Participants

- **What we are measuring?** Teacher knowledge and the LMT measures. Deborah Ball, University of Michigan
- **Reports from the field.**
  - DeeAnn Huinker & Kevin McLeod, University of Wisconsin, Milwaukee
  - Hillary Hertzog, Nancy O’Rode Jerry Gold, Joel Zeitlin, California State University Northridge
  - Raven McCrory, Michigan State University
- **Discussion.** Deborah Ball

Overview

- What is mathematical knowledge for teaching? How can it be assessed?
- What have we learned about the mathematics these students (future elementary teachers) are learning in their undergraduate classes?
- What matters? What works?
- What do we wish we knew?
- How are we going about improving?
Learning Mathematics for Teaching (LMT)

Heather Hill
Harvard University

Deborah Loewenberg Ball
Hyman Bass, Merrie Blunk, Charalambos Charalambous, Sean Delaney, Imani Goffney, Jennifer Lewis, Geoffrey Phelps, Stephen Schilling, Laurie Sleep, Mark Thames, and Deborah Zopf
University of Michigan

A practice-based theory of mathematical knowledge for teaching (MKT)

1. Study instruction, and identify the mathematical work of teaching
2. Analyze what mathematical knowledge is needed to do that work effectively, and how it must be understood to be useful for the work
3. Develop, test, and refine measures of MKT using multiple methods as a means to evaluate professional education, investigate effects on students’ learning, and improve theory
4. Develop and study interventions to help teachers develop MKT

Mathematical knowledge for teaching (MKT)

- What do we mean when we use this term, “mathematical knowledge for teaching”?  
  - Mathematical knowledge, skill, habits of mind that are entailed by the work of teaching
- What do we mean by the “work of teaching”?  
  - The tasks in which teachers engage, and the responsibilities they have, to teach mathematics, both inside and outside of the classroom

Knowing multiplication

\[ 49 \times 25 \]
Knowing multiplication for teaching

How did students get each of these answers?

(a) \[ 49 \times 25 = 1485 \]
(b) \[ 49 \times 25 = 225 \]
(c) \[ 49 \times 25 = 1275 \]

Knowing radical expressions

Simplify: \[ \sqrt{150} \]

Knowing radical expressions for teaching

Which of the following is best for setting up a discussion about different solution paths for simplifying radical expressions?

(a) \[ \sqrt{54} \]
(b) \[ \sqrt{156} \]
(c) \[ \sqrt{128} \]
(d) These examples all work equally well.

Representing operations

Which model cannot be used to show that \[ 1 \frac{1}{2} \times \frac{2}{3} = 1 \]?
Learning Mathematics for Teaching (LMT) instruments

- Multiple-choice math tests for teachers in specific content domains (number/operations, algebra, geometry)
- But not typical mathematics tests
  - Composed of items meant to represent problems that occur in teaching

Sample item A:
Choosing examples: Ordering decimals

Which of the following lists would be best for assessing whether your students understand decimal ordering?

A. \(0.5\quad 7\quad 0.01\quad 11.4\)
B. \(0.6\quad 2.53\quad 3.12\quad 0.45\)
C. \(0.6\quad 4.25\quad 0.565\quad 2.5\)
D. These lists are all equally good for assessing whether students understand how to order decimal numbers.

Sample item B:
Evaluating unconventional solutions: Multiplication

Which student is using a method that could be used to multiply any two whole numbers?

<table>
<thead>
<tr>
<th>Student A</th>
<th>Student B</th>
<th>Student C</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>x25</td>
<td>x25</td>
<td>x25</td>
</tr>
<tr>
<td>125</td>
<td>175</td>
<td>25</td>
</tr>
<tr>
<td>+75</td>
<td>+700</td>
<td>150</td>
</tr>
<tr>
<td>875</td>
<td>875</td>
<td>875</td>
</tr>
</tbody>
</table>

Mathematical knowledge for teaching

Ball, Thames, Phelps (2007). Content knowledge for teaching: What makes it special?
### What are we measuring?

