Participants

- **What we are measuring:** Yaa Cole, LMT Project, University of Michigan
- **Projects using LMT measures:**
  - Lou Ann Lovin, James Madison University
  - Meg Moss, Pellissippi State Technical Community College
  - Stephanie Smith, Georgia State University
  - Beth Costner & Frank Pullano, Winthrop University
  - Raven McCrory, Michigan State University
- **Discussion:** Sybilla Beckmann, University of Georgia

Overview

- What have we learned about what these students (future elementary teachers) are learning in their undergraduate mathematics classes?
- What matters? What works?
- What do we wish we knew?
The Learning Mathematics for Teaching (LMT) Instruments

Heather Hill
Harvard University

Yaa Cole, Hyman Bass, Laurie Sleep, Deborah Loewenberg Ball
University of Michigan

AMTE Annual Conference
Tulsa, OK • January 24, 2008

Knowing multiplication:

Multiply: 35
x 25

875

Knowing multiplication for teaching
Which of these students 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>x 25</td>
<td>x 25</td>
<td>x 25</td>
</tr>
<tr>
<td>175</td>
<td>175</td>
<td>175</td>
</tr>
<tr>
<td>+75</td>
<td>+700</td>
<td>150</td>
</tr>
<tr>
<td>875</td>
<td>875</td>
<td>875</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>875</td>
</tr>
</tbody>
</table>

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
Which model cannot be used to show that \(1 \frac{1}{2} \times \frac{2}{3} = 1\)?

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

**Validation efforts**
- Practicing teacher MKT scores linked to student gains
  - Better performance = higher student gains
- Practicing teacher MKT scores linked to the mathematical quality of their classroom instruction \((r = .77)\)
- Responses on items match teacher thinking about items in cognitive interviews
- Content matching to NCTM standards within strand

**Uses**
- Evaluating professional development
- Evaluating pre-service teacher preparation programs
Mathematical Knowledge for Teaching of Prospective Elementary Teachers: James Madison University

LouAnn Lovin
lovinla@jmu.edu
James Madison University

Brief Program Description
IDLS Major
Candidates choose between 2 concentrations:
- Mathematics/Science
- Humanities/Social Science

Required Mathematics Courses
- MATH 107 Number, Number Systems, Operations, Algebra
- MATH 108 Number, con't, Geometry
- MATH 207 Probability, Statistics

Overview of Study
Using the LMT measures we are examining elementary teachers' performance at our institution by
- Examining assessment data at different points in the program;
- Comparing the math/science elementary teacher candidates' performance with that of the humanities/social science elementary teacher candidates.
- Comparing the elementary teacher candidates' performance with that of beginning mathematics majors.

Additional mathematics courses for mathematics/science concentration:
- Algebra, Analysis, Geometry, Statistics
- Courses not taken by mathematics majors

Mathematics Methods Courses
- ELED 433 and ELED 533 (PreK-6)
  - Two mathematics methods course
  - 433: Number and Operations, Algebra, Geometry
  - 533: Geometry (con't), Probability, Statistics

Emphasis is (supposed to be) unpacking school mathematics
Developing Mathematical Knowledge for Teaching: Two Camps

Camp A
- Teachers need to know mathematics of the school curriculum in depth;
- Courses that treat advanced mathematics are useless to teaching.

Camp B
- Teachers need to know more than they are responsible for teaching;
- Advanced mathematics study is important to being able to have perspective and make good judgments.

