# FIRST 8 STUDIOS™

**WGBH**

**EARLY MATH**

# Gracie & FRIENDS™

**Early Math with** *Gracie & Friends*™ is a math-focused curriculum supplement based on the Next Generation Preschool Math research project and funded by the National Science Foundation. The research focused on the development of **8 learning apps**, more than **40 hands-on and traditional preschool activities**, and a **digital Teacher's Guide**—all designed and tested for preschool classroom use.

# Early Math with *Gracie & Friends*™

Researchers, and public media curriculum and game developers have joined together with advisors, teachers, and children under the NSF-funded Next Generation Preschool Math research and development project, resulting in the mobile app series and tablet-infused preschool curriculum supplement Early Math with *Gracie & Friends*™. The team developed eight math iPad apps (four for subitizing and four for equipartitioning), a new curriculum to integrate the technology with 46 original hands-on and traditional classroom activities, and a digital Teacher's Guide. All resources are available free to the public from First 8 Studios at WGBH. Images from the apps are shown below.
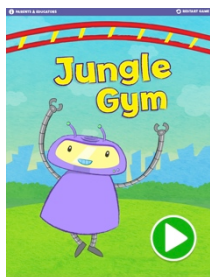
**first8studios.org**
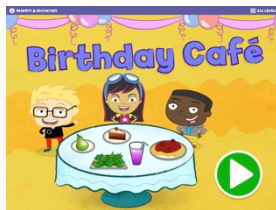
**Gracie & Friends Birthday Café** (subitizing)
Children seat friends at the table and make sure that each friend gets something to eat.

**Gracie & Friends City Skate** (subitizing)
Children collect groups of a specific number of objects as they go through the city.

**Gracie & Friends Jungle Gym** (subitizing)
Children dangle robots with the same number of dots together on the jungle gym.
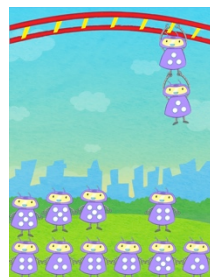
**Gracie & Friends Treasure Bubbles** (subitizing)
Children work together to pop bubbles with a specific number of treasures inside.

**Gracie & Friends Photo Friends** (equipartitioning)
Children's pictures are in the game, and they work together to distribute items equally.

**Gracie & Friends Lemonade Stand** (equipartitioning)
Children tilt the iPad to get the same number of ice cubes into each cup.

**Gracie & Friends Breakfast Time** (equipartitioning)
Children cut up breakfast items and share them with friends.
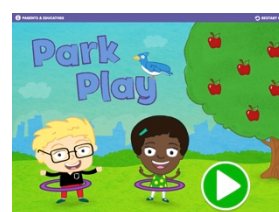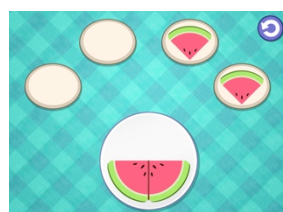
**Gracie & Friends Park Play** (equipartitioning)
Children equally share apples, hula hoops, pie, and bubble clouds.

**Next Generation Preschool Math Project: Research Summary**

Introduction: Why is Early Childhood Math so Important?

Early math learning has been found to predict later math and reading achievement, even more than early reading does. Our approach selectively integrates tablet-based games and non-digital, hands-on activities into existing preschool structures to capitalize on the technology's affordances to maximize young children's mathematics learning.

Development of the Next Generation Preschool Math (NGPM) Supplement

We designed a set of research-based activities, both digital and non-digital, to introduce the mathematical concepts of subitizing (quickly identifying the quantity of objects in a set— key to understanding the notions of quantity and cardinality) and equipartitioning (creating equal-sized groups from a collection or equal-sized pieces from a continuous whole—a precursor to proportional reasoning), two foundational aspects of mathematics not typically taught in preschool. The design team included designers at WGBH and researchers at EDC and SRI.

We drew on prior research on math instruction and learning trajectories for the two content areas to develop a set of prototypes. These prototypes were tested with a small group of preschoolers and teachers and then revised into two full "alpha" units that were pilot tested in three locations. These units were revised again prior to testing the "beta" units in an experimental design. The units then were made final and were released to the public through the Apple store (digital games) and a website (lesson plans and non-digital activity materials).

