across both school-day and out-of-school-time settings to implement the program in their own learning spaces. This scalable approach has enabled NBA Math Hoops to successfully operate in classrooms, after-school programs, community centers, libraries, and summer learning sites—particularly in underresourced communities where culturally relevant, high-engagement math programs are welcomed.

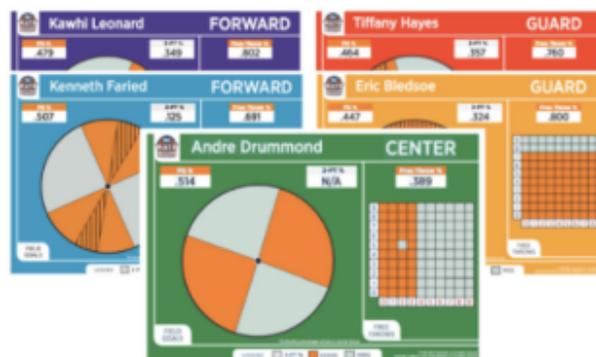


The program has received several awards, such as the Reimagine Education Awards (2019 & 2020), Choice Brain Toy Award, and Transform Awards North America. It has also been profiled in national media outlets such as Good Morning America, Education Week, and Forbes. Internal and external formative evaluations of the program have consistently shown gains in students' math fluency, higher order reasoning, and student confidence, particularly among students in underserved communities.

## How NBA Math Hoops Is Played

NBA Math Hoops is an interactive board game in which pairs of students compete against each other to reach the highest score. Each team selects five NBA and WNBA players to be on their team, represented by cards with each player's actual shooting statistics. The game board looks like a full basketball court with circles surrounding each basket indicating typical 2-point and 3-point shooting locations. The circles on one half of the court contain odd numbers and the other half even (see Figure 1).

**Figure 1. NBA Math Hoops Game Board and Player Cards**



Each turn of the game involves several steps. To begin, a team rolls two 10-sided dice and records the resulting numbers—such as a 6 and 3. Next, they add, subtract, multiply, and divide the two numbers and record those results, which would be  $9(6 + 3)$ ,  $3(6 - 3)$ ,  $18(6 \times 3)$ , and  $2(6/3)$ . Teams select a circle on their side of the court that matches one of the even or odd numbers. They then look at their player cards and select the player who has the best chance of making a shot from that location. To shoot from that spot, teams place a clear spinner on top of the selected player's circle chart and spin the spinner. If the spinner lands on the orange portion of the card, they make the shot. If it lands on the grey portion, they miss it. Regardless of the result, it is the next team's turn. Teams repeat this process for 10 minutes, switch sides of the court at halftime, and then play the second half. The team with the most points at the end of the second half is the winner.



## NBA Math Hoops Implementation

While the game is the central component of NBA Math Hoops, the program also includes 10 lessons that support students in learning the game, developing more advanced strategies of game play, and developing mathematical fluency and problem-solving. Teachers are typically trained in a 2-to-3-hour session, which involves learning the rules of the game, playing the game, reviewing the lessons and game materials, and planning for implementation.

## Examining Impact, Implementation, and Cost-Effectiveness

To evaluate the program's effectiveness, WestEd conducted a 2-year randomized controlled trial in a summer enrichment program serving rising 4th, 5th, and 6th graders in an urban Southern school district. The research questions examined the program's impact on math and social-emotional outcomes, as well as how consistently it was implemented, which students benefited most, and what it costs to deliver.

### Confirmatory Research Question

1. What is the impact of NBA Math Hoops on students' math learning compared to business-as-usual summer STEM programming at the end of summer enrichment camp and the spring of the following school year?

### Exploratory Research Questions

2. What is the impact of NBA Math Hoops on students' self-efficacy, math interest value, math utility value, self-management, and social awareness compared to business-as-usual summer STEM programming at the end of summer school and the spring of the following school year?
3. To what extent was the NBA Math Hoops program implemented with high levels of fidelity as measured with indicators of dosage, adherence, and quality of implementation?
4. To what extent do student characteristics moderate the impact of NBA Math Hoops on students' math learning, self-efficacy, math interest value, math utility value, self-management, and social awareness when compared to business-as-usual summer STEM?
5. What is the per-pupil cost of implementing the NBA Math Hoops Summer program and its overall cost-effectiveness?

# About This Study

## Study Design

This study was a randomized controlled trial conducted in an urban school district in the Southern United States over two summers, 2024 (Cohort 1) and 2025 (Cohort 2). Students were randomly assigned to either (a) an NBA Math Hoops classroom or (b) a comparison classroom receiving the district's "business-as-usual" STEM enrichment instruction, which covered a mix of science, technology, engineering, and math topics. Because the study used a randomized controlled trial design with low differential attrition, the positive effects found by the study (as detailed in the Results section below) can be confidently attributed to the NBA Math Hoops program.

## Who Participated

The study took place during a free, district-run summer enrichment camp serving rising 4th, 5th, and 6th grade students. The final analytic sample included 256 students—130 in the comparison condition and 126 in the NBA Math Hoops condition. The large majority of students (95%) identified as Black, slightly more than half were female, and fewer than half were performing at or above grade level in math at the end of the prior school year. A total of 11 teachers participated as NBA Math Hoops teachers and 26 as STEM enrichment teachers, the large majority of whom were certified teachers with more than 3 years of teaching experience.

## What Was Measured

Students completed a math assessment and a social–emotional learning (SEL) survey at the beginning and end of the summer camp. The math assessment measured students' operational fluency, number operations, fractions and decimals, and data and probability skills. It included validated items from the National Assessment of Educational Progress (NAEP). The SEL survey measured math self-efficacy, math interest value, math utility value, and self-management and social awareness. Researchers and trained interns also conducted classroom observations and teacher and student interviews, and they collected daily instructional logs from teachers.

## How the Data Were Analyzed

The research team compared post-study math and SEL scores between the two groups using statistical models that accounted for students' starting scores, gender, and special education



status. The study also examined whether effects differed across student characteristics and calculated the per-pupil cost and cost-effectiveness of the program.

For a complete description of the study's design, participants, measures, and analysis, see Appendix A. Method.

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## Confirmatory Results

The Confirmatory Results and Exploratory Results sections present findings across the study's five research questions. Before examination of outcomes, there are a couple of points worth noting:

- **Baseline Comparability.** Prior to the intervention, students in the treatment and control groups were at similar levels of math achievement and math self-efficacy (though the control group reported higher math values and self-management and social awareness—see Table A3 in Appendix A for details).
- **Attrition.** Of the 489 students enrolled in the study, 37 opted out and an additional 233 did not have complete pre- and post- assessment data—largely because many students attended only part of the summer camp due to travel and other obligations. This resulted in an analytic sample of 256 students, reflecting an overall attrition rate of 48 percent. However, the difference in attrition between the treatment and control conditions was only 2 percentage points (supporting confidence in the comparisons that follow).

### Research Question 1: Impact on Math Achievement

NBA Math Hoops students significantly outperformed peers in math—the equivalent of an 8-percentile-point gain.

