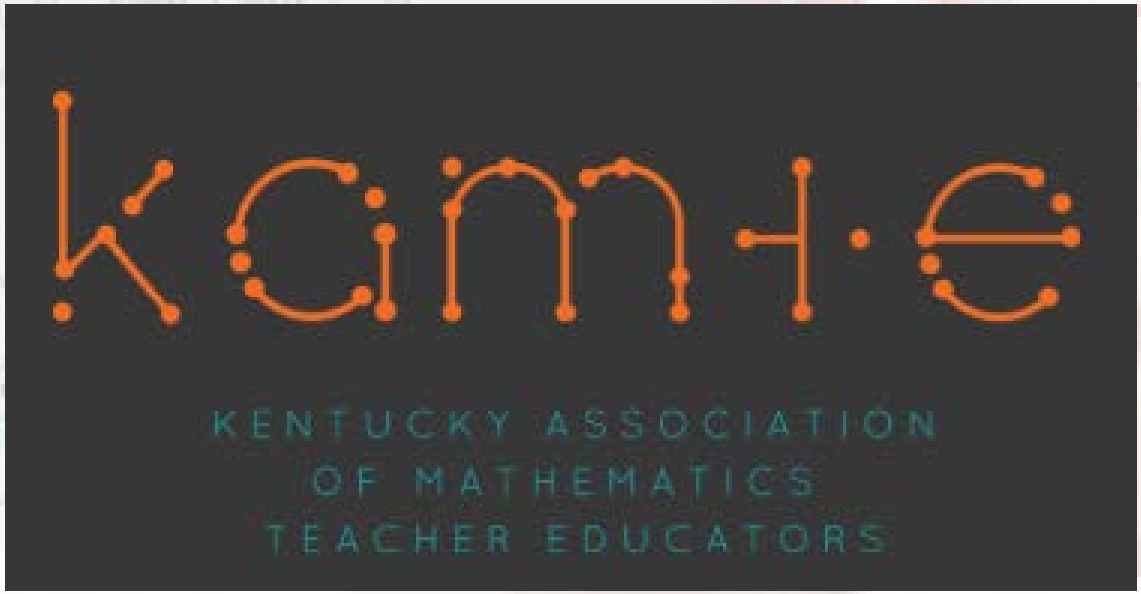
Unpacking Effective Teaching Practices in Teaching Mathematics



KEEP Conference, May 21, 2018

Background: Standards for Preparing Teachers of Mathematics

STANDARD C.2. PEDAGOGICAL KNOWLEDGE AND PRACTICES FOR TEACHING MATHEMATICS

Well-prepared beginning teachers of mathematics have foundations of pedagogical knowledge, effective and equitable mathematics teaching practices, and positive and productive dispositions toward teaching mathematics to support students' sense making, understanding, and reasoning.

Indicator C.2.3. Implement Effective Instruction

Well-prepared beginning teachers of mathematics use a core set of pedagogical practices that are effective for developing students' meaningful learning of mathematics.

Teachers must not only understand the mathematics they are expected to teach (Ball, Thames, & Phelps, 2008) and understand how students learn that mathematics (Fuson, Kalchman, & Bransford, 2005), they must be skilled in using content-focused instructional pedagogies to advance the mathematics learning of each and every student (Forzani, 2014). Well-prepared beginning teachers of mathematics have begun to develop skillful use of a core set of effective teaching practices, such as those described in *Principles to Actions* (NCTM, 2014a) and listed in Table 2.2 below.

TABLE 2.2. MATHEMATICS TEACHING PRACTICES (NCTM, 2014a)

Establish mathematics goals to focus learning. Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions.

Implement tasks that promote reasoning and problem solving. Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies.

Use and connect mathematical representations. Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.

Facilitate meaningful mathematical discourse. Effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.

Pose purposeful questions. Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and relationships.

Build procedural fluency from conceptual understanding. Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems.

Support productive struggle in learning mathematics. Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.

Elicit and use evidence of student thinking. Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning.

Note. Reprinted from *Principles to Actions: Ensuring Mathematical Success for All* (p. 10) by the National Council of Teachers of Mathematics, 2014. Reston, VA: NCTM. Copyright 2014 by National Council of Teachers of Mathematics. Used with permission.

