Initial Efficacy of a First-Grade Mathematics Intervention on Measurement & Statistical Investigation

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Case for the Research

- Measurement and statistical investigation offer important contexts for students to ***apply*** and ***strengthen*** their understanding of whole numbers & operations

- Significant value in our everyday lives
  - e.g., measuring objects and interpreting political polls

- Yet ***little intervention research*** has been conducted in these areas for students with or at risk for mathematics learning disabilities (MLD)

Precision Mathematics (PM) Project

Aims of this 4-year, NSF-sponsored DRK-12 project:

1. ***Design a first-grade mathematics intervention*** focused on critical concepts and problem-solving skills related to measurement & statistical investigation

2. ***Demonstrate the "promise" of the PM intervention*** for increasing student mathematics achievement in areas of mathematics beyond whole numbers and operations

PM First-Grade Intervention

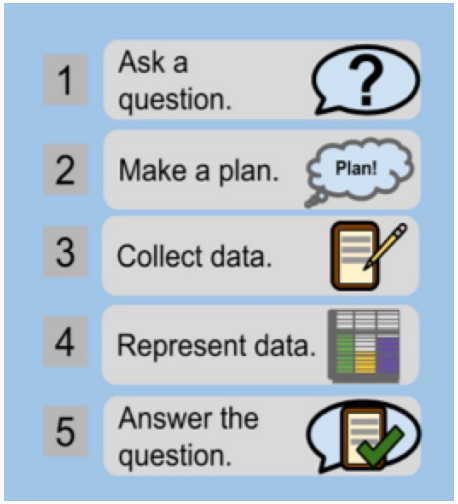
- **First-grade mathematics intervention**
  - **32 lessons:** 30 min. per day, 4 days per week for 8 weeks
  - **Mathematical content**: Measurement and Data topics from the first-grade *Common Core State Standards* (2010)
  - **Hybrid platform**: Print- and technology-based activities
  - **Small-group formats** (5:1 student-teacher ratio)
  - **Students**: First-grade students who are at risk for MLD

- **Promoting meaningful, authentic learning contexts**
  - Situated the intervention in *Life* and *Earth Science* topics from the U.S. *Next Generation Science Standards* (2013)

Mathematical Content

- **Length Measurement**: Understand that length is continuous attribute that can be subdivided into smaller lengths, and concepts of *unit iteration* and *conservation*

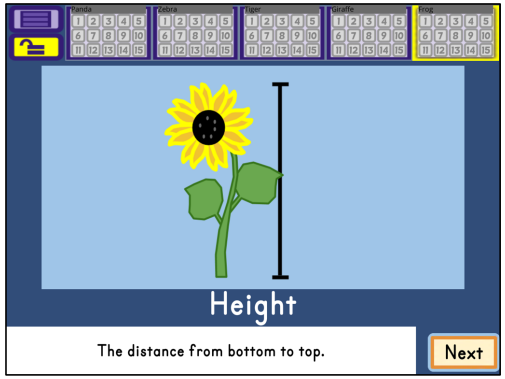
- **Data Analysis**: Understand and apply a framework of statistical investigation (GAISE, 2017)



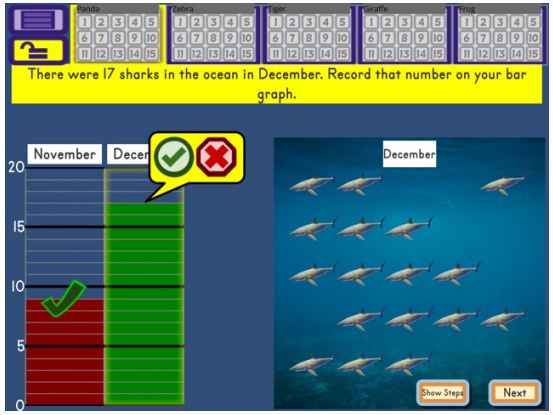
Technology-based Platform

- An iPad app that uses Wi-Fi to connect student iPads to a teacher iPad.
- ***"Teacher View"*** feature allows the teacher iPad to control the student iPads (e.g., selecting activities).

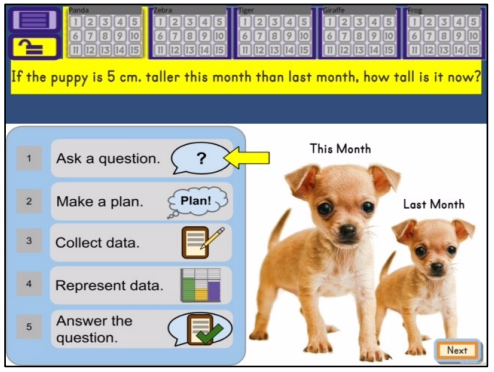
Technology-based Activities



VOCABULARY



DATA REPRESENTATION



PROBLEM SOLVING

Precision Mathematics

PILOT STUDY

Original Research

Efficacy of a First-Grade Mathematics Intervention on Measurement and Data Analysis

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Abstract

Well-designed mathematics instruction focused on concepts and problem-solving skills associated with measurement and data analysis can build a foundational understanding for more advanced mathematics. This study investigated the efficacy of the Precision Mathematics Level 1 (PM-L1) intervention, a Tier 2 print- and technology-based mathematics intervention designed to increase first-grade students' conceptual understanding and problem-solving skills around the areas of measurement and data analysis. Employing a randomized controlled trial, 96 first-grade students at risk for mathematics difficulties were randomly assigned within classrooms to either a treatment (PM-L1) or a control (business-as-usual) condition. A statistically significant positive effect was found on one of five outcome measures, with the other four showing positive but nonsignificant results. Results also suggested preliminary evidence of differential response based on students' number sense and early literacy risk status. Implications for using mathematics interventions focused on measurement and data analysis to build comprehensive, multitiered service delivery models in mathematics are discussed.

