Bridging Mathematics Content Gaps in Pre-service Teachers

Ben McCarty
Alistair Windsor

Mathematical Sciences,
University of Memphis

The opinions expressed are those of the presenters and do not represent the views and opinions of the University of Memphis

Purposes of this Session

- ❖ Start a conversation around mathematical content for teacher preparation

- ❖ We DO NOT have all the answers.

- ❖ We may not have ANY of the answers.

National Recommendations

- Recommendations from the Mathematical Education of Teachers II

    - Prospective elementary teachers: at least 12 semester-hours.

    - Middle grades (5–8) math teachers: at least 24 semester-hours of mathematics

    - High school math teachers: a major in mathematics with three courses with a primary focus on high school mathematics from an advanced viewpoint.
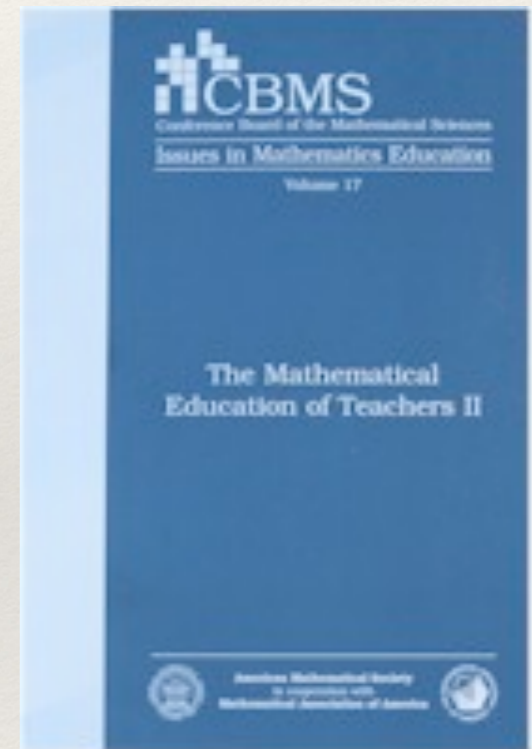
National Recommendations

❖ Our Elementary candidates get 12 hours of mathematics instruction but that includes 3 semester hours of general education mathematics and the MET II says "mathematics courses such as college algebra, mathematical modeling, liberal arts mathematics, and even calculus or higher level courses *are not an appropriate substitute for the study of mathematics for elementary teachers*"
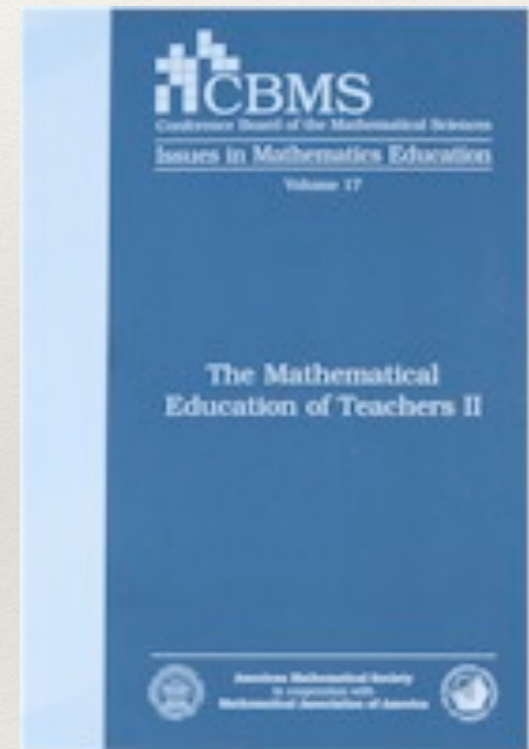
Questions for the Audience

❖ Does your program require 12 semester hours of mathematics (including mathematical methods) courses for their Elementary candidates?

❖ Does your program require 12 semester hours of mathematics (including mathematical methods) courses *designed especially for Elementary candidates* for their Elementary candidates?

Math Content Gaps

- Pre-service Elementary

  - Students are generalists (everyone is licensed to teach 5th grade mathematics).

  - May have had weak elementary mathematics instruction and have weak elementary mathematics knowledge.