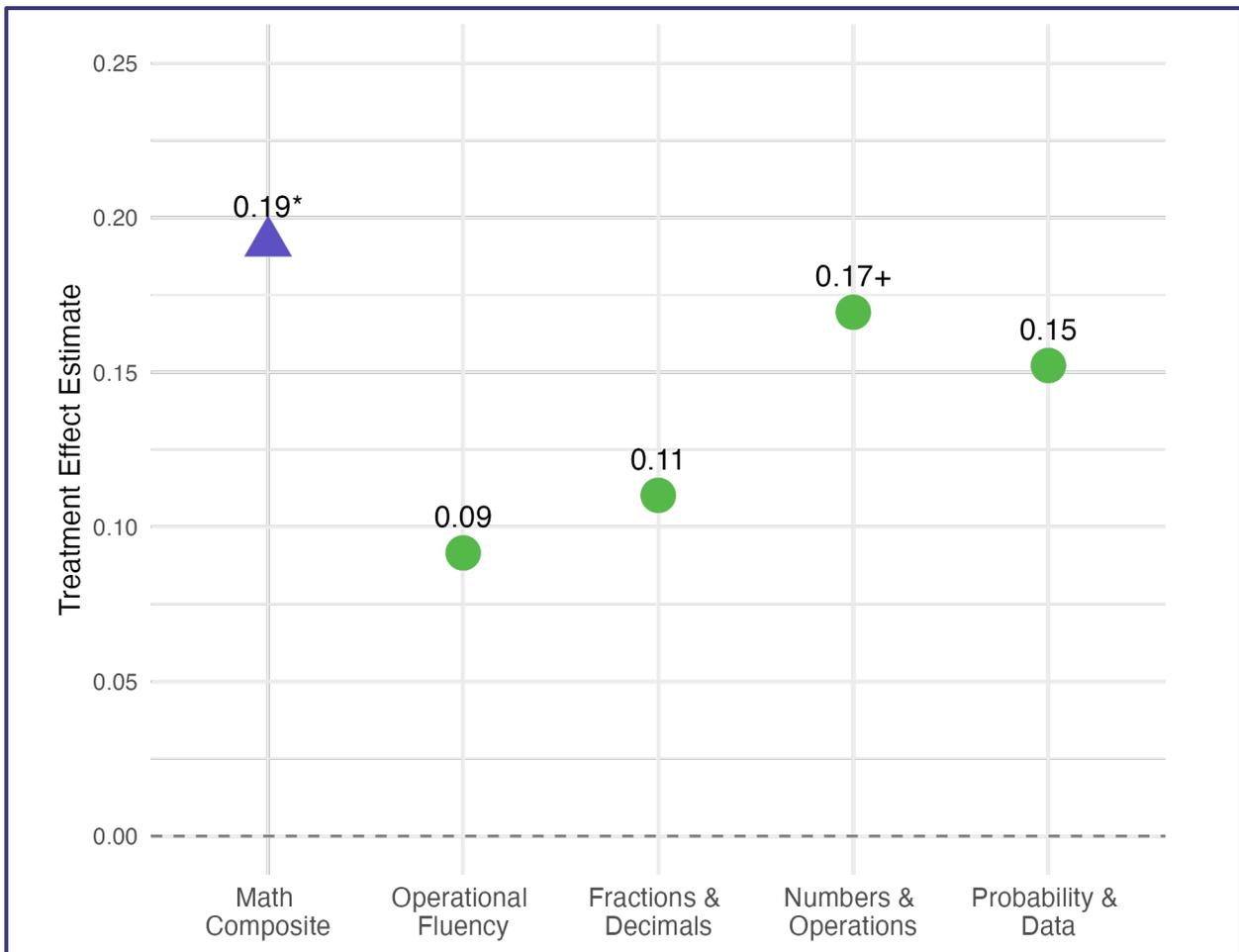
Regression estimates indicate that there was a significant difference between the composite math score of students in the treatment condition as compared to the control condition ( $\beta = 0.19$ ,  $p < 0.05$ ), controlling for pre-math composite score, pre-SEL composite score, gender, and individualized education program (IEP) status. Main effects are plotted in Figure 2 in effect size units (see detailed results in Table B1). These results indicate that **students in NBA Math Hoops classrooms scored, on average, 0.19 standard deviations higher than their peers in**

**STEM enrichment classrooms** in summer camp. This difference is equivalent to a student in the 50th percentile moving to the 58th percentile, an 8-percentile rank change.

To further explore if there are differential impacts on subscores of the composite score, we ran exploratory analyses with each standardized math subscore as the outcome and included the corresponding pre-subscore as a predictor in the model. These results are also shown in Figure 2 (see detailed results in Table B1).

Exploratory analyses indicated that the largest contributors to the significant difference in the composite math score were Numbers and Operations ( $\beta = 0.17$ ,  $p < 0.10$ ) and Probability and Data ( $\beta = 0.15$ ,  $p > 0.10$ ). The average impacts on the other math subscores were also positive (Figure 2).

**Figure 2. Estimated Impact of NBA Math Hoops on Math Achievement**



Note. Purple triangle = composite outcome. Green circles = subscores.

+ =  $p < 0.1$ , \* $p < 0.05$ , \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .

# Exploratory Results

The exploratory research questions allowed us to explore the potential impacts of NBA Math Hoops beyond math achievement, the instructional context in which this study took place, the potential variable impacts of NBA Math Hoops based on student characteristics, and the cost-effectiveness of NBA Math Hoops based on this study. The answers to these research questions provide important context for understanding the confirmatory results presented above and can provide guidance for future research of this program.

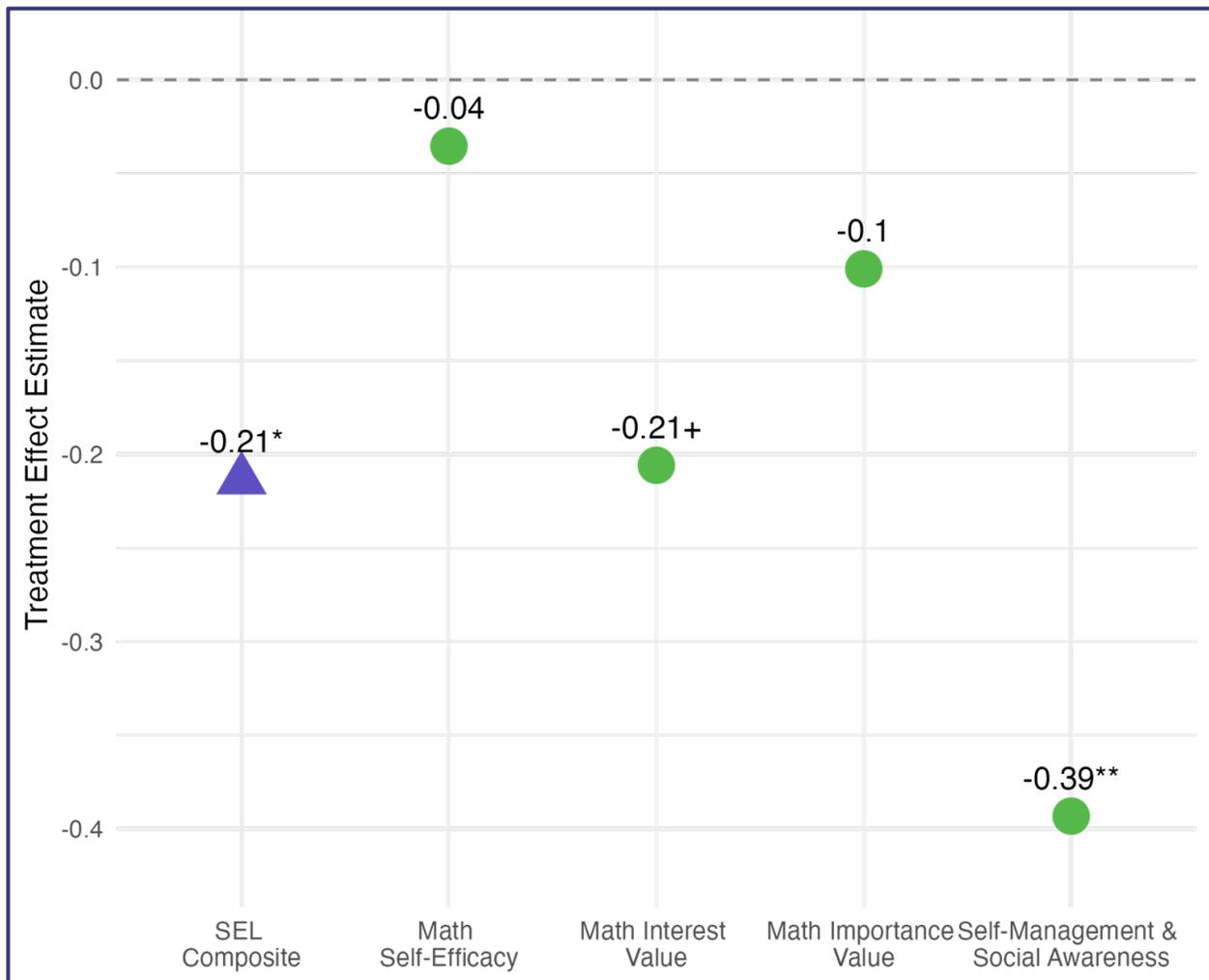
## Research Question 2: Impact on Social–Emotional Learning

NBA Math Hoops students had significantly lower SEL levels—but they still scored at moderately high levels on the SEL measures.

Regression estimates indicate that there was a significant difference between the composite SEL score of students in the treatment condition as compared to the control condition ( $\beta = 0. -21$ ,  $p < 0.05$ ), controlling for pre-math composite score, pre-SEL composite score, gender, and IEP status. Results are presented in Figure 3 in effect size units (see detailed results in Table B2). These results indicate that **students in NBA Math Hoops classrooms scored, on average, 0.21 standard deviations lower than their peers in STEM enrichment classrooms** in summer camp. This difference is equivalent to a student in the 50th percentile moving to the 42nd percentile, an 8-percentile rank decrease.

As shown in Figure 3, exploratory analyses indicated that the largest contributors to the significant difference in the composite SEL score were self-management and social awareness ( $\beta = -0.39$ ,  $p < 0.001$ ) and math interest ( $\beta = -0.21$ ,  $p < 0.05$ ). The average impacts on the other SEL scales were also negative. For context, the post-self-management and social awareness scale had a mean of 3.56 and a standard deviation of 0.71 in the control group (Table A3). The post-math interest value scale had a mean of 3.44 and a standard deviation of 0.93 in the control group. In this context, the estimated difference in the raw scale between control and treatment on these two scales was 0.28 for self-management and social awareness and 0.19 for math interest value. In both cases the raw post- mean and predicted post- mean for the treatment group was above the midpoint of the scale, indicating that, on average, students reported moderate-high levels of each of these measures.

