Technology and the Future of Preschool:

Developmentally-Appropriate and Evidence-Based Approaches to Integrating Technology in the Classroom

Phil Vahey, SRI International
Ashley Lewis Presser, EDC
Ximena Dominguez, SRI International

Today's Question:
What is the best way to integrate technology into preschool?

Preschool Children

- Potential…
  - benefits?
  - challenges?
  - concerns?

Preschool Teachers

- Potential…
  - benefits?
  - challenges?
  - concerns?

Overarching Goals of This Project

- Design, develop, and evaluate curriculum supplement that integrates technology to promote early mathematics
  - Includes materials/activities common in preschool settings
    - Learning activities conducted in groups, pairs, or individually
    - Activities for circle time, learning center time, snack time, and playground time
  - Includes supports for teachers and children
  - Teaches important but often ignored mathematics content

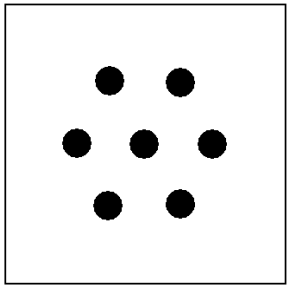
Next Generation Preschool Math (NGPM)

- *Integrated* preschool mathematics supplement:
  - Technology-based materials
  - Hands-on materials (including games and books)
  - Teacher Professional Development
  - Online Teacher Guide

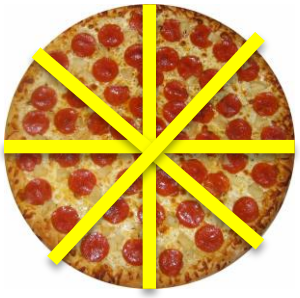
- Supports young children's learning of key ideas in mathematics:
  - Subitizing (key to understanding the notion of quantity and cardinality)
  - Equipartitioning (key to understanding rational number reasoning).

You may be wondering…

- We will about this in more detail, but here's a sneak peak.
  - What is subitizing?

