

# Mathematics Methods Courses as Sites for Scholarly Inquiries

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# The “Arbaugh Research Group” (ARG!)

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# Today's Talk

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- Context for Scholarly Inquiries: Secondary Mathematics Methods Course
- Study 1: *Preservice Secondary Mathematics Teachers' Learning of Purposeful Questioning and Judicious Telling for Promoting Students' Mathematical Thinking* (Ben Freeburn's Dissertation Study)
- Study 2: Unintended (but Good!) Outcomes: Impacting PSTs' Visions of Role of Teacher (accepted for the 2016 NCTM Research Conference)
- Group Discussion

# The Seed

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“Currently, the field of teacher education is undergoing a major shift – a turn away from a predominant focus on specifying the necessary knowledge for teaching towards specifying practices that entail knowledge and doing....The fundamental aim undergirding this turn is to better support teachers in learning how to use knowledge in action”

(McDonald, Kazemi, & Kavanagh, 2013, p. 378).

# Some Terms We Use

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Pedagogies of Practice

Approximations of Practice

Decomposition of Practice

Representations of Practice

# “Pedagogies of Practice”

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Teacher education pedagogies

Integration of pedagogies of investigation and pedagogies of enactment

Focus on how people learn to engage in complex practice

(Grossman, et al., 2009)

# “Approximations of Practice”

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“Approximations of practice refer to opportunities for novices to engage in practices that are more or less proximal to the practices of a profession.” (Grossman et al., 2009, p. 2058)

# “Decomposition of Practice”

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“Decomposition of practice involves breaking down practice into its constituent parts for the purposes of teaching and learning.” (Grossman et al., 2009, p. 2058)



# “Representations of Practice”

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“Representations of practice comprise the different ways that practice is represented in professional education and what these various representations make visible to novices” (Grossman et al., 2009, p. 2058).

Examples include video cases, written cases, peer teaching activities, lesson plans, video-recorded teaching episodes, etc.

# Our Context

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## Secondary Mathematics Methods Course

- One of three methods courses
- This course is taken in conjunction with a course on using technology for learning mathematics; students take 3<sup>rd</sup> methods course in the subsequent semester
- Typically taken in junior year

PSTs engage in *Cycles of Enactment and Investigation (CEIs)* (Lampert et al., 2013).

# Our Decomposition of Practice: Three Types of Teacher Talk (TTT):

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**Asking Assessing Questions:** Questions that “can assess what students understand about the problem (e.g., clarify what the student has done and what the student understands)” (Smith, Bill, & Hughes, 2008, p. 136).

**Asking Advancing Questions:** Questions that “help students advance towards the mathematical goals of the lesson. Teachers can extend student beyond their current thinking by pressing them to extend what they know to a new situation or think about something they are not currently thinking about” (Smith, Bill, & Hughes, 2008, p. 136).

**Telling (Initiating):** “The set of teaching actions that serve the function of stimulating students’ mathematical constructions via the introduction of new mathematical ideas into a classroom conversation” (Labato, Clarke, & Ellis, 2005, p. 110).

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# Cycle of Enactment and Investigation

Lampert, et al. (2013)

