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Becoming Explicit: Articulating Practice in the Elementary Mathematics Laboratory

Deborah Ball, Nicole Garcia, Meghan Shaughnessy

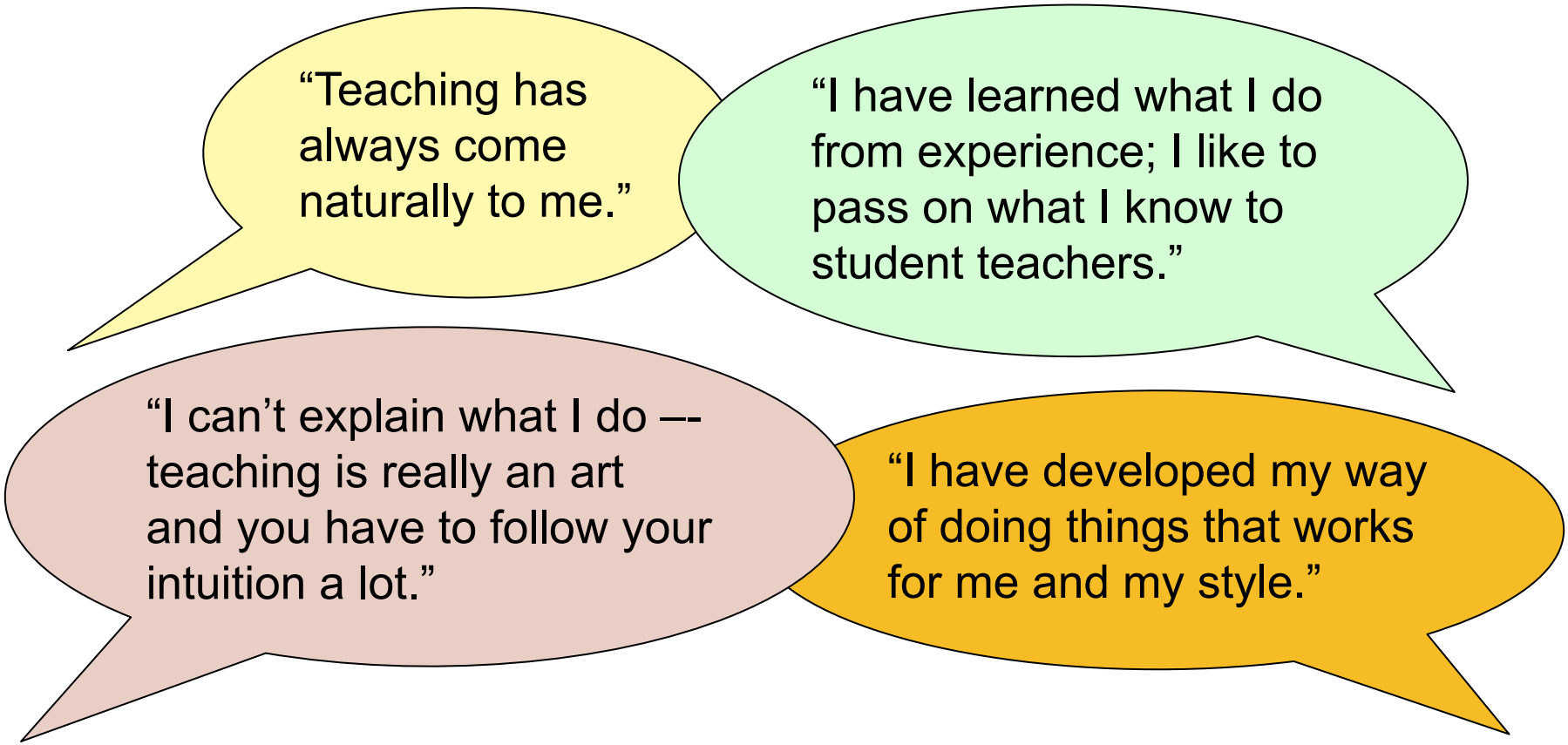
March 2, 2014 • AACTE 2014 • Indianapolis, IN

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What great teachers often say about teaching



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What's wrong with this?

1. Undermines the idea that teaching is a profession that can be developed through careful unpacking of the practice and a common technical language
2. Perpetuates the belief that teaching is individual and tacit
3. Reinforces the predominance of "style" over skill

If teaching is individual and must be figured out by each person on the job, then there is little hope of ensuring that all young people receive skillful instruction.

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The work of teaching and the challenge for teacher education

1. Unpacking practice into explicitly learnable elements
2. Developing explict and useful language for practice
3. Accessing and using examples of actual practice
4. Continuing to develop ways to help students learn specific things

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Overview

① Using of a laboratory context to work on the improvement of teaching: A focus on explicit teaching

② Teachers' learning in the Elementary Mathematics Laboratory (EML)

③ Teacher candidates' learning using records of practice from the EML

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What is the EML?