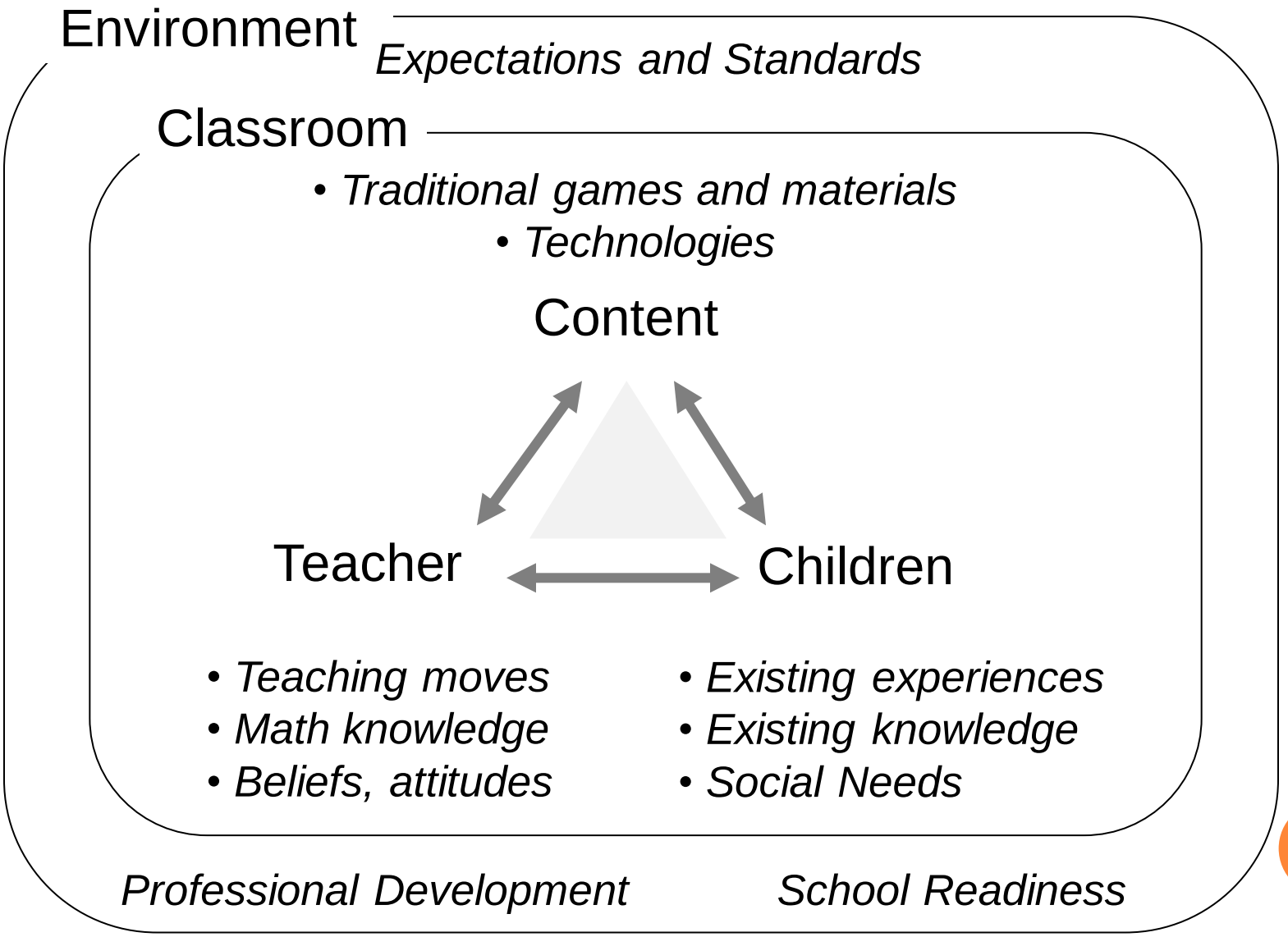


  - What is equipartitioning?



How Research Informs Development

Technology used In Context



Designing Content (1 of 3): Evidence-Based Curriculum Design

- Developed a Learning Blueprint:
  - Detailed learning goals
  - Example (generic) tasks
  - Documented ways to vary difficulty
  - Example scaffolds to support children
- Used to guide development of prototype activities
  - All activities aligned and evaluated along with learning blueprint
  - User-tests framed by learning blueprint
- Used to guide development of child assessment

Designing Content (2 of 3): Non-Digital Activities

- Classroom activities include a host of common formats/materials which preschool teachers and children are familiar and comfortable with, such as:
  - Children's literature and non-digital games. These can introduce and reinforce/extend the math and science topics.
  - Whole and small group activities that reinforce concepts and use manipulatives and tangible materials.

Designing Content (3 of 3): Tablet-Based Games

- Tablet-based games designed to both:
  - Allow children to individually explore and practice key ideas and concepts in a fun, "low-stakes" environment that is engaging and provides encouraging feedback.
  - Be inherently collaborative and foster children's social skills by inviting children to engage each other in rich interactions and talk about sophisticated math and science topics.

Designing for Children

- Support children by providing opportunities to:
  - Apply what they have learned in different formats
  - Engage in new, fun and productive experiences
  - Socially engage and collaborate in math activities
  - Build their understanding of important math



Designing for Teachers

- Supporting teachers with PD that:
  - Meets teachers where they are,
  - Helps them infuse their existing classroom routines (circle time, choice time, snack time, playground time) with important mathematics, and
  - Uses interactive activities and video resources

- Digital Teachers Guide has:
  - Supports when preparing to teach the unit,
  - Just-in-time scaffolds when preparing for a particular activity, and
  - Reports on children's progress in the online activities.

NGPM Content: Subitizing

What is subitizing?

- Subitizing is "instantly seeing how many"
  - Comes from the Latin word for "suddenly"

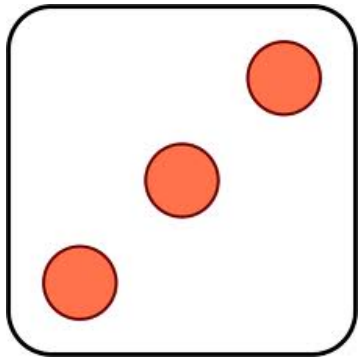
- Subitizing focuses on both the whole and each individual unit, so it **builds on counting skills to foster deeper understanding of quantity**

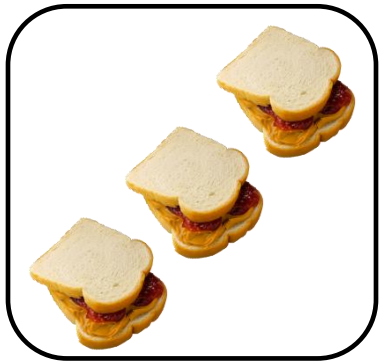
Why does subitizing matter?