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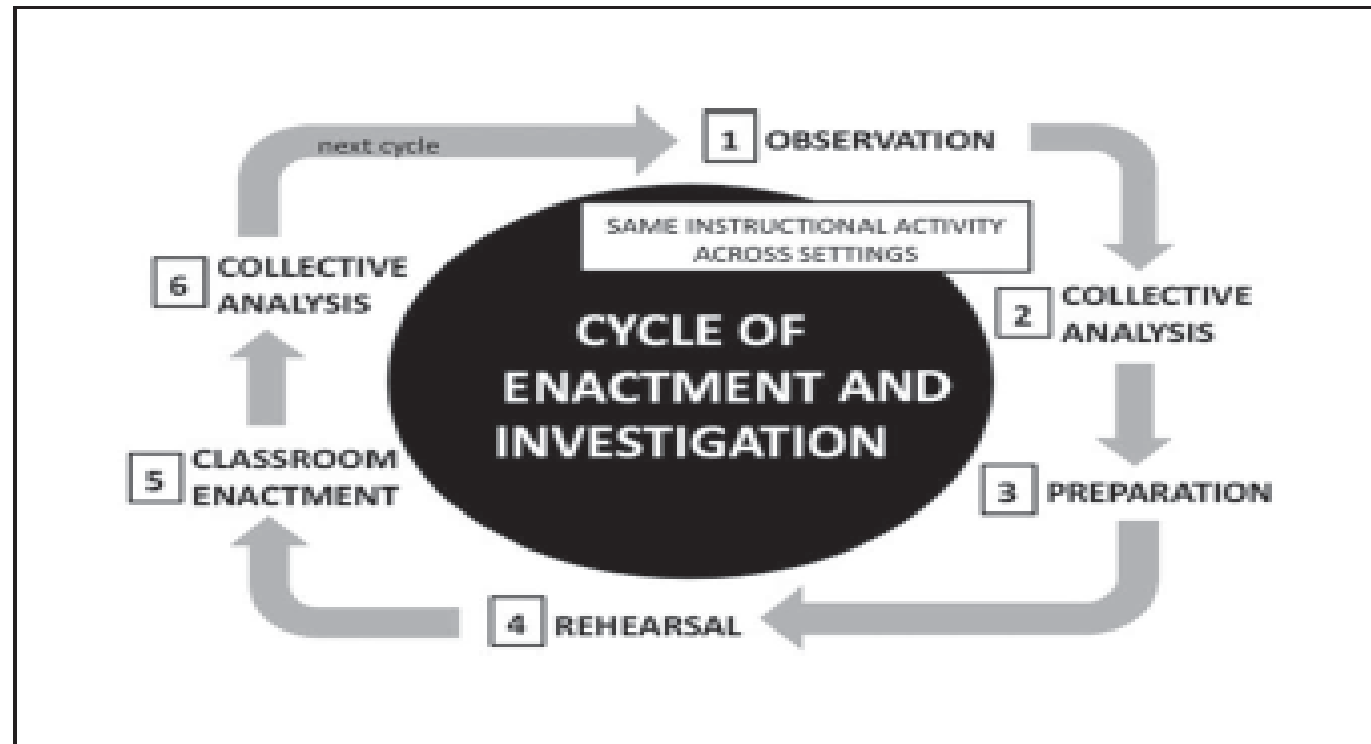
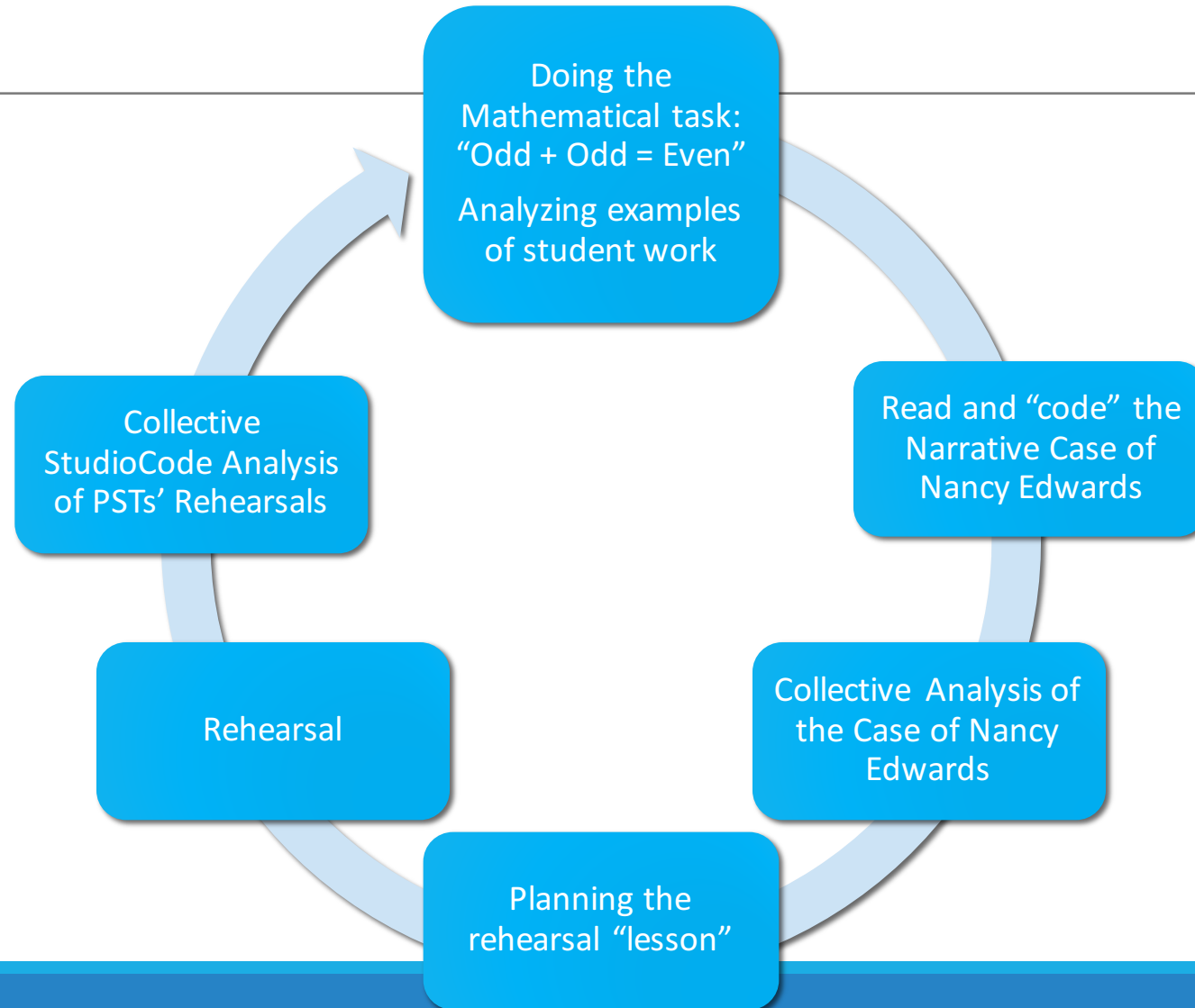