- Content knowledge
  - Common
  - Specialized
- Knowledge of content and students
- Number/operations
- Patterns, functions and algebra
- Geometry
- Probability/statistics

### Validation work: How do we know that the items measure what we intend?

- Responses on items match teacher thinking about items in cognitive interviews
- Content matching to NCTM standards within strand
- Practicing teachers’ MKT scores linked to student gains
  - Better performance = greater student gains
  - Teacher content knowledge significant
  - Small effect (< 1/10 standard deviation): 2-3 weeks of instruction
  - But student SES is also about the same size effect on achievement
- Practicing teachers’ MKT scores linked to the mathematical quality of their classroom instruction ($r=.77$)

### Uses

- Evaluating professional development
- Evaluating pre-service teacher preparation programs
- Investigating the relationship between teachers’ mathematical knowledge and student achievement gains

### Knowing what a polygon is
Developing a useful definition of “polygon”

A polygon is a simple closed plane curve composed of finitely many straight line segments.

Possible examples: What is the reason for each?

(a) (b) (c) (d) (e) (f) (g)
Project Goal: Teacher Learning Continuum

Build and sustain the capacity of teachers, from initial preparation through induction and professional growth, to deeply understand mathematics and use that knowledge to improve student achievement.

How do preservice teachers compare to inservice teachers on measures of mathematical knowledge for teaching?

- Do preservice teachers demonstrate stronger MKT than inservice teachers?
- Can we impact and improve the MKT of preservice or inservice teachers?
- Which group might make larger gains on MKT? Why?
**MET Report Recommendations**

- Prospective teachers need math courses that develop deep understanding of the mathematics that they teach.
- Mathematical education of teachers should be a partnership between math faculty and math education faculty.
- There needs to be more collaboration between math faculty and school teachers.

**Design Team Philosophy**

- Mathematics faculty provide rigorous mathematics content.
- Mathematics education faculty focus on mathematical knowledge for teaching.
- Teachers-in-Residence (teachers on special assignment at UWM) make connections to classroom practice in urban settings.

**Mathematics Focus Area Minor Courses for MCEA Majors**

- Problem Solving
- Geometry
- Discrete Probability and Statistics
- Algebraic Structures
- Calculus experience
- Elective

**Subjects**

**Preservice Teachers**
- Math Foundations (EC & Gr 1-8)
- Math Minor (Gr 1-8)

**Inservice Teachers**
- Math Assessment Leaders (Gr K-7)
- Math Teacher Leaders (Gr K-8)
Context: Geometry

Preservice Teachers
- Math Foundations: ~3/4 of a 3-credit course
- Math Minor: 3-credit course plus Foundations

Inservice Teachers
- Assessment Leaders: Monthly PD ~14 hours
- Teacher Leaders: Monthly PD ~16 hours

Geometry
- Geometry as a measuring tool
- Spherical Geometry
- Geometry as a logical system
- Rigid Motions

Topic Sequence

Aug  Measurement Personal Benchmarks
Sept Error in Measurement
Oct  Compounding Error in Measurement
Dec  Characteristics of Triangles
     van Hiele Levels Geometric Thinking
Jan  Properties of Quadrilaterals
Feb  Area (Decomposition, Additive property)
Mar  Coordinate System, Transformations
Apr  Pythagorean Theorem
June Volume

Instrument
- MKT Geometry & Measurement Items
- Project built scale (Reliability $\alpha=0.78$)
- 22 items (multiple choice)
- Item Response Theory (IRT) scores:
  Two-parameter model to estimate ability
- Pretest & Posttest: Same instrument

www.mmp.uwm.edu/_resources/math_content.htm
Preservice Results: MKT Geometry

Inservice Results: MKT Geometry

Results MKT Geometry

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Pretest Mean (SD)</th>
<th>Posttest Mean (SD)</th>
<th>Change</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preservice: Foundations</td>
<td>204</td>
<td>-0.43 (0.55)</td>
<td>-0.04 (0.58)</td>
<td>0.39</td>
<td>.000</td>
</tr>
<tr>
<td>Preservice: Math Minor</td>
<td>24</td>
<td>-0.03 (0.61)</td>
<td>0.24 (0.62)</td>
<td>0.27</td>
<td>.006</td>
</tr>
<tr>
<td>Assessment Leaders</td>
<td>62</td>
<td>-0.36 (0.75)</td>
<td>0.09 (0.69)</td>
<td>0.45</td>
<td>.000</td>
</tr>
<tr>
<td>Math Teacher Leaders</td>
<td>79</td>
<td>-0.10 (0.78)</td>
<td>0.34 (0.81)</td>
<td>0.44</td>
<td>.000</td>
</tr>
</tbody>
</table>

Instrument Source: The University of Michigan, Learning Mathematics for Teaching (LMT) Project.

