HMH

Research Results

# Waggle Math: QED Study Grades 3–5, 2020–2021 SY

## Study Profile

**District:**

22 Schools in One Missouri School District

**Grades:**

3–5

**Participants:**

1,172 Grade 3–5 Students
(586 matched students)

**Evaluation Period:**

2020–2021 School Year

**ESSA Level:**

Tier 2 Moderate ESSA Evidence

**Study Conducted by:**

JEM & R, LLC

**Study Design:**

Quasi-Experimental Design

**Outcome Measure:**

HMH Growth Measure

# Executive Summary

This quasi-experimental study examined the impact of *Waggle*® Math on mathematics achievement for 1,172 students in Grades 3–5 during the 2020–2021 school year. Students who used *Waggle* Math with higher levels of implementation demonstrated statistically significant mathematics growth compared with matched peers who did not use the program, indicating that implementation level was a key driver of impact.

Notably, these outcomes reflect learning gains observed during an approximately four-month instructional window from mid-year to end-of-year, demonstrating that meaningful effects were detected over a relatively brief implementation period.

Exploratory subgroup analyses indicated that *Waggle* Math students across demographic groups—including students eligible for free or reduced-price lunch and students receiving special education services—demonstrated statistically significant growth over time. Collectively, these findings highlight the importance of sustained, frequent, and intentional implementation when using adaptive supplemental math programs to support student learning.

# The Challenge

As instructional demands increase in elementary mathematics, students in Grades 3–5 are expected to develop fluency with foundational mathematics skills while also applying conceptual understanding to increasingly complex problem-solving tasks. At the same time, teachers face ongoing challenges delivering targeted mathematics practice that responds to a wide range of student readiness levels within limited instructional time. These challenges are amplified in classrooms where students require differentiated opportunities for reinforcement, acceleration, or remediation alongside core mathematics instruction.

Disruptions to instruction during the COVID-19 pandemic further intensified concerns about unfinished learning in mathematics, particularly in relation to skill mastery and sustained learning progress. In this context, students benefit from supplemental learning experiences that provide appropriate challenge, scaffolded support, and timely feedback—conditions that promote productive struggle and mathematical growth. For educators, this underscores the need for flexible, data-informed tools that can support differentiated math practice and sustain student engagement in real-world classroom settings.

# The Solution

## *Waggle* Math

To address these instructional challenges, HMH developed *Waggle* Math, a supplemental digital learning solution for Grades K–8 designed to support personalized mathematics practice alongside core instruction. *Waggle* Math leverages adaptive technology and embedded formative assessment to deliver targeted, skill-specific practice that adjusts dynamically in response to student performance.

Through differentiated learning pathways, *Waggle* Math supports students in building foundational mathematics skills while engaging in productive struggle supported by scaffolded hints and immediate, in-the-moment feedback. The program is organized around *Waggle*'s Learn, Practice, and Play instructional activities, which are designed to support conceptual understanding, skill development, and sustained engagement. These activities may be assigned by teachers or automatically sequenced based on individual student needs, allowing instruction to respond flexibly to variations in readiness and progress.

For teachers, *Waggle* Math provides real-time insights into student performance and usage patterns, enabling data-informed instructional decision-making and targeted differentiation. By integrating ongoing formative assessment with adaptive learning technology, *Waggle* Math offers actionable data that supports instructional planning, progress monitoring, and responsive support. When implemented with sufficient frequency and fidelity, *Waggle* Math functions as a meaningful supplemental support for improving students' mathematics outcomes alongside Tier 1 instruction.

# The Study

## Study Design and Purpose

A quasi-experimental design (QED) study was conducted by JEM & R, LLC, an independent research firm, during the 2020–2021 school year to examine the impact of *Waggle* Math on student outcomes. While many teachers in the participating schools continued to deliver instruction via remote or hybrid learning due to the outbreak of COVID-19, only teachers delivering in-person instruction were eligible for the QED study.

