Scaling Innovation in Developmental Math:
Lessons from Research and Practice

Susan Bickerstaff, Community College Research Center
Barbara Lontz, Montgomery County Community College

November 8, 2012
AMATYC
We conduct quantitative and qualitative research on:

- Teaching and learning in higher education
- Access to and success in postsecondary education
- High school to college transitions
- Missions, governance and accountability
- Workforce education
Our **Challenge**

- Outcomes for students referred to developmental education are discouraging
  - Vast majority of students do not complete the **sequences** to which they are referred
  - Developmental education is not effective for students near the **cut-off point**
  - Traditional **assessment** and **placement** mechanisms have flaws
Innovation in Developmental Education

• CCRC national scan of reforms in developmental education suggests that experimentation and innovation are widespread
• However, most reforms affect relatively few students and remain small in scale and largely unknown outside their institutions
• Institutional norms in higher education make it difficult to sustain meaningful change
Common Reform Types

**Structural** reforms focus on reorganization of instructional time and delivery (e.g., compressed courses, mainstreaming, and modularization).

**Curricular** reforms focus on rationalizing and refining content (e.g., alternative pathways, contextualization, and course elimination).

**Pedagogical** reforms focus on changes to teaching (e.g., student-centered activities, conceptual learning, and metacognition).

*Approaches are NOT mutually exclusive*
Community College Research Center and partner colleges work to **scale promising reforms** at new institutions.

- **Faculty-driven effort**, with intentional focus on classroom practice.
- Rather than strict fidelity, faculty work to **adapt** the reform to the institutional context.
- For more information visit [www.scalinginnovation.org](http://www.scalinginnovation.org)
Concepts of Numbers: A Case Study for Scaling Meaningful and Sustainable Reform
Causes for Concern at MCCC

• The success rates* for the past eight years in our arithmetic classes had been declining

• The success rates fell between 35% - 45%

• Our numbers reflect a national trend of declining math scores

*success rates are grades of C or better
Concepts of Numbers

• All learning outcomes of a traditional arithmetic course are covered but in a different order

• Lessons proceed through concepts, (addition, subtraction, multiplication, division & combinations) using a discovery approach

• Students are assessed on the same skills as the traditional arithmetic course
Concepts' Guiding Principles

• Faculty become facilitators of knowledge; students learn through discovery

• New embedded skills are introduced on an as-needed basis

• If a student understands a skill and its usefulness, practice problems can be kept to a minimum

• Calculators are not used in this course

• All students can learn math

“Teach me, and I will forget. Show me, and I will remember. Involve me, and I will understand.”
Chinese Proverb
Concepts of Numbers Outline

- Unit 1: History of Numbers
- Unit 2: The Real Number System
- Unit 3: Comparisons
- Unit 4: Addition
- Unit 5: Subtraction
- Unit 6: Multiplication
- Unit 7: Division
- Unit 8: Combinations
Unit 1: History of Numbers

• In understanding the evolution of numbers, students will better understand/appreciate our present system.

• The following civilizations are covered:
  Babylonian
  Greek
  Egyptian
  Roman
  African
  Mayan

• The concepts of place value and place holders are explored.
Unit 2: The Real Number System

- All sets of numbers are introduced: natural, whole, integers, rational, irrational & real
- Numbers are classified according to their sets
- Numbers are located on a number line
- “All numbers are created equal.” B.Lontz
Unit 3: Comparisons

• The concepts of <, > and =

• *like* numbers are compared (integers, fractions with the same denominator)

• *unlike* numbers are compared (irrational numbers with rational numbers, fractions with different denominators, fractions with decimals)

• Numbers that are *like* are easier to compare
Unit 4: Addition

• Addition (combining) of the following quantities:
  
  whole numbers
  decimals
  fractions
  integers
  algebraic expressions

• Application of the addition concept (perimeter, money problems)

• Identity element, commutative & associative properties, and binary operation concepts are introduced
Unit 5: Subtraction

• Subtraction (find differences) of the following quantities:
  - whole numbers
  - decimals
  - fractions
  - integers
  - algebraic expressions

• Application of subtraction (temperature, money problems)

• Solving equations that use the Addition Property
Unit 6: Multiplication

• Multiplications (repeated combinations) of the following quantities

  whole numbers
  fractions
  decimals
  integers
  algebraic expressions (distributive prop)

• Exponents

• Application of multiplication (area, circumference, percents)

• Properties (commutative, associative, identity & inverse)
Unit 7: Division

• Division (repeated subtractions) of the following quantities:
  whole numbers
  fractions
  decimals
  integers

• Application of division (percents, unit pricing)

• Solving equations using the Multiplication Property
Unit 8: Combinations

• Simplifying expressions involving multiple operations (order of operations)

• Solving multiple step applications, (ratio & proportion)

• Solving algebraic equations:
  \[6(x+5) = -2(x -5)\]
Outcome Data

Success Rates: Success is a grade of C or better: Withdraws count as non-success

<table>
<thead>
<tr>
<th>MAT010 Concepts of Numbers versus MAT010 Traditional Course</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Concepts of Numbers</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Traditional Arithmetic</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

- the top 13% of Arithmetic Accuplacer scorers were accelerated into the next course (a 4 credit beginning algebra class)

** an additional top 12% of Arithmetic Accuplacer scorers were accelerated into the next course (a 4 credit beginning algebra class)
What students say …

• “She explained the math to us in a way that I have never experienced. I thought it was taught to us to make sense.”