Points of Assessment

For elementary candidates
- At beginning of first mathematics course, MATH 107
- At end of last required mathematics course, MATH 207
- At end of mathematics methods course, ELED 433 (PreK-6)

For mathematics majors
- At beginning of MATH 235 (Calculus I)

Elementary Teacher Candidates and Mathematics Majors – Fall 2006

<table>
<thead>
<tr>
<th></th>
<th>Total Score (% Correct)</th>
<th>Numbers &amp; Operations</th>
<th>Geometry</th>
<th>Patterns, Functions, &amp; Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 107</td>
<td>52.19%</td>
<td>50.95%</td>
<td>54.53%</td>
<td>48.26%</td>
</tr>
<tr>
<td>Math 207</td>
<td>54.43%</td>
<td>53.70%</td>
<td>60.52%</td>
<td>48.79%</td>
</tr>
<tr>
<td>Methods</td>
<td>65.43%</td>
<td>66.69%</td>
<td>70.94%</td>
<td>57.03%</td>
</tr>
<tr>
<td>Math 235</td>
<td>63.83%</td>
<td>62.50%</td>
<td>69.23%</td>
<td>59.84%</td>
</tr>
<tr>
<td>sig</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Others &gt; 107</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methods &gt; 207</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M/S</td>
<td>54.40%</td>
<td>53.88%</td>
<td>55.96%</td>
<td>50.15%</td>
</tr>
<tr>
<td>Hum</td>
<td>49.55%</td>
<td>48.50%</td>
<td>52.90%</td>
<td>44.31%</td>
</tr>
<tr>
<td>sig</td>
<td>p &lt; 0.000</td>
<td>p &lt; 0.000</td>
<td>p &lt; 0.000</td>
<td>p &lt; 0.000</td>
</tr>
<tr>
<td>Post Hoc Results</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math 235</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Differences between Mathematics/Science vs. Humanities/Social Science

Math 107 (N = 465, Fall 2004-Fall 2006)

<table>
<thead>
<tr>
<th></th>
<th>Total Score (% Correct)</th>
<th>Numbers &amp; Operations</th>
<th>Geometry</th>
<th>Patterns, Functions, &amp; Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td>M/S</td>
<td>54.40%</td>
<td>53.88%</td>
<td>55.96%</td>
<td>50.15%</td>
</tr>
<tr>
<td>Hum</td>
<td>49.55%</td>
<td>48.50%</td>
<td>52.90%</td>
<td>44.31%</td>
</tr>
<tr>
<td>sig</td>
<td>p &lt; 0.000</td>
<td>p &lt; 0.001</td>
<td>p &lt; 0.016</td>
<td>p &lt; 0.001</td>
</tr>
</tbody>
</table>

Math 207 (N = 270 Fall 2005-Fall 2006)

<table>
<thead>
<tr>
<th></th>
<th>Total Score (% Correct)</th>
<th>Numbers &amp; Operations</th>
<th>Geometry</th>
<th>Patterns, Functions, &amp; Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td>M/S</td>
<td>54.40%</td>
<td>53.88%</td>
<td>55.96%</td>
<td>50.15%</td>
</tr>
<tr>
<td>Hum</td>
<td>49.55%</td>
<td>48.50%</td>
<td>52.90%</td>
<td>44.31%</td>
</tr>
<tr>
<td>sig</td>
<td>p &lt; 0.000</td>
<td>p &lt; 0.001</td>
<td>p &lt; 0.016</td>
<td>p &lt; 0.001</td>
</tr>
</tbody>
</table>
Discussion

- Significant growth from MATH 107 to MATH 207 across all subscores for all candidates.
- Less growth in Patterns, Functions, and Algebra.
- Math/Science concentrations start and end by performing significantly better than Humanities concentrations.
- Beginning math majors performed significantly better than combined math/sci, humanities MATH 107 and MATH 207.
- It appears that the mathematics methods course matters!
- Significant growth from MATH 207 to ELED 433 across all subscores for all candidates.
- After the methods course, the elementary candidates are performing about the same as beginning math majors.

The growth (or lack of growth) is more apparent in particular kinds of items.

- Performance on items evaluating students' alternative methods does not improve overall, although on some items there is some evidence that they begin to move away from evaluating the work as incorrect if the student did not use a standard algorithm.
- Little emphasis on analyzing student work in ELED 433 this particular semester.

