CHANGE OVER TIME: TRACING AND ANALYZING NOVICE TEACHERS' SKILLS WITH ELICITING AND INTERPRETING STUDENT THINKING

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SITUATING THE STUDY

- **Practice-based teacher education** aims to prepare preservice teachers' by developing skill with specific instructional practices
  - Pedagogies of enactment (Grossman, Hammerness, & McDonald, 2009)
  - Rehearsals (e.g., Lampert et al., 2013)
- Knowing how teachers' skills develop over time could inform and refine teacher education programs
- Our question: **What does it look like to develop skill with specific teaching practices over time?**

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OUR FOCUS: THE PRACTICES OF ELICITING AND INTERPRETING

- **Eliciting:** posing questions or tasks that provoke or allow students to share their thinking about specific academic content (TeachingWorks, 2011)
- **Interpreting:** Characterizing what a student thinks based on evidence from the student's words, actions, or writing (Developed drawing on Stiggins, 2001)

In actual teaching, eliciting and interpreting student thinking are interwoven and often happen simultaneously. (Shaughnessy & Boerst, 2017)

WHY FOCUS ON ELICITING AND INTERPRETING STUDENT THINKING?

The teaching practices of eliciting and interpreting student thinking are crucial, because:

- Teachers need to ascertain what students know and understand **to design instruction** that responds to and builds on students' strengths
- Teachers' questions and conclusions about students' thinking **can expand or constrain learning opportunities**
  - Deficit orientations can lead teachers to discount student ideas or pursue less ambitious learning goals
  - Carefully probing student thinking can help teachers leverage student ideas and advance mathematical reasoning

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LEARNING ABOUT TEACHERS' SKILL WITH ELICITING AND INTERPRETING

Simulations are **approximations of practice** that can be used for assessing professional learning.

Simulations:

- are commonly used in many professional fields
- place authentic, practice-based demands on a participant
- purposefully suspend or standardize some elements of the practice-based situation
- can provide insights that are not possible or practical to determine in real-life professional contexts

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SIMULATION STRUCTURE

Each simulation:

- is designed around a specific piece of student work
- involves a teacher educator taking on the role of a student
- includes a detailed student profile to support standardization of the student
- consists of **three parts**

Part 1: Teacher Prepares → **Part 2:** Simulated Interaction → **Part 3:** Interview

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PART 1: PREPARATION

The teacher:

1. **Prepares for an interaction with a standardized student about one piece of student work**

$$\begin{array}{r} 29 \\ 36 \\ +\ 18 \\ \hline 623 \\ 83 \end{array}$$

Final answer 83

Your goal is to elicit and probe to find out what the “student” did to produce the answer as well as the way in which the student understands the steps that were performed

$$\begin{array}{r} 29 \\ 36 \\ +\ 18 \\ \hline 623 \\ 83 \end{array}$$

Final answer 83

Correct answer, alternative algorithm, degree of understanding is unclear

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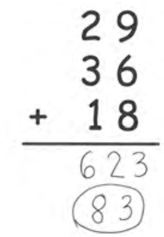
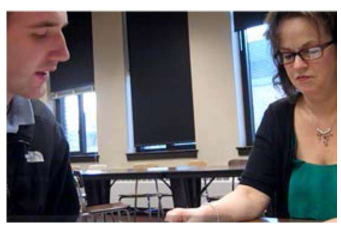
PART 2: ENGAGE IN SIMULATION



The teacher:

1. Prepares for an interaction with a standardized student about one piece of student work
2. **Interacts with the student to probe the standardized student's thinking**



A Standardized Student

Developed response guidelines focused on:

- What the student is thinking such as
  - Uses an alternative algorithm (column addition), except the student is working from left to right
  - Applies the method correctly and has conceptual understanding of the procedure
- General orientations towards responses such as
  - Talk about digits in columns in terms of the place value of the column (e.g., 23 ones)
  - Give the least amount of information that is still responsive to the question
- Responses to anticipated questions

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SAMPLE SIMULATION

PART 3: TEACHER IS INTERVIEWED

The teacher:

1. Prepares for an interaction with a standardized student about one piece of student work
2. Interacts with the student to probe the standardized student's thinking
3. **Responds to questions about their interpretation of the student's thinking**

Interviewing about interpretations

Teachers are asked to

- Describe the student's process
- Indicate what the student does and does not understand about the process

