



**RESEARCH + PRACTICE  
COLLABORATORY**

# **Mobile Technology and Early Math Learning: A Design-Based Implementation Research Approach**

3/12/15



**RESEARCH + PRACTICE  
COLLABORATORY**



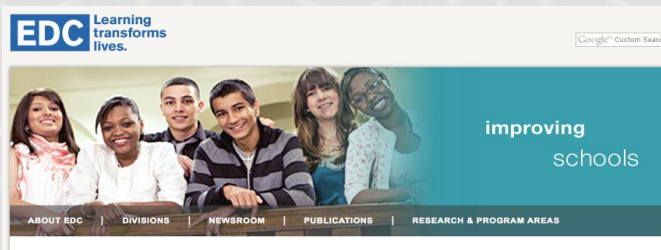
# Agenda

Topic	Presenter
Welcome & Introductions	Dr. Pamela J. Buffington, Education Development Center (EDC)
Research + Practice Collaboratory Background	Dr. Pamela J. Buffington
Design Based Implementation Research Overview	Dr. William Penuel, University of Colorado - Boulder
Q & A	Dr. William Penuel
DBIR in the Context of Early Mathematics Learning and Teaching in Mobile Technology Rich Classrooms	Dr. Pamela J. Buffington
Q & A	Dr. Pamela J. Buffington
Open Discussion Looking Forward: NCSM/NCTM	Dr. Pamela J. Buffington Dr. William Penuel



# Introductions

- Dr. Pamela J. Buffington
- Education Development Center, Inc.



- Dr. William Penuel
- University of Colorado - Boulder



RESEARCH + PRACTICE  
COLLABORATORY



# Research + Practice Collaboratory

---

- Effort to bridge gap in research + practice in science, technology, engineering, & math education
- Collaboration of practitioners, researchers, formal and informal STEM partners  
(Education Development Center, U Colorado-Boulder, Exploratorium, U Washington - Seattle, Inverness Research, SRI)
- Create contexts & mechanisms R+P cultural exchange, collaboration, & adaptation
- Create supporting products and resources



RESEARCH + PRACTICE  
COLLABORATORY



# R + P Collaboratory Activities (EDC)

---

## Maine Adaptation Site Work

- Local, deep collaborations of researchers and practitioners engaged in educational improvement efforts (Math & Technology)



## Interactive Technology Inquiry Group

- Inquiry Groups provide opportunities for small groups of practitioners and researchers/experts to discuss persistent problems in education in and to engage with related research and practice (Interactive Technologies/Math)



# Design-Based Implementation Research: Inspiration and Principles

William R. Penuel

*University of Colorado Boulder*



RESEARCH + PRACTICE  
COLLABORATORY



# Scaling and Sustainability in Mathematics Education

---



**Mary Kay Stein:** Task Design vs. Task Enactment



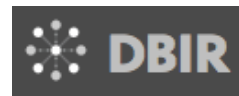
**James P. Spillane:** Advice giving, distributed leadership



**Cynthia Coburn:** Depth of Interaction



RESEARCH + PRACTICE  
COLLABORATORY





# Translational Model

---

- Type I Translation
  - From basic science to interventions developed under carefully controlled conditions (e.g., lab)
  - Examples of STEM Interventions: Curricula, Afterschool Programs, Mentoring Programs, Professional Development Programs
- Type II Translation
  - From interventions to the field
- Development of compelling evidence from rigorous research determines trajectory of an intervention



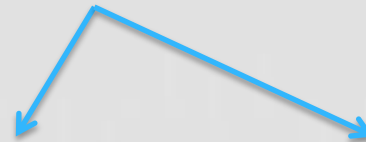


# Translational Model

Type I Translation



Type II Translation



Design and  
Development

Efficacy  
Trials

Effectiveness  
& Scale Up  
Studies

Involvement of R&D Team

Involvement of Evaluators & Practitioners



RESEARCH + PRACTICE  
COLLABORATORY



EDC Learning  
transforms  
lives.



# DBIR: An Approach for RPPs

---

- Works within ongoing *research-practice partnerships*
- Engages teams in *design across levels and settings*
- Uses *implementation theory and research* to inform improvements to design
- Engages in *systematic study* of interventions along the way



# Translation vs. Partnership

Translation Metaphor	Research-Practice Partnerships
The aim is to move an efficacious intervention <i>from</i> research <i>to</i> practice (from “bench” to “bedside”)	The aim is to produce usable, effective, and sustainable innovations through <i>joint work</i>
Goal is to promote adherence to an implementation model (an aspect of fidelity).	Goal is to support productive adaptation and use creative adaptations to inform design.
Programs are judged to be effective when they work in systems as they are now.	Researchers and practitioners create changes in systems that are needed to make programs work.
Researchers and practitioners operate in distinct spheres; researchers aim to “hand off” programs to practitioners.	Researchers and practitioners create a opportunities for ongoing exchange, including to support spread and sustainability.