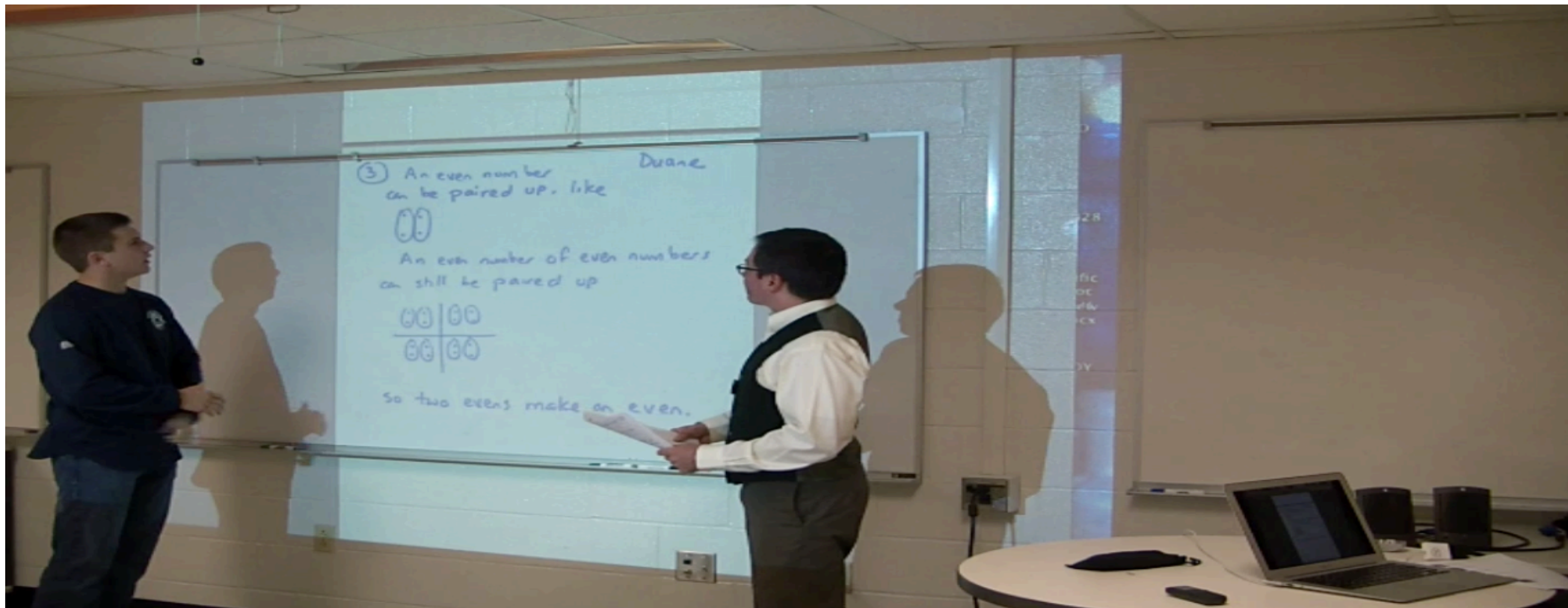
Figure 1. Cycle of enactment and investigation