A live laboratory for the design and study of teaching:

- 10-day summer mathematics program for 5th grade students from Ypsilanti Community Schools
- Live setting for the study of teaching, learning, and mathematics by teacher and school district leaders, teacher candidates, teacher educators, researchers, mathematicians and other university faculty, the public
- Source of unusual records of practice



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Why is it called a “laboratory”?

Laboratory:

A planned setting developed for real-time studies of the interplay of instructional design, teaching, and learning



Features of the laboratory:

- Teaching that is public, perceptible, and made studyable
- Careful documentation
- Experimentation and interdisciplinary study

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A site for collective work on practice

- Opportunity to deliberate collectively about instructional decisions, and to develop and discuss experiments
- Diverse participants with varied interests, areas of expertise, and "lenses" for viewing practice lend different perspectives and expand the range of discussion





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What are we studying in the EML?

Ways to unpack and name specific teaching practices with respect to:

- What is involved in teaching specific aspects of the Common Core in mathematics?
- How can students be challenged mathematically with complex mathematical work while also filling in "gaps" in their past learning?
- What is involved in teaching mathematics with a deliberate focus on equity?

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Today's focus

Two Common Core mathematical practice standards:

1. Make sense of problems and persevere in solving them.
2. Construct viable arguments and critique the reasoning of others.

One high-leverage practice (HLP): Making content explicit

1. **What have we learned about teaching through our work in the laboratory?**
2. **How does the laboratory support teachers' learning?**

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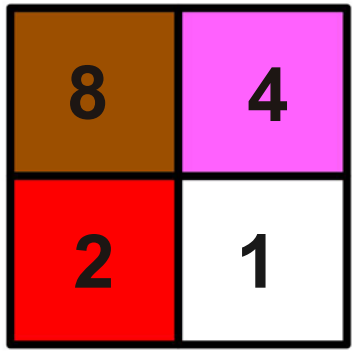
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WHAT HAVE WE LEARNED ABOUT THESE CCSS STANDARDS AND THIS HLP FROM OUR WORK IN THE LABORATORY?

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What is this problem asking, and what is involved in trying to solve it?





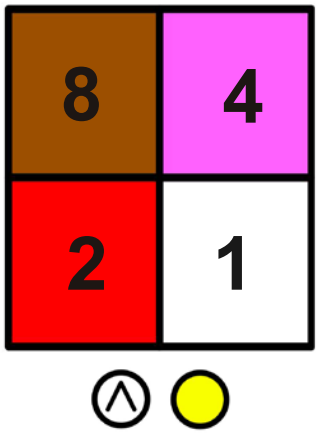
Using exactly one positive and one negative checker, find all the numbers that can be represented on this minicomputer board.

Prove your answer and explain why.

(Papy Minicomputer)

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Identifying and using problem "conditions"



Using exactly one positive and one negative checker, find <u>all</u> the numbers that can be represented on this minicomputer board. Prove your answer and explain why.

CONDITIONS OF THE PROBLEM

1. Use exactly one positive and one negative checker.
2. Must be a number that can be made on the Minicomputer.

PROPOSED SOLUTIONS

3 *YES, because it can be made with a positive on the 4 and a negative on the 1. This (1) uses exactly one positive and one negative checker and (2) it can be made on the Minicomputer.*

9 *NO, because it cannot be made on the Minicomputer with exactly one positive and one negative checker on the Minicomputer.*

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The role of conditions of a problem

- Identifying conditions can help in making sense of and interpreting a problem (MP.1)
- Using the conditions can help in persevering on a difficult problem (MP.1)
- Conditions are useful in constructing a mathematical argument (MP.3)
- Referring to the conditions is useful in critiquing an argument (MP.3)

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HLP #1: Making content explicit

- With increasingly greater expectations for engagement in complex mathematical work, it is crucial to unpack and structure opportunities to learn key ideas and practices, e.g.:
  - What it means to explain your thinking about an answer
  - What is involved in showing your work
  - How to work on a hard math problem
  - How to study mathematics on your own
- An entailment of equitable teaching to make ideas and practices transparent and learnable for all students (Delpit, ELA)

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Explicit teaching ≠ direct instruction

- Naming, labeling, writing about important aspects of mathematical ideas, concepts, and procedures:
- Naming, highlighting, scaffolding specific mathematical practices
- Naming and supporting qualities of productive mathematical habits and mindset

(Mann, Owens, & Ball, 2013)

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Teachers' Learning in the EML

EXPLICITLY SUPPORTING STUDENTS TO EVALUATE MATHEMATICAL EXPLANATIONS

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Practicing teachers' participation in the EML

- Practicing teachers, researchers, teacher educators and others attend the EML to study teaching
- Adults attend a prebriefing, observe the laboratory, and attend a debriefing
- Practicing teachers continue their learning by attending professional development sessions for the second half of the day