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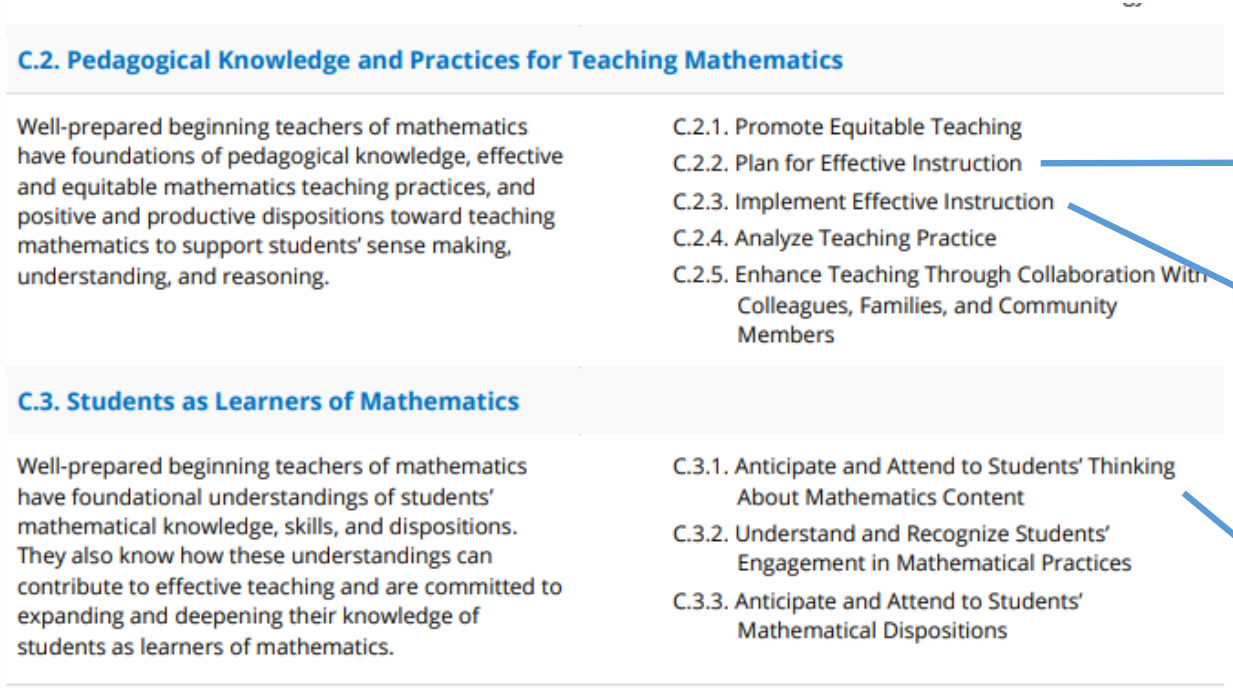


C.2. Pedagogical Knowledge and Practices for Teaching Mathematics

Well-prepared beginning teachers of mathematics have foundations of pedagogical knowledge, effective and equitable mathematics teaching practices, and positive and productive dispositions toward teaching mathematics to support students' sense making, understanding, and reasoning.

- C.2.1. Promote Equitable Teaching
- C.2.2. Plan for Effective Instruction
- C.2.3. Implement Effective Instruction
- C.2.4. Analyze Teaching Practice
- C.2.5. Enhance Teaching Through Collaboration With Colleagues, Families, and Community Members

C.3. Students as Learners of Mathematics

Well-prepared beginning teachers of mathematics have foundational understandings of students' mathematical knowledge, skills, and dispositions. They also know how these understandings can contribute to effective teaching and are committed to expanding and deepening their knowledge of students as learners of mathematics.