# Modified Cycle of Enactment and Investigation



# Rehearsal: even x even = even

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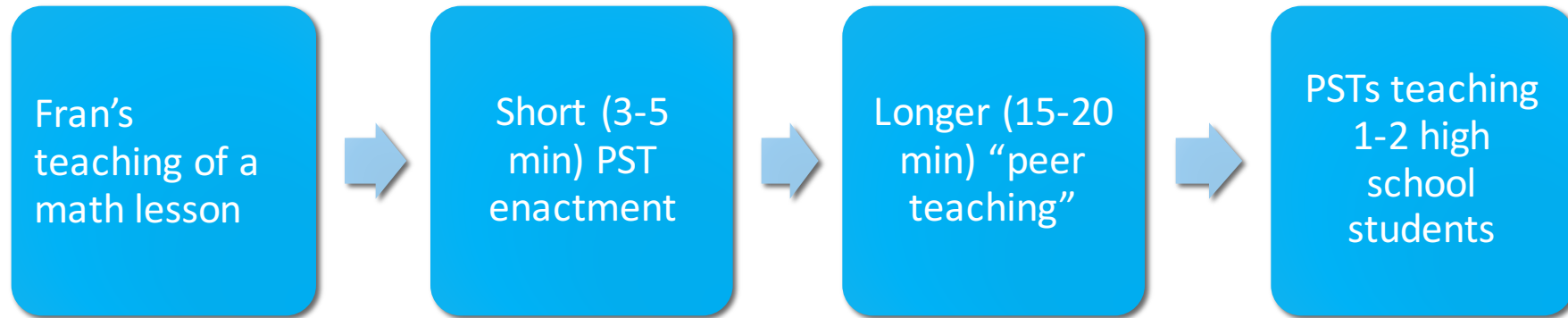


# Analysis using StudioCode<sup>®</sup>

The screenshot displays the StudioCode software interface for video analysis. The main window shows a video of two men in a classroom. A whiteboard in the background contains handwritten text and mathematical equations: "An even number can be paired up. like (0) 2x - 2y = 4xy", "An even number of even numbers can still be paired up (0) (0) (0) (0)", and "so two evens make an". A "Code mode" window is overlaid on the right, showing a list of analysis segments: "Telling\_1 1" (blue), "Assessing\_1 2" (green), "Advancing\_1 3" (orange, highlighted with a red border), and "Other\_1 4" (grey). The bottom of the interface features a timeline with a video player and a track for analysis segments, including "Assessing\_1", "Other\_1", "Telling\_1", and "Advancing\_1", each with sub-segments and purpose labels like "Purpose: To see what" and "Purpose: As".

# 4 Cycles of Enacted Instruction

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Other course activities focused on:

- Strands of Mathematical Proficiency (what does it mean to “know” mathematics?)
- CCSS-M Content Standards and Standards for Mathematical Practice (what should students learn and how should they learn it?)