# A Family of Approaches

...for relating research to practice  
...for developing evidence related to innovations  
...for bringing innovations to scale



“improvement science”



“problem-solving research, development,  
and implementation”



“designing for  
improvement at scale”



RESEARCH + PRACTICE  
COLLABORATORY



# Four Principles of DBIR

---

1. Teams form around a focus on persistent problems of practice from multiple stakeholders' perspectives.
2. To improve practice, teams commit to iterative, collaborative design.
3. To promote quality in the research and development process, teams develop theory related to both classroom learning and implementation through systematic inquiry.
4. Design-based implementation research is concerned with developing capacity for sustaining change in systems.



# Two Problematic Ideas about DBIR

---

- **Problematic Idea #1:** All DBIR projects involve large-scale efforts where innovations have already been developed.
  - Smaller-scale DBIR projects can be undertaken with small (but multidisciplinary) teams of researchers and educators .
- **Problematic Idea #2:** Capacity building should focus on the capacity of educators.
  - The target of capacity building is the partnership's capacity to *improve improvement*.



# Building Capacity for DBIR

---

- Graduate education
  - Within educational leadership programs
  - Within teacher education programs
  - Within learning sciences programs
- Building practical “tools of the trade” for research-practice partnerships
  - Organizing collaborative design
  - Developing and using implementation evidence





# Questions & Answers

---



RESEARCH + PRACTICE  
COLLABORATORY

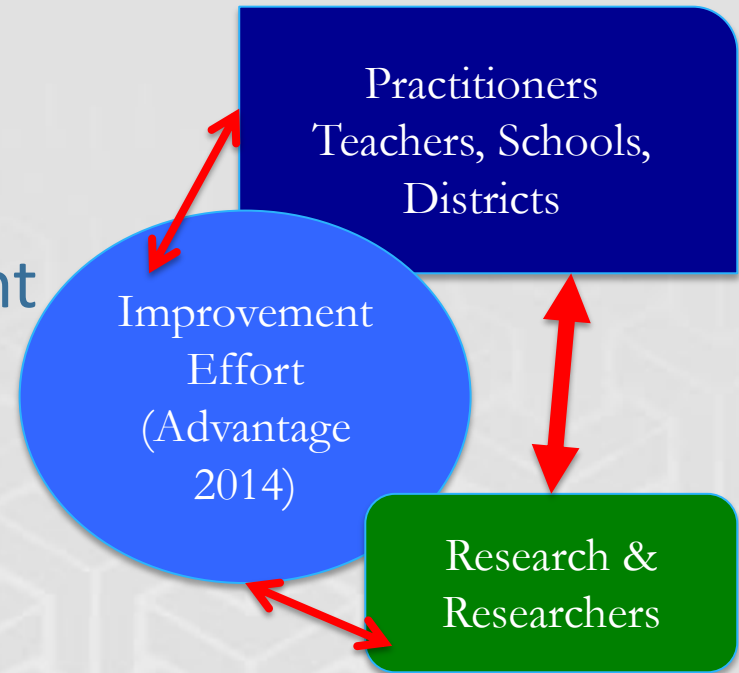


EDC Learning  
transforms  
lives.



# Adaptation Site

- Involving sustained partnerships between research + practice
- Existing educational improvement efforts (iPads K-3)
- On the ground Design Based Implementation Research (DBIR) Projects



# District Benefits of Participation

---

- Access to STEM content expertise in support of current improvement efforts
- Access to STEM researchers to assist in research design and analysis
- Opportunity to build local capacity and knowledge through collaborative research efforts
- Opportunity to contribute to education theory & practice through ongoing inquiry & documentation



# Collaboratory Benefits of Participation

---

- Access to rich STEM learning context (Advantage 2014)
- Access to a community of practice with deep practitioner knowledge
- Opportunity to connect Inquiry Group topic (Interactive Technologies) to Adaptation Site work
- Opportunity to work in Opportunity to learn in an authentic education setting