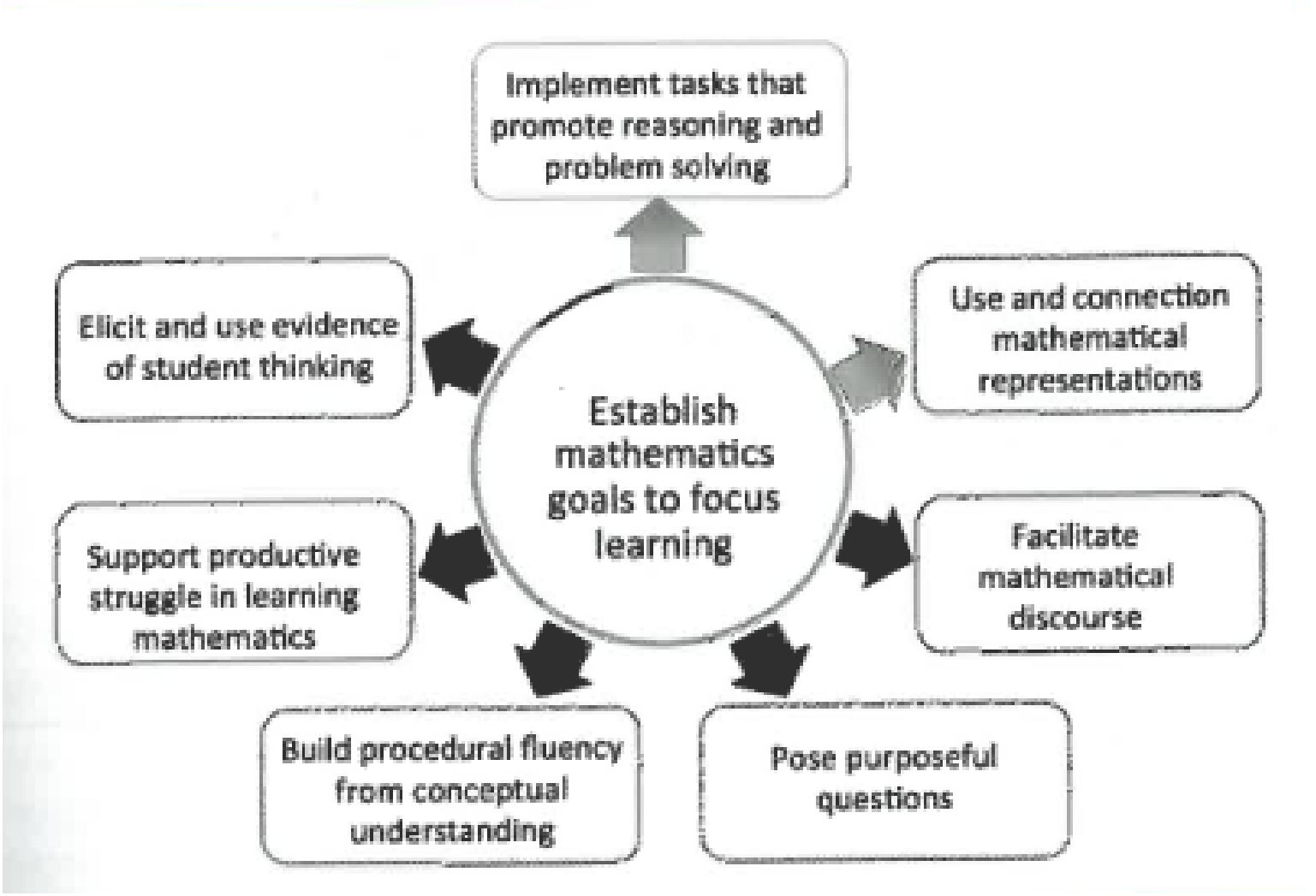
- C.3.1. Anticipate and Attend to Students' Thinking About Mathematics Content
- C.3.2. Understand and Recognize Students' Engagement in Mathematical Practices
- C.3.3. Anticipate and Attend to Students' Mathematical Dispositions

MTP1: Establish mathematics goals to focus learning

MTP2: Implement tasks that promote reasoning and problem solving

MTP8: Elicit and use evidence of student thinking

MTP1: Establish Mathematics Goals to Focus Learning



Goals Analysis

- Three Potential Goal Statements for a Multiplication Lesson

Main Task: The third-grade class is responsible for setting up the chairs for the spring band concert. In preparation, the class needs to determine the total number of chairs that will be needed and ask the school's engineer to set up 7 rows of chairs with 20 chairs in each row, leaving space for a center aisle. How many chairs does the school's engineer need to retrieve from the central storage area?

Goal1: Students will solve a variety of multiplication word problems and write the related multiplication equations.

Goal 2: Students will write equations for multiplication word problems and label the meaning of each factor in their equations as it relates to the context of the word problem.

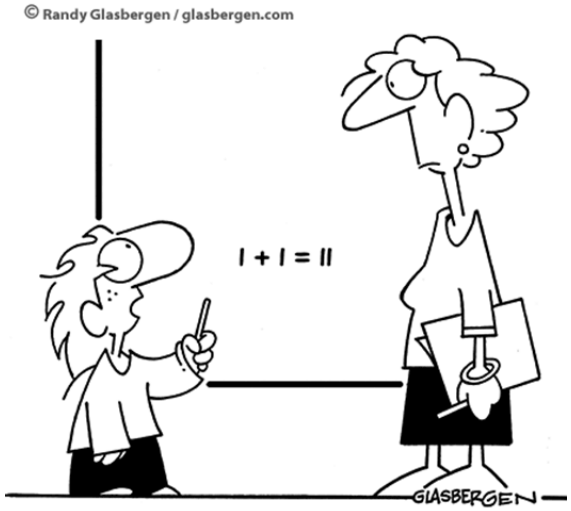
Goal 3: Students will understand the structure of multiplication as comprising equal groups within visual or physical representation (e.g., collection of arrays), understand the numbers in multiplication equations (i.e., number of equal groups, size of each group, total amount), and connect representations to multiplication of equations.