- Stepping stone to more sophisticated understanding of number and quantity
- Introduces cardinality (last number in a set is the amount of the group), “how many”, “more or less”, parts and wholes.
- Helps children develop and refine understanding of :
  - Number sense and quantification
  - Arithmetic strategies (such as using a counting on strategy to figure out “how many” or seeing a 3 by 3 cube of dots and knowing that its 9)
  - Early basis for addition

Subitizing and complex shapes

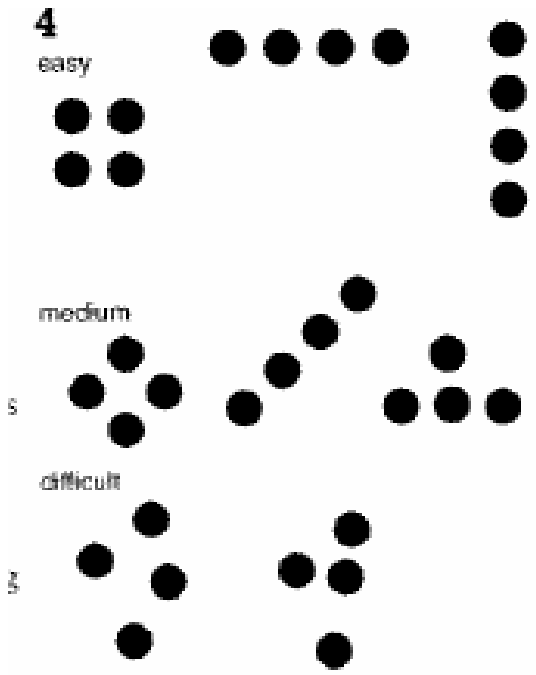
- Simple shapes are easier than more complex shapes or drawings





Subitizing & Arrangements

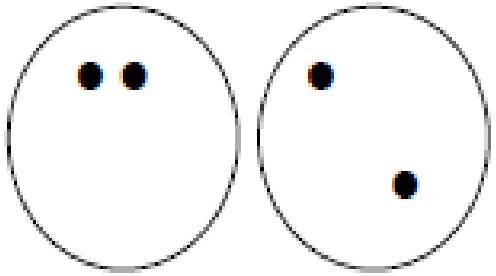
- For young children (2-4 yrs), linear arrangements easiest, followed by rectangular, circular & scrambled



Subitizing & Spacing

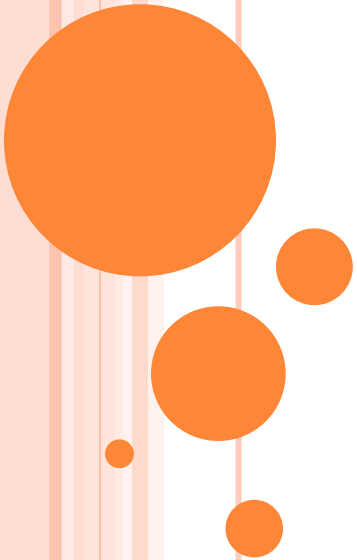
Spacing changes the difficulty of subitizing tasks

- E.g., close spacing easier than spread out spacing



Some ways to foster subitizing

- **"Quick Images"** – showing a set of objects for 1-2 seconds and asking students to tell "how many?"
- **What card doesn't belong?** – have children identify the one card that doesn't belong
- **Concentration** – games with different arrangements of the same number
- **Find the number** – call out a number and children find the right card quickly or vice versa



NGPM Content: Equipartitioning

Unit 2: Equipartitioning (EP)

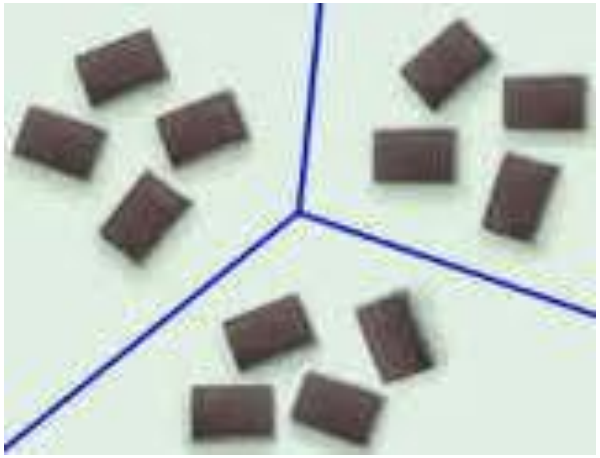
- EP activities
  - popular with preschool children, in part because fairness is very important to them
  - involves both a conceptual understanding of number (understanding the math idea), and practical application to real geometric objects (ex. partitioning a pie)
  - helps develop sophisticated number reasoning concepts, such as ratio and proportion (Confrey et al., 2009).