# Identify & Convene Key Stakeholders

---

- District
  - Administrators (Superintendent, Asst. Superintendent, Curriculum Director, Principals)
  - Teachers & Specialists (Math Content Specialist, Technology Integrator, Special Educators, Elementary Teachers)
  - District Design Team (School Board, Parents, Teachers, Admin)
- Higher Education
  - Mathematics Education Faculty/Researchers – 2 Local Universities
- Education Development Center Staff
  - Math & Technology Experts & Researchers



# Problem Identification

---

- Engage in a collaborative process to identify 2-3 highest priority areas of difficulty (i.e. persistent problems) for students in mathematics in technology rich PK-2 classrooms
- Identify evidence associated with areas of difficulty/persistent problems
- Prioritize persistent problems based on levels of evidence and opportunity to intervene

Auburn School Department & Education Development Center with partners supporting researcher & practitioner collaboration as part NSF funded R&P Collaboratory.



RESEARCH + PRACTICE  
COLLABORATORY



# Reflect on Learning & Challenges

---

As you have been working to improve the math achievement of early learners by leveraging iPads and their apps ...

- What have you learned?
- What are the successes?
- What are the persisting challenges or problems?
- What do you want to understand more deeply?





# Identified Problems of Practice

---

- There is not a clear vision of effective practice for the learning & teaching of mathematics in technology rich primary (PK-3) classrooms
- There are persistent difficulties in the area of numeracy
- There are persistent difficulties in the area of numbers & operations



# Targeted Focus - Mathematical Practices

- Focus in on 3 practices
  - **MP3.** Construct viable arguments and critique the reasoning of others
  - **MP4.** Model with mathematics
  - **MP5.** Use appropriate tools strategically



**Standards for Mathematical Practice**

---

**MP1.** Make sense of problems and persevere in solving them.

**MP2.** Reason abstractly and quantitatively.

**MP3.** Construct viable arguments and critique the reasoning of others.


**MP4.** Model with mathematics.


**MP5.** Use appropriate tools strategically.

**MP6.** Attend to precision.

**MP7.** Look for and make use of structure.

**MP8.** Look for and express regularity in repeated reasoning.

**COMMON CORE**  
STATE STANDARDS INITIATIVE  
PREPARING AMERICA'S STUDENTS FOR COLLEGE & CAREER



# Establish Shared Vision

---

- Clarify Adaptation Site Goals (operationalize)
- Engage in Hands-on Activities
- Investigate Evidence Related to Identified Problems of Practice
  - Numeracy/Number & Operations
  - Mathematics Practices (MP3, MP4, MP5)
- Explore Research – Practice Collaboration
- Describe Potential Research – Practice Tools (Briefs / Snapshots of practice)



# Early Math Learning Trajectories

- Research – Practice Briefs
- Inform mathematics learning & teaching practices
- 4 Briefs
- Bridge Research + Practice

## PRACTICE BRIEF

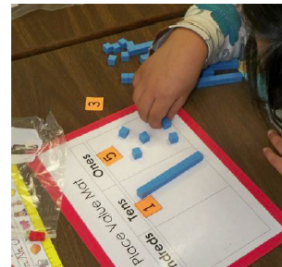
### Composition of Number, Place Value, and Multidigit Addition and Subtraction

This brief, derived from a chapter from *Learning and Teaching Early Math: The Learning Trajectories Approach* (Clements & Sarama, 2009), provides a summary of key ideas and a developmental progression related to *Composition of Number, Place Value, and Multidigit Addition and Subtraction*. The chapter was abridged, maintaining the authors' original language except for clarification and abbreviation purposes, with the goal of highlighting research and illustrations that may help familiarize educators with learning trajectories and their underlying concepts. It is part of a collection of briefs on early math learning trajectories, produced by the Research+Practice Collaboratory ([researchandpractice.org](http://researchandpractice.org)), a project funded by the National Science Foundation to build stronger bridges between the worlds of educational research and practice.

This brief addresses three topics involving increasingly sophisticated composition of number: arithmetic combinations ("facts"), place value, and multidigit addition and subtraction.

**Composing Number:** Composing and decomposing numbers is an approach to addition and subtraction, one that is often used alongside with counting strategies (e.g., the "doubles-plus-one" strategy of making 15 where a student might compose the number 14 by putting together 2 sevens, then add 1 using counting).

**Initial Competencies with Part-Whole Relationships:** Toddlers learn to recognize part-whole relations in nonverbal, intuitive, perceptual situations and can nonverbally represent parts that make a specific whole (e.g., ●● and ●● make ●●●●). Between 4 and 5 years of age, children learn from everyday situations that a whole is made up of smaller parts and thus is bigger than its parts; however, they



RESEARCH + PRACTICE  
COLLABORATORY



EDC Learning  
transforms  
lives.