**Figure 3. Estimated Impact of NBA Math Hoops on Social–Emotional Learning**



Note. Purple triangle = composite outcome, green circles = subscores.

+ =  $p < 0.1$ , \* $p < 0.05$ , \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .

### Research Question 3: Fidelity of Implementation

NBA Math Hoops was implemented with high fidelity—most teachers completed nearly all lessons and played games regularly.

#### Adherence: Teachers Taught an Average of 8 of the 10 Total NBA Math Hoops Lessons

On average, teachers reported implementing NBA Math Hoops components (i.e., a lesson or a game) on 12 of the 14 or 15 potential days of instruction at each site. Schools also often

held assemblies or went on field trips, which prevented NBA Math Hoops instruction during those activities.

### Lesson Implementation

Teachers reported teaching some or all of NBA Math Hoops lessons on an average of **8.44 days, completing an average of 8.31 of the 10 NBA Math Hoops lessons** (Table 1). All but three teachers completed at least 8 lessons.

**Table 1. Mean Number of NBA Math Hoops Lessons and Games Played, by Teacher**

Component	Mean (Standard Deviation)	Range
Logs completed	14.25 (0.58)	[13, 15]
# of logs with NBA Math Hoops	12 (1.59)	[10, 15]
# of logs with NBA Math Hoops lesson	8.44 (2.42)	[5, 14]
# of lessons taught	8.31 (1.4)	[5, 10]
# of logs with NBA Math Hoops game(s)	6.31 (3.44)	[1, 12]
# of games played	14.5 (8.82)	[2, 36]

### Game Play

After completing introductory sessions that explained the rules of the game, teachers were expected to play NBA Math Hoops at least once per day of summer school. This amounted to roughly 10 games over the 14.5 day summer session.

Teachers engaged students in playing NBA Math Hoops Games on an average of 6.31 days of summer camp, completing an average of 14.5 games played in each NBA Math Hoops classroom. In the **majority of treatment classrooms, teachers (71%) played more than 10 NBA Math Hoops games over the course of summer camp**. Table 2 below summarizes the range of NBA Math Hoops games played in each classroom.



**Table 2. Range of NBA Math Hoops Games Played, by Classroom**

NBA Math Hoops games played	# of classrooms
0	0
1–5	2
6–9	4
10+	15

### Lesson and Game Implementation Combined

To understand how teachers implemented the different components of the NBA Math Hoops program together, we categorized teachers into two levels of lesson implementation (at least 9 lessons and fewer than 9 lessons) and game implementation (at least 10 games played and fewer than 10 games played). **Nearly half of the classrooms implemented at least 9 lessons and 10 games** (Table 3). Three of the four classes that implemented at least 9 lessons but fewer than 10 games, played 8 games, nearly reaching the ideal level of adherence.

**Table 3. NBA Math Hoops Lessons Taught and Games Played**

	< 9 lessons (number of classrooms)	9 or more lessons (number of classrooms)
<8 games played	1	1
8 or 9 games played	1	3
10 or more games played	5	10

### Treatment Contrast: What Control Classrooms Were Teaching

Control teachers completed a total of 326 logs indicating they covered a combination of STEM and nonacademic topics. Table 4 shows the percentage of logs in which teachers reported covering STEM and nonacademic topics. **A majority (52%) of the control classrooms' STEM enrichment instruction covered topics in science.** Instruction also included math (27% of logs),



technology (17% of logs), and engineering (17% of logs). Table 4 further shows that **when STEM enrichment teachers covered math topics, they were most likely to cover numbers and operations (59%) and other (22%) topics.**

**Table 4. Topics Taught in STEM Enrichment**

Topic	% of logs
Any STEM	89
Science	52
Technology	17
Engineering	17
Math	27
Numbers & operations	59
Rational numbers	11
Probability	5
Data	3
Geometry	1
Other	22

### **Dosage: Students in the Study Sample Attended More Than 80 Percent of Camp Days on Average**

As stated earlier, on average, treatment classrooms had NBA Math Hoops–related instruction on 12 of the 14 or 15 available days of summer camp. Student dosage also depended on individual attendance. While overall summer camp attendance was quite low compared to the school year, many students with lower attendance rates were not included in the study sample because they were not present on the post-assessment and survey administration or make-up days. This resulted in higher attendance rates, on average, for students in the study—86 percent of camp days in the control condition and 81 percent of camp days in the treatment condition (Table 5).



**Table 5. Student Summer Attendance by Condition**

Condition	Mean (SD)
Control	0.86 (0.14)
Treatment	0.81 (0.17)

**Quality: NBA Math Hoops Classrooms Fostered Higher Participation, Engagement, and Retention of Math Concepts Than Did Control Classrooms**

Based on classroom observations and on student and teacher interviews, there were differences between classrooms engaged in NBA Math Hoops as compared to the STEM enrichment control classrooms (Table 6).

NBA Math Hoops classrooms emphasized interactive, game-based learning, often using real-world connections to basketball. Overall, **NBA Math Hoops fostered higher levels of participation, deeper cognitive engagement, and greater retention of mathematical concepts.**

In contrast, the **control classrooms' STEM instruction varied significantly**, blending some hands-on activities with mostly traditional instructional methods.

**Table 6. Observed Teaching Strategies and Student Behaviors by Condition**

Category	NBA Math Hoops	STEM enrichment
Teaching strategies	<ul style="list-style-type: none"> <li>• Interactive, game-based, and collaborative learning</li> <li>• Real-world connections to basketball</li> <li>• Competition and storytelling enhance engagement</li> <li>• Encourages productive struggle with students by exploring solutions before providing direct answers</li> </ul>	<ul style="list-style-type: none"> <li>• Structured, content-driven learning</li> <li>• Mix of hands-on and traditional methods</li> <li>• Some creative problem-solving activities, but often relied on worksheets, videos, and direct instruction</li> <li>• Teachers provide direct answers, limiting productive struggle</li> </ul>



Category	NBA Math Hoops	STEM enrichment
<b>Student engagement and behavior</b>	<ul style="list-style-type: none"> <li>• Highly engaged, excited, and actively participating, especially during game-based lessons</li> <li>• Sports connections increase motivation</li> <li>• Collaborative classrooms with students helping each other</li> </ul>	<ul style="list-style-type: none"> <li>• Varied engagement</li> <li>• High participation during few hands-on activities like engineering projects</li> <li>• Lower engagement with traditional instruction</li> <li>• Some students were disengaged or distracted</li> </ul>

## Teaching Strategies

### *NBA Math Hoops Classrooms*

NBA Math Hoops employed interactive, game-based, and collaborative teaching methods, often drawing real-world connections to basketball. **Teachers in NBA Math Hoops classrooms frequently used storytelling, competition, and hands-on tools to enhance engagement and understanding.** For example, one teacher used “reading aloud, worksheets, and the games” to create a dynamic learning environment while connecting lessons to real-world applications by using “[NBA Math] basketball concepts like free throws and shot clocks to teach percentages.” (Quotations are taken directly from interviews.) This approach **encouraged productive struggle**, allowing students to explore solutions independently before receiving direct answers. Treatment classroom **teachers were also highly responsive**, often adjusting their methods based on student engagement.

### *Control Classrooms*

Instruction in the STEM enrichment control classrooms, by contrast, was more varied, blending hands-on activities with traditional, content-driven approaches. Some STEM classes engaged students through creative problem-solving and experimentation. For instance, in one class students participated in “rocket launches, teamwork, and predicting outcomes.” However, other STEM classrooms leaned heavily on worksheets, videos, and direct instruction, including lessons classified by observers as “call and response throughout.”

## Student Engagement and Behavior

### *NBA Math Hoops Classrooms*

Students in NBA Math Hoops classrooms consistently **demonstrated high levels of enthusiasm, collaboration, and active participation.** In contrast to call-and-response patterns seen in some STEM enrichment classes, observers documented activities and students working together. For instance, in one classroom an observer noted, “Two groups played against each other ... the competition was high.” One teacher noted that “students worked in groups to play the game



and took shots on the virtual board,” underscoring the interactive nature of the NBA Math Hoops program.

### **Control Classrooms**

Engagement in STEM enrichment classrooms varied significantly based on the instructional approach. Hands-on, project-based lessons were used and described as students being “immersed in their engineering process.” Other, more traditional instruction approaches were less interactive and featured less engagement. For example, one teacher noted that “a couple of students ... slept during moments without instruction.”

## **Research Question 4: Variation in Impact by Student Characteristics**

NBA Math Hoops produced greater gains for students with stronger incoming math scores.