Two Types of Equipartitioning

- Partitioning collections into equal sized **groups**
- Partitioning wholes into equal sized **parts**

Equipartitioning of Groups (derived from collections)

- Producing equal-sized groups a larger collection of items
  - E.g., 3 groups of 4 chocolate pieces each from the whole collection of chocolate pieces (12)



Another Example of Equal Sized Groups

- Sharing a set of marbles, where each child gets the same number of marbles (requires that the number of marbles be divisible by the number of children).



Equipartitioning of Parts Derived from Wholes

- Producing equal-sized parts (from continuous wholes, such as circles & rectangles),

- Rectangles are easier
  are easier than circles

Example of Equal Parts Derived from Wholes

- E.g., slicing a cake so that everyone gets the same amount of cake.

Combinations: Equal Parts & Equal Groups

- Equal-sized combinations of parts *(from wholes)* and groups *(from collections)*, such as constructing "fair shares" for each of a set of individuals.

- E.g., each set has 1 equal slice of pie and an equal number of blueberries

Example of Equal Wholes & Parts

- Example of a combination is sharing cookies, so that each person gets (say) 2.5 cookies (two whole, plus one half).

Key to Equipartitioning is Same Size or Amount!

- Equipartitioning is NOT simply breaking, fracturing or segmenting in which the goal is not necessarily the creation of equal-sized groups or parts.
- KEY is that each grouping has the same AMOUNT!
- Counter-example: if one cuts a cake so that everyone gets a piece but not all pieces are the same size, that is NOT equal sharing.

Integrating technology Activities with Non-digital Activities

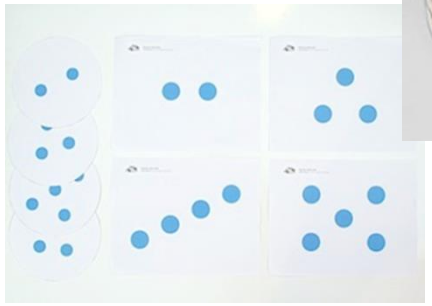
"Playing Preschool"

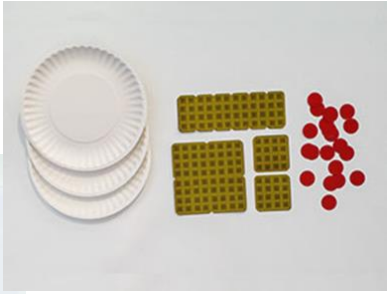
Group A: Collaborative Digital Games

- Play collaboratively
  - Bubble Fun
  - Photo Friends

Group B: Non-digital Classroom Games

- Play in small groups
  - Pounce & with Pictures
  - Waffle Share





Using Technology to Encourage Math Talk In Preschool classrooms

Encouraging Math Talk

- How and why is it important to engage children in math talk?
  - Teacher's scaffolding of math talk can:
    - Promote children's understanding and use of mathematic vocabulary
    - Invite children to reason and explain their thoughts
- **Digital Teacher's Guide directly focuses on helping teachers encourage math talk.**