Sample Response Analysis (Difficult Items – Evaluating Student Work)

- Method was wrong, even though answer is right.
- Answer is wrong.
- Method is right, but would be messy.
- Method only works sometimes.
- Not sure.

Sample Response Analysis (Difficult Items – Evaluating Student Work)

- Made a mistake and then tried to compensate.
- Used an easy number and then dealt with other numbers.
- Made a mistake with the standard procedure.
- Added ten to both numbers, then subtracted (Describes what student did).
- Not sure.
Implications

- Develop openness to alternative methods
  - Increase focus on analysis of student work in content and methods
  - Fall 2007: 3 sections of ELED 433 on a continuum
  - Concurrent mathematics education seminar with the mathematics courses
- Increased emphasis on Patterns, Function, and Algebra
  - Supplement with Navigations
- Any mathematics course for prospective elementary teachers?
  - Data at end of mathematics major, end of secondary math methods course in graduate year.
  - Because teachers need to have fluency with MKT, especially SKC, is there a difference in response time on particular items between the elementary candidates and math majors?
  - Data at end of 2nd elementary math methods course in graduate year.
Specialized Understanding of Mathematics: A Study of Prospective Elementary Teachers

Meg Moss

Research Questions

1) What are the areas of strength and areas of weakness in the content knowledge for teaching mathematics of prospective elementary teachers as they enter their mathematics methods course?

2) Does a relationship exist between quantity or type of content courses and the CKTM of prospective elementary teachers?

3) Does the CKTM change as prospective elementary teachers take their methods course?

Description of Sample

- Four universities, seven sites
- n=244 pretest, n=221 posttest
- Students enrolled in elementary mathematics teaching methods course

Measures and Variables

- Content Knowledge for Teaching Mathematics – measures developed by Learning Math for Teaching/ Study for Instructional Improvement Project through The University of Michigan
- Number and Operation Content Knowledge (NOCK)
  - Common Content Knowledge
  - Specialized Content Knowledge – representing mathematical ideas, providing explanations, analyzing alternate algorithms
- Geometry Content Knowledge
Methodology

• Question 1: What are the areas of strength and what are the areas of weakness in the CKTM as prospective elementary teachers enter their methods course?
  – Pretest item analysis

• Question 2: Does a relationship exist between quantity or type of content courses and the CKTM of prospective elementary teachers?
  – Analysis of relationship between content courses and content understanding

Methodology

Question 3: Growth during Methods Course?
  – Pretest during first two weeks of semester, posttest during last two weeks of semester
  – Paired Samples t-test
  – Item analysis of items that saw growth

Data Analysis and Findings

• Question 1: What are the areas of strength and what are the areas of weakness in CKTM as prospective elementary teachers enter their methods course?
  Conducted an item analysis on 11 items with highest number of correct answers and 11 items with lowest number of correct answers
Areas of Strength

- Six items from NOCK
  - Five of these common content knowledge
  - One was specialized content knowledge – representing fraction subtraction
- Five items from Geometry
  - Analyze characteristics of two and three dimensional shapes
  - Interpreting definitions of three dimensional shapes

Areas of Weakness

- NOCK – 9 items
  - One was common content knowledge – $xy$
  - Eight were specialized content knowledge
    - Providing mathematical explanations (3)
    - Representing mathematical ideas (2)
    - Interpreting non-standard algorithms (3)
- Geometry – 2 items
  - Relationship between area and pi
  - Effects of changing one dimension on the area, volume and surface area

Question 2: Relationship between previous content courses and CKTM

- Previous content courses
- Do students who take math for teachers I and II score differently than those who do not? Yes $p = .008$, effect size .40

NOCK Indicators

- Do students who take Math for Teachers I score differently on the NOCK items? No $p = .182$
**Geometry Indicators**

- Do students who take Math for Teachers II score differently on Geometry items?
  Yes, p=.017, effect size .38