### **Variation in Impact on Math Achievement by Student Characteristics**

Results of exploratory analyses examining the interaction of NBA Math Hoops and student gender, IEP status, pre-math composite score, and pre-SEL composite score are shown in Figure 4 (detailed results in Table B3). Results indicated that there was a significant interaction between pre-math composite score and treatment ( $\beta = 0.26$ ,  $p < 0.01$ ) and that there was no significant interaction with the other covariates explored in this manner.

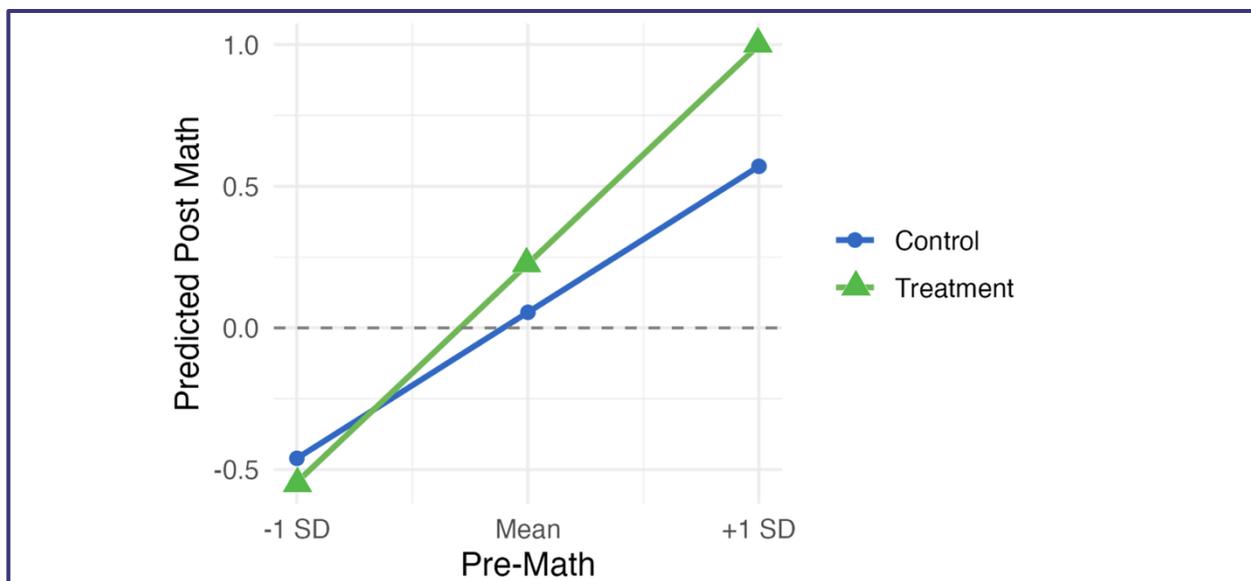
That is, **students who entered the program with stronger math scores benefited even more from NBA Math Hoops than did students with lower incoming math scores.** The program’s effects did not vary significantly based on gender, IEP status, or incoming SEL scores.

These findings are illustrated by Figure 4, which shows the predicted post-math composite score ( $y$ -axis) for students in treatment (green line with the triangles) and control (blue line with the circles) based on their standardized pre-math score ( $x$ -axis), holding other characteristics equal. The dots show the predicted performance of treatment and control students with pre-math composite performance 1 standard deviation below the mean, at the mean, and 1 standard deviation above the mean. In the graph, estimated post-math composite scores are based on students who are girls without IEPs, who have mean SEL composite scores, and who were in the median block in terms of post-math performance. On the left-hand side of the graph, the control line starts at a slightly higher level of predicted performance than the treatment line.

**Students who started the study about 1 standard deviation below their peers (~16th percentile) were predicted to perform similarly whether they were in the treatment or**

**control group.** As pre-math scores increase, moving right on the graph, the two lines cross, with predicted treatment post-math scores becoming higher than for control. For **students at the mean pre-math score (~50th percentile), the treatment group students were predicted to outperform their peers by about 1 quarter of a standard deviation.** As pre-math scores continue to increase to the right, the distance between the treatment and control lines widens. For **students with pre-math scores 1 standard deviation higher than their peers (~84th percentile), their predicted post-math scores were about 1 half of a standard deviation higher than their peers.**

**Figure 4. Predicted Post- Math Achievement by Pre- Math Achievement Score**



### Variation in SEL Effects by Student Characteristics

Results of exploratory analyses examining the interaction of NBA Math Hoops and student gender, IEP status, pre-math composite score, and pre-SEL composite score are shown in Table 7. Results indicated that there was a significant interaction between pre-math composite score and treatment ( $\beta = 0.26$ ,  $p < 0.01$ ) and that there was no significant interaction with the other covariates explored in this manner. **The program's effects did not vary significantly based on gender, IEP status, or incoming SEL scores.**



**Table 7. Variation in SEL Treatment Effects by Student Characteristics**

	SEL—gender interaction	SEL—IEP interaction	SEL—pre-math interaction	Math—pre-SEL interaction
Intercept	0.073 (0.275)	0.127 (0.250)	0.149 (0.252)	0.131 (0.251)
Treatment	-0.140 (0.164)	-0.223 (0.102)*	-0.225 (0.096)*	-0.208 (0.090)*
Math composite pre-	-0.002 (0.071)	-0.002 (0.071)	-0.082 (0.065)	-0.003 (0.071)
SEL composite pre-	0.619 (0.065)***	0.615 (0.064)***	0.612 (0.063)***	0.600 (0.093)***
Female	0.068 (0.164)	-0.003 (0.115)	0.012 (0.116)	-0.004 (0.118)
IEP	-0.160 (0.248)	-0.194 (0.480)	-0.158 (0.246)	-0.152 (0.248)
Interaction: Treatment x...				
Female	-0.140 (0.222)			
IEP		0.070 (0.508)		
Math composite pre-			0.143 (0.073)+	
SEL composite pre-				0.031 (0.127)
# of observations	253	253	253	253
R2	0.550	0.549	0.553	0.549

These findings are illustrated by Figure 5, which shows the expected post-SEL score (y-axis) for students in treatment (green line with triangles) and control (blue line with circles) based on their standardized pre-math score (x-axis), holding other characteristics equal. The dots show the predicted performance of treatment and control students with pre-math performance 1 standard deviation below the mean, at the mean, and 1 standard deviation above the mean. In the graph, estimated post-SEL scores are based on students who are girls without IEPs, who have mean SEL composite scores, and who were in the median block in terms of post-SEL level.



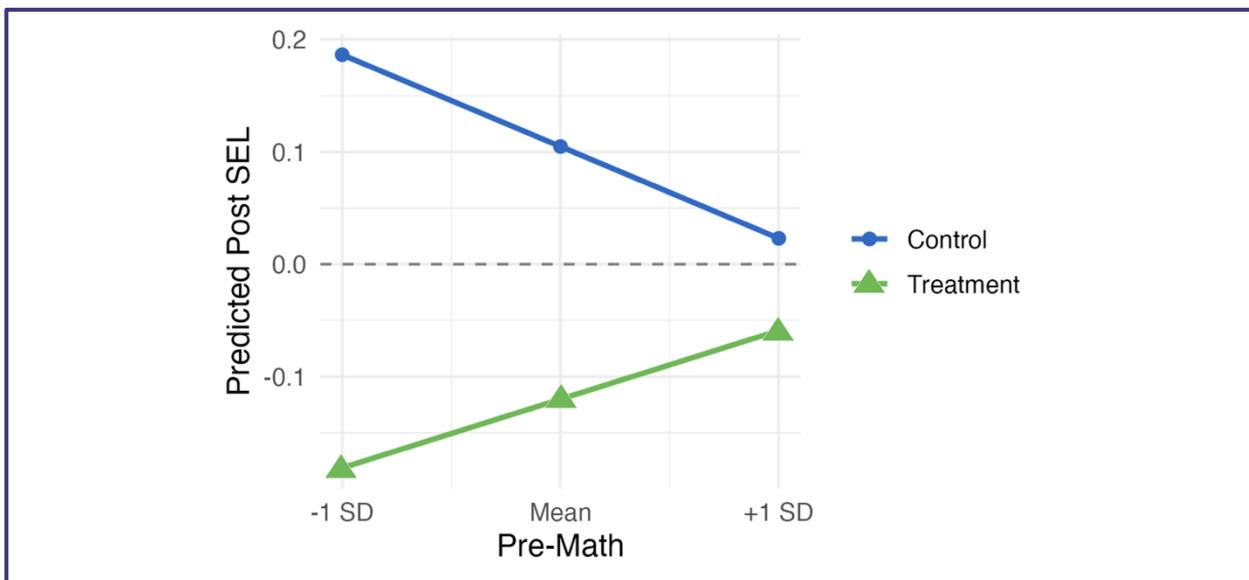
On the left-hand side of the graph, the control line starts at a much higher level of predicted post-SEL than the treatment line.