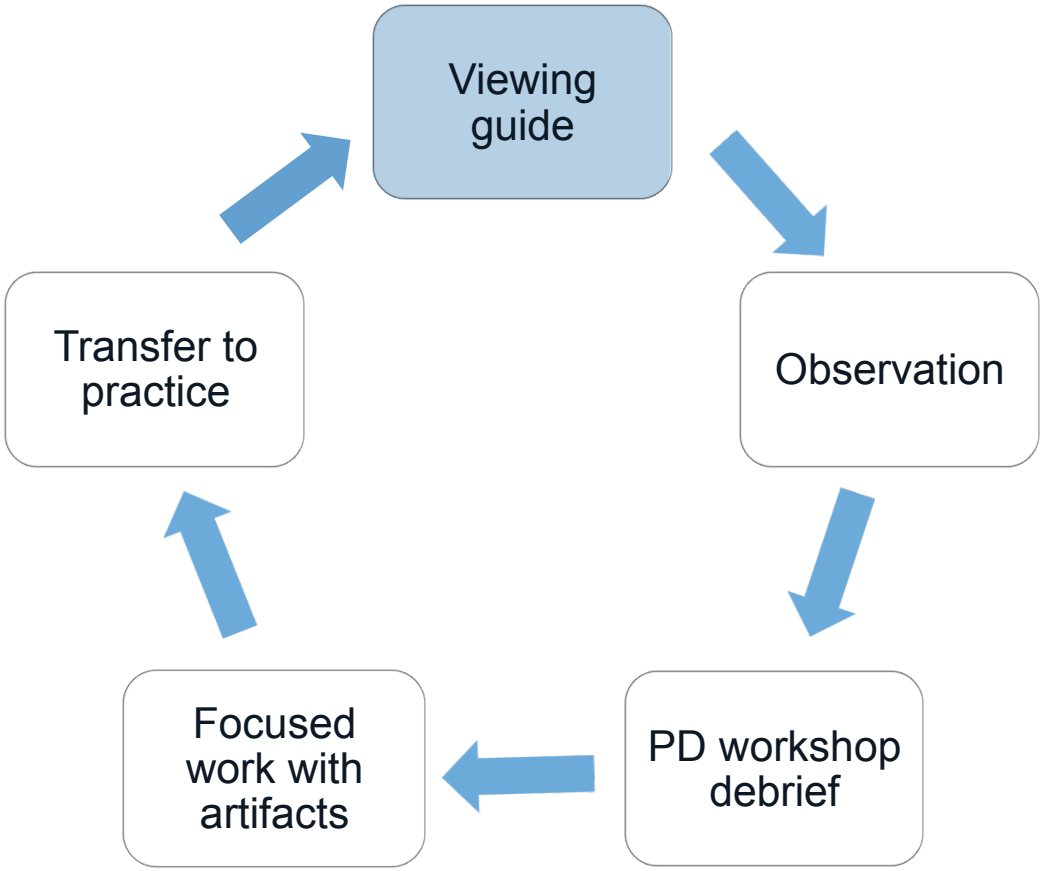
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Professional development themes

- Leading whole class discussions
- Considering worthwhile tasks
- Examining the high-leverage practices
- Teaching the mathematical practices

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Professional development process



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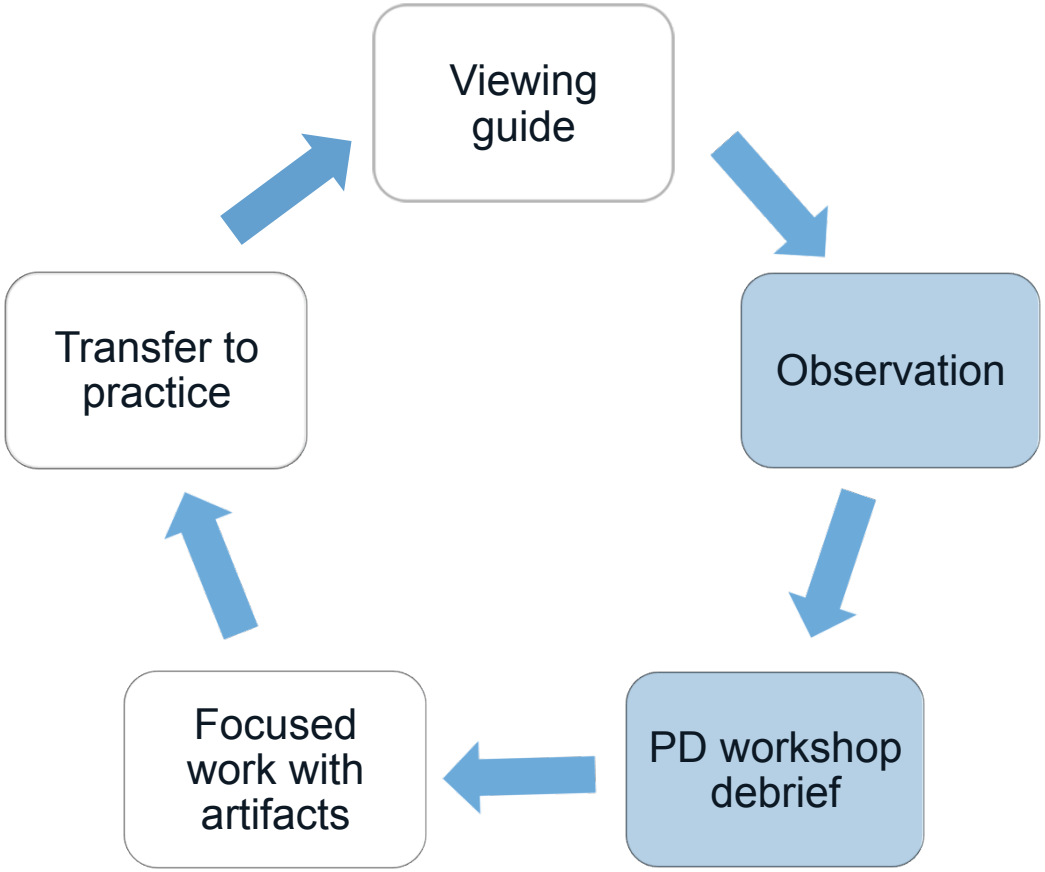
Viewing guide

