Learning Cycles and Mathematical Practices in the Classroom Math Talk Community

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For more details about the Math Talk Community and videos of math talk in action, please see the 13 hours of audio-visual Teaching Progressions I have made. You can find links to these and to papers and other presentations at **karenfusonmath.net**

This presentation is also posted there.

Fuson, K. C. & Murata, A. (2007). Integrating NRC principles and the NCTM Process Standards to form a Class Learning Path Model that individualizes within whole-class activities. *National Council of Supervisors of Mathematics Journal of Mathematics Education Leadership, 10 (1)*, 72-91.

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Murata, A. & Fuson, K. C.(2016). Class learning zone and class learning paths: Responsive teaching in first-grade mathematics. In E. A. Silver & P. A. Kenney (Eds.), *More lessons learned from research: Volume 2: Useful and usable research related to core mathematical practices* (pp. 70-91). Reston, VA: NCTM.

Math Talk Community

Bridging for teachers and students by coherent learning supports

Learning Path

Phase 3 Formal math methods, fluency

Math Sense-Making
Math Structure

Math Drawings
Math Explaining

Phase 2 Research-based mathematically desirable and accessible methods, understanding and growing fluency

Math Sense-Making
Math Structure

Math Drawings
Math Explaining

Phase 1 Student-generated methods, exploring and growing understanding

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Common Core Mathematical Practices
Used in a Math Talk Community

Math Sense-Making:
Make sense and
use appropriate precision

1 Make sense of problems and
   persevere in solving them.
6 Attend to precision.

Math Drawings:
Model and use tools

4 Model with mathematics.
5 Use appropriate tools strategically.

Math Structure:
See structure and generalize

7 Look for and make use of structure.
8 Look for and express regularity in
   repeated reasoning.

Math Explaining:
Reason, explain, and question

2 Reason abstractly and quantitatively.
3 Construct viable arguments and
   critique the reasoning of others.

Figure 2

The Math Practices in action

A teacher asks every day:

Did I do math sense-making about math structure using math drawings to support math explaining?

Can I do some part of this better tomorrow?

Learning Path Teaching-Learning

The lessons (should) contain the mathematical learning paths.
Teach the lessons using:

1. The Learning Path Topic Phases
With Major Means of Responsive Assistance and Student Methods for Each Phase

A Guided Introducing	B Learning Unfolding	C Kneading Knowledge
		D Maintaining Fluency
Engage and Involve	Coach: Model, Instruct/Explain, Clarify, Question, Give Feedback	Manage
Concrete & slow	Good B1 helping step or compact or B2 less-good compact	Fluency with a compact method

2. Learning Path Lesson Cycle: The Nurturing Math Talk Community

The Solve and Discuss Escalator to advance students within a lesson:

Solve and Discuss problem 1   to   Solve and Discuss problem 2   to   Solve and Discuss problem 3   to   … as needed.

As different student methods are shared, discussed, and corrected, students advance in their thinking and eventually in methods.

Teacher builds, leads, and focuses the instructional conversation using the **Mathematical Practices**:

Students do math sense-making about math structure using math drawings to support math explaining.

3. Learning Path Unit Cycle: The Mastery Learning Loop

Big Idea One   to   Big Idea Two   to   Big Idea Three   to   …   Unit Test

Differentiate for one day after each Big Idea lesson chunk and before and after the unit test.

1a. Learning Path Topic Phases

Phases for a Math Topic

A. Guided introducing

Introduce topic, very short phase, visual models

Students share methods.

Teacher elicits solution methods and addresses common errors when necessary.

B. Learning unfolding

Student Activity pages, Solve and Explain classroom structure

Students explain methods with drawings to stimulate correct relating of concepts and symbols.

Model (show) & Instruct/Explain

Students discuss and compare methods so the math aspects become explicit.

Focus: Clarify, Question

Extend: Question, Give Feedback

Teacher models and explains only when necessary.

C. Kneading knowledge

Student Activity Pages, Homework, Quick Practice

Students gain fluency.

Reflection and some explaining as needed

D. Maintaining fluency & relating to later topics

Remembering

Review the rest of the year.

Occasionally discuss and relate old problems.

Means of Responsive Assistance*

Engage and Involve*

All students participate in developing understanding.

Coach*

Guide student learning with more-explicit supports (from students also)

Model, Instruct/Explain

Clarify, Question, Give Feedback

Continual formative assessment helps you decide: more coaching or move to managing

Manage*

Help students monitor, be responsible for, and take ownership of their own learning.