**Students in the control group who started the study about 1 standard deviation below their peers in the study (~16th percentile) are predicted to have SEL levels about 0.36 standard deviations higher than similar peers in the treatment group.** For context, the raw individual post-SEL survey scales, which range from 1 to 5 with a midpoint of 3, had post- means between 3.35 and 4.22 and post- standard deviations of 0.7 to 1 (Table A3). In this context, these predicted differences for students with pre-math scores 1 standard deviation below the mean are about 0.3 to 0.5 on the raw scales. And the predicted post-SEL mean levels are above the midpoint of the scale for both treatment and control students. Moving right on the graph, as pre-math scores increase, the two lines become closer together, indicating a decreasing difference in impact for students with higher starting math scores.

**For students at the mean pre-math score (~50th percentile), students in the control group are predicted to have higher post-SEL than their similar peers in the treatment group by about 0.22 standard deviations.** As pre-math scores continue to increase to the right, the distance between the treatment and control lines narrows further.

**For students with pre-math scores 1 standard deviation higher than their peers (~84th percentile), the control group predicted post-SEL score is about 0.1 standard deviations higher than their peers in the treatment group.**

**Figure 5. Predicted Post- SEL Level by Pre- Math Achievement Score**



## Research Question 5: Program Costs and Cost-Effectiveness

### NBA Math Hoops Can Be Implemented at Low Cost

Learn Fresh makes NBA Math Hoops free for participating educators and students. Learn Fresh covers the costs for the board games, player cards, and shipping and handling to program sites.

#### Program Costs

Costs that the program sites need to cover include time and travel for NBA Math Hoops trainers to prepare teachers to use the program,<sup>1</sup> summer teacher salaries for teachers implementing the program, and time for teachers to be trained on NBA Math Hoops.

Table 8 presents the costs associated with implementing NBA Math Hoops for the study's analytic sample ( $n = 256$ ) and for the total number of students who were originally part of the study ( $n = 489$ ) but who either opted out or had incomplete data.

**Table 8. Program Costs**

	Cost	Cost per student analytic sample ( $n = 256$ )	Cost per student total students ( $n = 489$ )
Materials, shipping, and handling <sup>a</sup>	\$102.07	\$4.25	\$4.25
Time and travel for in-person trainers	\$3,481.78	\$13.60	\$7.12
Teacher salaries	\$41,040.00	\$160.31	\$83.93
Teacher time for training	\$1,600.00	\$6.25	\$3.27
<b>Total per pupil</b>		<b>\$184.41</b>	<b>\$98.57</b>
<b>Total materials and training</b>		<b>\$17.85</b>	<b>\$11.37</b>

<sup>a</sup> Costs for Learn Fresh's materials and for shipping and handling fees apply to each class section of 24 students:  $\$102.07/24 = \$4.25/\text{pupil}$ . Since the game is free for participating programs, these costs are not absorbed for participating programs.

<sup>1</sup> Learn Fresh does offer programs a virtual training option, which is \$88.90 per program site, regardless of the number of participants. This accounts for 2 hours of one NBA Math Hoops staff to deliver the virtual training.



The per-pupil student cost for the study and total study samples, are \$184.41 and \$98.57, respectively. The table also presents the costs for materials and in-person training, since teacher salaries and trainings for new programming are typically part of district summer programming budgets. These costs are \$17.85 per pupil for the analytic sample and \$11.37 for the total study sample.

### Cost-Effectiveness

As stated earlier, NBA Math Hoops produced an impact of 0.19 standard deviations on the study's composite measure of math achievement. That is, students in NBA Math Hoops scored, on average, the equivalent of an 8 percentile point gain over their peers in the comparison group.

To determine the cost-effectiveness ratio of the program, we calculated the cost per student associated with the estimated average increase in math achievement observed in this study. On average, the NBA Math Hoops program required an investment of **\$184.41 per student in the analytic sample to realize and average achievement increase of 0.19 standard deviations**. For the total study sample, and assuming the average impact was the same for students not in the analytic sample, it would require an investment of \$98.57 to realize an average increase in math achievement of 0.19 standard deviations. **Assuming that NBA Math Hoops is integrated into typical summer programming, the cost-effectiveness ratio is reduced to \$17.85 and \$11.37 per student, respectively, to realize an increase of 0.19 standard deviations.**

### Cost Savings of Virtual Training

NBA Math Hoops offers both in-person and virtual training to support educators in implementing the game with students. The teachers in this study only received in-person training. This study did not test the effects of NBA Math Hoops virtual training, so the results do not necessarily apply to this mode of delivery. However, the virtual training is widely used, and NBA Math Hoops reports high levels of teacher satisfaction with the virtual training and of comfort leading the program in their respective program sites post-training. **The costs for the virtual training would have been less than 35 cents per student for this study.** Considering that NBA Math Hoops virtual training and materials are free to participating programs, sites that opt for the virtual training and integrate NBA Math Hoops into their typical summer programming could do so at no additional cost.

# Discussion

The findings from this study are encouraging for researchers, practitioners, and policymakers focused on accelerating math learning outside of the school day.

First, **the impacts on students' math learning are robust**. In roughly 15 days of instruction, students with NBA Math Hoops as their core summer curriculum significantly outperformed comparison students on a rigorous test of math learning. Because the study was a randomized controlled trial design with low differential attrition, these positive effects can be confidently attributed to the program.

Second, **NBA Math Hoops is cost-effective**. An investment of less than \$20 per student could produce an average increase of 0.19 standard deviations in students' math achievement. And while the study did not test the program's free virtual teacher training option, it is widely used and free for participating programs. This means that the program could be even more cost-effective for programs that select the virtual option and integrate NBA Math Hoops into their standard summer programming.

Third, the **program is easy for teachers to use**. With only a few hours of training, coupled with 90-minute blocks of instructional time during the summer, it is feasible for other districts and schools to incorporate NBA Math Hoops into their summer programming.

Finally, the qualitative data from the study indicate that **students consistently enjoyed playing a game that requires mathematical operations and problem-solving**. This has implications for game designers. It is possible to carefully design learning experiences for students that are both engaging and educative. Future game designers might consider the structure of games like NBA Math Hoops, in which math is integrated into game play and strategy rather than treated as an "add-on."

Despite these positive results, every study has limitations. This study was conducted in one Southern school district with its typical summer student population, so these findings might not directly apply to other district contexts. It was also not practical to randomly assign teachers to NBA Math Hoops or STEM enrichment, so some of the effects could be attributed to the characteristics of teachers who taught each type of summer program. Future studies may be able to attend to these limitations and further strengthen conclusions.



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# Appendix A. Method

## Context

This study took place during a summer enrichment camp provided by an urban school district in the southern United States. The district serves about 15,000 students. In the summers of 2024 and 2025, the district held a summer enrichment camp in the month of June that was free to attend for any student in the district.

The camp was located in elementary school and middle school buildings across the district both summers. Students who expressed interest in attending the camp were assigned to a school site based on the school they attended during the school year and their grade level. Rising 4th and 5th graders attended elementary school sites, while rising 6th graders, having just completed elementary school, attended middle school sites. Each summer school site served as the camp site for students who attended a set of geographically proximal schools during the school year. In 2024 (Cohort 1) and 2025 (Cohort 2), the summer camp was held at five and four elementary schools, respectively. Three middle schools served as summer school sites both summers.

The camp was in session for 19 days in each summer and included a morning STEM enrichment block taught by district teachers. This study took place during the STEM enrichment block for rising 4th, 5th, and 6th graders attending the camp in both summers. During this block, students received either 75 minutes of NBA Math Hoops instruction or 75 minutes of STEM enrichment instruction on each day of camp when special activities, like field trips or assemblies, were not taking place. In both summers, academic instruction took place on 14 to 15 of the 19 days of the camp, depending on the school site. The days without academic instruction involved time taken by the study to administer pre- and post- measures and the school sites holding assemblies and going on field trips.

At some school sites, projected enrollment was high enough to accommodate four classes of students. In these cases, one teacher at each site was trained to implement NBA Math Hoops and the other three teachers taught STEM. Two of the STEM teachers taught the control students for the entire morning enrichment block. One of the three STEM teachers taught the treatment students STEM enrichment during the time when the other treatment class was receiving NBA Math Hoops instruction. So, one treatment class would attend NBA Math Hoops with the NBA Math Hoops teacher while the other treatment class attended a STEM enrichment class with the third STEM teacher. Then the two treatment classes would switch, and the second treatment class attended NBA Math Hoops while the first attended STEM class in the second half of the morning enrichment block.



## Teacher Training and Study Preparation

Prior to the 2024 (Cohort 1) and 2025 (Cohort 2) summer sessions, teachers received virtual training on the design of the research study. WestEd researchers led the study training, which described expectations for participating in a randomized controlled trial and an overview of data collection dates and procedures. Teachers assigned to teach NBA Math Hoops received 2 hours of in-person training led by Learn Fresh staff. The training focused on how to play the game and implement the associated lessons, as well as expectations for use over the 19-day summer camp. In Cohort 2, STEM enrichment teachers attended district-provided professional development to learn how to use a new STEM enrichment program provided by the district.