MMP website
www.mmp.uwm.edu
DeAnn Huinker
huinker@uwm.edu
Kevin McLeod
kevinm@uwm.edu
Milwaukee Public Schools

- 93,000 students in 218 schools
- Largest school district in Wisconsin
- 27th largest district in the nation
- Nearly 6200 teachers
- 87% minority student population
- 75% receive free or reduced lunch
- Student achievement is well below state averages; gaps persist for all subgroups

(Source: 2005-2006 MPS Report Card)

Teachers-in-Residence

- Experienced teachers from the Milwaukee Public Schools.
- On special assignment at the university.
- Link academic teacher preparation and urban classroom practice.
- Align teacher preparation and K-12 reform initiatives.

UW-Milwaukee Teacher Programs

- Early Childhood (ECE, Birth-age 8)
- Middle Childhood through Early Adolescence (MCEA, grades 1-8)
- Early Adolescence through Adolescence (EAA, grades 6-12)

MCEA (Gr 1-8) Program Structure

Required of all MCEA majors:
2 content area minors, 18 credits each
Option A:
  Mathematics or Natural Sciences
Option B:
  Social Studies
  or English/Language Arts
  or Bilingual/ESL/World Languages
**MCEA (Grades 1-8) Sequence**

- **Mathematical Explorations for Elementary Teachers, I & II (6 cr)**
- **Math Minor or Science Minor (18 cr)**
  - Praxis I (required for SOE admission)
- **Teaching of Mathematics: Elementary and Middle Grades (6 cr)**
  - Praxis II (required for student teaching)
  - Portfolio (required for graduation)

---

**School-based Learning Team**

- Math Teacher Leader
- Principal
- Other Key Teachers
- Literacy Coach

Math Teacher Leaders are “key” for focusing their Learning Teams and schools on mathematics.
Mathematics for Elementary School Teaching: What Is It and How Do Teachers Learn It?

Hillary Hertzog, Nancy O’Rode
Elementary Education
Jerry Gold, Joel Zeitlin
Mathematics Department

CSUN Teacher Education for Elementary Mathematics Teaching

Math 210: Number and Operations Class 3 semester units
Math 310: Geometry, Probability, Statistics Class 3 units + Math 310 Lab: Investigate Math Concepts through Manipulatives 1 unit
Mathematics Methods Class 2 units
1st Student Teaching and Seminar 4 units
2nd Student Teaching and Seminar 7 units

CSUN Teacher Education: What are we teaching?

Focus:
- Conceptual and Procedural Understanding
- Student Discourse and Explanations
- Multiple Representations and Connections
- Students Engaged in Rich Problems

Mathematics for Elementary School Teaching: What Is It and How Do Teachers Learn It?
Our Guiding Questions:

- What are we teaching?
- What are Teacher Candidates learning?
- What knowledge about mathematics and teaching do Teacher Candidates carry into their field experiences?
CSUN Teacher Education: What are we teaching?

Math 210: Number and Operations Class
Former Texts: Billstein or Sowder, Parker & Baldridge
Currently: Parker & Baldridge or Beckmann

Math 310: Geometry Class
Former Texts: Billstein or Sowder
Currently: Billstein or Beckmann

What are students learning? Measuring Success

Using Ball & Hill (2004) survey of MKT: Mathematical Knowledge for Teaching (LMT/CKTM)

Advantages:
1. already developed
2. scaled (in-service teachers, z-scores)
3. reliable
4. valid
5. correlated with in-service teachers’ higher pupil gains

Drawbacks:
1. Time & convenience
2. Not all math sections participate... yet.