How does the teacher support students in learning to give mathematical explanations that:

- Have a clear purpose
- Have a logical structure
- Use representations and language clearly and carefully
- Have a focus on meaning and are oriented to the listeners

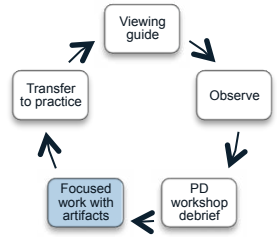
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Professional development process



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Permutations of 1, 2, and 3



- How many different three-digit numbers can you make using the digits 1, 2, and 3, using each digit only once?
- Show all the three-digit numbers that you found.
- How do you know that you have found them all?

Solve the problem and consider how you would explain that a particular three-digit number is or is not a solution.

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The conditions of the problem

How many different three-digit numbers can you make using the digits 1, 2, and 3, using each digit only once? Show all the three-digit numbers that you found.

How do you know that you have found them all?

THREE CONDITIONS

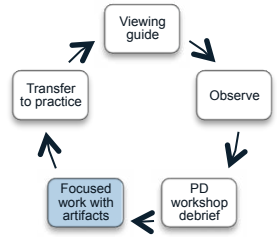
1) Use only 1, 2, and 3
2) Use exactly three digits
3) Use each digit only once

WORK OF THE CLASS SO FAR

- Unpacked the conditions of the problem
- Shared non-examples with justifications

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Classroom video



How many different three-digit numbers can you make using the digits 1, 2, and 3, using each digit only once? Show all the three-digit numbers that you found.

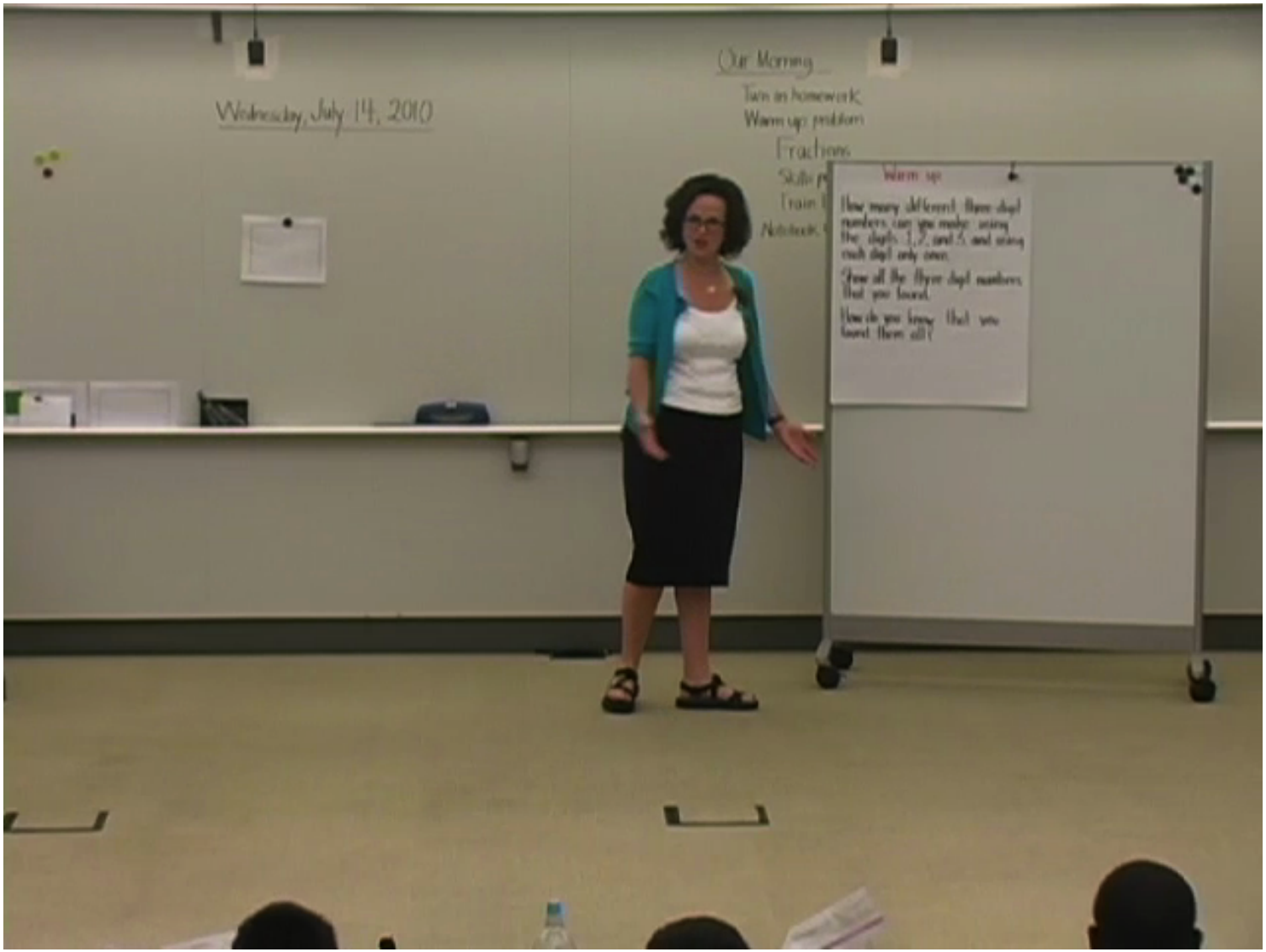
How do you know that you have found them all?