# Technology Brief

- Used to frame fall trial strategies – using technology tools and applets in the targeted K-2 classrooms
- Used in Leveraging Learning Conference sessions

## RESEARCH SUMMARY



### Using Technology to Promote Mathematics Learning in the Early Grades

#### Overarching issues

The availability of a vast array of touch-screen mobile technologies holds promise for more widespread and tailored use of technology for learning in K–12 learning environments, yet questions remain about the best ways to leverage those technologies. Mathematics teachers may endorse the use of technology, yet need guidance on (1) how technology can be used in developmentally appropriate ways to foster mathematics learning, (2) strategies for instructionally sound integration of technology into the classroom, and (3) how to select technology tools that best foster the conceptual learning of mathematics and encourage the use of mathematics practices such as reasoning and problem solving.

#### Affordances of technology for learning mathematics

Research supports the assertion that developmentally appropriate technology and media-supported instruction can support learning for young children in a variety of content domains, including mathematics (e.g., Clements & Sarama, 2008; Varol & Colburn, 2007). The developmentally appropriate use of technology has been endorsed by a number of professional associations, including the National Council of Teachers of Mathematics, which states:

*“Technology is an essential tool for teaching and learning mathematics effectively; it extends the mathematics that can be taught and enhances students learning.”* (NCTM, 2003, p.1)



# Co-Design/Co-Investigate

---

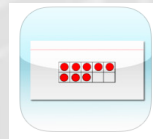
- Teams in each of the participating schools
  - 1 teacher per grade level
  - 1 principal
  - 1 outside researcher (math ed)
- Learning together
- Posing and testing strategies in the classroom





# Example Strategies

- Use apps as tools for thinking –
  - Use ‘Number Rack’ in the context a lesson to represent quantities
- Use apps to capture student thinking –
  - Use screen capture of app use
  - Use Explain Everything to capture student motion, representations, and explanations



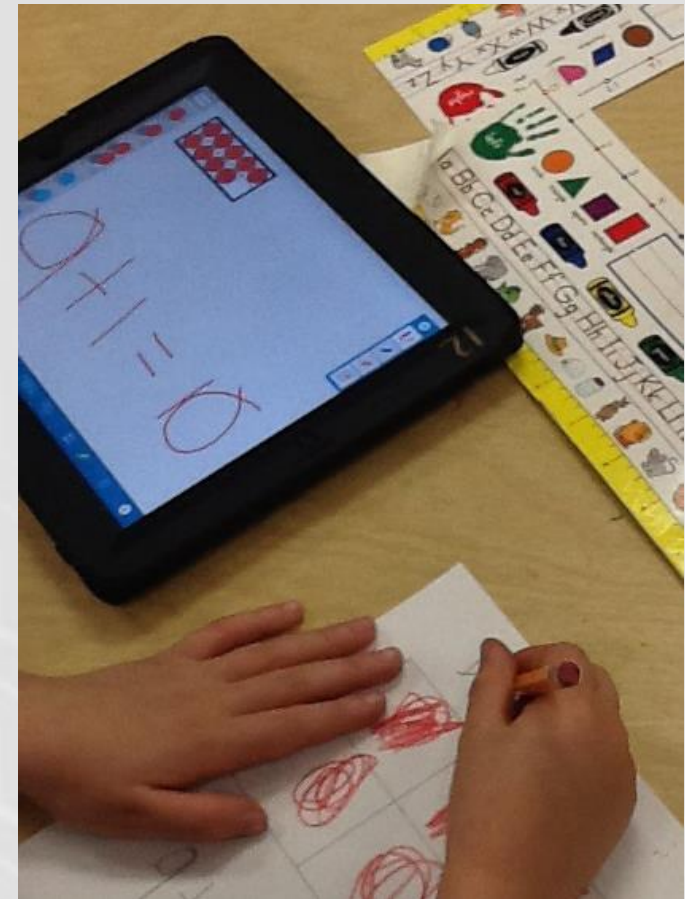
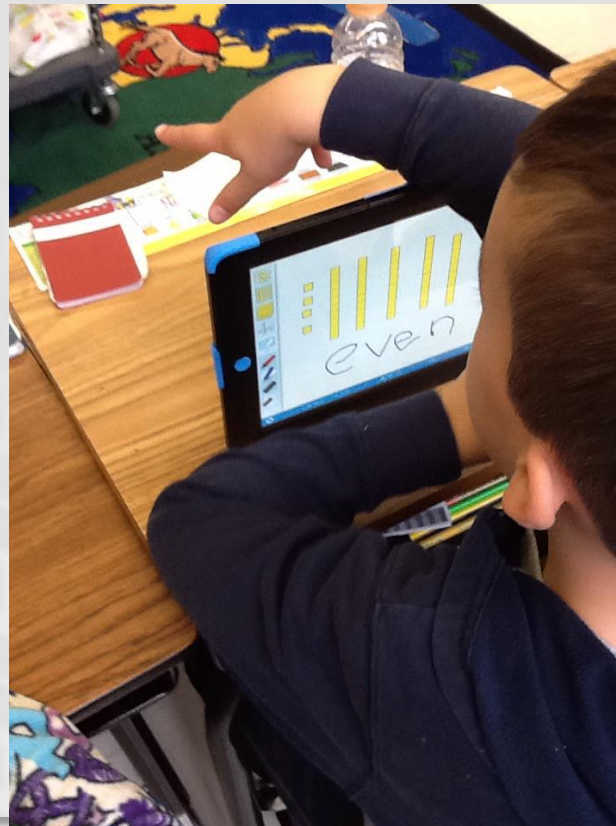