Sample Question:
Number & Operations Content Knowledge
http://sitemaker.umich.edu/lmt/files/LMT_sample_items.pdf

Mrs. Harris was working on divisibility rules. She told her class that a number is divisible by 4 if the last two digits are divisible by 4. One of her students asked her why the rule for 4 worked. She asked the other students if they could come up with a reason, and several possible reasons were proposed. Which of the following statements comes closest to explaining the reason for the divisibility rule for 4? (Mark ONE answer.)

a) Four is an even number, and odd numbers are not divisible by even numbers.
b) The number 100 is divisible by 4 (and also 1000, 10,000, etc.)
c) Every other even number is divisible by 4, for example, 24 and 28 but not 26
d) It only works when the sum of the last two digits is an even number.

Mathematical Knowledge for Teaching Reporting Domains

- Number & Operations (Form A, B, C)
  CK = Content Knowledge
  KSC = Knowledge of students & content
  PFA = Patterns, functions & algebra
- Geometry (Form A and B)
  CK = Content Knowledge
Research Plan

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 210: Number and Operations Class</td>
<td>MKT - Number &amp; Operations (Form A &amp; B) Pre/Post</td>
</tr>
<tr>
<td>Math 310: Geometry, Probability, Statistics Class</td>
<td>MKT - Geometry Form A &amp; B Pre/Post</td>
</tr>
<tr>
<td>Mathematics Methods Class</td>
<td>MKT - Number &amp; Operations Form C Pre/Post</td>
</tr>
<tr>
<td>1st Student Teaching and Seminar</td>
<td>MKT - Number &amp; Operations (K. Students and Content) Form C Supervision Lesson Observational Lesson Evaluations/ Assessment Project</td>
</tr>
<tr>
<td>2nd Student Teaching and Seminar</td>
<td></td>
</tr>
</tbody>
</table>

Mathematical Knowledge for Teaching Results for Geometry

<table>
<thead>
<tr>
<th></th>
<th>Spr 05</th>
<th>Fall 05</th>
<th>Spr 06</th>
<th>Fall 06</th>
<th>Spr 07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre test</td>
<td>-0.5</td>
<td>-0.57</td>
<td>-0.66</td>
<td>-0.36</td>
<td>-0.49</td>
</tr>
<tr>
<td>Post Test</td>
<td>0.14</td>
<td>0.03</td>
<td>0.14</td>
<td>-0.19</td>
<td>-0.01</td>
</tr>
<tr>
<td>Gain</td>
<td>0.66</td>
<td>0.6</td>
<td>0.77</td>
<td>0.19</td>
<td>0.44</td>
</tr>
</tbody>
</table>

N = 80 75 123 58 85

Tentative Interpretation of this Data

- The positive gain scores seem to indicate that Math 310 students do increase their Mathematical Knowledge for Teaching as a result of taking this course.

Math Knowledge for Teaching Results: Numbers & Operations

<table>
<thead>
<tr>
<th></th>
<th>CK = Content Knowledge</th>
<th>KSC = Knowledge of Students &amp; Content</th>
<th>PFA = Patterns, Functions &amp; Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre test</td>
<td>Spr 05</td>
<td>Fall 05</td>
<td>Spr 06</td>
</tr>
<tr>
<td>Post Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N = number taking both pre and post tests, whereas the post test averages include all those taking the test. Similarly for post test averages.
Conclusions & Questions:
Math Course Data

- Students show gains in Number and Operations Content Knowledge.
  - We should continue our current practices.
  - Does their learning endure?
  - Do the education courses need to devote a major part of their time reinforcing students’ knowledge of arithmetic content?
- Patterns, Functions, and Algebra show increasing gains each semester.
- In Numbers & Operations KSC (Knowledge of Students and Content) data there is no consistent pattern. Not unexpected since this is not the focus of the math courses. We continue to collect data for gauging progress later in the program after math methods and field experience, which do focus on these goals.