- Questions to Consider:
  - How are the goal statements the same and how are they different?
  - What mathematics is the focus of each goal statement?
  - What potential does each goal hold to guide teacher actions in focusing student learning on understanding the operation of multiplication?

Performance Goals versus Learning Goals

- Performance Goals
  - describe what we want **students to say, write, show, or demonstrate** as a result of the lesson.
  - indicate what students **should be able to do** and **do not** necessarily require students **to understand the mathematical ideas underlying their actions** or performance.
- Learning Goals
  - describe what students **should understand about a mathematics** topic as an outcome of instruction.
  - portray **a deeper grasp of mathematical concepts**, **insight into reasons why procedures work and relations or connection among mathematical ideas.**

MTP2: Implement Tasks that Promote Reasoning and Problem Solving



"The level and kind of thinking in which students engage determines what they will learn."

Hiebert, Carpenter, Fennema, Fuson, Wearne, Murray, Oliver, & Human, 1997

Cognitively Engaging Tasks

Initial Sorting Do an initial sort of the tasks into two categories, tasks as cognitively engaging and not cognitively engaging

Sorting by Using Task Analysis Guide

- Using the task analysis guide sort tasks further into one of the four levels of cognitive demand that best describes they type of thinking required to solve each task.
- Identify the specific criteria from the tasks analysis guide to support categorization of the tasks.

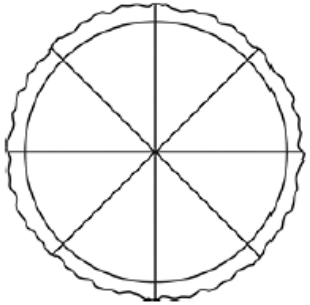
Implications

- Why does it matter?

MTP8: Elicit and Use Evidence of Student Thinking

Subject: Mathematics, Grade: 4, Year: 2013
Content Classifications: Number properties and operations, Moderate, Type: SCR, Difficulty Level: Hard

Nick has a whole pizza.



Nick says he will eat $\frac{1}{2}$ of the pizza.

He says he will give $\frac{3}{8}$ of the pizza to Sam and $\frac{3}{8}$ of the pizza to Joe.

Can Nick do what he says?

◯ Yes ◯ No

Explain or show why or why not.

Did you use the calculator on this question?

Ryan

Yes he can because $1+3+3=7$ he will have one more piece to eat.

Karen

∴ why because he still has $\frac{1}{8}$ left over and so he could do it and still have left over.

Helen

N=Nick
J=Joe
S=Sam

Sam needs two more pieces.