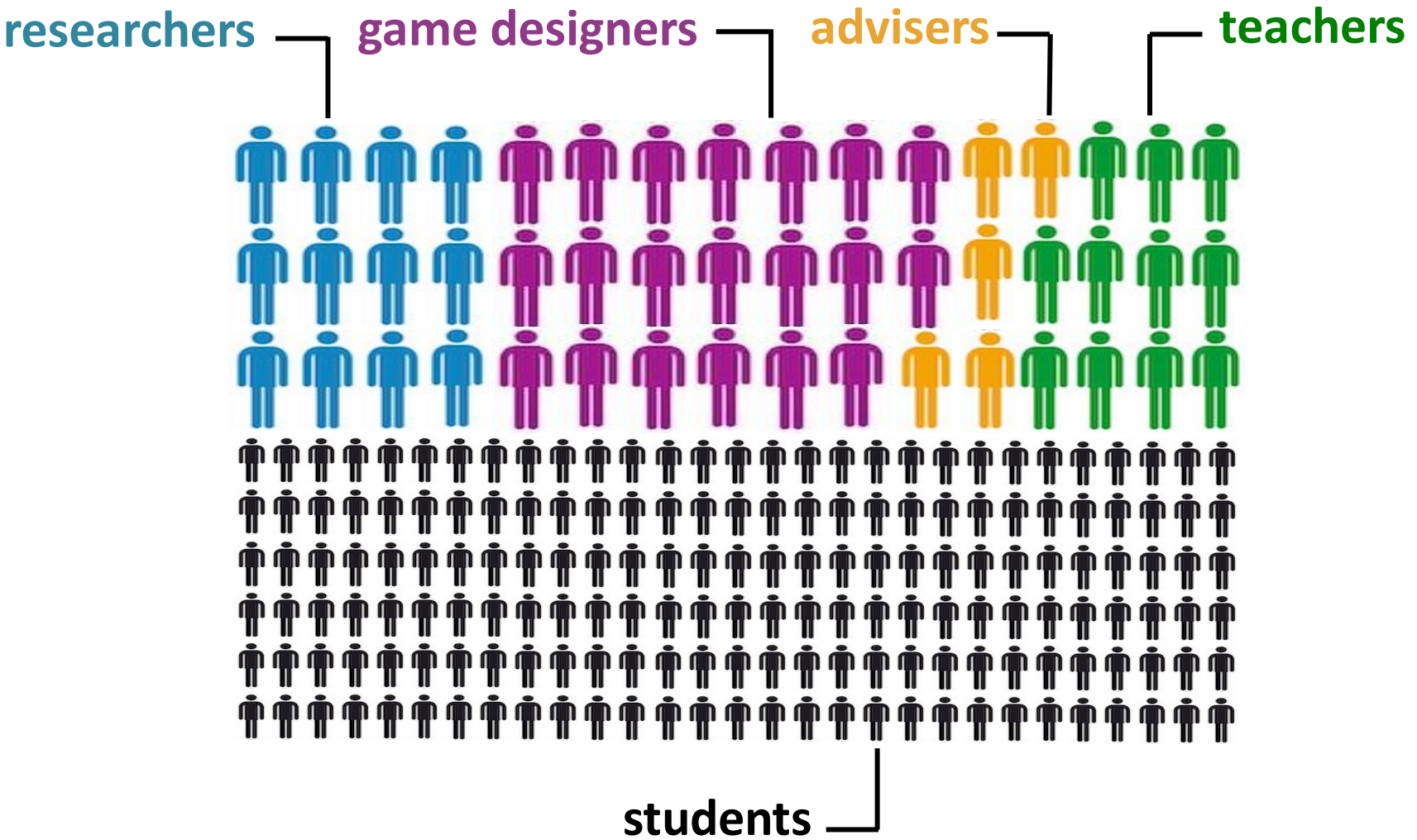
NGPM Research Trajectory

From Development to Field Trial

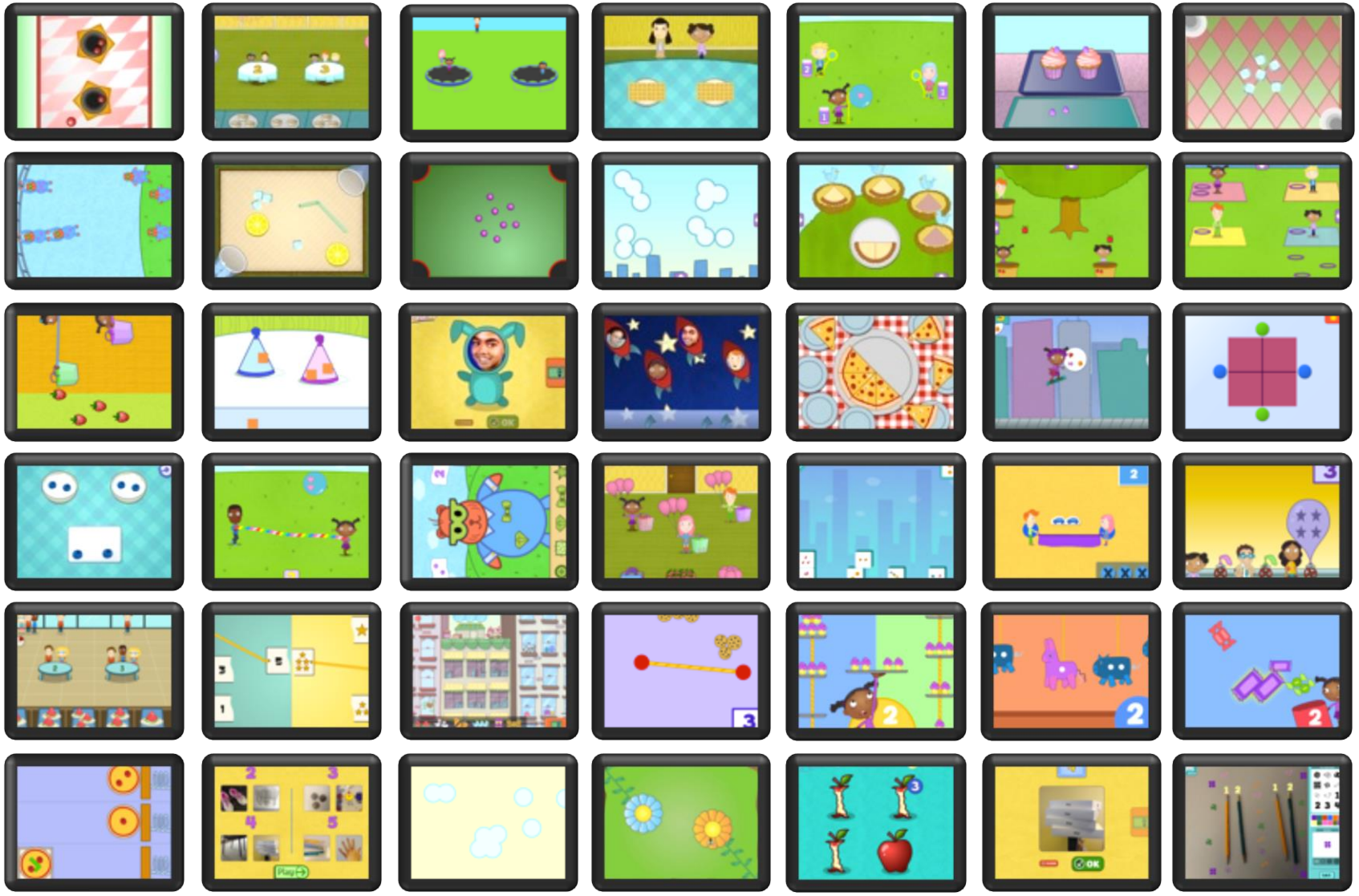
NGPM Development Team

- A multidisciplinary team utilized the Evidence-Based Curriculum Design to create 50 prototypes
- Formatively tested prototypes
- Refined selected prototypes into 8 games that were integrated with non-digital classroom activities

NGPM Development Team



Next Generation Preschool Math



Next Generation Preschool Math

4 SUBITIZING IPAD APPS

4 EQUIPARTITIONING IPAD APPS

NGPM Pilot study

- Alpha version of 8 games + non-digital activities piloted in 3 participating classrooms serving children from low-income families

- Findings from classroom observations:
  - identified areas that needed revisions
  - teachers were comfortable using technology in the classroom,
  - use of technology was developmentally and socially appropriate
  - teacher professional development and the Teachers' Guide helped teachers implement program

- Findings from child assessment:
  - children improved their understanding of target skills: scores at post-assessment were significantly higher than at pre-assessment ($F(1, 18) = 24.338$, $p < .001$)

Current NGPM Field Study

- In progress: NGPM Field Trail
  - Research Question: *Does NGPM significantly impact young children's mastery of subitizing and equipartioning?*
    - 16 teachers/classrooms
    - Data collection will conclude in December 2013
    - Results will be available by Summer 2014
- Final revisions will be completed by next fall (2015)

How NGPM Informs other projects?

- We believe the *Curricular Activity System* framework can be of general applicability in designing (or adopting/adapting) effective and appropriate interventions to promote STEM readiness and integrate technology in meaningful ways.
- Example: *Next Generation Preschool Science (NGPS)*, an NSF-funded project to promote young children's learning of science practices and concepts.
  - The NGPS program will:
    - include classroom activities (e.g., children's books, hands-on science investigations, etc.)
    - integrate technology to innovatively support inquiry (e.g., tablets will be used to record and analyze data, and simulations will be developed to reinforce the learning that occurs in scientific investigations)
    - include strong supports for teachers (PD and Teacher Guide)

Future NGPM Efforts

- We hope to:
  - develop units target other key ideas and content areas,
  - integrating non-cognitive skills (i.e. persistence, cooperation) as foci into games
- Future efforts may also seek to further refine game mechanics that may be particularly beneficial for preschool children and teachers
  - Pausing feature for teachers
  - Drawing feature for teachers
  - More data use by teachers
- Further develop professional development to help preschool teachers utilize student data to inform instruction.

Best Practices for Technology Integration

Best Practices for technology in Preschool

- Matching the technology source and use with the learning goal
  - In NGPM, the research design process used a very specific learning goal; but not all commercially available games have that focus and fit
- Integrating into existing preschool context
- Linking digital and non-digital learning (manipulatives & literacy based)
- Design for Joint Media Engagement: May not always be teacher to student, but rather peers
- Limit playtime to 10-15 minutes

DESIGN PRINCIPLES FOR DEVELOPING EDUCATIONAL GAMES FOR YOUNG CHILDREN

- *Multiple opportunities to learn across games.*
- *Multiple opportunities to learn within a game.*
- *Carefully select visual objects.*
- *Limit audio cues.*
- *Provide opportunities to learn the game mechanics.*
- *Consider the impact of game mechanics on pace.*
- *Allow touch responses with a wide range.*
- *Carefully select feedback.*
- *Selectively integrate physical movement into games.*
- *Level games to match children's growing competence.*
- *Provide compelling game context.*

Design Principle #9:

Selectively integrate physical movement into games.

Three types of Collaborative Play

- **"Watching" collaboration**: a child watches or observes another child play often to get a sense of how to play the game.
- **"Modeling" collaboration**: a child is actively engaged in showing another child something specific about game play.
- **"Interdependence" collaboration**: children play together as equal collaborators each advancing the game play towards the specific goal of "winning."
- Children can move between the three levels (watching, modeling and interdependence) during the same game play event.

Ways to encourage Collaboration with Digital Technology

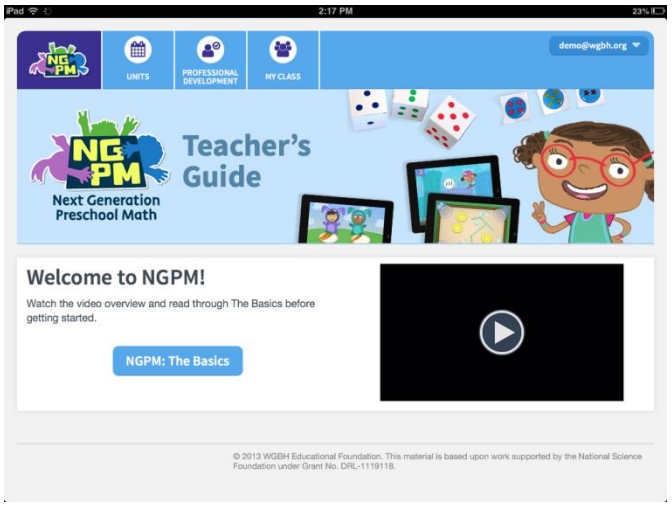
- Build competence with the iPad (i.e. turn on, navigate, etc.)
- Allow opportunities for children to go through the different levels and forms of collaboration
- Build in a small warm-up activity to get children use to doing things together (i.e. ask one student to turn on the iPad and the other to open the game).
- Provide concrete directions about how to collaborate:
  - Tell children before a collaborative game that they need to both touch the screen during the game.
  - Ask them to sit closely next to one another and put the iPad where both children can see and touch it.
- Praise pairs that are collaborating well.
- Intervene if you see a pair is not collaborating well and trouble shoot the difficulties.

What does positive integration of technology into preschool look like?

- Moderately sustained attention and perseverance with a digital tasks (not switching back and forth to the detriment of learning)
- Listening and watching other children play
- Children touching each other's screens
  - Peer-to-peer Joint Media Engagement
  - Child-to-teacher Joint Media Engagement
- Parallel play with collaborative goals
- A video snapshot: http://nextgenmath.org/2013/10/10/video-notes-from-the-field-collaborative-games/

In conclusion …

- Digital activities can be integrated into preschool a positive way when supports are provided



- Technology can
  - facilitate learning for BOTH teachers (PD) and children (learning games),
  - help teachers collect data on children's progress, and
  - help build and maintain excitement about learning STEM topics.