# Scholarly Inquiry into Our Work

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- We began with a Broad Research Question:

What outcomes exist when secondary mathematics preservice teachers engage in a methods course designed around cycles of enacted instruction with a particular decomposition of practice (assessing questions, advancing questions, and judicious telling).

- Our guiding theoretical perspective was Pedagogies of Practice:

Mathematics teacher educators who employ pedagogies of practice focus on developing mathematics PTs' understanding of principles behind core practices that constitute teaching mathematics (e.g., equity, learning for mathematical understanding), develop mathematics PTs' abilities to enact the core practices (e.g., setting up mathematical tasks, leading mathematical discussions), and mathematical content knowledge (MCK) for school mathematics (Lampert et al., 2010; Lampert et al., 2013; McDonald et al., 2013). (Freeburn, 2015, p. 14)

# Data Collection (n=17)

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Fran's teaching of a math lesson	Short (3-5 min) PST enactment	Longer (15-20 min) "peer teaching"	PSTs teaching 1-2 high school students
<ul style="list-style-type: none"><li>• Studio-code coded audio (collaborative)</li><li>• Studio-code memos</li><li>• Audio of small gp coding session</li></ul>	<ul style="list-style-type: none"><li>• Video of rehearsals</li><li>• Studio-code coded video (Collaborative)</li><li>• Studio-code memos</li><li>• Audio of small gp coding session</li><li>• Lesson plan</li></ul>	<ul style="list-style-type: none"><li>• Video of peer teaching</li><li>• Studio-code coded video (Collaborative)</li><li>• Studio-code memos</li><li>• Audio of small gps coding session</li><li>• Lesson plan</li></ul>	<ul style="list-style-type: none"><li>• Audio of "lesson"</li><li>• Studio-code coded audio (Individual)</li><li>• Studio-code memos</li><li>• Lesson plan</li><li>• Written reflection (post coding)</li></ul>

## Additional Data:

- 3 interviews with each student
- Student notebooks
- Students' completed assignments

- Video recording of whole group discussions
- Audio recording of small group discussions

# Study 1: *Preservice Secondary Mathematics Teachers' Learning of Purposeful Questioning and Judicious Telling for Promoting Students' Mathematical Thinking* (Ben Freeburn's Dissertation Study)

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- Research Questions:
  - What conceptions of assessing questions, advancing questions, and judicious telling, did four PSMTs construct?
  - What were the PSMTs' pathways for constructing their conceptions across the semester?
  - In what ways were course activities, designed around decomposition of practice, representations of practice, and approximations of practice, connected to the PSMTs' construction of their conceptions?
- 2-Part Theoretical Framework:
  - The Object of Learning: Teaching Practices and Types of Teacher Talk (Assessing Questions, Advancing Questions, and Judicious Telling)
  - Theoretical Perspective for Teacher Learning: Constructivism

Findings from Study 1: The PSTs developed multifaceted definitions of assessing questions, advancing questions, and judicious telling. For example,

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<p>Assessing questions:</p> <ul style="list-style-type: none"><li>• “Can assess what students understand about the problem (e.g., clarify what the student has done and what the student understands)” (Smith et al., 2008, p. 136)</li></ul>	<p>Assessing questions:</p> <ul style="list-style-type: none"><li>• Determine students’ mathematical thinking understanding, and/or knowledge<ul style="list-style-type: none"><li>○ Determine students’ approaches or rationales for work as they engage in a task</li><li>○ Determine students’ rationales for answers to a mathematical task</li><li>○ Gauge students’ mathematical understanding and/or capabilities</li><li>○ Other facets associated with the first feature</li></ul></li><li>• Inform teachers’ subsequent instruction</li><li>• Support students’ reflection</li><li>• Role in whole class discussions</li><li>• Guide students’ mathematical thinking</li><li>• Relation to advancing questions</li><li>• Other facets</li></ul>
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Assertion 2: Although the PSMTs constructed similar features to their conceptions of assessing questions, advancing questions, and judicious telling, there were nuances among the features.

