Reinventing the Wheel:
A Conceptual Approach for Teaching
Arithmetic & Prealgebra

Barbara Lontz, Assistant Professor of Mathematics
Medea Rambish, Dean of Support Services
Overview

• Discuss the national problem of under-preparedness
• Learn about the course redesign: *Concepts of Numbers*
• Participate in a sample lesson
• Review the evaluative outcome data, including achievement gap trends
• Share the triumphs and struggles of bringing innovative ideas to scale
National Crisis

- Underpreparedness for college is a national problem
- Developmental mathematics has been identified by Achieving the Dream as the biggest barrier to community college student success
- Experts say that new math teaching methodologies must be found
MCCC Causes for Concern

• The success rates* for the past six years in our arithmetic classes have been declining
• The success rates fell between 35% - 45%
• Our numbers reflect a national trend of declining math scores
• Traditional arithmetic is taught through topics, (whole numbers, fractions, decimals, signed numbers)

*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

• “Teach me, and I will forget. Show me, and I will remember. Involve me, and I will understand.” *Chinese Proverb*

• 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 needed in this course

• All students can learn math
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, e.g. 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>
<th>Fall 2008</th>
<th>Spring 2009</th>
<th>Fall 2009</th>
<th>Spring 2010</th>
<th>Fall 2010</th>
<th>Spring 2011</th>
<th>Fall 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concepts of Numbers</td>
<td>74%</td>
<td>63%</td>
<td>68%</td>
<td>60%</td>
<td>58%</td>
<td>57.4%</td>
<td>57.7%</td>
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<tr>
<td>N=19</td>
<td></td>
<td>N=19</td>
<td>N=19</td>
<td>N=255</td>
<td>N=380</td>
<td>N=350</td>
<td>N=704</td>
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<tr>
<td>Traditional Arithmetic</td>
<td>45%</td>
<td>34%</td>
<td>41%</td>
<td>40%</td>
<td>40%</td>
<td>37.8%</td>
<td></td>
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<tr>
<td>N=664</td>
<td></td>
<td>N=429</td>
<td>N=567</td>
<td>N=236</td>
<td>N=284</td>
<td>N≈150</td>
<td>N=0</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)
Achievement Gap Trends

![Graph showing grade point average by instructional approach and race]
Achievement Gap Trends

• More recent data (fall 2011) show that a cohort of African American male students who receive mentoring do better in MAT 010 than African American male students who aren’t in the mentoring program.

• This data also show that the mentored students’ success rates are higher than the overall success rate for MAT 010.
Discovery Approach

- Locate the following points on the number line: 0.3, \(\frac{-21}{7}\), 2, \(\sqrt{7}\), \(\frac{9}{11}\), 0.3, -1.5, \(\frac{-5}{3}\)
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 easy 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*
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.”
Success Pipeline – Math Redesign
Scaling a Promising Practice

• Institution buy-in
  Ø financial
  Ø time for development
• Department approval
  Ø bringing to a larger scale
  Ø faculty willingness to try something new
  Ø training
• Monitoring/Assessment
• Fall 2011 Concepts received a William And Flora Hewlett Scaling Innovation Project two-year grant through the Community College Research Center (CCRC) to replicate at other colleges and improve learning within
• Information
  Barbara Lontz blontz@mc3.edu
  Medea Rambish mrambish@mc3.edu
“Planning and plodding wins the race”

The Tortoise and the Hare, Aesop