# Sample Lesson Gr.2

- Place Value (4 digit)  
Haunted House Lesson
- Deepen Mathematical Communication (MP3)
- Use Models (MP4)
- Tools – Number Pieces App, Explain Everything



# Representing/Discussing Representation



RESEARCH + PRACTICE  
COLLABORATORY



EDC Learning  
transforms  
lives.



# Refined Research Question

---

- What are the ways in which mobile tablets (iPads) can be used in early grades mathematics classrooms in order to promote mathematical communication and understanding of numeracy and number and operations?



# Outcomes

---

- Mathematical Communication
  - Construct viable arguments and critique the reasoning of others
  - Accurate and appropriate use of mathematical vocabulary
- Sense-making, in number and operations
  - Use of models and representations during sense making
  - Use appropriate tools strategically





# Questions

---



RESEARCH + PRACTICE  
COLLABORATORY



# Looking Ahead

- NCTM & NCSM National Conferences, April 2015

## Opening Session, Monday, April 13, 7pm.

Learn how the application of Design-Based Implementation Research (DBIR) in Denver Public Schools is facilitating increased collaboration between researchers, teachers, and district leaders.

William Penuel, Ph.D.

Professor, Educational Psychology & Learning Sciences

University of Colorado, Boulder

Catherine Martin, Ph.D.

Director of Mathematics and Science

Denver Public Schools

Tuesday, April 14, 2015

8:30 AM-9:45 AM

## Early mathematics with mobile technology: A research-practice collaboration

**Jere Confrey, Michael Muir, Josephine Louie, Pam Buffington and Catherine McCulloch**

**Discussion Session**

**Grand Ballroom B (Westin - Boston Waterfront)**



CONFERENCES & EVENTS | ANNUAL CONFERENCE

## 2015 NCSM Annual Conference

### Tuesday Sessions

245	11:15 AM to 12:15 PM	156 B	General	Regular Presentation	Examining the opportunities and challenges of using technology to support teaching and learning mathematics
-----	----------------------	-------	---------	----------------------	-------------------------------------------------------------------------------------------------------------

Improving Early Mathematics Learning & Teaching in iPad-Infused Classrooms: A Research and Practice Collaboration

This session will explore a model for improvement in which researchers and practitioners collaborate to identify and address persistent challenges related to early mathematics learning and teaching in iPad-infused, K-2 classrooms. Key strategies, learning, benefits, and challenges will be shared.

Lead Speaker: Amber Eliason

Co-Presenter: Pamela Buffington

Co-Presenter: Laura Shaw



RESEARCH + PRACTICE  
COLLABORATORY



# Thank You

---

## Contacts:

william.penuel@colorado.edu

Pbuffington@edc.org

## On the web:

<http://learndbir.org>

<http://researchandpractice.org>

## On Twitter:

@LearnDBIR @bpenuel

## In print:

Fishman, B. J., Penuel, W. R., Allen, A.-R., & Cheng, B. H. (Eds.). (2013). *Design-based implementation research: Theories, methods, and exemplars*. National Society for the Study of Education Yearbook. New York, NY: Teachers College Press.

Penuel, W. R., Fishman, B. J., Cheng, B., & Sabelli, N. (2011). Organizing research and development at the intersection of learning, implementation, and design. *Educational Researcher*, 40(7), 331-337.



RESEARCH + PRACTICE  
COLLABORATORY