In the current climate of a globalized economy, the demand for a highly skilled workforce has dramatically increased (National Science Board, 2018). Consequently, the notion of preparing all students, including those with mathematics difficulties (MD), for early mathematical learning has gained national prominence. The raised standards bar for mathematics teaching and learning is evidenced by the advent of the Common Core State Standards for Mathematics (CCSS-M; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Under the CCSS-M, students at every grade level are expected to develop proficiency in all areas of mathematics, including length measurement and data analysis.

A robust understanding of measurement and data analysis is essential in the science, technology, engineering, and mathematics (STEM) fields. Civil engineers, for example, use measurement to obtain precise estimates of mass and strain, whereas an epidemiologist will collect and analyze data to identify trends in health-related events, such as measles outbreaks (Paules, Marston, & Fauci, 2019). Academically, measurement and data analysis hold significant value. Students who acquire a robust understanding of early measurement and data analysis concepts are better positioned

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Research Questions

- **RQ#1**: What was the **overall effect** of Precision Mathematics compared to a control condition for first-grade students with or at risk for MLD?

- **RQ#2**: To what extent do students' initial early literacy and numeracy skills ***influence*** the impact of Precision Mathematics?

Method & Procedures

1. Recruited **10 first grade classrooms** from 5 schools

2. Screened all students (***N* = 221**) on a battery of whole number assessments for mathematics difficulties (MD)

3. Randomized the **10 lowest-performers** in each classroom

4. **96 students with MD** were randomized to one two conditions:
   - **Precision Mathematics** (treatment) = 49
   - **Control** (business-as-usual) = 47

First-Grade Student Participants

Variable	PM (n = 49)	Control (n = 47)
Female	58%	64%
White	87%	87%
Hispanic	10%	11%
Multiple races	~3%	~3%
Special education eligible	8%	13%
English learners	8%	2%

Treatment Condition

10 PM intervention groups

- Delivered in small-group formats: 5:1 student-teacher ratio

Taught by district- & researcher-employed interventionists

- 100% female; Avg. number of years teaching: 7.60
- Bachelor's degree: 80%; Current teaching license: 20%

Professional Development & In-class Coaching

- Two 4-hour curriculum workshops & 2 coaching visits each

Fidelity of implementation: (*M* = 63% to 81%)

Instructional Dosage

- All 10 groups completed 100% of the lessons

Control Condition (BAU)

Core (Tier 1) mathematics instruction

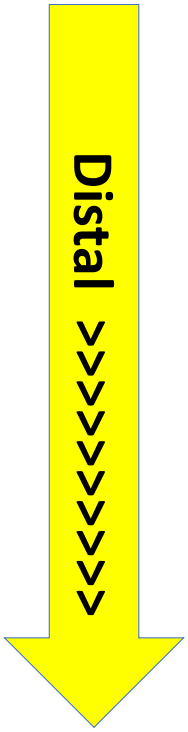
- Classrooms taught by 10 certified teachers
- Avg. amount of daily math instruction**: 71 min**.
- Prioritized mathematics content:
  - Number & Operations in Base-10
  - Operations & Algebraic Thinking

Mathematics intervention

- ~40% of control students received intervention support
- *Bridges in Mathematics Intervention* program

Outcome Measures

1. **PM Proximal Assessment** (PM Content Team, 2016)
   - 16-item, researcher developed measure
2. **ASPENS: Number ID (0 to 20) CBM** (Clarke et al., 2011)
3. **ASPENS: 1st gr. CBM Battery** (Clarke et al., 2011)
   - 4 CBMs focused on number proficiency (number sense skills)
     - Base-10, math +/- facts
     - Missing number, magnitude comparison
4. **Early Measurement CBM (EM-CBM)** (PM Measurement Team, 2016)
   - 4 CBMs focused on early measurement:
     - Comparison of 3 Items; Measurement of 2 items using an object
     - Iterative Measurement #1; Iterative Measurement #2
5. **easyCBM – CCSS-M** (Alonzo et al., 2006)
   - Distal outcome measure targeting all domains in 1st gr. CCSS-M



Results

- **RQ#1:** What was the overall impact of Precision Math as compared to control?
  - **Results:** Positive effects on all five student mathematics measures (*g* = .08 to .45)
  - **What does this mean?**
    - Precision Mathematics intervention demonstrated "**promise**" to improve student outcomes in areas of mathematics beyond whole number and operations

- **RQ#2**: To what extent do students' initial early literacy and numeracy skills ***influence*** the impact of Precision Mathematics?
  - **Results:** Students with more intensive needs in early literacy and numeracy appeared to benefit the most from the Precision Mathematics intervention
  - **What does this mean?**
    - The instructional design of Precision Mathematics (i.e., systematic & explicit instruction) may meet the instructional needs of students with significant MD

Thank You!

For more info about the Precision Mathematics project, please contact:

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