**Group Statistics**

<table>
<thead>
<tr>
<th></th>
<th>Math for Teachers II</th>
<th></th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geometry</td>
<td>0.0751715</td>
<td>0.98262659</td>
<td>0.07018761</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.3069501</td>
<td>1.02195829</td>
<td>0.14750697</td>
<td></td>
</tr>
</tbody>
</table>

**Independent Samples Test**

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
<th>95% Confidence Interval of the Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zscore(scoregeo)</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0.06794275</td>
<td>2.396</td>
<td>242</td>
<td>0.017</td>
<td>0.38212159 - 0.15949661</td>
</tr>
<tr>
<td>Zscore(scoregeo)</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0.06794275</td>
<td>2.339</td>
<td>69.829</td>
<td>0.022</td>
<td>0.38212159 - 0.16335424</td>
</tr>
</tbody>
</table>

**Quantity or Type**

- Do students who take a higher number of content courses score differently? No, p=.138

**Descriptive Statistics**

<table>
<thead>
<tr>
<th>Between-Subjects Factors</th>
<th>Value Label</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>bands of totalmath</td>
<td>&lt;= 2</td>
<td>99</td>
<td>-0.0909223</td>
<td>1.03805914</td>
<td>0.0000000</td>
</tr>
<tr>
<td>bands of totalmath</td>
<td>3 - 3</td>
<td>87</td>
<td>0.0468434</td>
<td>0.91190588</td>
<td>1.0000000</td>
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<tr>
<td>bands of totalmath</td>
<td>4+</td>
<td>58</td>
<td>0.2254600</td>
<td>1.04231224</td>
<td>0.0000000</td>
</tr>
</tbody>
</table>

**Tests of Between-Subjects Effects**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. (2-tailed)</th>
<th>95% Confidence Interval of the Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>239.042</td>
<td>2</td>
<td>119.521</td>
<td>1.979</td>
<td>0.138</td>
<td>0.38212159 - 0.15949661</td>
</tr>
<tr>
<td>bandtotmath</td>
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<td>1</td>
<td>243.000</td>
<td>1.995</td>
<td>0.138</td>
<td>0.38212159 - 0.16335424</td>
</tr>
</tbody>
</table>

**Paired Samples Test**

<table>
<thead>
<tr>
<th>Paired Differences</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Std. Error Mean</td>
<td>Lower</td>
</tr>
<tr>
<td>Pair 1</td>
<td>Zscore: score1 - standz</td>
<td>2.446</td>
<td>0.05155450</td>
</tr>
</tbody>
</table>

**Question 2: Growth during Methods Course?**

- Statistically significant growth was found
- Growth equivalent to about one item out of 48, p = .015, effect size = .123

**Paired Differences**

<table>
<thead>
<tr>
<th>Source</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td>Zscore: score1 - standz</td>
<td>2.446</td>
<td>0.05155450</td>
<td>2.02450253</td>
<td>-2.22771032</td>
</tr>
</tbody>
</table>

**Items with largest growth**

- Four of the items that showed the most improvement were from the geometry content area
- Four were from the number and operation content area
- Of the four number and operation items that showed the most improvement, three of those were from the specialized content knowledge domain.
Special Thanks

- Dr. P. Mark Taylor, Committee Chair
- The Appalachian Math and Science Partnership, an NSF funded project
The Impact of a Developmental Teacher Preparation Program on Elementary Preservice Teachers’ Mathematics Beliefs and Knowledge

Stephanie Smith
with acknowledgment to
Susan Swars
Marvin Smith (Kennesaw State)
Lynn Hart

Background of Study

• Mathematics Endorsement Research Project (MERP) is the outcome of a recently mandated four-course mathematics sequence
• Longitudinal, comparative studies that examine the mathematics beliefs and knowledge of elementary preservice teachers

Three Study Phases

• Baseline study of 2-semester math methods sequence, with a 3-course math content requirement (2 journal articles)
• Comparative study of exchanging 2nd semester of math methods for a reorganized 4-course content requirement (in progress)
• Extension study of 1 cohort in 4 experimental math content courses—focused on understanding content, children’s thinking, and elementary curriculum in number, geometry, algebra, and data analysis (in progress)