VIEWING FOCUS

To what extent does each explanation:

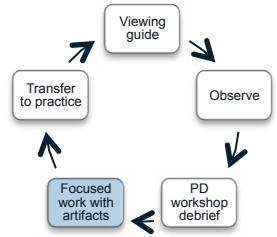
- Have a clear purpose
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Classroom video: A second viewing



How many different three-digit numbers can you make using the digits 1, 2, and 3, using each digit only once? Show all the three-digit numbers that you found.

How do you know that you have found them all?

VIEWING FOCUS

- What is the teacher doing to support students in learning to give mathematical explanations?
- What else might the teacher do?

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Classroom video

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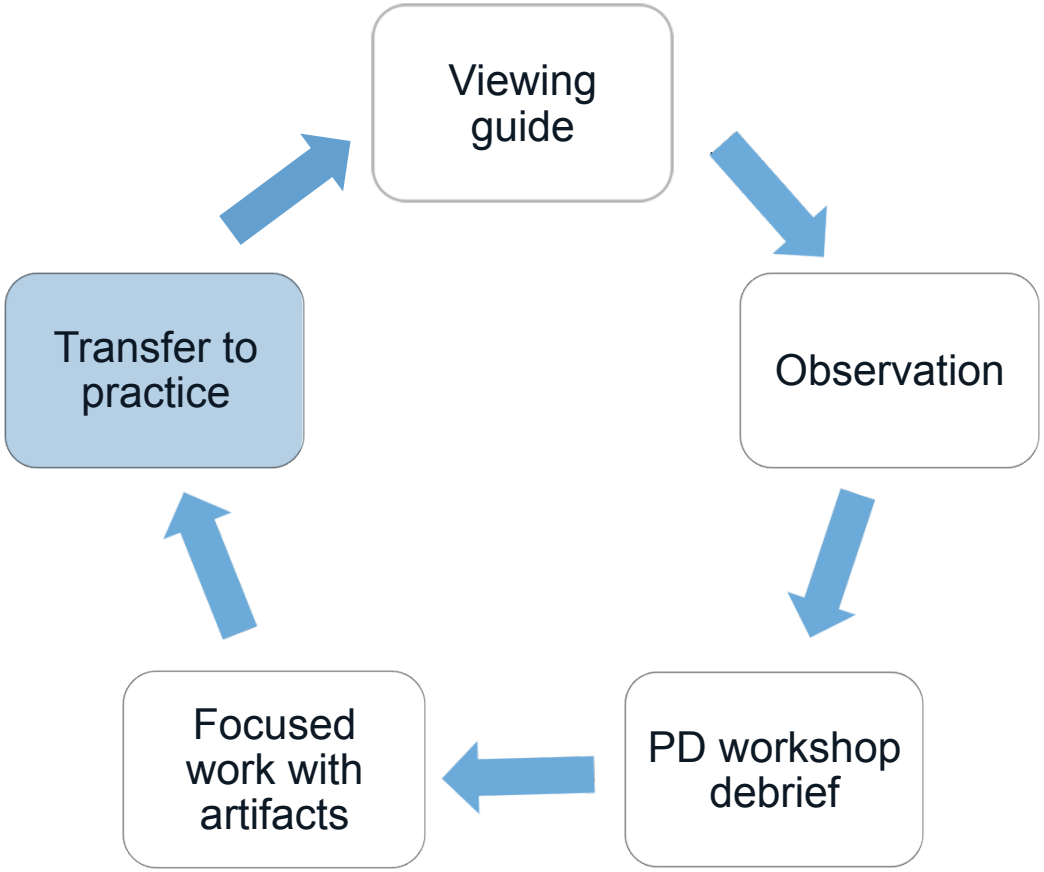
How do you know that you have found them all?