• “You did not teach me math but you helped me learn math.”

• “With this course, I feel that I have learned so much and got to fully understand math and became good at it. I am a lot more confident about math now.”
What faculty say …

• I can’t imagine ever going back to the traditional way of teaching this material.
  Chris Matus, West Chester University

• My students enjoy math more and therefore, I enjoy teaching more. Introducing them to some algebraic ideas early on has made prealgebra easier to teach and more natural for the students.
  Steve Solomon, MCCC adjunct

• To be honest, I didn’t think I would like it but my mind has been changed; the students enjoy it and I look forward to teaching it again.
  Joe Freiwald, MCCC retired FT faculty
Scaling a Promising Practice

- **Institution buy-in**
  - financial
  - time for development

- **Department approval**
  - bringing to a larger scale
  - faculty willingness to try something new
  - training

- **Monitoring/Assessment**

- **Replicating Process**
Scaling Innovation

In Fall 2011, the Concepts course redesign received a William And Flora Hewlett Scaling Innovation Project two-year grant through the Community College Research Center (CCRC) to replicate at other colleges (Reading Area Community College & Berkshire Community College) and to improve learning within
Deeper Learning

- Implementation Team
- Universal Portal

- course improvements
- journaling (reflections)
- video segments
- class observations
- best practices
Findings from *Scaling Innovation*

1. Instructors’ questions about teaching in innovative courses vary over time and according to their personal and professional dispositions and identities.

2. Faculty learning activities related to curriculum and pedagogy are most powerful when purposeful, contextualized and responsive to instructor needs.
Varying Faculty Questions and Needs

Faculty Identity and Disposition

- Ready to act
  - How will this reform address student needs?
- Have ideas for improvement
  - How is the new course structured?
- Unsure how to improve
  - How will I use class time?
- Reluctant to change
  - What are students learning?
- Discomfort with new approach
  - What are the course materials?
- Disagree with reform premise
  - What instructional techniques are most effective?
- Satisfied with status quo
  - What are the assignments?

Reform Implementation

- What is the evidence of success?
- Which students are eligible?
- How will students get enrolled?
- How are students assessed?
- What are course policies?

Faculty Identity and Disposition

- Have ideas for improvement
- Unsure how to improve
- Reluctant to change
- Discomfort with new approach
- Disagree with reform premise
- Satisfied with status quo
# Contextualizing Faculty Learning

**LESS CONNECTED TO CLASSROOM PRACTICE**
- Designed for broad appeal across disciplines and/or colleges
- Presentations by consultants
- One-time workshops
- Descriptions of “best practices”
- Generalized descriptions of context
- Sharing strategies in the abstract

**GROUNDED IN DAILY TEACHING WORK**
- Infrastructure for ongoing collaboration, experimentation and refinement
- Examination of course materials, including classroom activities, assignments, and assessments
- Review of wide array of data including course outcomes and student work
Purposeful and Responsive Faculty Learning Opportunities

Purpose

Audience

Structure
Purposeful and Responsive Faculty Learning Opportunities

**Audience**
- What are instructors’ dispositions toward the reform?
- What expertise do they bring?
- How will participating in the activity benefit them?

**Purpose**
- Is the purpose clear to participants?
- Are the activities tied to instructors’ day-to-day work of teaching?
- Are conversations contextualized in practice?

**Structure**
- What venue and activities best meet the purpose?
- What format is realistic given time and resource constraints?
Promise of **Contextualized** and **Purposeful** Engagement Structures

• Makes *pedagogy* visible and available for inquiry and discussion

• Builds stakeholder *buy-in*, facilitating scaling efforts and reform sustainability

• Facilitates a cultural shift toward *continuous improvement* and away from short-term reform launch efforts
It’s really hard to get faculty to look at teaching differently or changing curriculum in drastic ways when they’ve invested their identity in that way of teaching. ‘You’re not challenging a certain curriculum; you’re challenging me or the essence of who I am.’ - Faculty Leader

It has been one of the most positive and rewarding experiences of my professional career in higher education. I’m having opportunities to do things I didn’t know were possible in this way. Doing research, publications, presentations; those were all things I’ve dreamed of, and now I’m living that dream. - Faculty Leader
For more information

Susan Bickerstaff: bickerstaff@tc.edu
Barbara Lontz: blontz@mc3.edu

Please visit us on the web at
http://ccrc.tc.columbia.edu

where you can download presentations, reports, and briefs, and sign-up for news announcements. We’re also on Facebook and Twitter.