After the trainings and as soon as student rosters were available, teachers were assigned to the treatment or control group at each summer school site in both summers. Teachers in the treatment group were asked to use NBA Math Hoops as their primary instructional materials while control teachers were asked to teach with their normal STEM enrichment materials. All participating teachers were asked not to deviate from these planned instructional materials and not to assign students to different classrooms or conditions after randomization.

Given the large number of summer school sites and sections within sites, WestEd trained local college students studying to become teachers as interns to help the study team monitor parental consent documentation, administer the study's pre- and post- math assessment and social-emotional learning (SEL) survey, and observe classrooms.

## Participants

### Teachers

Participating teachers were employed by and hired by the district to work as instructors in the summer camp. When possible, math teachers were hired to teach NBA Math Hoops and science teachers were hired to teach STEM. The district assigned teachers to teach NBA Math Hoops or STEM enrichment. All teachers consented to participate in the study and received a short research orientation to ensure they understood what was required of them.

A total of 11 teachers participated in the study as NBA Math Hoops teachers, with five of those teachers participating in both cohorts. A total of 26 teachers participated in the study as STEM enrichment teachers, with four of those teachers participating in both cohorts. Of those 26 teachers, 5 taught STEM enrichment to treatment students when they were not in NBA Math Hoops instruction during the morning instructional block, with the remaining 21 teaching STEM enrichment to students in the control condition. A large majority of participating teachers (>85%) were certified teachers with more than 3 years of teaching experience, had previously taught summer school, and identified as Black women. More than half of participating teachers had at least 10 years of teaching experience.



## Students

Participating students were rising 4th, 5th, and 6th grade students attending the district summer camp and enrolled in one of the participating teachers' classes during the morning STEM enrichment program. An informational letter detailing the study, including its benefits and risks, was sent home to students' families with a form to return if a student's family wanted to opt them out of participating in the study. Opting out of the study did not impact any student's experience in summer camp or during the school year. Students were read an informational script about the study and were provided time to ask any questions they had about it.

### Sample Size and Attrition Rate

Across the two cohorts of the study, a total of 489 rising 4th, 5th, and 6th grade students were enrolled in the district summer camp and assigned to one of the classrooms participating in the study prior to randomization (see **Error! Reference source not found.A1**). Any students who joined the program after randomization occurred were excluded from study eligibility. In Cohort 1, the first day of camp saw many delays to start the day, including reports that the buses that many families relied on to get their children to camp were late or did not run at all. As a result, we included students who first attended on the second day of camp for the first cohort. We asked teachers to have those students in STEM enrichment classrooms until the third day of camp. After the second day of camp in Cohort 1, we randomly assigned any new students, using a similar blocking scheme as on Day 1, when possible. We then shared updated rosters with site leaders and teachers that included these new students. Table A1 shows overall program enrollment, sources of attrition, and attrition rate for the entire sample, as well as control and treatment conditions.

**Table A1. Student Sample Size and Attrition Rate**

Students	Overall	Control	Treatment
Total	489	243	246
Opted out	37	18	19
Incomplete data	233	113	120
Total in study	256	130	126
Cohort 1	129	67	62



Students	Overall	Control	Treatment
Cohort 2	127	63	64
% attrition	48	47	49

A total of 37 students (18 control, 19 treatment) were opted out of the study. An additional 233 students did not have complete pre- and post- survey and assessment data. This is due in large part to the nature of summer camp in this district, which sees many students attend for only some of the camp because of travel and other obligations. As a result, 256 students were included in the study's analytic sample, with 130 in the control condition and 126 in the treatment condition, reflecting an overall attrition rate of 48 percent and a differential attrition of 2 percentage points.

### Student Characteristics

Characteristics of the students, as indicated in district administrative data, included in the final analysis are shown in **Error! Reference source not found.** Across the 2 years of the study, there were about 100 students in each of grades 4 and 5 and 44 students in grade 6. Slightly more than half of the students in the sample were identified as female. A large majority of students (95%) were identified as Black. Students with individualized education programs (IEPs) made up about 14 percent of the sample. While English Language Learner status was provided by the district, very few students were identified as ELL and so are omitted from this report. Less than half of the participating students were at or above grade level in math based on their scores on the end-of-year i-Ready benchmark assessment.

**Table A2. Student Characteristics**

Characteristic	Overall N (%)	Control N (%)	Treatment N (%)	Missing N (%)
Grade 4	109 (43)	62 (48)	47 (37)	3 (1.2)
Grade 5	100 (39)	47 (36)	53 (42)	3 (1.2)
Grade 6	44 (17)	19 (15)	25 (20)	3 (1.2)
Female	134 (52)	66 (51)	68 (54)	3 (1.2)
Black/African American	244 (95)	124 (95)	120 (95)	3 (1.2)



Characteristic	Overall N (%)	Control N (%)	Treatment N (%)	Missing N (%)
Individualized education program	35 (14)	16 (12)	19 (15)	3 (1.2)
EOY math benchmark at or above grade level	119 (46)	59 (45)	60 (48)	4 (1.6)

### Baseline Comparability of Treatment and Control Groups

Students in the treatment and control groups were at similar levels of math achievement and math self-efficacy. However, the control group had higher math values and self-management and social awareness (0.2 to 0.31 standard deviations higher). Means and standard deviations of raw scores for the treatment and control students at pre- and post-study for the math assessment subscores and SEL survey scales are shown in Table .

**Table A3. Mean and Standard Deviation on Pre- and Post- Student Measures**

Measure	Control pre	Treatment pre	Standardized mean difference pre	Control post	Treatment post	Standardized mean difference post
<b>Math</b>	Mean (SD)	Mean (SD)	Mean	Mean (SD)	Mean (SD)	Mean
<b>Operational fluency</b>	8.14 (4.87)	9.03 (5.58)	0.18	10.12 (6.01)	11.33 (7.02)	0.20
<b>Fractions &amp; decimals</b>	3.4 (1.75)	3.48 (1.67)	0.05	3.42 (1.77)	3.73 (1.74)	0.18
<b>Numbers &amp; operations</b>	2.52 (1.38)	2.49 (1.52)	-0.02	2.51 (1.42)	2.81 (1.48)	0.21
<b>Probability &amp; data</b>	3.68 (2.05)	3.83 (2.45)	0.07	3.6 (2.17)	4.21 (2.46)	0.28
<b>Math composite</b>	--	--	0.10	--	--	0.30



Measure	Control pre	Treatment pre	Standardized mean difference pre	Control post	Treatment post	Standardized mean difference post
SEL scales						
Math self-efficacy	3.66 (0.88)	3.61 (0.85)	-0.06	3.56 (0.81)	3.52 (0.86)	-0.05
Math interest value	3.56 (1.06)	3.35 (1.12)	-0.2	3.44 (0.93)	3.19 (1.07)	-0.27
Math importance value	4.45 (0.74)	4.22 (0.98)	-0.31	4.17 (0.97)	4.06 (0.87)	-0.11
Self-management and social awareness	3.78 (0.75)	3.56 (0.71)	-0.3 (0.95)	3.86 (0.72)	3.44 (0.7)	-0.59
SEL composite			-0.28 (1.01)			-0.32

## Study Procedures

### Randomization

While students are asked to register for camp before the school year ends, many who do register never attend and many who do not register do attend. This makes the registration rosters inadequate for determining who will attend the camp and, thus, potentially participate in the study. To capture accurate attendance information, WestEd researchers and interns documented which students were present on the first day of camp at each school site. These rosters were then matched to and merged with administrative data provided by the district that included student prior-year grade-level and end-of-year i-Ready math benchmark assessment scores and levels. Students were block-randomized with blocks being formed by school site; grade level and a student's i-Ready score, whether (a) at or above grade level or (b) below grade level. Within each block, students were randomly assigned with a 50 percent chance of being placed in the treatment or control condition. In the few cases in which a student's i-Ready score was not available, they were randomly assigned within their school site and grade level with a 50 percent chance of being placed in the treatment or control condition.



## Pre- and Post-Study Student Data Collection

During the beginning of the first week of summer camp, researchers or interns administered the pre-study math assessment and SEL survey. They readministered these as post-study instruments during the end of the final week of summer camp. The majority of students completed the assessment and survey online via Qualtrics and SurveyMonkey, respectively. In rare cases in which the internet failed or devices were not working, researchers used paper copies of the instruments. For students who were absent during the post-testing windows, researchers and interns attempted to conduct makeups with students the following day. Before completing the online survey, students were guided through sample questions and responses to ensure they understood how to respond to questions on their devices. Researchers and interns then read each item aloud to students as they completed the survey.

## Teacher Instructional Logs

For every day of summer camp, teachers completed an online instructional log detailing the day's activities. Researchers monitored responses and prompted teachers to fill out missing logs over the course of the study.