The study was designed to meet ESSA Tier 2 Moderate Evidence criteria and evaluated *Waggle* Math under real-world classroom conditions. Students who used *Waggle* Math were compared to a matched group of comparison (control) students who did not use the program.

## Research Questions

The study addressed the following research questions:

1. What is the impact of *Waggle* Math use on students' mathematics achievement?
2. Do *Waggle* Math users demonstrate significant growth over time?
3. Are there variations in outcomes across different student subgroups?

## The District

The study was conducted in one Missouri school district comprising 22 schools and serving more than 14,000 students in a suburban community. The analytic sample closely reflected districtwide demographic characteristics, providing appropriate contextual grounding for interpretation of findings. The district had previously purchased *Waggle* Math and implemented the program during the study year.

## Analytic Sample

The final analytic sample for the *Waggle* Math study included 1,172 students in Grades 3–5, drawn from one Missouri school district. The sample consisted of 586 students who used *Waggle* Math and 586 matched control students who did not use the program. All elementary students who used *Waggle* Math and who attended school in person during the 2020–2021 school year were eligible for inclusion.

The matched sample included: 210 Grade 3 Waggle Math students and 210 Grade 3 control students; 325 Grade 4 *Waggle* Math students and 325 Grade 4 control students; and 51 Grade 5 *Waggle* Math students and 51 Grade 5 control students.

The sample represented a diverse population, including students across racial/ethnic groups, students eligible for free or reduced-price lunch, and students receiving special education services. Matching procedures ensured that treatment and control groups were comparable on key demographic characteristics. Chi-square analyses indicated no statistically significant differences between *Waggle* Math and control groups across demographic characteristics, supporting the comparability of the matched samples.

The analytic sample closely mirrored districtwide demographics and statewide averages (with the exception of free/reduced-price lunch eligibility). Key demographic characteristics of the analytic sample included: 67% White, 12% Black, 9% Hispanic, 8% Multiracial/Other, 3% Asian, and 1% Native American or Alaska Native; 49% male, 51% female; 19% Free or Reduced-Price Lunch; and 15% Special Education (<2% of students were identified as English learners).

## Propensity Score Matching

To ensure equivalence between *Waggle* Math users and non-users, propensity score matching procedures were employed prior to outcome analyses. All students who attend school in person during the 2020–2021 school year and who used *Waggle* Math were eligible for inclusion in the treatment group. The initial control pool consisted of students with no recorded *Waggle* Math usage and who attended school in person during the study year.

The final analytical control sample was selected based on propensity score matching methods. This procedure matched each *Waggle* Math student with the closest non-*Waggle* Math student based on the following characteristics (covariates) provided by the district:

- Race/Ethnicity
- Gender
- Free/Reduced-Price Lunch Eligibility
- Special Education status
- English Language Learner status
- Gifted status

The following three-step procedure was used to match the students and create the final analytical sample:

**Step 1.** First, a logistic regression model was used to estimate each student's propensity to be a *Waggle* Math user based on the specified covariates (listed above). The resulting propensity score reduced

multiple student characteristics to a single composite value, which was then used as the distance measure for matching treatment and control students.

**Step 2.** Matches for the treatment group were obtained from the control group using a nearest neighbor algorithm (SPSS 27 FUZZY extension procedure). A small number of treatment students were not able to be matched using the SPSS procedure and were instead matched to a control student by randomly selecting a student with a similar propensity score.

**Step 3.** Balance was assessed through t-tests of means to examine differences in means of each of the measures between the identified *Waggle* and non-*Waggle* students. As noted, no significant differences were observed between the matched *Waggle* and non-*Waggle* students.

## Measures

***HMH Growth Measure.*** The HMH Growth Measure® is a research-based, computer-adaptive benchmark assessment designed to measure students' achievement relative to grade-level expectations and their growth over time. The assessment can be administered in a group setting in approximately 30–45 minutes and is typically administered up to three times per year (beginning-of-year, mid-year, and end-of-year).