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“Judicious telling conveys mathematical terminology”

Steve: A way for a teacher to share a definition or term when the student cannot remember

Leslie, Gretchen, and Nick: A way for teachers to insert a mathematical term or word for a student generated idea

Nick: A way to support students' engagement in mathematics discourse

## Assertion 3

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While the PSMTs constructed conceptions that included similar features of assessing questions, advancing questions, and judicious telling, different perturbing course activities promoted the PSMTs to construct the feature



# What did we learn from this study about our teacher education practices?

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- That students needed extended “exposure” to the decomposition of practice – while the students came to the same broad understandings of TTT by the end of the course, those understandings happened at different times in the course and were prompted by different course activities.
- That different parts of the CEIs prompted learning in different students.
- That the students did indeed learn what we wanted them to learn, and in pretty sophisticated ways.

We continue to utilize CEIs and have a focus on TTT in this course; it has “proven” effective in achieving our instructional goals.

## Study 2:

# Unintended (but Good!) Outcomes: Impacting PSTs' Visions of Role of Teacher

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Prompted by reading through the entirety of the students' completed assignments.

“Something is going on here”

How can a theoretical framework help us to understand the differences in the ways PSTs were “talking” about teaching and learning over the course of the semester?

Theoretical Framework: *Visions of High Quality Mathematics Instruction* [VHQMI] (Munter, 2014)

- The VHQMI rubric has three interrelated dimensions: *Role of Teacher*, Classroom Discourse, and Mathematical Tasks.

# VHQMI Role of Teacher Dimension

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- Contains five levels of sophistication, from 0 (low) to 4 (high)
- Within each level, consideration is given to three potential ways of characterizing a teacher's role: influencing classroom discourse; attribution of mathematical authority; and conception of typical activity structure.
- Use of this rubric to analyze data allows researchers to assess an individual teacher's level of sophistication in terms of his/her vision of role of teacher.

# Research Question:

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How did secondary PSTs' visions of "role of teacher" change as an unintended outcome of a mathematics methods course in which they experienced sustained engagement in instructional activities that focused on posing purposeful questions and eliciting and using evidence of student thinking (NCTM, 2014)?

## Data Sources:

- Five sources collected in first two weeks of the semester (Interview 1, Reading Journal 1, Reading Journal 2, audio-recording of whole group discussion in class 4)
- Three sources from the last two weeks (Final Paper, Interview 3, and audio-recordings of small group Studio-Code analysis sessions).

# Abbreviated Findings

Role of Teacher Rubric	Percentage of Instances Labeled <b>Low-Level</b> (Levels 0, 1, and 2) at <b>beginning of semester</b>	Percentage of Instances Labeled <b>High-Level</b> (Levels 3 and 4) at <b>end of semester</b>
Influencing Classroom Discourse	74.49%	53.52%
Attribution of Authority	67.8%	82.91%
Conception of Typical Activity Structure	86.99%	76.09%

We also present qualitative findings, illustrating the differences in sophistication from beginning of the semester to the end of the semester.  
(Come to our NCTM Research Conference Session!!)

# What did we learn from this study?

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## Intended Outcomes vs. Unintended Outcomes

Intended outcomes: findings from Study 1 (they learned what we wanted them to learn)

“What the study reported here indicates is that a focus on these specific teaching practices [asking purposeful questions/eliciting and using evidence of students’ thinking] in a secondary mathematics methods course also supported the “unintended outcome” of an increase of sophistication in PSTs’ VHQMI, findings that serve to bolster the field’s focus on these teaching practices.”

# Lingering questions for ARG

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- In what ways did the students' practices change over the course of the semester? In other words, did they get better (or not) at asking assessing questions, advancing questions, and telling judiciously? (analysis of the audio/video recordings of their "teaching")
- In what ways did their abilities to correctly identify the TTT get better (or not) over the course of the semester? (analysis of their coding)
- What did three doctoral students learn about mathematics teacher education from participating in group planning meetings for a course that....(analysis of audio-recordings of planning meetings; interviews with doctoral students)
- Others?

# Discussion

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What do *you* want to know?



# Thanks!

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