## Classroom Observations

Interns conducted weekly classroom observations at school sites. At each school, an intern observed one treatment and one control classroom for 15 minutes each using a protocol designed by the research team to capture what teachers and students were doing during instruction.

## Teacher Interviews

WestEd researchers conducted teacher interviews with eight Cohort 1 teachers, four in each condition, via videoconferencing. The interviews took place within a week of the completion of summer camp.

## Student Interviews

WestEd researchers conducted student interviews for Cohort 1 only at each study site. They randomly selected two students from each condition to participate in the interview and gave the selected students and their families the opportunity to opt out. The interviews took place during the final week of summer school.



## Measures

The WestEd research team used a variety of teacher and student measures to understand the implementation of NBA Math Hoops and STEM enrichment instruction and the impact of instruction on student math achievement and SEL.

### Teacher Measures

#### Teacher Background Survey

As part of the project onboarding process, participating teachers completed a teacher background survey. The survey collected information related to teachers' demographics, educational background, time in the district, prior experiences teaching summer camp, and feelings about teaching summer camp during the study.

#### Daily Instructional Logs of NBA Math Hoops Implementation

Teachers' responses to daily instructional logs were used to understand implementation of NBA Math Hoops in treatment classrooms. On the logs, NBA Math Hoops teachers indicated if they taught any NBA Math Hoops lessons or played any NBA Math Hoops games. If they responded to either question affirmatively, they were asked follow-up questions about which lesson(s) they taught and how many games their students played (one, two, three, or four or more), respectively. If a teacher responded that their students played four or more games in a class period, those responses were recoded as four games for the purpose of summarizing how many games were played in each treatment classroom.

#### Daily Instructional Logs of STEM Enrichment Implementation

Teachers' responses to daily instructional logs were used to understand implementation of STEM enrichment in control classrooms. In the logs, control teachers indicated if they taught a STEM topic or a nonacademic topic. They also indicated which, if any, STEM domain topics were covered in that lesson—science, technology, engineering, or math. If teachers indicated that they covered any math topics, a follow-up question asked which math topics were primarily covered—number operations, rational numbers, probability, data, geometry, or other topics.

### Student Measures

#### Demographic Data

Student demographic information was provided by the district. Student gender was indicated as either male or female. Student race/ethnicity was indicated as Asian, Black, Hispanic, or White. The large majority of students were identified as Black, so race/ethnicity was recoded as Black and not Black for reporting purposes. Student prior year attendance was calculated as the



percentage of attended days divided by enrolled days in the school year preceding the summer camp. Student scores and performance levels from their end-of-year i-Ready math benchmark assessment (administered in the spring of the school year prior to the summer camp) were included in the data provided by the district. Performance levels were recoded to indicate whether the student performed at or above their grade level at the end of the school year prior to the summer camp.

### **Math Assessment**

The study included a pre- and post- student math assessment designed to measure the key concepts and skills emphasized in the NBA Math Hoops program. The assessment contained two parts. First, students had 1 minute to complete a 60-item operational fluency assessment, which consisted of single-digit addition, subtraction, multiplication, and division questions. Second, students completed a 25-minute, fill-in-the-blank and multiple-choice section composed of validated items from the grade 4 National Assessment of Education Progress (NAEP). The 20-item assessment contained items from NAEP's Number and Operations domain and the Data, Analysis, Statistics, and Probability domain—the two domains most closely aligned with the content of NBA Math Hoops. Within the Number and Operations domain, the assessment also included a subset of items that addressed fraction and decimal topics. Item difficulties ranged from easy to medium to hard across the assessment. The text box below presents an assessment question from each content area.



## Sample Student Math Assessment Items (Grade 4, NAEP)

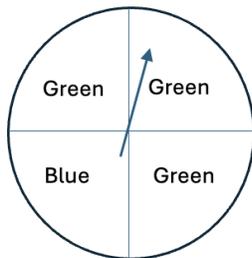
### Number and Operations

What is the greatest number of 30-cent apples that can be purchased with \$5.00?

- A. 6
- B. 15
- C. 16
- D. 17

### Data, Analysis, Statistics, and Probability

Ms. Livingston's class spins the arrow on the spinner 92 times.



Of the following, which is the most likely result?

- A. 66 green, 26 blue
- B. 46 green, 46 blue
- C. 23 green, 69 blue
- D. 2 green, 90 blue

Student responses were scored, awarding 1 point for each correct answer. Four subscores were created by summing the scores for subsets of items corresponding to the four types of questions on the assessment: operational fluency, numbers and operations, fractions and decimals, and probability and data. Following the recommendation of Schochet (2008), each subscore was standardized using the control group's mean and standard deviation. Then a composite of the four standardized subscores was created by calculating the mean of each student's four standardized subscores. The composite score was further standardized to the mean and standard deviation of the control group's composite score to allow for interpretation of the results in standard deviation units.



### Social–Emotional Learning Survey

The research team adapted an SEL survey from the Panorama Social–Emotional Learning Survey and the Panorama Student Survey (Panorama Education, 2024). The items from the Panorama surveys were adapted for the context of the study (see example items in Table ). As shown in the right-most column of Table , the survey used in this study was built from five scales in the Panorama Surveys—self-management, social awareness, self-efficacy about specific subjects, classroom engagement, and valuing of subjects—totaling 31 items.

Exploratory factor analysis of the survey results in this study indicated that several items did not load well onto any one factor and several other items cross-loaded on more than one factor, resulting in 19 items remaining in the analysis for this study. A four-factor solution fit the data best. These results indicated that the self-management and social awareness scales did load on a single factor. They also indicated that the valuing of subject items related to students' enjoyment and interest in math loaded with classroom engagement items and not with the other valuing of subjects items. For analysis, the interest-related valuing of subject items were combined with the classroom engagement items that were all consistent with intrinsic value (Eccles & Wigfield, 2002). Table summarizes the length and Cronbach's  $\alpha$  of each scale used in analysis.

**Table A4. Student SEL Measures**

Study scale	# of items	$\alpha$	Example study items	Panorama scale
<b>Self-management and social awareness</b>	8	0.81	During the past 30 days, how often did you pay attention and ignore distractions?	Self-management
			During the past 30 days, how carefully did you listen to other people's points of view?	Social awareness
<b>Math self-efficacy</b>	4	0.74	How sure are you that you can learn all the topics taught when you are learning math?	Self-efficacy about specific subjects
<b>Math interest value</b>	5	0.86	How interesting do you find the things you learn in math?	Valuing of Subject
			When you are learning math, how excited are you to participate?	Classroom engagement
<b>Math importance value</b>	2	0.61	How important is it to you to do well in math?	Valuing of subject



In a similar manner to the math assessment, the four SEL scale scores were standardized and then combined into a composite score created by taking the mean of each student's standardized scale score. The composite score was further standardized to the control group composite score mean and standard deviation to allow for interpretation in standard deviation units.

## Analysis

### Research Questions 1 & 2: Impact on Math Achievement and Social–Emotional Learning

To measure the impact of NBA Math Hoops on student math achievement and SEL, respectively, we employed ordinary least squares linear regression with fixed effects for blocks and robust standard errors to account for the clustering of students in schools. For each outcome domain (i.e., math achievement and SEL) we conducted domain-specific confirmatory analyses, as recommended by Schochet (2008). Following this approach, we used the standardized domain composite pre- and post- scores as outcomes and predictors, respectively, in our regression models. We used these models to test a hypothesis about impact on each domain globally. If we found a statistically significant difference between treatment and control on a composite measure of one domain, we performed exploratory analyses within each domain to identify specific outcomes that contributed to the main effect. These exploratory analyses helped interpret the global findings.

For each outcome domain (math achievement and SEL), the corresponding standardized composite post- score was used as the outcome. The standardized composite math achievement and SEL pre- scores, student gender (female = 1, male = 0), and student special education status (has an IEP = 1, does not have an IEP = 0) were used as predictors. Student grade level was not included as a predictor because grade level is perfectly colinear with blocks. Student race/ethnicity was not included in these analyses because a large majority of participating students were identified as Black.

### Research Question 3: Fidelity of Implementation

To calculate the number of NBA Math Hoops lessons and games played, we analyzed data reported from each teacher's instructional log.

### Qualitative Analysis

Student and teacher interview transcripts were analyzed using grounded theory (Glaser & Strauss, 1967; Strauss & Corbin, 1990). This theory emphasizes an inductive approach in which the codes, categories, and themes emerge, organically, from the verbatim transcripts and observation data rather than being predetermined by existing theories or hypotheses.