Theoretical Perspectives

• Research has established a robust relationship between beliefs and teaching practices (Romberg & Carpenter, 1986; Thompson, 1992; Wilson & Cooney, 2002)
• Focus on impact of methods course(s) is primarily on change in beliefs
• Focus on impact of content courses is on change in knowledge for teaching and change in beliefs
Theoretical Perspectives

- Teacher efficacy is considered by many researchers to be a two-dimensional construct
  - Personal teaching efficacy
  - Teaching outcome expectancy

Teacher change model:
- Generate interest in change
- Problematize current practices and propose possible solutions
- Experiment with possible solutions
- Reflect on the outcomes for students and teachers
  (Smith, Smith, & Williams, 2005)
- To propose and experiment with possible solutions involves beliefs and PCK

Increasing literature on the importance of elementary teachers having highly developed, specialized content knowledge for teaching mathematics (Ball, 1991; Ma, 1999)
- Components of this specialized content knowledge include generating representations, interpreting student work, and analyzing student mistakes (Hill, Schilling, & Ball, 2004)

Phase 1 Research Questions

- What are the changes in elementary preservice teachers’ mathematics beliefs during a developmental teacher preparation program that includes a two-semester mathematics methods sequence?
- What is the relationship between elementary preservice teachers’ mathematics beliefs and their specialized content knowledge for teaching mathematics at the end of a developmental teacher preparation program?
Phase 1 Setting and Participants

- 24 elementary preservice teachers
- Enrolled in a Bachelor of Science program at a large urban university
- Teacher preparation program has a developmental model for field placements
- Completed a two-semester sequence of mathematics methods courses
  - First semester focus PK-2
  - Second semester focus 3-5

Phase 1 Mixed Methods Data

- Mathematics Teaching Efficacy Beliefs (PMTE+MTOE), administered four times (see Enochs, Smith, & Huinker, 2000)
- Mathematics Beliefs Instrument (MBI), administered four times (derived from Peterson, Fennema, Carpenter, & Loef, 1989)
- Learning Mathematics for Teaching Instrument (LMT), administered one time at end of program (see Hill, Schilling, & Ball, 2004)
- Interview Protocol, one time at end of 2nd math methods course

Quantitative Results

- Significant increases in mathematics teaching efficacy beliefs and significant shifts in pedagogical beliefs toward cognitive perspective during the program
- Cognitively-oriented pedagogical beliefs (MBI) increased significantly after the first methods course; slight decrease after the second methods course was not significant; decrease after student teaching was small but significant

Quantitative Results

- Teaching efficacy (PMTE) scores largely changed after the second methods course; mean remained constant after student teaching
- Outcome expectancy (MTOE) scores increased after first and second methods courses; mean decreased slightly after student teaching
Additional Quantitative Results

- MARS (Mathematics Anxiety Rating Scale), see Richardson & Suinn, 1972
  - 98-item instrument (Initial, Post1, Post 2)
  - Anxiety scores changed *inversely* to PMTE
  - Discontinued this measure for methods courses; reinstated for Phase 3 (experimental content courses)

Score Correlations

- No relationship between teaching efficacy, outcome expectancy, and pedagogical beliefs at the beginning of the first methods course
- Significant relationships between all three at the end of the second course and between teaching efficacy and pedagogical beliefs at the end of student teaching

LMT Results

- Significant correlation between teaching efficacy, cognitively-oriented pedagogical beliefs, and LMT scores at the end of the teacher preparation program
Phase 1: Conclusions

- Two-methods-course developmental program produced more cognitively oriented beliefs and increased confidence.
- As these preservice teachers studied, experimented with, and reflected on ways to implement standards-based pedagogy, most became more confident in their abilities to teach mathematics effectively.