Each unit is designed to take approximately two to three weeks to complete and includes four digital games, non-digital classroom activities, and a digital teacher's guide (lessons, professional development videos, and a calendar feature). There are approximately five non-digital classroom activities for each digital game, designed to integrate into existing preschool classroom structures, so that activities were planned around circle time, center time, story time, outdoor play, and snack time. In addition, activities occurred in various student groupings: individual, pairs, small groups, and whole groups. The digital games consisted of three types:

1) two individual, self-leveling games that tracked children's progress on mastery of the content area;
2) one collaborative game intended for two children to play simultaneously; and
3) one "sandbox" game that provided more space for playful gameplay.

## Research Design

A blocked, cluster-randomized trial was conducted to investigate the potential of NGPM to impact preschool children's math knowledge. The main research questions were

1) Does experiencing NGPM impact young children's mastery of subitizing and equipartioning?
2) Can the NGPM units feasibly be implemented in preschool classrooms?

Sixteen preschool teachers from centers serving low-income children in two metropolitan areas (New York City and San Francisco) participated in the study. Centers were matched into eight pairs, based on demographic variables, and were randomized into either the treatment group or the business-as-usual control group. Treatment-group teachers attended a one-day professional development session that addressed the mathematics content, typical difficulties children experience in learning the content, methods for teaching the specific content, a technology orientation, and an overview of each digital game and non-digital activity. Treatment classrooms also received a set of five iPad tablets, one for the teacher and four for the children to use in a digital learning center, as well as all non-digital materials and books. Teachers completed pre- and post- surveys, a sample of 170 children completed individually administered assessments, and researchers conducted classroom observations.

## Research Findings

The two groups were similar on mathematics knowledge at the beginning of the study (baseline equivalence) on both the unit-specific (NGPM Assessment) and general math knowledge measures (REMA Assessment; See Figure 1 below). The treatment group outperformed the control group (statistically significant difference) on the NGPM unit-specific content (See Figure 2 below). Specifically, the treatment group's post-test scores (M=59.69) were statistically different than the control group's (M=53.53) on the unit-specific NGPM content (subitizing and equipartitioning) after statistically controlling initial math knowledge (p=.026, effect size=.51).
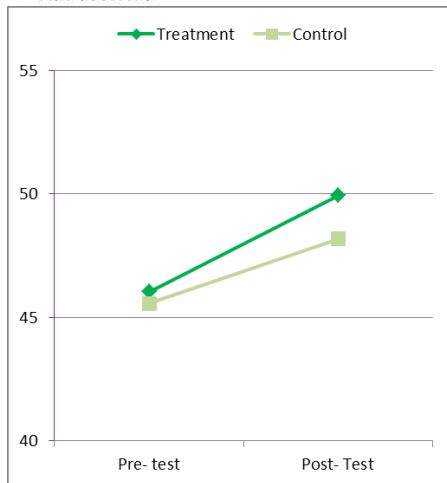
**Figure 1.** Baseline Equivalence of Treatment and Control Group REMA Assessment Scores
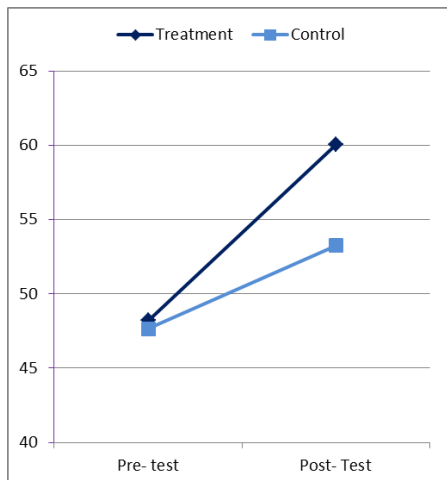


**Figure 2.** Comparison of Treatment and Control Group NGPM Assessment Scores

Teachers found the materials and activities useful, were able to successfully integrate them into the classroom, and were interested in using additional materials in the future. In addition, teachers are still using the materials a year after the study concluded, and report anecdotally that parents say their children, now in kindergarten, are more prepared in math than are their peers.

Conclusions and Future Research

Our promising study findings suggest that that NGPM improves preschool children's ability to subitize and equipartition. In addition, implementing NGPM was both feasible in preschool classrooms and useful to teachers, who are now asking for additional units. Overall, these findings add credibility to the practice of integrating tablet-based games into the classroom to support learning.