The Growth Measure provides data on students' mathematics performance using a research-based scaled score and three performance levels (below level, on level, above level), allowing for comparison of student performance within grade level across administrations.

The primary outcome measures from this assessment include:

- Scale Scores: Scaled scores range from 1 to 99 and support comparison of individual student performance as well as aggregation of performance within grade-level classrooms.
- Student Growth Index (SGI): SGI measures the amount of growth a student achieves within a school year, with a target score of 100, regardless of grade level or prior achievement. SGI has an effective range of approximately 50 to 150 and uses changes in scaled scores across test administrations to track progress toward targeted growth. SGI is a criterion-referenced growth model that allows educators and researchers to categorize student growth between assessment points within a school year.

Of note, although district teachers had the opportunity to collect Growth Measure data across three time points, insufficient beginning-of-year data were available for analysis: only 4% of elementary students had both beginning- and mid-year data, and 3% had beginning- and end-of-year data. In contrast, 93% of students had both mid-year and end-of-year data. As a result, this study focuses on changes in performance from mid-year to end-of-year.

## Outcome Analysis

Growth Measure scale scores were analyzed to examine differences in mathematics growth between students who used *Waggle* Math and matched students who did not. All analyses therefore reflect an approximately four-month instructional period (January to May). Primary analyses focused on changes in performance from mid-year to end-of-year, with supplemental analyses examining growth indices and subgroup patterns.

## Implementation

Teachers self-reported using *Waggle* Math 1–2 days per week, for 20–30 minutes per session. All teachers used *Waggle* Math in class and did not assign it as part of homework. Specifically, during the school year, teachers reported using *Waggle* Math as an independent practice activity as part of the warm-up or to reinforce and provide extra practice for skills learned or previously taught during core instruction, with variation in usage levels observed across classrooms.

### Usage Data

Student usage data from the *Waggle* Math program was pulled to determine the total number of adaptive practice activities completed for each student in the school district.

### Implementation Implications

Findings from this study indicate that students' *Waggle* Math implementation level was a key factor associated with student mathematics growth. Students who consistently engaged with the program by completing 10 or more adaptive practice activities over the study period demonstrated significantly greater gains than peers. This pattern underscores the importance of regular, sustained use of *Waggle* Math as a supplemental practice tool, supported by intentional scheduling and monitoring of student progress to ensure sufficient engagement over time.

# Results

Results are presented by research question and focus on mathematics achievement and patterns across student subgroups.

### Impact on Achievement

Student Math Growth Measure scale scores were analyzed to examine differences in learning gains between students who used *Waggle* Math and matched control students who did not. Primary analyses focused on changes in performance from mid-year to end-of-year. Results are presented below.

Growth Measure scale scores were analyzed to determine whether significantly different learning gains were observed over a four-month period between students who used the *Waggle* Math program and matched control students who did not. Results from repeated measures ANOVA showed that students using *Waggle* Math demonstrated similar growth rates (7-point increase) on the Growth Measure, $F(1, 1170) = .004$, $p = .950$.

When growth rates for students who used *Waggle* Math with a higher level of implementation (completed 10+ adaptive practice activities) were compared to control students, significant differences were observed. As shown, students who used *Waggle* Math with higher levels of implementation demonstrated significantly greater growth rates (8 points) than matched control students who did not use *Waggle* Math (6 points), $F(1, 757) = 4.262$, $p < .05$. Analyses were also conducted by comparing the matched control group and each level of *Waggle* Math implementation (<5, 5–9, and 10+ adaptive practice activities); results showed a marginally significant relationship with the high usage *Waggle* Math implementation group showing the greatest gains among all four groups, $F(3, 1168) = 2.145$, $p = .093$. See Figure 1.