Phase 1: Conclusions

- At the end of the program, the correlation between knowledge of mathematics for teaching (LMT), personal teaching efficacy beliefs (PMTE), and cognitively-oriented pedagogical beliefs (MBI) shows the complexity and interrelatedness of these various aspects of teachers’ beliefs and knowledge.

Phase 1: Conclusions

- As students developed their understanding of the mathematical content knowledge needed to teach in the elementary grades they became better able to understand and embrace more cognitively-oriented pedagogy and more confident in their skills and abilities to teach mathematics effectively. This supports content courses focused on understanding mathematics needed for teaching.
Phase 1: Conclusions

• The timing of these effects varied across the semesters of the program
  – Focus of methods course semesters
  – Focus of developmental field placements
  – Effects of traditional student teaching
• Value of longitudinal study: observe timing and persistence of changes
• Value of interviews: disclose diverse profiles of change hidden within quantitative means

Phase 1: Conclusions

• LMT provides a useful measure of content knowledge for teaching and a connection between changes in beliefs and changes in content knowledge for our continuing MERP studies

Phase 3: Course Content

• Typical emphasis on elementary/middle content in number, geometry/spatial sense, probability/statistics, and algebraic concepts
• Experimental cohort emphasizes understanding content in the context of worthwhile tasks in the elementary curriculum as well as children’s thinking during those tasks
  – Children’s Mathematics: CGI
  – Thinking Mathematically: Integrating Arithmetic & Algebra in Elementary School
  – Developing Mathematical Ideas

Contact & References

• szsmith@gsu.edu
• Swars, Smith, Smith, & Hart. (in review). JMTE.
• Swars, Hart, Smith, Smith, & Tolar. (2007). SSM.
The Winthrop Story

Beth Greene Costner
Frank Pullano

General Program Information

• Early Childhood (PK to 3)
• Elementary (2 to 6)
• Middle Level Math & Language Arts (5 to 8)
• Special Education (PK to 12)
• Family and Consumer Sciences

Courses

• CTQR 150: Critical Thinking & Quantitative Reasoning
• General Education Requirement
• Sets (w/counting)
• Logic
• Probability
• Statistics

• MATH 291: Basic Number Concepts for Teachers
• Problem Solving (w/patterns)
• Basic Number & Computation
• Number Theory (primes, factors, etc.)

Courses

• MATH 292: Number, Measurement, & Geometry Concepts for Teachers
• Basic Geometry
• Rational Numbers
• Measurement

• MATH 393: Algebra, Data Analysis, and Geometry Concepts for Teachers
• Required for ELEM and ML only
• Proportional Reasoning
• Geometry & Measurement
• Algebraic Thinking
**Common Elements in MATH Courses**

- Lab Kits
- Activity Supplement
- Article Responses
- Problem Solving
- Projects
- Skills Check
- Use of Standards
- Course Coordinator
- Billstein, Libeskind, & Lott
- Coordination w/ Methods Faculty (esp in ELEM)
- Grade Requirements
- Use of Standards
- Course Coordinator
- Billstein, Libeskind, & Lott
- Coordination w/ Methods Faculty (esp in ELEM)
- Grade Requirements

**Skills Check Requirements**

- Given three times per semester in MATH 291, 292, & 393
- Equivalent to one midterm exam grade
- 30 questions
- 80% correct to earn points
- Mix of question types
- Some common questions across courses
- Review opportunities

**Skills Check Topics**

- Simplifying fractions
- Careless mistakes
- Computation
  - Whole numbers
  - Integers
  - Rational numbers
- Order of operations
- Percentages
- Basic word problems
- Using variables
- Solving equations
- Simplifying radicals
- Measures of center
- Place value
- Set operations
- Subsets and elements
- Interpreting graphs
- LCM & GCF
- Prime factorization
- Basic measurement skills
- Geometric terminology
- Triangle theorems
- Area and perimeter of irregular figures
- Decimal, fraction, and percent relationships

