HOW WELL DO WE UNDERSTAND THE ROLE OF MATHEMATICAL KNOWING IN TEACHING?

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24 May 2018 • Oslo, Norway
IN SEARCH OF TEACHERS’ MATHEMATICAL KNOWLEDGE

Teachers must know mathematics in order to teach it.

Teachers don’t know enough mathematics.

What mathematics do teachers NEED to know?

What mathematics DO teachers know?

Teachers should major in mathematics/take more courses.
A (PERHAPS) SURPRISING DISCOVERY, AND A NEW QUESTION

The amount of mathematics a teacher studies does not ensure good mathematics teaching!

What mathematical skill and insight DOES teaching require?
FROM NEED—TO USE

How is mathematics USED in teaching?
How is mathematics USED in teaching?

- Knowledge quartet (Rowland)
- Mathematical discourse in instruction (Adler)
- Mathematical perspective (Klein project)
- Tasks of teaching mathematics (LMT)
- Situated reaction competency (COACTIV)
- Commognition (Sfard)
- Equitable teaching (Goffney)
- Noticing learners (Phillips, Sherin, Jacobs)
- Responding to instructional situations (Herbst and Chazan)

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BUILDING TOOLS TO “MEASURE”

Many projects developed items and tasks to measure teachers’ mathematical knowledge.
HOW DID DEVELOPING MEASURES OF TEACHER KNOWLEDGE AFFECT OUR UNDERSTANDING?

How is mathematics USED in teaching?

How does mathematics help make teaching GOOD for learners?
PROGRESS AND PROBLEMS

PROGRESS
- Established that there are special kinds of knowing for teaching
- Developed ways to study outcomes of teacher education and professional development

CHALLENGES
- More cognitive than about practice
- Not dynamic, about what teachers actually have to DO mathematically
- Compartmentalized teaching—e.g., attention to equity
<table>
<thead>
<tr>
<th>Teachers’ competencies</th>
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<tr>
<td>Teachers’ knowledge of some mathematics</td>
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<tr>
<td>Teachers’ pedagogical content knowledge</td>
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<td>Teachers’ professional knowledge</td>
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<td>Teachers’ values and beliefs</td>
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<td>Teachers’ reasoning</td>
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mathematical knowledge
values, beliefs, PCK, etc.
mathematical knowledge
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→

teaching and learning
mathematical knowledge
values, beliefs, PCK, etc.
WHAT IS THE “WORK” OF MATHEMATICS TEACHING?
WHAT IS THE WORK OF TEACHING?
SEEING THE MATHEMATICAL WORK OF TEACHING

Requires that we take a socio-cultural perspective on teaching and learning:

- Discursive nature of teaching and learning (e.g., Sfard, Adler, many others)
- Diversity: language, identities, race and ethnicity, class, gender

There is something to the **mathematically interactive, discursive, and performative work of mathematics teaching** that is important to understand.
NEXT—AND IMPORTANT—STEPS

To look at how mathematical listening, speaking, interacting, acting, fluency, and doing are part of the work of teaching, not just resources for it
TRY THIS

- Make a definition of “even number” that is—
  - Mathematically accurate and precise
  - Can be understood by an eight-year-old
  - Will not lead to misconceptions
AN EXPLORATION OF THE MATHEMATICAL WORK OF TEACHING

1. Designing tasks for specific mathematical learning goals
2. Discussing children’s solutions in class
3. Assessing children’s learning
DESIGNING TASKS

Learning goal:
Students will be able to identify a fractional region in an area model, e.g.:
WHAT IS THE MATHEMATICAL WORK OF DESIGNING INSTRUCTIONAL TASKS?

Knowing the key mathematical ideas from the perspective of learners

- **Equal** parts
- Naming fractions
- Different models: rectangles, circles, sets, number lines

Being able to design mathematical work that is both accessible and challenging
DESIGNING TASKS: WHAT IS THE MATHEMATICAL WORK OF TEACHING?

What fraction of the rectangle below is shaded gray?

What fraction of the rectangle below is shaded gray?
VIDEO: DISCUSSING CHILDREN’S SOLUTIONS IN CLASS
WHAT IS THE MATHEMATICAL WORK OF LEADING DISCUSSIONS IN CLASS?

- Listening to and interpreting students’ ideas and language: Antar, Gabriella, Gabi, VirShawn, Kassie
- Making mathematical connections across students’ comments
- Formulating mathematical comments and questions in motion
- Noticing students’ mathematical strengths and dispositions and supporting students’ mathematical identities: Antar, Gabriella, Gabi, VirShawn, Kassie
- Steering toward the mathematical learning goal (Sleep, 2012)

What makes this all mathematical work?
ASSESSING CHILDREN’S LEARNING

What do we want to find out about children’s mathematical learning?

Their progress in being able to identify a fractional region in an area model.

What task could you use?
WHAT IS THE MATHEMATICAL WORK OF ASSESSING CHILDREN’S LEARNING?

Designing tasks

What fraction of the rectangle is shaded red?

Interpreting children’s work

1. What fraction of the rectangle below is shaded red?

Explain how you know:

It's 2/5 because you put a line through the rectangle. So their are all 5 equal parts.
1. What fraction of the rectangle below is shaded red?

E.J.

Explain how you know:

It's \( \frac{2}{6} \) because you put a line through the rectangle. So there are all \( \frac{2}{6} \) equal parts.

MADISON

Explain how you know:

Because there is 6 total and 2 shaded in.
WHAT IS THE MATHEMATICAL WORK OF ASSESSING CHILDREN’S LEARNING?

- Reading children’s writing and representations
- Considering subtle aspects of understanding (e.g., children’s explanations)
- Referencing the mathematical learning goal and also noticing other aspects of children’s work

What makes this all mathematical work?
MATHEMATICAL WORK OF TEACHING

Some examples:

- Hearing students, reading students
- Translating across many differences
- Speaking mathematically fluently and across differences
- Building students’ mathematical identities
- Using mathematical tasks as tools for students’ learning
NEXT STEPS IN UNDERSTANDING THE ROLE OF MATHEMATICAL KNOWLEDGE IN TEACHING

1. Re-focusing from teacher knowledge

2. Identifying and studying the demands of the work of mathematical listening, speaking, interacting, acting, fluency, and doing

3. Supporting teachers to learn to do the mathematical work of teaching, and assessing teachers’ skills with this form of mathematical knowledge in teaching
TAKKE!

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Slides will be available on my website

https://deborahloewenbergball.com/

(“Google” Deborah Ball)
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