



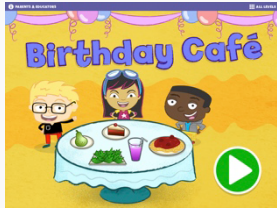
Early Math with *Gracie & Friends*[™] is a math curriculum supplement based on the Next Generation Preschool Math research project funded by the National Science Foundation. The research focused on the development of **8 apps, 38 hands-on and traditional preschool activities**, and a **digital Teacher's Guide**—all designed and tested for preschool classroom use.



Early Math with *Gracie & Friends*™

Researchers and public media producers partnered with schools and advisors to create Early Math with *Gracie & Friends*™. Originating as an NSF-funded research and development project titled Next Generation Preschool Math, the *Gracie & Friends* curriculum focuses on the mathematics of subitizing and equipartitioning, and integrates 38 hands-on activities with the use of 8 math apps on an iPad. Digital professional development and lesson plans prepare teachers to implement the activities. All resources are available for free from First 8 Studios at first8studios.org

Subitizing



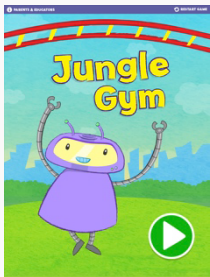
Gracie & Friends Birthday Café

Children seat friends at the table and make sure that each friend gets something to eat.



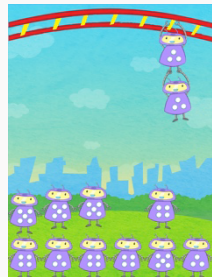
Gracie & Friends City Skate

Children collect groups of a specific number of objects as they go through the city.



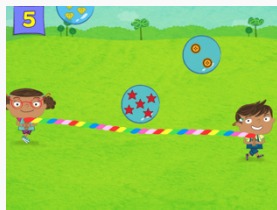
Gracie & Friends Jungle Gym

Children dangle robots with the same number of dots together on the jungle gym.



Gracie & Friends Treasure Bubbles

Children work together to pop bubbles with a specific number of treasures inside.

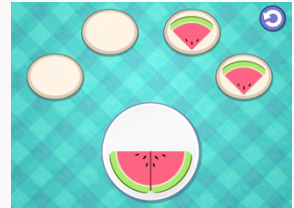


Equipartitioning



Gracie & Friends Breakfast Time

Children cut up breakfast items and share them with friends.



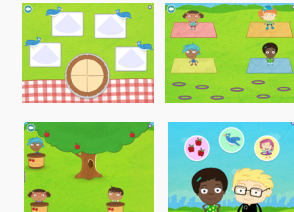
Gracie & Friends Lemonade Stand

Children tilt the iPad to get the same number of ice cubes into each cup.



Gracie & Friends Park Play

Children equally share apples, hula hoops, and pies among friends.



Gracie & Friends Photo Friends

Children's pictures are in the game, and they work together to distribute items equally.



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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 and maximize young children's mathematics learning.

Development of the Next Generation Preschool Math (NGPM) Curriculum

We designed a set of research-based activities, both digital and hands-on, to introduce two mathematical concepts: 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, fractions, and division). These foundational aspects of mathematics are not typically taught in preschool. Our team included game designers and curriculum developers at public media station WGBH and researchers at Education Development Center (EDC) and SRI International.

Drawing on prior research on math learning trajectories and curricular activity systems, we identified the two content areas and developed a set of prototype games to address them. These prototypes were tested with a small group of preschoolers and teachers and then revised into two full “alpha” curriculum units that were pilot tested in three locations across the country. These units were revised again and retested as “beta” units in a blocked, cluster-randomized control trial (RCT) study. Based on the positive RCT findings and feedback from teachers and researchers, the curriculum units were finalized and released to the public through the Apple App Store (digital games) and the First8Studios.org Web site (professional development resources, lesson plans, and non-digital activity materials).

Each curriculum unit is designed to take approximately two to three weeks to complete and includes digital games, hands-on classroom activities (read aloud books, rhymes, and block center, learning center, snack time, and outdoor play activities), and a digital teacher's guide including lessons, guidance for each activity, and professional development. The curriculum engages children in various groupings: individuals, pairs, small groups, and whole class. There are about five non-digital classroom activities for each digital activity, and the digital games are designed for integration into the preschool classroom digital learning centers. The digital games provide increasingly challenging levels in order to provide feedback and support children's content. Two games were specifically designed for collaborative play, and promote joint media engagement.

Research Design

The main research questions were:

- 1) Does experiencing the *Gracie & Friends* math units impact young children's mastery of subitizing and equipartitioning?
- 2) Can the *Gracie & Friends* math 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 other teaching materials. Teachers completed pre- and post- surveys, a sample of 170 children completed individually administered assessments, and researchers conducted classroom observations.

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Learning
transforms
lives.

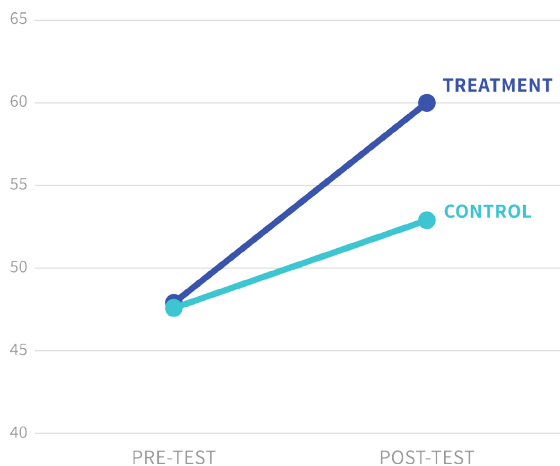
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Research Findings

The two groups of children (treatment and control) had similar mathematics knowledge at the beginning of the study (baseline equivalence) on subitizing, equipartitioning, and general math knowledge measures. At the end of the study, the treatment group outperformed the control group (statistically significant difference) on the unit-specific content. 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 content (subitizing and equipartitioning) after statistically controlling initial math knowledge ($p=.026$, effect size $=.51$).



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. We found that teachers were still using the materials a year after the study concluded, and reported 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 the Early Math with *Gracie & Friends* curriculum improves preschool children's ability to subitize and equipartition. In addition, implementing the curriculum 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 build on existing early education approaches and support learning.

Early Math with *Gracie & Friends* Impact

The team is pleased to share that Early Math with *Gracie & Friends* has been helping to set the quality standard for early learning with technology and has also been making an impact for children, teachers, and parents:

- *Gracie & Friends* Birthday Cafe was featured as one of the "Best New Apps & Games" in the Apple App Store's Kids category.
- *Gracie & Friends* Birthday Cafe was named one of the "Best Ed Tech of 2014" by Graphite (Common Sense Media's teacher platform), and was listed first in Graphite's "10 Best Math Tools for Elementary."
- *Gracie & Friends* Lemonade Stand was named one of the "Best Learning Apps & Games of the Year" in 2015 by Balefire Labs.
- All 8 of the apps have been either Parents' Choice Recommended or Approved Award winners
- The apps are played in 143 countries across the globe.

We are happy to share these free resources for early math learning, and we are thankful to the teachers and children who have helped to shape them.

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