**Figure 1.** Growth Measure Performance by Student Group, High *Waggle* Math Usage Students and Control Students

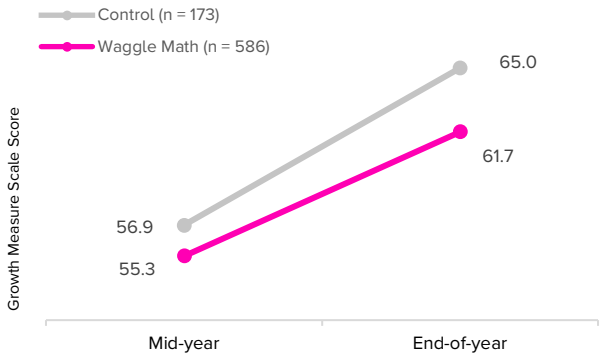


**Figure note:** *Significant at $p<.05$

These results suggest that students using *Waggle* Math with higher frequency (and fidelity) experienced a higher rate of growth relative to matched peers over the same instructional period. These results are notable given the approximately four-month instructional window examined in the study.

Given these findings, additional analyses examined whether students who used *Waggle* Math demonstrated significant growth over time and whether outcomes varied by implementation level, performance domain, and student subgroup.

## *Waggle* Students' Growth Over Time

To determine the extent to which students that used the *Waggle* Math program showed significant learning gains from January to May 2021, outcomes analyses were conducted via paired sample t-tests. Exploratory analyses were also conducted on the relationship between overall levels of *Waggle* Math implementation and student performance. To address whether varying degrees of usage was associated with student learning gains, *Waggle* Math usage data was analyzed. Students were categorized into three levels of usage based on this data (<5 adaptive practice activities completed, 5–9 adaptive practice activities completed, and 10+ adaptive practice activities completed).

Student Growth Index (SGI) scores were analyzed to determine if there was a relationship between SGI scores and student usage. As previously indicated, SGI scores between 95–105 indicate targeted growth. Results showed a significant relationship such that students that completed 10+ adaptive practice activities achieved significantly higher growth rates than students that completed less than 10 adaptive practice activities, $F(2, 424) = 4.948$, $p<.05$.

As reported in the Impact on Achievement section above, significant learning gains were observed among *Waggle* Math users from mid-year to end-of-year, $t(585)= -15.328$, $p<.001$. To better understand the extent of this growth, the Math Growth Measure proficiency bands (Below Level, On Level, and Above Level) were examined to determine whether there is a relationship between mid-year and end-of-year levels (i.e., did they tend to increase, decrease, or be maintained). There was a significant relationship in student performance level growth from mid-year and end-of-year, $X^2(4) = 192.28$, $p<.001$. Among *Waggle* Math students who experienced changes in their mathematics performance levels, a significantly greater proportion of students experienced gains (31%) than declines (6%). See Figure 2 below.

The Math Growth Measure includes six K–8 domains that vary by grade level. These include Numbers (K–8); Operations & Algebra (K–8); Measurement, Data & Probability (K–8); Geometry (K–8); Fractions, Ratios & Proportions (3–7); and Functions (Grade 8). Performance level changes for each of the domains applicable to Grades 3–5 were analyzed via chi-square to determine if a significant relationship exists.

Significant relationships were observed on all subtests such that performance levels among *Waggle* Math users were more likely to increase than decline, *p<.05*. The largest increases in performance levels were observed in the domains of Geometry and Fractions (44% of students moved to a higher performance level) and Ratios & Proportions (45% of students moved to a higher performance level). Notably, among all subtests, the percent of students who improved their performance level was higher than those who declined. See Figure 2 below.