Plot Showing Results of Number and Operations Content Knowledge in Fall 2005

Post-Test z-scores plotted against Pre-Test z-scores showing improvement

Gains on Number and Operations Content Knowledge Construct in Fall 2005

Statistical Significance
Fall 2005 Number and Operations Content Knowledge Construct

Test of Only Took Both Test Mean

<table>
<thead>
<tr>
<th>Attribute (numeric): Gain</th>
<th>Ho: population mean of Gain equals 0</th>
<th>Ha: population mean of Gain is not equal to 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count:</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Mean:</td>
<td>0.44007</td>
<td></td>
</tr>
<tr>
<td>Std dev:</td>
<td>0.959509</td>
<td></td>
</tr>
<tr>
<td>Std error:</td>
<td>0.145324</td>
<td></td>
</tr>
<tr>
<td>Student's t:</td>
<td>3.008</td>
<td></td>
</tr>
<tr>
<td>DF:</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>P-value:</td>
<td>0.0044</td>
<td></td>
</tr>
</tbody>
</table>
Working on How We Teach

1. Math instructors make up list of required topics, sample final and common final.
2. View videos of instructors using Ball Video Protocol [http://sitemaker.umich.edu/lmt/faq_about_video_codes](http://sitemaker.umich.edu/lmt/faq_about_video_codes)
3. Examine low score MKT items – “How are we presenting these topics? Can we present them better?”
4. Should we be giving added help to weak (as measured by arithmetic test, MKT scores) students in our first math course?

Long Term Considerations:

- What is the effect of 1 or 2 math content courses on teacher candidates several years later when they enter the classroom?
- “Are we producing teachers who use the methods we have modeled?—HOW DO WE make this happen?
- “The Answer”

The Answer

Work with our colleagues in Elementary Education so that we both are offering coherent, coordinated, well-reinforced and cognitively demanding classes and experiences for our teacher candidates.

CSUN Teacher Education for Elementary Mathematics Teaching

- **Math 210: Number and Operations Class**
  - Focus: Conceptual and Procedural Understanding
  - Focus: Student discourse and explanations
  - Focus: Multiple representations and connections
  - Focus: Students engaged in rich problems

- **Math 310: Geometry Class**
  - Focus: Model mathematics lessons while Teacher Candidates learn to create lessons with
  - Focus: Problem Solving
  - Focus: Explanations
  - Focus: Multiple Representations
  - Focus: Making Connections

- **Mathematics Methods Class**
- **1st Student Teaching**
- **2nd Student Teaching**
  - Focus: Support for Teacher Candidates to implement problem solving lessons
CSUN Teacher Preparation
What are we teaching?

<table>
<thead>
<tr>
<th>4-Yr Option (Treatment)</th>
<th>2-Yr Option (Treatment)</th>
<th>2-Yr Option (Control)</th>
<th>5th Year (No Treatment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MKT Instructors</td>
<td>MKT Instructors</td>
<td>Regular Curriculum</td>
<td>MKT Instructors</td>
</tr>
<tr>
<td>Math 210: Number and Operations Class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 310: Geometry Class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematics Methods Class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Student Teaching</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd Student Teaching</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What are Teacher Candidates Learning?
Is this knowledge carried over to Student Teaching?

Table 1: Means (z-scores) of MKT Geometry Measures for Three Groups of Teacher Candidates (Longitudinal Study)

<table>
<thead>
<tr>
<th>MKT Geometry Measures</th>
<th>4-Year Undergraduate Cohort n = 25</th>
<th>2-Year Undergraduate Cohort n = 17</th>
<th>2-Year Undergraduate Control Group n = 33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Test Geometry Class</td>
<td>-0.17</td>
<td>-0.45</td>
<td>---</td>
</tr>
<tr>
<td>Post Test Geometry Class</td>
<td>0.85</td>
<td>0.10</td>
<td>---</td>
</tr>
<tr>
<td>Student Teaching Post Test</td>
<td>0.58</td>
<td>-0.20</td>
<td>-0.41</td>
</tr>
<tr>
<td>Gains</td>
<td>.75</td>
<td>.25</td>
<td>---</td>
</tr>
</tbody>
</table>

Table 2: Means (z-scores) of MKT Number and Operations Measures - Knowledge of Students and Content - for Three Groups of Teacher Candidates

<table>
<thead>
<tr>
<th>MKT Number &amp; Operations-Knowledge of Students and Content Measures</th>
<th>4-Year Undergraduate Cohort n = 25</th>
<th>2-Year Undergraduate Cohort n = 17</th>
<th>2-Year Undergraduate Control Group n = 33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Methods Class Post-test</td>
<td>-0.004</td>
<td>-0.481</td>
<td>-0.236</td>
</tr>
<tr>
<td>Student Teaching Post-test</td>
<td>0.270</td>
<td>-0.067</td>
<td>-0.089</td>
</tr>
<tr>
<td>Gains</td>
<td>0.274</td>
<td>0.414</td>
<td>0.147</td>
</tr>
</tbody>
</table>