Qualitative analysis consisted of the following five steps:

- 1. Open Coding:** The initial phase of analysis involved open coding, in which the transcripts were carefully read and meaningful segments of text were identified and labeled with descriptive codes. At this stage, the focus was on breaking the data into manageable chunks and allowing patterns to naturally emerge from the responses. This phase was highly exploratory because it sought to capture all potentially relevant ideas and concepts without preconceptions.
- 2. Focused Coding:** After open coding, the next step involved focused coding, in which individual codes were grouped into broader categories. These categories were informed by the specific questions posed in the research design and served to organize the data into meaningful clusters. The goal during this phase was to identify recurring patterns and trends that appeared across participants' responses and to begin linking the codes directly to the research questions. This step refined the analysis by clustering related codes under category headings that captured common themes across participants' experiences.
- 3. Theme Development:** As the analysis progressed, categories were refined and integrated into overarching themes. These themes represented the key findings related to each research question, with an emphasis on those aspects of the data that were most pertinent to the inquiry. The grounded theory approach allowed flexibility during this stage, ensuring that themes emerged from the data in a way that was authentic and directly relevant to the research objectives. This iterative process of refining and revisiting the categories provided a deeper understanding of the data.
- 4. Iterative Process:** Throughout the coding process, an iterative approach was maintained in which categories and themes were constantly revisited and refined. This iterative nature of grounded theory allowed the researchers to stay closely connected to the data, ensuring that the final themes were grounded in the participants' actual responses.
- 5. Anchoring the Analysis in Research Questions:** The final step involved organizing the data into thematic categories that were directly linked to the research questions. This ensured that the analysis remained focused and aligned with the objectives of the study. By organizing the findings in this way, the research provided a comprehensive, question-driven exploration of the data, offering insights that were deeply rooted in the participants' experiences.

### Quantitative Analysis

We used descriptive statistics to gain a better understanding of how NBA Math Hoops was implemented and how it contrasted with the STEM enrichment instruction received by students in the control condition. To understand teacher adherence to and dosage of the NBA Math Hoops program, we summarized NBA Math Hoops teacher logs to determine, for each teacher, how many days of the camp they implemented NBA Math Hoops instruction (lessons and/or



games), which and how many NBA Math Hoops lessons they taught, how many lessons total each teacher taught, and how many NBA Math Hoops games were played. Total NBA Math Hoops games played are lower bound estimates because responses that indicated that four or more games were played on a given day were recoded to four games played. We then summarized these teacher totals across all NBA Math Hoops classrooms.

To understand the contrast between treatment and control conditions, we summarized STEM teachers' responses to their teacher logs. For each STEM teacher, we summarized what STEM topics they covered and, if they reported teaching any math, what math topics they covered, their perceptions of the accessibility of their instruction to their students, and their perceptions of their students' engagement during instruction.

#### **Research Question 4: Variation in Impact by Student Characteristics**

To evaluate interactions between student characteristics and NBA Math Hoops on the impact of NBA Hoops, we extended the models described above by including an interaction term between variables representing different student characteristics and the treatment indicator. An interaction with each student characteristic was tested in a separate model. Student characteristics tested in these models were gender, special education status, standardized pre-math score, and standardized pre-SEL score.

#### **Research Question 5: Program Costs and Cost-Effectiveness**

We calculated the per-pupil cost of implementing the summer NBA Math Hoops program by adding the cost of NBA Math Hoops materials, teacher training, and teacher salaries and dividing the total by the number of students in the study. To gain a more practical view of per-pupil costs, we also calculated the per-pupil costs by dividing the total cost by the total number of students who participated in the summer program, even if they were not included in the study. To calculate the cost-effectiveness of the program, we divided the per-pupil program cost by the estimated effect size of the program on math achievement.



# Appendix B. Detailed Results

**Table B1. Regression Estimates of Impact of NBA Math Hoops on Math Achievement**

	Math— composite model	Math—fluency	Math— fractions & decimals	Math— numbers & operations	Math— probability & data
<b>Intercept</b>	-0.081 (0.226)	-0.362 (0.186)+	0.285 (0.334)	-0.112 (0.550)	-0.069 (0.268)
<b>Treatment</b>	0.192 (0.087)*	0.092 (0.086)	0.110 (0.154)	0.169 (0.097)+	0.152 (0.117)
<b>Pre- measure score</b>	0.657 (0.062)***	0.682 (0.061)***	0.469 (0.066)***	0.424 (0.089)***	0.511 (0.047)***
<b>SEL pre- composite</b>	0.012 (0.038)	0.048 (0.049)	0.028 (0.049)	0.072 (0.070)	-0.095 (0.062)
<b>Female</b>	0.028 (0.091)	0.096 (0.101)	0.128 (0.100)	-0.183 (0.133)	0.029 (0.106)
<b>IEP</b>	-0.299 (0.155)+	-0.282 (0.133)*	-0.463 (0.189)*	-0.141 (0.185)	-0.223 (0.147)
<b># of observations</b>	253	253	253	253	253
<b>R2</b>	0.716	0.704	0.472	0.461	0.584

+ =  $p < 0.1$ , \* $p < 0.05$ , \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .



**Table B2. Regression Estimates of Impact of NBA Math Hoops on SEL**

	SEL— composite model	SEL—math self-efficacy	SEL—math interest value	SEL—math importance value	SEL—self- management and social awareness
<b>Intercept</b>	0.126 (0.247)	0.057 (0.401)	0.587 (0.159)***	0.127 (0.168)	-0.183 (0.148)
<b>Treatment</b>	-0.214 (0.091)*	-0.035 (0.110)	-0.206 (0.101)*	-0.101 (0.112)	-0.393 (0.105)***
<b>SEL pre- measure score</b>	0.614 (0.063)***	0.579 (0.074)***	0.562 (0.068)***	0.335 (0.066)***	0.704 (0.053)***
<b>Math pre- composite</b>	-0.003 (0.071)	0.079 (0.078)	0.051 (0.090)	-0.020 (0.068)	-0.075 (0.063)
<b>Female</b>	-0.002 (0.117)	-0.100 (0.130)	0.030 (0.117)	0.161 (0.123)	-0.088 (0.117)
<b>IEP</b>	-0.153 (0.248)	-0.141 (0.223)	-0.033 (0.220)	-0.360 (0.303)	-0.015 (0.179)
<b># of observations</b>	253	253	253	253	253
<b>R2</b>	0.549	0.462	0.433	0.451	0.664

+ =  $p < 0.1$ , \* $p < 0.05$ , \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .



**Table B3. Variation in Math Achievement Treatment Effects by Student Characteristics**

	Math—gender interaction	Math—IEP interaction	Math—pre- math interaction	Math—pre- SEL interaction
Intercept	-0.153 (0.241)	-0.083 (0.223)	-0.041 (0.190)	-0.069 (0.225)
Treatment	0.291 (0.114)*	0.210 (0.084)*	0.172 (0.084)*	0.206 (0.086)*
Math composite pre-	0.657 (0.062)***	0.656 (0.063)***	0.515 (0.091)***	0.656 (0.063)***
SEL composite pre-	0.018 (0.038)	0.012 (0.036)	0.009 (0.037)	-0.027 (0.049)
Female	0.122 (0.138)	0.030 (0.091)	0.053 (0.092)	0.022 (0.091)
IEP	-0.309 (0.157)+	-0.215 (0.194)	-0.309 (0.147)*	-0.296 (0.155)+
Interaction: Treatment with...				
Female	-0.189 (0.160)			
IEP		-0.141 (0.250)		
Math composite pre-			0.256 (0.088)**	
SEL composite pre-				0.084 (0.071)
# of observations	253	253	253	253
R2	0.717	0.716	0.728	0.717

+ =  $p < 0.1$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

**Table B4. Variation in SEL Treatment Effects by Student Characteristics**

	SEL—gender interaction	SEL—IEP interaction	SEL—pre- math interaction	Math—pre- SEL interaction
<b>Intercept</b>	0.073 (0.275)	0.127 (0.250)	0.149 (0.252)	0.131 (0.251)
<b>Treatment</b>	-0.140 (0.164)	-0.223 (0.102)*	-0.225 (0.096)*	-0.208 (0.090)*
<b>Math composite pre-</b>	-0.002 (0.071)	-0.002 (0.071)	-0.082 (0.065)	-0.003 (0.071)
<b>SEL composite pre-</b>	0.619 (0.065)***	0.615 (0.064)***	0.612 (0.063)***	0.600 (0.093)***
<b>Female</b>	0.068 (0.164)	-0.003 (0.115)	0.012 (0.116)	-0.004 (0.118)
<b>IEP</b>	-0.160 (0.248)	-0.194 (0.480)	-0.158 (0.246)	-0.152 (0.248)
<b>Interaction: Treatment with...</b>				
<b>Female</b>	-0.140 (0.222)			
<b>IEP</b>		0.070 (0.508)		
<b>Math composite pre-</b>			0.143 (0.073)+	
<b>SEL composite pre-</b>				0.031 (0.127)
<b># of observations</b>	253	253	253	253
<b>R2</b>	0.550	0.549	0.553	0.549

+ =  $p < 0.1$ , \* $p < 0.05$ , \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .

