Developing Teacher Mathematical Content Knowledge & Pedagogy: A Professional Learning Model

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Introductions

Hello
my name is

Name
Location
Role
Math Experience
How do you feel about professional learning in your setting?

<table>
<thead>
<tr>
<th>Putting together a jigsaw puzzle</th>
<th>Building a plane while flying it</th>
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<tbody>
<tr>
<td>Navigating to a new place</td>
<td>Herding kittens</td>
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Session Goals

1. Understand a **model of professional learning** in which content knowledge, pedagogical knowledge, and knowledge of student thinking are developed within the actual work of teaching.

2. Learn about the role of **instructional routines** in teacher and student learning.

3. Understand **equitable practices** and how they can be developed within the model of professional learning.

4. Evaluate current professional learning structures and identify ways to **integrate components** of the model of professional learning.
<table>
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<th>Time</th>
<th>Activity</th>
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<td>9:00 - 9:15</td>
<td>Opening</td>
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<td>9:15 - 10:00</td>
<td>The Professional Learning Model</td>
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<tr>
<td>10:00 - 11:30</td>
<td>Building Teacher Content and Pedagogical Knowledge</td>
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<tr>
<td>11:30 - 2:00</td>
<td>Instructional Routines</td>
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<td>- 60 minute lunch</td>
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<td>2:00 - 3:15</td>
<td>Continued Learning for All</td>
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<td>3:15 - 4:00</td>
<td>Planning and Close</td>
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The Professional Learning Model
Fraction Lab Professional Learning

Summer Fraction Lab (7 days, 5 including students for half-days)

• Southern California elementary school
• Teachers from several Title 1 schools
• Enrollment of 465 students
• Kindergarten through sixth grade
• 76% Latinx
• 77% socioeconomically disadvantaged
• 44% English learners
• 10% students with disabilities

Ongoing learning throughout the 2018-2020 school year
Goals for the Professional Learning

- Development of Beliefs
- Development of Professional Vision
- Development of Knowledge
- Content Knowledge
- Pedagogical Knowledge
- Knowledge of Student Thinking
- Learning from Teaching
Why fractions?

Even students’ overall IQ, family income, and family education do not predict future algebra achievement as strongly as does fraction knowledge (Siegler et al., 2012).
Teach:
1. Instructional routine
2. Task
3. Instructional routine
4. Task
Content Learning

1. Reading the standards and thinking about the big ideas of each grade level in 3-5 fractions.

2. Reading excerpts from the 3-5 NF Progression Document and pulling out the big ideas of the grade levels.

3. Engaging in mathematics as learners: completing fraction math tasks from grades 3 to 5, with discussion on the mathematical concepts within the tasks, mapping back to the standards and Progressions.
Plan for Teaching

- Do the math
- Partner share/anticipate student strategies
- Unpack the mathematical goal
  - Where does it fit within the progression?
  - What is prerequisite knowledge?
- Plan for launch and “in-action” elements
Teach
Reflect

CORE PRACTICES OF RESPONSIVE TEACHING

ELICITING AND RESPONDING TO STUDENT THINKING

ORIENTING STUDENTS TO EACH OTHERS’ IDEAS AND TO THE MATHEMATICAL GOAL

POSITIONING STUDENTS COMPETENTLY

TEACHING TOWARD AN INSTRUCTIONAL GOAL
“Opportunity to learn remains one of the best predictors of student learning (NRC, 2001). Differentials in learning outcomes therefore are not a result of inclusion in any demographic group, but rather are significantly a function of disparities in opportunities that different groups of learners have with respect to:

- access to grade-level (or more advanced) curriculum,
- teacher expectations for students and beliefs about their potential for success,
- exposure to effective or culturally relevant instructional strategies,
- and the instructional supports provided for students.”

Having the opportunity to hypothetically plan lessons but then see the outcome of the lessons was powerful. The process of anticipating their responses and then seeing their strategies was wonderful.

The students provided us with the ability to immediately practice what we learned and have feedback.

It was crucial to have the students as part of this training so that we could see how they solved the problems. I think what we learned from the students will stick with us so much more than if it had just been a lecture on what concepts students struggle with.

I felt the most growth in content knowledge. I enjoyed beginning this training by mapping the standards of all the grade levels where fractions are introduced and building my knowledge of the content from these. The tasks that we administered showed me the different ways of exposing students to fractions in varying ways and thinking about the relation with the progression of the standards.
Reflect and Connect

Considering the Principles, goals for the professional learning, and the professional learning model, what do you want to consider or think more about for your setting?
Building Teacher Content and Pedagogical Knowledge
“The inescapable conclusion of this study is that there is a powerful relationship between what a teacher knows, how she knows it, and what she can do in the context of instruction.”

“In case after case, the quality of the modifications made to curriculum materials, the goals for student learning, and even beliefs about what mathematics is were shaped by teachers' knowledge.”