Results for All Undergraduate Teacher Candidates

<table>
<thead>
<tr>
<th>Classes</th>
<th>n</th>
<th>Number &amp; Operations Content</th>
<th>Number &amp; Operations Students and Content</th>
<th>Patterns, Functions, Algebra Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Test Math 210</td>
<td>234</td>
<td>-0.72</td>
<td>-0.59</td>
<td>-0.41</td>
</tr>
<tr>
<td>Post Test Math 210</td>
<td>234</td>
<td>-0.41</td>
<td>-0.49</td>
<td>-0.24</td>
</tr>
<tr>
<td>Post Test Math Methods</td>
<td>225</td>
<td>-0.09</td>
<td>-0.21</td>
<td>1.12</td>
</tr>
<tr>
<td>Post Test 2nd Sem. St. Teaching</td>
<td>75</td>
<td>--</td>
<td>-0.009</td>
<td>--</td>
</tr>
</tbody>
</table>
CSUN Teacher Preparation

Undergraduate
- 4 year Option
- 2 Year Option
- Earn B.A. and Credential

5th Year Program
- Post Bacc
- Diverse Math backgrounds

Results for Undergraduate and 5th year Program on Number and Operations Measures

<table>
<thead>
<tr>
<th>Program</th>
<th>n</th>
<th>Number &amp; Operations Content Knowledge</th>
<th>Number &amp; Operations Students and Content</th>
<th>Patterns, Functions, Algebra; Content Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate Program</td>
<td>225</td>
<td>-0.09</td>
<td>-0.21</td>
<td>1.13</td>
</tr>
<tr>
<td>Math Methods Post Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5th Year Program</td>
<td>110</td>
<td>-0.17</td>
<td>-0.21</td>
<td>1.04</td>
</tr>
<tr>
<td>Math Methods Post Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Research on Field Experiences

Developed Materials For Use in
- Mathematics Methods Class
- 1st Student Teaching
- 2nd Student Teaching

How does the data influence our thinking about preparing Teacher Candidates?

- What are we teaching?
  - Emphases on MKT
- What are Teacher Candidates Learning?
  - Gains in Number and Operations during Math Course
  - Gains in Geometry Knowledge during Math Course
- What do Teacher Candidates bring to their practice?
  - Number & Operations knowledge carries over into Student Teaching
  - Geometry Content Knowledge carries over
  - General Improvement from Math Course - Math Methods - Student Teaching
  - 5th year Program comparison is interesting
Further Questions about Data

- Are CSUN Teacher Candidates prepared to teach mathematics?
  - What can we infer from the MKT data?
  - How does the data inform program improvement?
  - Are fluctuations in semester means important?
- Can we say that Teacher Candidate participation in the MKT math courses have better prepared them to teach mathematics?
  - Where do we want our candidates to be?
  - Do these assessments demonstrate learning?
  - What is more important to consider—longitudinal data or cumulative data?

More Data on the Way

- 42 Teacher Candidates Completed the program in Spring 2007
- 130 Teacher Candidates will complete the program in Spring 2008
- Follow Up Study in First Year Teachers’ Classrooms (Spring 2008)
The ME.ET Project

Mathematical Education of Elementary Teachers
Raven McCrory
Michigan State University
http://meet.educ.msu.edu

This work is supported by the National Science Foundation, Grant #0447611, Michigan State University's College of Education, & the Center for Proficiency in Teaching Mathematics (CPTM) at the University of Michigan.

ME.ET Data

- Interview: 70 mathematics departments in 3 states
- Survey: 63 instructors from 33 institutions
  - 32% of instructors who received the survey from 47% of institutions in the study (33 of 70)
- Student data: matched pre and post for 883 students from 48 sections of 37 instructors at 15 institutions

How Many Classes?