  - Typically admit to "being not good at math."

- Pre-service Secondary

  - Assumption is that mathematics majors will not have content gaps.

Elementary Program

❖ University of Memphis K-6 candidates take mathematics courses specifically designed for them:

  ❖ Mathematics for Elementary Education 1 (Math. Dept.)

  ❖ Mathematics for Elementary Education 2 (Math. Dept.)

  ❖ Elementary Math Methods (ICL Dept.)

Elementary Program

❖ Mathematics for Elementary Education 1 (Math. Dept.)

Examination of mathematics taught in grades K-6 focusing on the Common Core Domains of Counting and Cardinality, Operations and Algebraic Thinking, Number and Operations in Base 10, Number and Operations - Fractions, and Expressions and Equations.

❖ Mathematics for Elementary Education 2 (Math. Dept.)

❖ Elementary Math Methods (ICL Dept.)

Elementary Program

❖ Mathematics for Elementary Education 1 (Math. Dept.)

❖ Mathematics for Elementary Education 2 (Math. Dept.)

Examination of mathematics taught in grades K-6 focusing on the Common Core Domains of Ratios and Proportional Reasoning, Number System, Measurement and Data, Expressions and Equations, Geometry, and Statistics and Probability.

❖ Elementary Math Methods (ICL Dept.)

Elementary Program

- Mathematics for Elementary Education 1 and 2

  - Use *Elementary Mathematics for Teachers* and *Elementary Geometry for Teachers* by Parker and Baldridge.

  - Based on the Singapore Mathematics Primary Mathematics curriculum.

    - Very good alignment with the Common Core.

  - Plan to use EngageNY/Eureka Mathematics curriculum.

    - Written entirely from the Common Core standards and progressions.

Elementary Program

- Mathematics for Elementary Education 1 and 2. Elementary Mathematics from an Elementary Perspective.

  - Mental Mathematics

  - Modeling

    - tape diagrams/bar diagrams.

    - array models.

    - area models.

  - Word problems (solving and constructing).

Threats to the Elementary Program

- Class size (capped at 30 - smallest service course we teach).

- Pass Rate (and advising).

- Personnel.

- Many candidates lack a growth mindset.

Syllabus for Math for Elementary Education 1

Texts: Parker and Baldridge Elementary Mathematics for Teachers, Primary Math 3A, Primary Math 4A, Primary Math 5A, Primary Math Workbook 5A, Primary Math 6A

1. Place Value and models for Arithmetic [Counting and Cardinality, Operations and Algebraic Thinking, Number and Operations in Base 10]
   1.1. Counting
   1.2. Place Value
   1.3. Addition
   1.4. Subtraction
   1.5. Multiplication
   1.6. Division
   1.7. Addendum on Classroom Practice
2. Mental Math and Word Problems [Operations and Algebraic Thinking]
   2.1. Mental Math
   2.2. Word Problems
   2.3. The Art of Word Problems
3. Algorithms [Numbers and Operations in Base 10, Operations and Algebraic Thinking]
   3.1. The Addition Algorithm
   3.2. The Subtraction Algorithm
   3.3. The Multiplication Algorithm
   3.4. Long Division by 1-digit Numbers
   3.5. Estimation
   3.6. Completing the Long Division Algorithm
4. Prealgebra [Expressions and Equations]
   4.1. Letters and Expressions
   4.2. Identities, Properties, Rules
   4.3. Exponents
5. Factors, Primes, and Proofs [The Number System, Operations and Algebraic Thinking]
   5.1. Definitions, Explanations and Proofs [Drop Proofs]
   5.2. Divisibility Tests
   5.3. Primes and the Fundamental Theorem of Arithmetic
   5.4. More On Primes
   5.5. Greatest Common Factors and Least Common Multiples
6. Fractions [Numbers and Operations – Fractions, The Number System]
   6.1. Fraction Basics
   6.2. More Fraction Basics
   6.3. Multiplication of Fractions and a Review of Division
   6.4. Division of Fractions
   6.5. More Division Word Problems
7. Ratios, Percentages, and Rates [Ratios and Proportional Reasoning]
   7.1. Ratios and Proportions

