Designing Materials to Support the Learning of K-6 Mathematics Teacher Educators

Association of Mathematics Teacher Educators

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BU School of Education

School of Education University of Michigan

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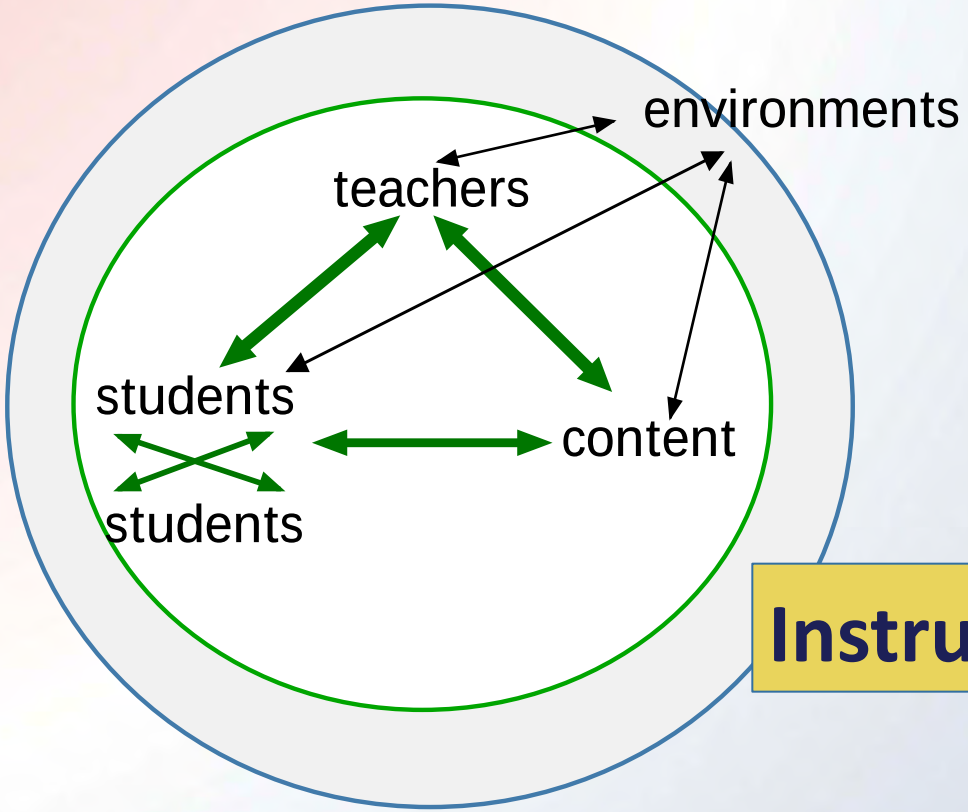
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Improving Student Outcomes



Instruction is key.

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The Broader Context

- Wide agreement that teachers matter for student learning
- But equally wide differences in the strategies needed to supply high quality teaching
- Challenges of making change in the political environment of U.S.—lack of educational infrastructure

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A Coherent Educational Infrastructure

1. A common mathematics curriculum
2. Coordinated examinations of student learning
3. Systems for supplying skilled teachers to every school
4. Professional training centered on practice
5. Schools that support the improvement of practice

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A Problem of Building Practice-Focused Content Preparation

- One central goal: Improving teachers' knowledge of mathematics needed for teaching
- People who teach teachers mathematics need support (including mathematicians)
- Developing materials as a way to:
  - Convey information about MKT
  - Support mathematics teacher educators in learning MKT and in learning to engage teachers with MKT

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Challenges

(for users and for developers)

- MKT can be hard for teacher developers to get a handle on and to teach
- Curriculum is not transparent
- Enacting tasks to focus on MKT can be challenging

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The Need for Support

Because of these challenges, there is a need to develop supports in the materials for mathematics teacher educators that:

- Provide opportunities to learn MKT
- Support enactment
- Provide information about design decisions

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What Do We Mean By "Support"?

1. Details about the goals and purposes
2. Help with preparing for class
3. Explanation and elaboration about specific MKT being taught in this lesson
4. Guidance about what to do and say
5. Information about what to anticipate and ways to use what comes up
6. Additional questions, tasks, and materials

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Whom Are We Trying to Support?

Mathematics teacher developers working in a wide range of contexts with varied background experiences:

- Mathematics background
- College teaching experience
- Elementary teaching experience
- Familiarity with elementary classrooms
- Experience working with prospective teachers
- Experience working with practicing teachers

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Whom Are We Trying to Support?

- What are the salient features of the different groups we are trying to support?
- What's hard about working with these groups?
- How does whom we are trying to support impact the types of support needed?

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What Are We Trying to Support?

- Understanding of the content (MKT) and its connection to teaching
- Understanding of how the design of the materials is intended to engage teachers with that content
- Enacting of pedagogy
- Articulating to teachers/colleagues what the content is and its relevance to teaching

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Tensions in Developing Materials

- What needs to be elaborated and detailed and how to weight these decisions in the context of considerations of usability in and usefulness for practice
- Balancing adaptable and flexibility (given the diversity of contexts in which teachers are taught math and the reality of users' adaptation) with specificity and detail
- Considerations of audience: differences in experience with teaching and mathematics (across and within groups)
- Tone (e.g. scripting vs. suggestions)
- Providing support vs. respecting professional experience
- Using tools in a mode that is intended differently from how users may interpret or react to or use them (e.g., our use of powerpoint slides as a support rather than a script)
- What (and how explicitly) ought to be modeled in design of the teacher education sessions to reflect what the teachers are supposed to do with kids?