<table>
<thead>
<tr>
<th></th>
<th>Elementary Certification</th>
<th>Middle School Certification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% that offer math</td>
<td>Courses required for</td>
</tr>
<tr>
<td></td>
<td>specialization</td>
<td>specialization</td>
</tr>
<tr>
<td>All</td>
<td>2.2</td>
<td>36.8%</td>
</tr>
<tr>
<td>PhD</td>
<td>2.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Master’s</td>
<td>2.3</td>
<td>46.2</td>
</tr>
<tr>
<td>Bachelor’s</td>
<td>2.1</td>
<td>11.8</td>
</tr>
</tbody>
</table>
CBMS Number of Classes

How Many Students?

- Students per class (ME.E.T data):
  - Mean 25.2, SD 8.5
  - Mode 25
- CBMS 2005
  - 29 (PhD)
  - 27 (MA)
  - 22 (BA)

Contrast with average class size in other introductory classes:
- 48 (PhD)
- 34 (MA)
- 25 (BA)

Instructor characteristics

- n=63
- Average age: 49
  - Oldest: 71
  - Youngest: 24
- 25 male, 37 female
- Average 16 years of college teaching
  - Range: 1 - 41 years, Median 15.5, Mode 20 years

Instructor characteristics, cont.

- Mean times teaching this class: 14
  - Range 0-60 (!), Median 9, Mode 0 (10 people)
- 26 have taught k-12, 37 have not
- 31 have current teaching certificates
- 62 in mathematics departments, 1 in education
Instructor characteristics, cont.

- Highest degree: 38 doctoral, 23 masters or equivalent, 2 bachelors
- PhD’s:
  - 15 in mathematics
  - 1 in computer science
  - 19 in math ed
  - 1 in physics, 2 other
- 57 have taken calculus
- 41 have taught calculus

Instructors

<table>
<thead>
<tr>
<th>Rank</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A no formal rank</td>
<td>2</td>
</tr>
<tr>
<td>Professor</td>
<td>13</td>
</tr>
<tr>
<td>Associate professor</td>
<td>13</td>
</tr>
<tr>
<td>Assistant professor</td>
<td>15</td>
</tr>
<tr>
<td>Instructor</td>
<td>10</td>
</tr>
<tr>
<td>Lecturer</td>
<td>5</td>
</tr>
<tr>
<td>Other title</td>
<td>1</td>
</tr>
<tr>
<td>Doctoral student</td>
<td>4</td>
</tr>
</tbody>
</table>

Resources

- Textbooks
- Policy documents
- Certification Standards
- Certification tests
- K-8 Standards

Instructor Knowledge

[Diagram showing instructor knowledge with various subjects and ratings]
Textbooks

- Primary resource for the class:
  - Billstein et al 12
  - Other textbook 11
  - Musser et al 8
  - Other materials (non-textbook) 8
  - Long 3
  - Wheeler 3
  - Bennett 2
  - Parker 2
  - Sonnabend 2
  - Bassarear 1

Textbook Use

Over the last year, how closely have you worked with faculty from education in...

- Collaborating on Research
- Co-teaching a mathematics or education course
- Designing overall curriculum for prospective elementary teachers
- Planning the content of this mathematics class
Knowledge of certification program

Student Learning

• Future Models:
  • Student level variables
    – demographics
    – attitudes
    – prior knowledge (pretest and SAT)
  • Instructor level variables
    – textbook
    – instructor demographics
    – OTL measures - coverage, goals

Results

• IRT Scores, normed to mean = 50, SD = 10
• Overall gain: 8 points (Effect size 0.8)

Test Scores by Section

Grand Mean
pre and post
n=48
Predicting PostTest Scores: Attitudes

“To solve math problems you have to be taught the right procedures.”
Controlling for Pre-test

Controlling for SAT
Both significant < 0.01

“I am good at math.”
Controlling for Pre-test

Controlling for SAT
Both significant < 0.01

Achievement Model

Findings

• Math Department chairs: knowledgeable and concerned
• Number of required courses is increasing
• Instructors: enthusiastic and dedicated, but not knowledgeable about important documents that could be influential
Findings

- Students:
  - They are learning mathematics
  - Prior knowledge matters, but not as much as one might expect
  - Instructor matters, but we don’t yet know how or why
- Now doing observations -- case studies
- Final data collection this spring