Teachers are asked to apply what they learned to

- Anticipate how the student would solve a similar problem
- Provide interpretations of understandings that are at the core of the process
- Generalize about the mathematical validity of the student's process

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METHODS

- Data set drawn from a larger study
- Selected participants based on completion of the same simulations at particular points in time
- **Sample**: 4 teachers, all White women, all graduates of the same 2-year undergraduate teacher education program
- **Data sources:** Each teacher completed 4 simulations at three points in time, which were video-recorded.
  - *Baseline:* Entry into the teacher education program
  - *Midpoint:* At the end of Year 1 of the teacher education program
  - *Practicing Teacher:* After 2-3 years of teaching (2 simulations)

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FOUR SIMULATIONS

Baseline

Column addition:
Student adds ones, then tens. Combines 6 tens and 2 tens.

$$\begin{array}{r} 29 \\ 36 \\ +\ 18 \\ \hline 623 \\ 83 \end{array}$$

Final answer 83

Midpoint

Mixed-number subtraction:
Student applies "borrowing" reasoning from whole-number subtraction.

$$\begin{array}{r} 9\frac{2}{10} \\ -\ 6\frac{7}{10} \\ \hline 2\frac{5}{10} \end{array}$$

Practicing Teacher: Addition Standard Algorithm

Student overgeneralizes the procedure of "carrying a 1."

$$\begin{array}{r} 1\ \ 1\ \ \ \\ 147 \\ 328 \\ +\ 269 \\ \hline 734 \end{array} \quad 17$$

Practicing Teacher: European Subtraction

Student uses alternative algorithm based on keeping a constant difference.

$$\begin{array}{r} 14 \\ 78\cancel{4} \\ -\ 3\,{}^{2}\cancel{1}\,5 \\ \hline 469 \end{array}$$

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METHODS OF ANALYSIS

- First pass:
  - Watched videos in chronological order by case
  - Wrote qualitative memos
- Developed and refined a coding scheme, including the following categories:
  - Nature of eliciting and interpreting
  - Mathematical Knowledge for Teaching (MKT) (Ball, Thames, & Phelps, 2008)
  - Orientation towards student thinking
  - Conceptions of mathematics
- Second pass:
  - Used Studiocode © software to create Q-A instances and apply codes
  - Double-coded videos and discussed disagreements to reach consensus
- Examined trends in codes, triangulated with memos and across cases

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FINDINGS

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HOW DID ELICITING AND INTERPRETING CAPABILITIES CHANGE OVER TIME?

1. From the baseline to the practicing teacher assessments, teachers demonstrated increased fluency with eliciting student thinking.

- Increase in number of distinct eliciting moves used
  - Ex: Asking the student to write or draw, posing an additional problem
- Decrease in frequency of “clunky questions” *(questions that were unclear or repeatedly rephrased)*
- Decrease in frequency of “fills” *(when a teacher assumes or “fills in” steps or understandings without having elicited the information from the student)*

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HOW DID ELICITING AND INTERPRETING CAPABILITIES CHANGE OVER TIME?

2. From the baseline to the practicing teacher assessments, teachers indicated greater awareness of patterns in student thinking and the broader mathematical landscape.

- Increase in frequency of “patterns in student thinking” and “math landscape” codes (0s at baseline)
- Example: Finding out the student doesn’t know the names of places; probing the student’s understanding of place value by asking ”How would you make $23 with money? What bills would you use?”

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HOW DID ELICITING AND INTERPRETING CAPABILITIES CHANGE OVER TIME?

3. There was some change, but also some persistence in teachers' orientations towards student thinking and conceptions of math.

- *One case*: Dramatic shift from trying to direct student to standard algorithm at baseline ("Let's try it my way") to being genuinely interested in making sense of the European Subtraction method
- *Another case*: Teacher consistently conveyed that there is one right way to solve a given math problem; "You can't just get a 10 out of nowhere"

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CONCLUSIONS & NEXT STEPS

- Simulations are useful for assessing the development of specific teaching practices
- It is **reasonable to expect** novice teachers to:
  - Develop increased fluency with eliciting moves
  - Draw on awareness of patterns in student thinking & the broader math landscape to interpret student thinking
- Shifting orientations toward student thinking and conceptions of math as a discipline is **more complicated**
  - What factors or experiences lead teachers to be more open to non-standard algorithms and to value student thinking?
  - How might we design TE courses to reliably disrupt beliefs that there's "one right way" to solve math problems?

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