**Figure 2.** Growth Measure Change in Performance Level, Overall and by Math Subtest

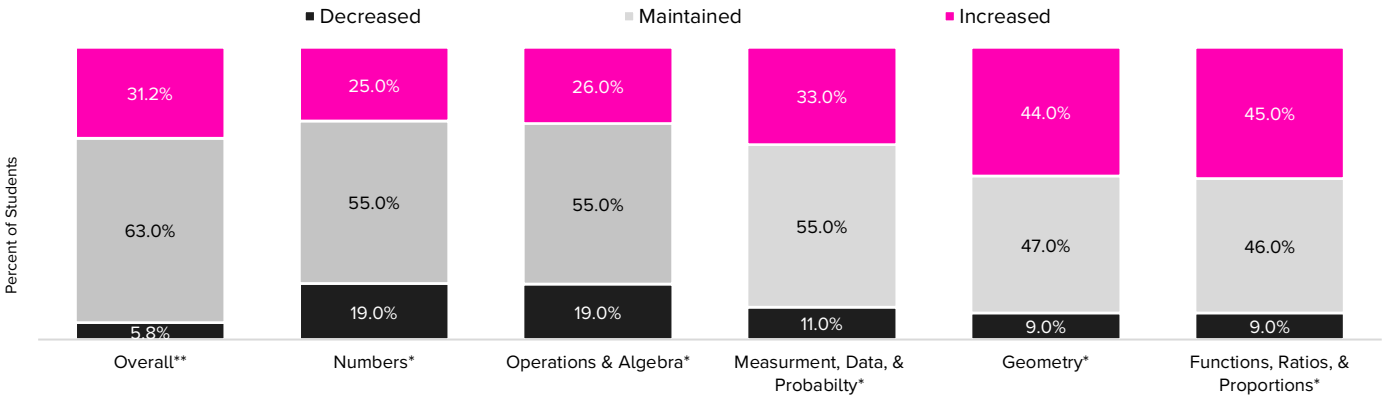


**Figure note:** **Significant at $p<.001$; *Significant at $p<.05$

## *Waggle* Students' Growth by Subgroup

To examine whether *Waggle* Math was associated with improvements among students of various subgroups, exploratory, descriptive analyses were conducted. Only the performance of *Waggle* Math students in specific student populations was examined in these paired t-test analyses. Of note, the sample sizes in some of the subgroups are small and there are unequal sample sizes between subgroups for a number of variables. Therefore, with the caveat that these analyses are limited, this provides readers with preliminary, descriptive information on the extent to which this program is associated with improvements among various subgroups.

Results showed significant learning gains among all grade levels of *Waggle* Math students on the Growth Measure, $p<.05$. Students in Grade 4 showed the highest level of growth (7 points), followed by Grade 3 (6 points) and Grade 5 (4 points). See Figure 3 below.

**Figure 3.** Growth Measure Gains by Grade

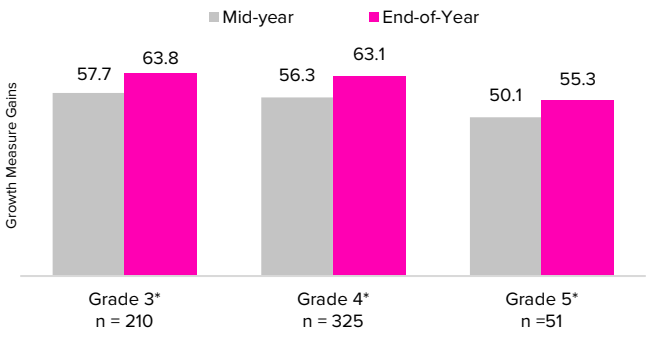


**Figure note:** *Significant at $p<.05$

Results examining the interaction of growth and gender showed no significant relationship, $p>.05$. This means that males and females grew at similar rates from mid-year to end-of-year.

Both White and minority students demonstrated significant learning gains from mid- to end-of-year testing. In addition, there was a significant relationship observed for minority status. White students showed higher mid-year to end-of-year gains (7 points) than minority students (5 points), $F(1, 584) = 5.006$, $p<.05$. Of note, both minority and White students demonstrated statistically significant gains from mid-year to end-of-year, $p>.05$. See Figure 4.