**MATH 291 Grades vs. Majors**

<table>
<thead>
<tr>
<th>Major</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECED</td>
<td>25</td>
</tr>
<tr>
<td>ELEM</td>
<td>47</td>
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<tr>
<td>SPED</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Major</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECED</td>
<td>10</td>
</tr>
<tr>
<td>ELEM</td>
<td>80</td>
</tr>
<tr>
<td>SPED</td>
<td>10</td>
</tr>
</tbody>
</table>
**MATH 292 Grades vs. Majors**

![Graph showing grades by major for MATH 292]

**Grade Comparison**

<table>
<thead>
<tr>
<th></th>
<th>ECED</th>
<th>ELEM</th>
<th>SPED</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Decrease</td>
<td>24</td>
<td>18</td>
<td>28</td>
</tr>
<tr>
<td>Unchanged</td>
<td>57</td>
<td>43</td>
<td>33</td>
</tr>
<tr>
<td>Increased</td>
<td>20</td>
<td>15</td>
<td>20</td>
</tr>
</tbody>
</table>

**Course Grades vs. Skills Check**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Score</th>
<th>Times to Pass</th>
<th># Not Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>27.5</td>
<td>1.6</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>25.8</td>
<td>2.2</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>24.1</td>
<td>2.6</td>
<td>7</td>
</tr>
<tr>
<td>D</td>
<td>21.0</td>
<td>1.0</td>
<td>1</td>
</tr>
<tr>
<td>E</td>
<td>22.0</td>
<td>1.0</td>
<td>1</td>
</tr>
<tr>
<td>F</td>
<td>18.0</td>
<td>1.0</td>
<td>2</td>
</tr>
<tr>
<td>N</td>
<td>18.0</td>
<td>1.0</td>
<td>2</td>
</tr>
</tbody>
</table>
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

- 70 mathematics departments in 3 states
- 63 instructors from 33 institutions
  - 32% of instructors who received the survey
  - from 47% of institutions in the study (33 of 70)
- Student data: pretest 822, posttest 783,
  matched pre and post (matched) 615
  from 36 sections of 25 instructors

Instructors

<table>
<thead>
<tr>
<th>Rank</th>
<th>Count</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>

Instructor Knowledge
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

Student Learning

• Objective: model student achievement
• Multilevel model: student:instructor
• Student level variables: demographics, attitudes, prior knowledge (pretest and SAT)
• Instructor level variables: textbook, instructor demographics, OTL measures

Achievement Model
Results

• Gain of 0.14 SD
• Problems with design: Students may not be taking the test seriously in some sections
• Predictors (controlling for pretest): SAT, “I like math.” “I am good at math.”

Test Scores

Pre/post scores by School

An idea

• Create a database of preservice teacher responses to LMT items
• Analyze for reliability, factors
• Recalculate item parameters
• Include beliefs items if possible, and look at correlations
Which problems/activities are most important? in courses for elementary teachers

What is the importance to actual elementary school teaching of various kinds of problems and activities we give in courses for elementary teachers?
Make-a-Ten Strategy

The **make-a-ten strategy** relies on breaking numbers apart and implicitly uses the associative property of addition:

\[ 8 + 6 \]
Make-a-Ten Strategy

The **make-a-ten strategy** relies on breaking numbers apart and implicitly uses the associative property of addition:

\[
8 + 6 = 8 + (2 + 4) = (8 + 2) + 4 = 14
\]
Understanding why the multiplication algorithm works with the distributive property as well as with pictures.

To write a googolplex in decimal notation you would need to write a 1 followed by a googol zeros. Explain why nobody could actually write a googolplex in decimal notation.
Using a definition

The diagram below is a map of Mr. McGregor's garden. Each plot in Mr. McGregor’s garden has been divided into 3 pieces of equal area. The shaded parts show where lettuce has been planted. What fraction of Mr. McGregor's garden is planted with lettuce? Using our definition of fraction, explain clearly why your answer is correct.