*Teacher initially models responsive assistance, then <u>EVERYONE</u> builds the classroom community in these ways.

Any means can be used at any time.

Student Helpers

High Students… Do they need to do MORE problems?

Formative Assessment Question (Lesson Focus)

- *Begin the lesson*
    - What learning can the student demonstrate?
        - **Student accountability**
    - **Success Criteria**
        - Teach with student outcomes in mind
- *End the lesson*
    - Students add any new learning
        - Students' self-evaluate
        - **Intrinsic motivation**

Phases for a Math Topic

B. Learning unfolding

Student Activity pages, Solve and Explain classroom structure

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1b. Learning Path Topic Phases: Student Methods

Phases for a Math Topic

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Student Methods

A Methods-with-Errors

Concrete & Slow methods

Phase B methods are possible

B1 Phase A methods begin to disappear and B1 methods are supported

B1 good Helping Step methods

B1 good Compact methods

B2 Methods from B1 stay and B2 methods are discussed and related to other methods

B1 good Helping Step methods

B1 good Compact methods

B2 less-good Compact methods

C Fluency with one B1 good Compact method or one B2 less-good Compact method without a visual model (some students are fluent with more than one method)

Methods in Phases A, B1, B2 are initially linked to a visual model/math drawing to support sense-making and explaining

2. Learning Path Lesson Cycle

The Nurturing Math Talk Community

Used Especially in Phases A and B

Build: Teacher builds a classroom culture of meaning-making

Lead: Teacher leads conversation toward the lesson learning goals

Focus: Teacher uses the Mathematical Practices: Helps students

do Math Sense-Making (MP.1 and 6)
about Math Structure (MP.7 and 8)
using Math Drawings (MP.4 and 5)
to support Math Explaining (MP.2 and 3)

Use Solve and Discuss classroom structure
in the whole class
In a small group

The teacher can do continual formative assessment about student thinking and helping.

The Solve and Discuss Escalator

How Students May Advance in a Lesson

All students solve the same problem. No "dumbing down" of the problems given.

Solve and Discuss Problem 1

Students solve using different methods and explain some methods.

Errors are corrected and explained.

Solve and Discuss Problem 2

Students solve using different methods and explain some methods.

Some may try methods they just saw explained. They can get help if they make errors or cannot explain completely.

All students see more-advanced methods explained again. Some are now more likely to try a new more-advanced method.

Solve and Discuss Problem 3

Understanding of more-advanced problems deepens with each Solve and Discuss cycle within a lesson.

3. Learning Path Unit Cycle: Focusing Differentiation via the Mastery Learning Loop

You are already differentiating in class via the Math Talk Learning Community.
You cannot do high quality math standards if you take time to differentiate every day.

Separate each unit into lesson chunks of 4 to 6 lessons.
Use a quiz or on-going formative assessment at the end of each lesson chunk.
Students can also self-identify as
a Student Helper, Needs More Practice, or Needs Teacher Help.
Then differentiate for one day after each Big Idea lesson chunk.
If needed, you can differentiate for one day before and after the unit test.

During these differentiation days,
on-level and above-level students work in groups on various tasks
including student helpers for those who need more practice or just one issue.
The teacher works with strugglers.
Students who need even more help can attend teacher-led RtI meetings 3 times a week.
Students who were sick can also attend these meetings.

Extra Math Time Support

Teacher led small group instruction (20-40 minutes)

- 4 days of RtI (prior grade) getting ready for the upcoming units
  - Explicit Instruction
    - Prior grade lessons

- 1 day of Unit 1 (prior unit) keeping the kids on the right track within current grade level
  - Explicit Instruction
    - Unit 1 lessons

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**Visual models are central core ideas and practices
in the CCSS and support reasoning and explaining.**

The models can be simple math drawings
that students can make and use in their own ways
in problem solving and explaining of thinking.

We want classrooms to be using the mathematical practices in the
Math Talk Community:

Students focus on math sense-making about math structure
using math drawings (visual models) to support math explaining.

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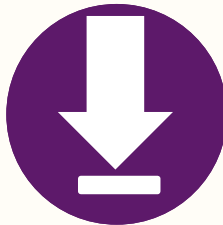
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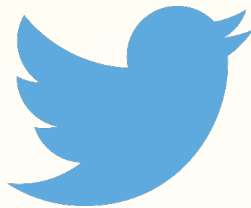
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