Syllabus for Math for Elementary Education 2

Texts: Parker and Baldridge Elementary Mathematics for Teachers, Primary Math 3A, Primary Math 3B, Primary Math 4A, Primary Math 5A, Primary Math 5B, Primary Math Workbook 5A, Primary Math 6A, Primary Math 6B, Parker and Baldridge Elementary Geometry for Teachers, New Elementary Mathematics Syllabus D

From Parker and Baldridge Elementary Mathematics for Teachers

7. Ratios, Percentages, and Rates [Ratios and Proportional Reasoning]
    7.1. Ratios and Proportions
    7.2. Changing Ratios and Percentages
    7.3. Solving Percent Problems by the Unitary Method
    7.4. Rates, Speed, and Dimensional Analysis
8. Negative, Numbers and Integers [The Number System]
    8.1. Negative Numbers
    8.2. Arithmetic with Integers
9. Decimals, Rational and Real Numbers [The Number System, Number and Operations in Base 10]
    9.1. Decimals
    9.2. Rational Numbers and Decimals

From Parker and Baldridge Elementary Geometry for Teachers

1. Learning to Measure [Measurement and Data, Number and Operations in Base Ten]
    1.1 Measurement Problems
    1.2 Measuring Length
    1.3 Measuring Weight and Capacity
    1.4 Measuring Angles

2. Geometric Figures [Geometry, Measurement and Data]
    2.1 Fundamental Geometric Ideas
    2.2 Triangles
    2.3 Symmetry and Triangles
    2.4 Parallelograms. Rhombuses and Trapezoids
    2.5 Geometric Constructions
3. Finding Unknown Angles [Geometry, Measurement and Data, Expressions and Equations]
    3.1 Unknown Angle Problems
    3.2 Finding Angles Using Parallel Lines
    3.3 Angles of a Polygon
4. Deductive Geometry [Geometry]
    4.5 Transformations
5. Area [Measurement and Data, Expressions and Equations]
    5.1 Area Units
    5.2 Rectangles and Area Properties
    5.3 Area of Triangles, Parallelograms and Trapezoids
8. Area Concepts and Circles [Geometry, Measurement and Data, The Number System, Expressions and Equations]
    8.1 Converting Area Units and Scaling
    8.2 Circles and Pi
    8.3 Area of Circles and Sectors
9. Volume and Surface Area [Geometry, Measurement and Data, Expressions and Equations]
    9.1 Introducing Volume
    9.2 Metric Volume
    9.3 Prisms
10. Data Displays, Probability and Statistics [Statistics and Probability]
    10.2 Center and Dispersion of

Secondary Gaps

* Starting out in Secondary Mathematics preparation I was told:

  Make sure your candidates take the PRAXIS II early since the longer they wait the more they will have forgotten and the harder it will be.

* Our courses are **not** preparing the candidates for the PRAXIS II and by extension for teaching high school.

Current Secondary Program

- UTeach replication for last four years.

- *One* mathematics course especially for secondary candidates (Functions and Modeling). Extensive use of calculators and some use of computers.

- Calculus sequence, Proofs, Elementary Number Theory, College Geometry, History of Mathematics, Abstract Algebra, and two Statistics courses.

  - None of these courses taught with technology (including virtually no calculator use).

Proposed Secondary Program

❖ BS Ed. housed in College of Education

❖ From mathematics courses: Introduction to Statistical Reasoning, Calculus 1 and 2, Proofs, and College Geometry (17 credits)

❖ Three content courses specific to Secondary candidates: Middle School Mathematics Content, High School Mathematics Content 1 and 2.

❖ Each course has an associated pedagogy corequisite: Middle School Mathematics Pedagogy, High School Mathematics Pedagogy 1 and 2.

Content for High School

- Common Core Conceptual Categories of

  - Number and Quantity

  - Algebra

  - Functions

  - Statistics and Probability (Conceptual)

- Follow themes to from Algebra 1 to Algebra 2 within each course (rather than separating into Algebra 1 and Algebra 2 courses).

- Geometry to be handled by Geometry Course (after redesign) and Statistics computation by Introduction to Statistical Reasoning.