VIEWING FOCUS

- What is the teacher doing to support students in learning to give mathematical explanations?
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Professional development process



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Affordances and challenges of using the lab to support this work

Affordances

- Close to practice
- Able to see impact in real time
- Can test teacher moves
- Teacher impact

Challenges

- Choosing segments for the session on the same day
- Predictability

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Teacher Candidates' Learning Using Records of Practice from the EML

EXPLICITLY TEACHING STUDENTS TO MAKE SENSE OF AND INTERPRET MATH PROBLEMS

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Teacher candidates' learning using records from the EML

- Teacher candidates are enrolled in a undergraduate teacher education program
- Video records and other artifacts are used in coursework, including a math methods course
- Focal HLPs in the mathematics methods course include:
  - Making content explicit
  - Leading a whole class discussion

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Leading a mathematics discussion

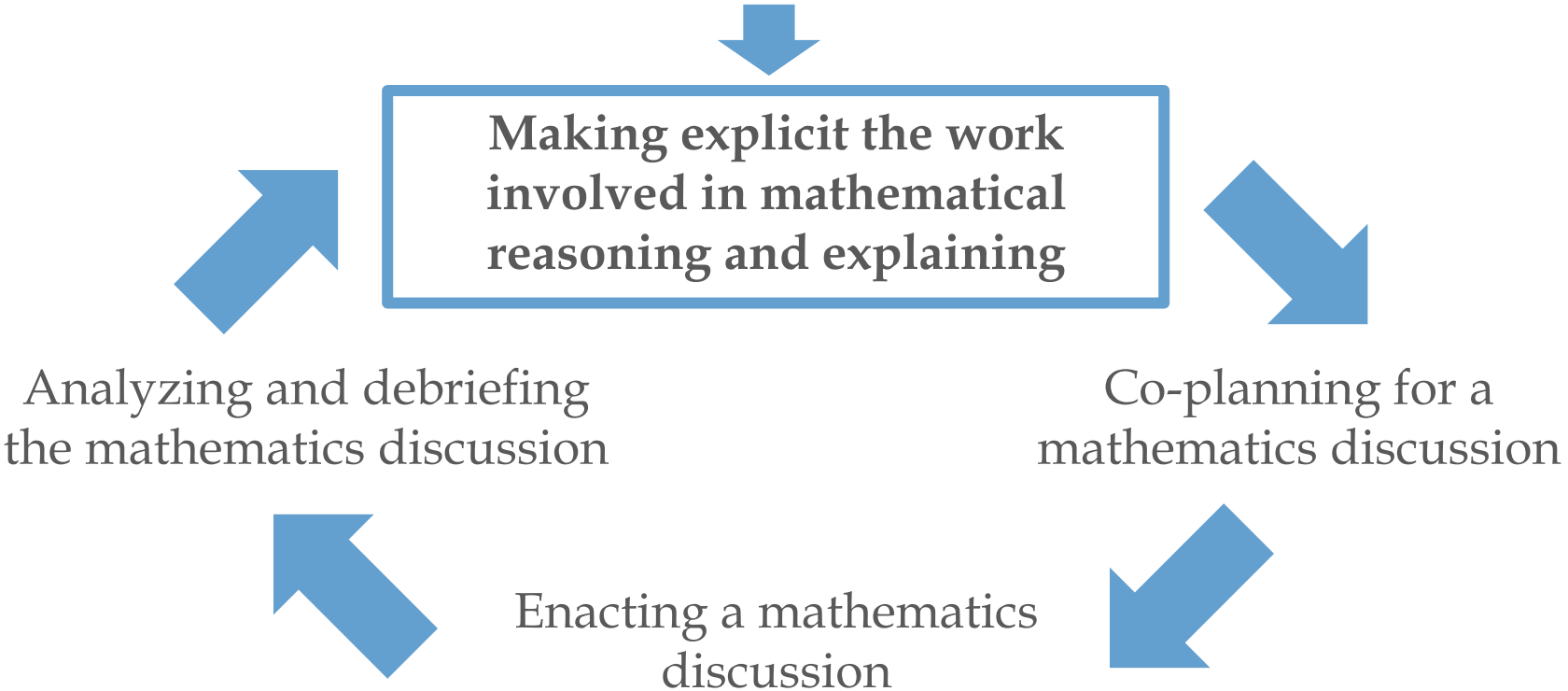
- Setting up the mathematics problem
- Independent work on the problem
- Launching the discussion
- Orchestrating the discussion
- Concluding the discussion

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Supporting teacher candidates in learning to be explicit in their teaching

Initial experience:

Working on reasoning and explaining as learners of mathematics



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The conditions of the problem

I have pennies, nickels and dimes in my pockets. If I pull out 2 coins, what amounts of money might I have?