**Figure 4.** Growth Measure Gains by Race/Ethnicity

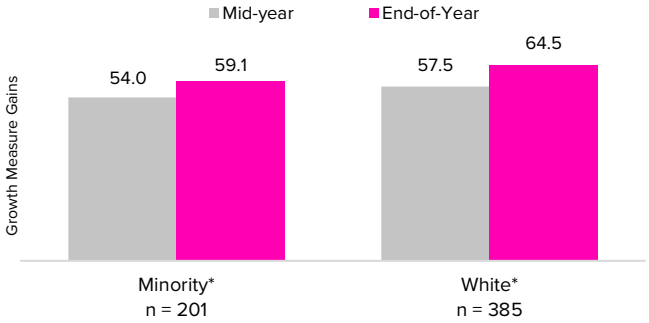


**Figure note:** *Significant at $p<.05$

For students eligible for free or reduced-price lunch, no significant interaction was observed between free/reduced-price lunch status and growth, $F(1, 584) = 2.378$, $p= .124$. Both students receiving free or reduced-price lunch and those not receiving free or reduced-price lunch demonstrated statistically significant growth from mid-year to end-of-year, $p>.05$. See Figure 5 below.

**Figure 5.** Growth Measure Gains by Free or Reduced-Price Lunch

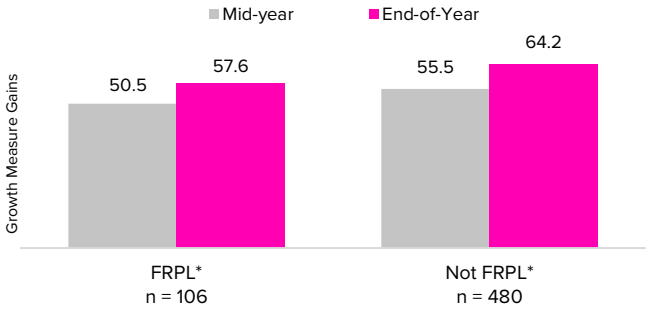


**Figure note:** *Significant at $p<.05$

For students identified as special education, a marginally significant interaction between special education and growth was observed, $F(1, 584) = 2.885$, $p= .09$. While growth rates of students receiving special education services and those not receiving services were both statistically significant, $p<.05$, an examination revealed that students not receiving special education services demonstrated slightly

higher rates of growth (6.7 points) from mid-year to end-of-year as compared to students receiving special education services (4.5 points) on the Growth Measure. See Figure 6.

**Figure 6.** Growth Measure Gains by Special Education Status

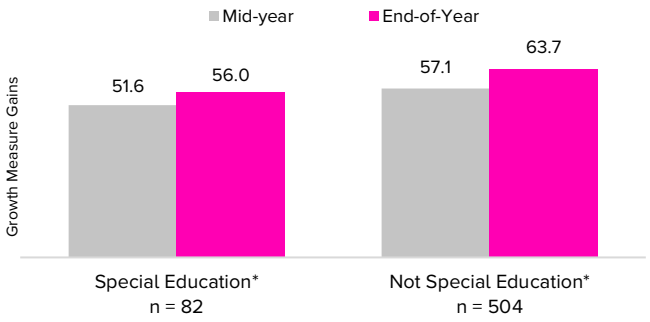


**Figure note:** *Significant at $p<.05$

## Conclusion

Findings from this quasi-experimental study provide ESSA Moderate Evidence that *Waggle* Math is associated with improved mathematics outcomes for students in Grades 3–5 when implemented with sufficient frequency and fidelity. Students who consistently engaged with *Waggle* Math by completing at least 10 or more adaptive practice activities demonstrated significantly greater growth than non-users, indicating that the program can accelerate mathematics learning in a relatively short period of time.

These results suggest that *Waggle* Math can serve as an effective supplemental support to Tier 1 mathematics instruction by helping address unfinished learning, reinforce foundational skills, and provide differentiated practice aligned to student needs. Exploratory analyses further showed measurable growth across diverse student groups, including students eligible for free or reduced-price lunch and students receiving special education services.

In sum, when implemented as intended, *Waggle* Math offers districts a scalable, data-informed approach to driving measurable mathematics growth, supporting instructional differentiation, and maximizing the return on investment of supplemental digital learning tools.

Learn more about *Waggle* at

**hmhco.com/Waggle**