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Design Choices

(decisions about focus and detail)

- Context (e.g., course, workshop)
- Time frame (how long is the context)
- Learners (e.g., preservice, inservice)
- Content (e.g., which aspects of MKT)
- Sequence and pacing
- Format
- Type of material (online, durable, etc.)
- Is the curriculum ordered and sequential or modular?
- How much context and rationale of the mathematical development built into the curriculum to provide
- How stand-alone and independent of the developers are the materials intended to be? What sorts of support are assumed to be necessary for the design?

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Teaching MKT Project (TMKT)

Overarching goal: Improve teachers' knowledge of the mathematics needed for teaching

- Developing materials to support instructors' learning of MKT and of ways to engage teachers in learning MKT
- Developing MKT-focused replacement units for use in a content courses for prospective elementary teachers

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Snapshot of Materials
(TMKT)

- Replacement units
- For use in mathematics content courses for elementary preservice teachers
- 80-minute sessions with suggestions for adaptation to 50-minute sessions
- Specified order for the sessions
- Downloads and binders (including editable files)
- Records of practice from elementary classroom

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Support for Instructors (TMKT)

- Supports for determining what to "replace" in existing courses and integrating them into the course syllabus
- Tasks focused on specialized content knowledge (and supports for using them with teachers)
- Supports for enactment
  - *Session plans* – suggestions for timing, emphases, and structure of sessions; notes on launching, maintaining, synthesizing discourse in the content course; common difficulties and suggestions
  - *Resources for sessions* – slides, handouts, homework, assessments, problems from textbooks, problem pools
  - *Resources for instructors* – commentaries on topics that cut across sessions, session-specific short papers

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Elementary Pre-Service Teachers Mathematics Project (EMP)

Project Goals:

- Improve prospective teachers' knowledge of the mathematics needed for teaching
- Develop materials for undergraduates that are both scaffolded and cognitively challenging
- Develop materials that support teacher educators in using academically productive talk to further learners' understanding of topics

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Years 1-2
(EMP)

Year 1 (2009-2010)

- Created modules of instructional materials for number theory, fractions, proportional reasoning, geometry, and geometric measurement
- Piloted drafts at 5 institutions in MA in math content courses for pre-service elementary teachers

Year 2 (2010-2011)

- Field testing at Boston University, Middle Tennessee State University and Utah State University
- Revising materials
- Refining support materials for instructors

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Support Materials for Instructors (EMP)

- Overarching emphasis on supporting instructors' use of academically productive talk
  - To develop prospective teachers' MKT
  - To initiate prospective teachers into the practice of generalizing and justifying mathematical ideas
- Two levels of support
  - Information pertinent to each instructional task
    - Prospective teachers' prior knowledge and misconceptions
    - Questions that elicit prospective teachers' thinking
  - Information pertinent to the modules
    - Setting up norms
    - Facilitation guidelines

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Framework for Developing Written Support Materials

- Purpose of framework: *To capture key design decisions involved in developing written support materials*
- Two axes of framework:
  - **Components of Instruction**: content, tools for teaching and learning, and environment and organization of instruction
  - **Types of Elaboration**: what aspects of the components of instruction are elaborated and how that elaboration is provided in the materials

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TMKT Task — The Bagel Problem

Session 1: Representations and language for fractions

Sessions 2 & 3: Exploring units - The Cookie Jar Problem

Session 4: Focusing on units - The Bagel Problem

Session 5: Division of fractions

Session 6: Explaining algorithms

Sessions 7 & 8: Exploring fractions on the number line.

Session 9: Consolidating understanding

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Two-Column Format of Plan

Detailed class plan

1. Launch of the Bagel Problem(~20 minutes)

Detailed description of activity	Comments & other resources
Display the problem the slide and ask someone to read it aloud. The Bagel Problem Sarah has 3 dozen bagels that she wants to share equally among 5 people. How many dozen or how much of a dozen can she give to each person? Consider having prospective teachers start by recording their first impressions of the problem without trying to solve it: e.g., "Don't start to solve the problem yet. Before you start working on a mathematics problem, it is a good strategy to step back and think about what you think the problem is asking and what might be involved in solving it. So, I want you to take a minute and, without starting to find the answer, write down any instincts, reactions, feelings you have about the problem – for example, what the problem is asking and any ideas you have about what might be involved?"	*Today's class begins directly with the presentation of the Bagel Problem, without an introduction to the themes in the session or an overview. The themes that emerge from work on this problem are discussed explicitly later in the session, since mentioning them at the outset might undercut the confusions and challenges that the problem is meant to provoke in prospective teachers' exploration of the Bagel Problem.* *The wording of the problem can sometimes be initially confusing. If you need to clarify the intent of the problem, you might ask whether each person will get more or less than a dozen. Because there are 3 dozen being shared among 5 people, then each person will get less than one dozen. You could emphasize, then, that the question is asking for just how much. Be*

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EMP Task — Divisibility I

Student Materials

- Focuses on understanding the mathematical reasons behind the divisibility tests for 2, 4, 5 and 10
- Generalizing similarities among rules
- Connecting this mathematics to the classroom

Instructor Materials

- Provides support for facilitating discussion of the task with undergraduates

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Focus Questions

Use the framework to examine example materials from each project:

- What decisions have the two projects made about designing written support materials?
- How does this framework capture the design decisions when developing written support materials? What else needs to be included?

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