Prove that you have found all of the amounts possible.

THREE CONDITIONS

1) Use only pennies, nickels, and dimes.
2) Use exactly two coins
3) Find the amount of money

CONNECTIONS WITH MATHEMATICAL PRACTICES

- Making sense of problems: Supports establishing a shared understanding of the problem
- Constructing mathematical arguments and critiquing the reasoning of others: Provide a means to explain whether a proposed solution is or is not a solution

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A mathematics problem set-up

Components

- Build a **shared understanding** of what the problem is asking (without giving away the solutions or methods)
- Give directions to **establish the work environment** as needed, depending on routinized norms of the classroom
- Support students in learning how to make sense of a problem and tools for persevering in solving and explaining it

Features

- Succinct
- Clearly organized
- Use language that is likely to be accessible to students
- Task is publically posted

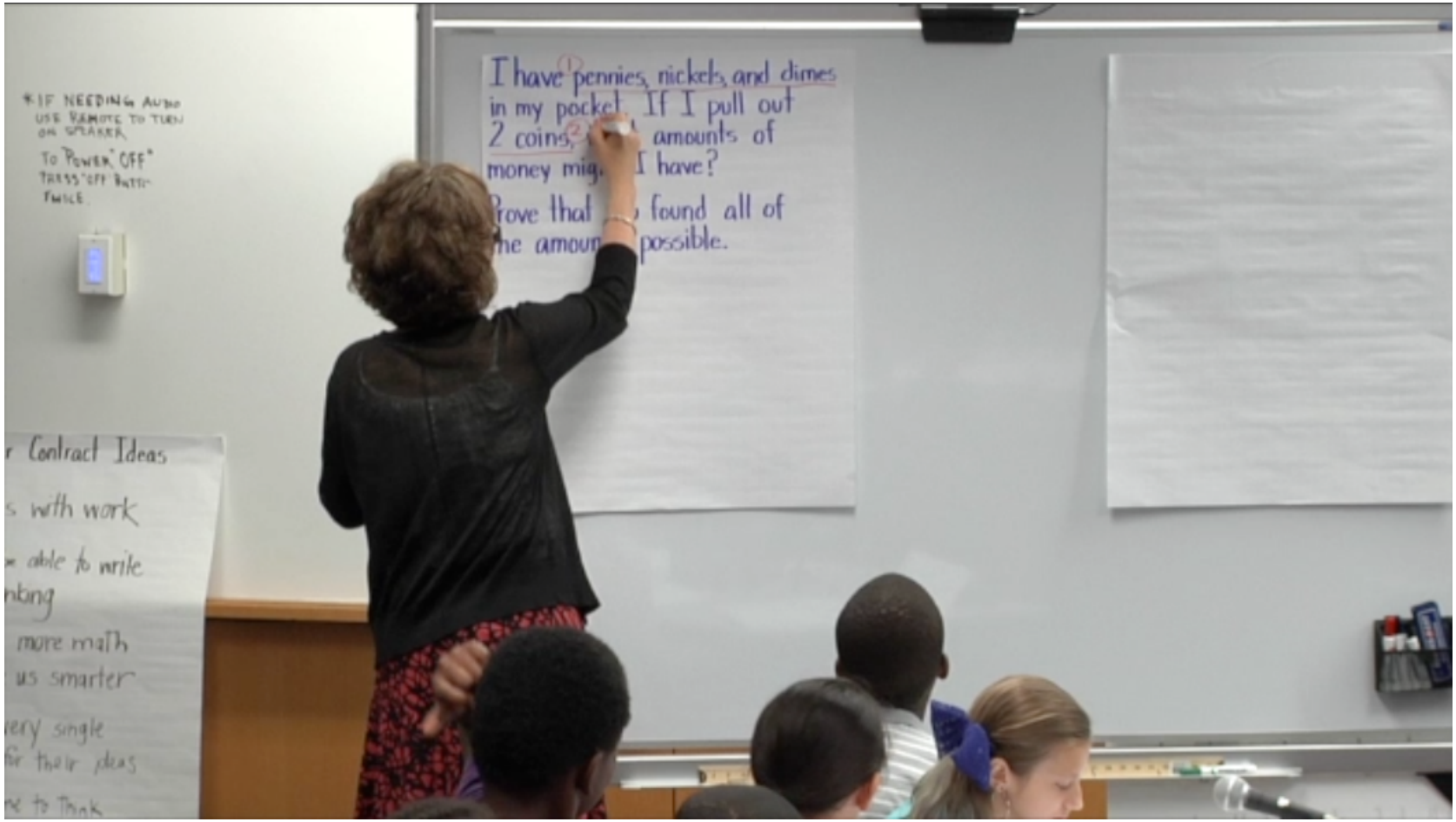
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Viewing focus

- What moves does the teacher make to establish a shared understanding of the task?
- How might the set-up be improved to be more effective?