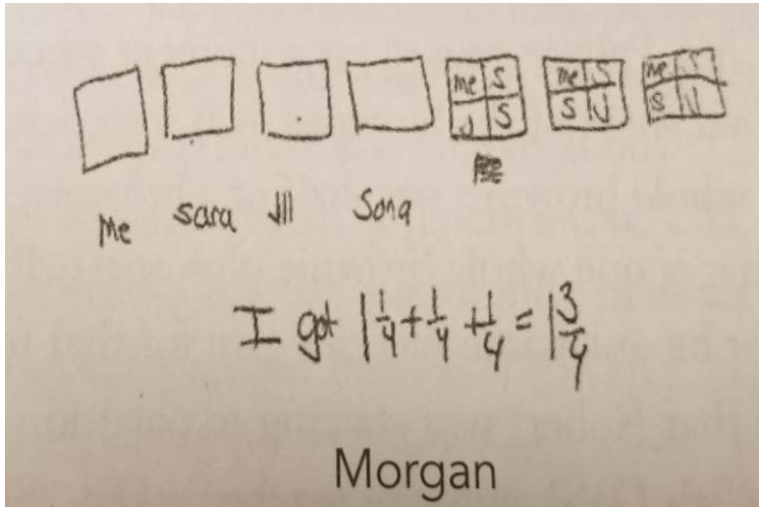
Ashley

Nick ate $\frac{4}{8}$
He has $\frac{4}{8}$ left over

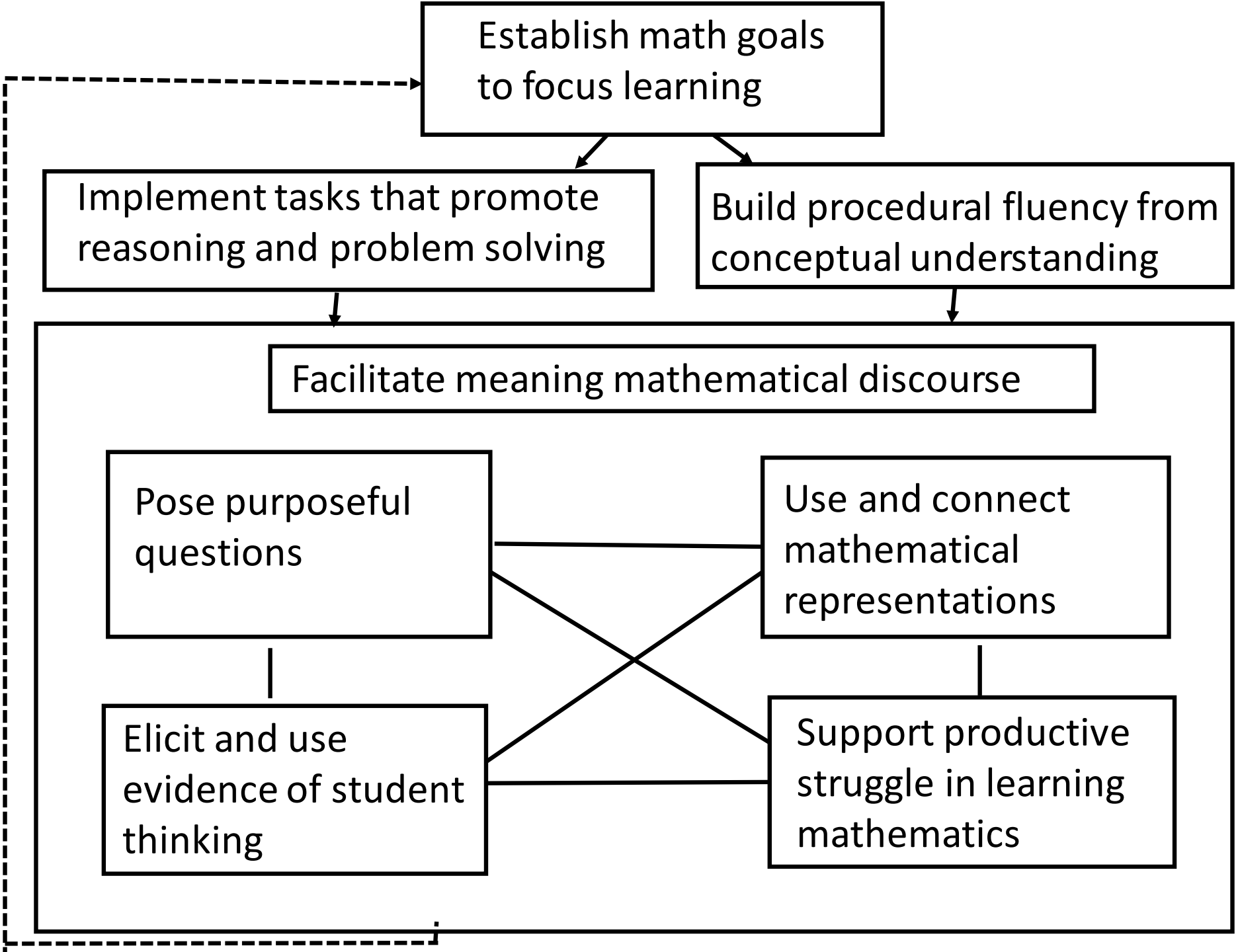
$\frac{3}{8}$ $\frac{3}{8}$ $\frac{6}{8}$ $\frac{6}{8} > \frac{4}{8}$

MTP8: Elicit and Use Evidence of Student Thinking

There are 7 brownies. Four friends are sharing the brownies so that everyone gets exactly the same amount. How much of the brownies will each friend get? What do you call that amount?



Formulate an assessing question and an advancing question for Morgan.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Elicit and use evidence of student thinking
Support productive struggle in learning mathematics

Concluding Remarks

"Identifying a set of practices that aims at complex outcomes for all students is a first step toward strengthening the teaching profession. These practices could provide a common foundation for teacher education, a common professional language, and a framework for appraising and improving teaching." (Ball & Forzani, 2010)