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Classroom video

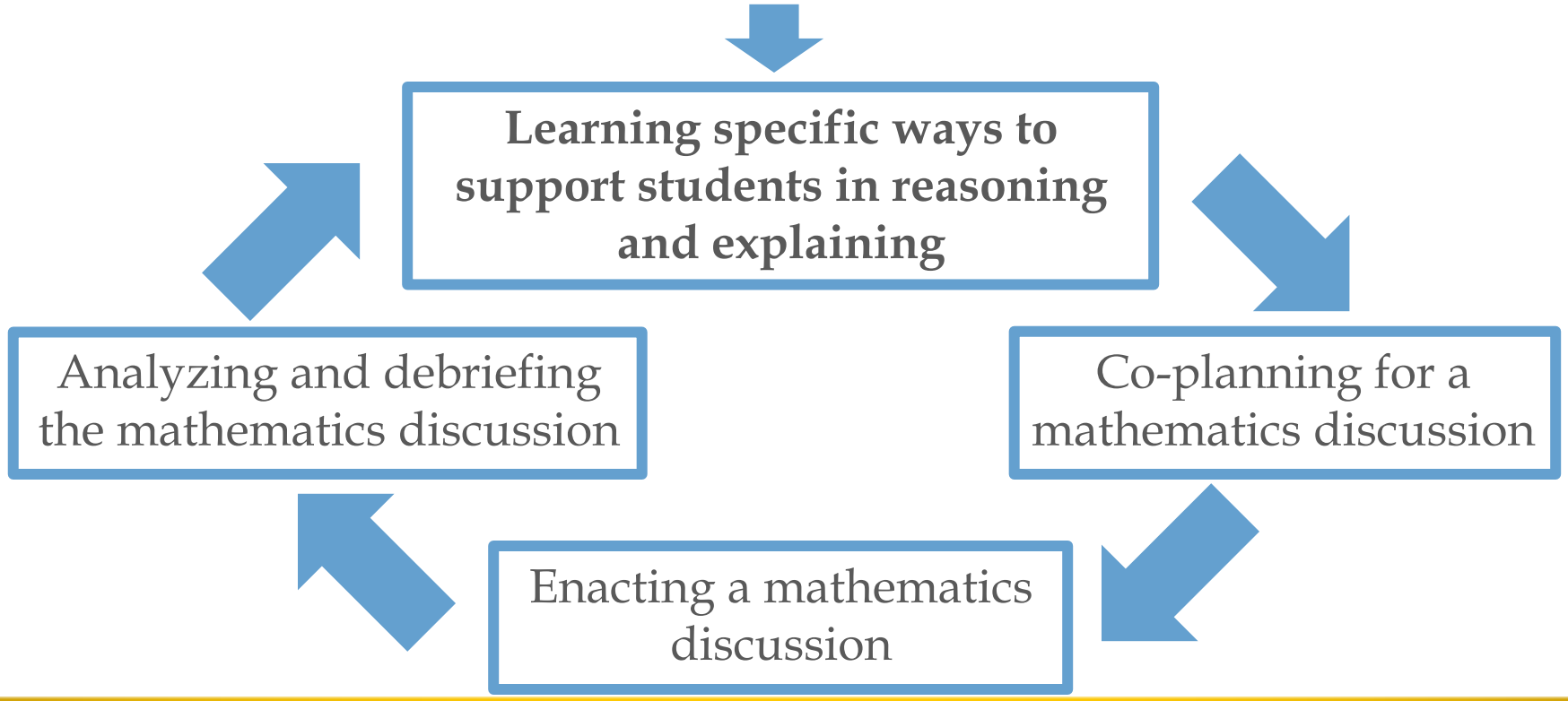


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Supporting teacher candidates in learning to be explicit in their teaching

Initial experience:

Working on reasoning and explaining as learners of mathematics



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Affordances and challenges of using the laboratory to support this work

Affordances

- High-quality but "natural" video
- Other detailed documentation and records
- Episodes of teaching and learning closely connected to specific Common Core content and high-leverage practices

Challenges

- Lack of opportunities for firsthand engagement with students
- Might not challenge teacher candidates' beliefs that "my students could never do this"

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CONCLUSIONS

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Using a laboratory to learn about teaching the Common Core

FINDINGS

- Specific teaching practices that simultaneously "fill in gaps" and also accelerate
- Specific ways to make mathematical practices explicit in class

NEXT STEPS

- Continue to develop ways to support students in constructing oral and written explanations
- Expand work to additional mathematical topics and practices

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Using a laboratory as a resource for professional learning experiences

FINDINGS

- The laboratory can support teachers' learning both in the lab and by using records from the lab
- The explicitness and detail of the work on instruction has been crucial for creating professional learning experiences

NEXT STEPS

- Follow up and support learning in the laboratory during the academic year
- Design opportunities for teacher candidates' learning in the laboratory
- Explore how to make the laboratory accessible using streaming

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