The Learning Progressions

Progressions Documents for the Common Core Math Standards

Funded by the Brookhill Foundation

Progressions

- Draft Front Matter
- Draft K-6 Progression on Geometry
- Draft K-5 Progression on Measurement and Data (measurement part)
- Draft K-5 progression on Measurement and Data (data part)
- Draft K-5 Progression on Number and Operations in Base Ten
- Draft K-5 Progression on Counting and Cardinality and Operations and Algebraic
  Thinking
- Draft 3-5 Progression on Number and Operations—Fractions
- Draft 6-8 Progression on Statistics and Probability
- Draft 6-8 Progression on Expressions and Equations
- Draft 6-8 Progression on The Number System; High School, Number
- Draft 6-7 Progression on Ratios and Proportional Relationships
- Draft High School Progression on Statistics and Probability

Contact Us
Reading the Fraction Progression

In groups of 3, each person select a grade level:
- 3rd grade read pages 2-4
- 4th grade read pages 5-9
- 5th grade read pages 10-13

Record your thinking as you read by underlining or highlighting:

What are the big ideas of the grade level?
Grade-Alike Groups

- Share what you highlighted as big ideas of the grade level
- Come to consensus on the big ideas
- Record the big ideas on chart papers
• Understanding fractions as magnitudes that can be represented on a number line provides an underlying structure for learning a range of fraction concepts and skills (Siegler, Thompson, & Schneider, 2011).

• Booth and colleagues (2014) found that students’ fraction magnitude knowledge predicts their improvement in algebra.

• Using number lines to support fraction magnitude understanding is an approach supported by the Common Core (NGA & CCSSO, 2010) and prior research (Siegler et al., 2011). However, using number lines to teach fractions has not been a strong focus in many U.S. mathematics classrooms in the past. Many curricula instead emphasize a part–whole representation of fractions (Ni & Zhou, 2005; Thompson & Saldanha, 2003).
Grade 3 Share
Grade 4 Share

\[
\frac{1}{2} + \frac{1}{4} > \frac{1}{3} + \frac{1}{5}
\]
Grade 5 Share

\[\frac{1}{2} \times \frac{5}{6} = \frac{5}{12}\]

[Diagram showing the multiplication of fractions with a visual model]
Let’s zoom into the progression!
Doing the math

Back in your groups of 3:

- 3rd - Find $\frac{2}{3}$

- 4th - Extending Multiplication From Whole Numbers to Fractions

- 5th - Connor and Makayla Discuss Multiplication
Reflect on the math in grade-alike groups

- What mathematics is being addressed specifically in the task? What is the mathematical goal?
- What math concepts is the task building on?
- What math concepts is the task building toward?
- What connections do you see to the Progressions?
Anticipating Students’ Responses

1. What strategies are students likely to use to approach or solve the task?

2. How will I respond to the work that students are likely to produce?

3. Which student strategies are likely to be most useful in addressing the mathematics to be learned?

Adapted from Smith and Stein (2018)
What strategies are students likely to use to approach or solve the task?

1. Grade-alike triad discussion
2. Share within grade-alike groups
3. Whole group share-out
Planning for launch, monitoring work, share out
Planning to launch the task

Preparing the work of teaching

• How will the task be launched?
• How will we ensure students understand the task?
• How much time will they have to work?
• What will we do as students work? Monitor...what will that look like?
• Discuss “in action” elements --- select, sequence, connect
Monitoring student work

- Pay close attention to students’ mathematical thinking
- Use a monitoring chart
- Watch and listen to students
- Ask questions that make thinking visible
Facilitating Share Out

“By making purposeful choices about the order in which students’ work is shared, teachers can maximize the chances of achieving their mathematical goals for discussion.”

~Smith and Stein (2018)

B. The teacher strengthens all students’ understanding of the content by strategically sharing students’ representations and/or solution methods.

4- Student solution methods are shared, and connections to the mathematics are explicit and purposeful. If applicable, connections between the methods are examined.

3- Student solution methods are shared, and some mathematical connections are made between them.

2- Student solution methods are shared, but few connections are made to strengthen student understanding.

1- Student solution methods are not shared.
Core Practices of Responsive Equitable Teaching

ELICITING AND RESPONDING TO STUDENT THINKING

ORIENTING STUDENTS TO EACH OTHERS’ IDEAS AND TO THE MATHEMATICAL GOAL

POSITIONING STUDENTS COMPETENTLY

TEACHING TOWARD AN INSTRUCTIONAL GOAL
Observing for the Core Practices

Illustrative Mathematics:
Preparation for Fraction Multiplication
Workshopping the Core Practices

1. What would it look like in practice?
2. What would it *not* look like in practice?
3. What is the benefit of it?
Reflect and Connect

Think about PL Principle 1

Professional learning is content-driven. Professional learning builds teachers’ content knowledge and pedagogical content knowledge in the literacy and mathematics needed to teach to the standards for their grade.

In your setting, how often does professional learning attend to building teachers’ content knowledge? How often does it attend to building teachers’ pedagogical knowledge? What are areas to address when planning for future professional learning?
Instructional routines
Choral Counting as an Instructional Activity

Experience the activity as a learner

Observe and unpack the activity with K-8 students
Choral Counting

Count by $\frac{1}{3}$. Start at $\frac{1}{3}$.
Discussing the Activity

What did you notice?

What do you wonder?
Choral Counting as an Instructional Activity

For student learning...

For teacher learning...

Considering this lens...
  • What are the opportunities for student learning within the activity?
  • What are the opportunities for teacher learning within the activity?
Discussing the Activity

Reflect on your experience as a “learner” participating in choral counting

- Use the core practices to consider both teacher and learner actions.
- Share in your small groups/pairs what you noticed across the 4 core practices:
  - Setting and maintaining expectations for student participation... *what does it mean to participate?*
  - Eliciting and responding to students
  - Orienting students to each other
  - Orienting students to the content
Teacher Moves in Choral Counting

- Organize written counting sequence
- Elicit strategies for counting
- Ask “what did you notice about the numbers?”
- Represent student contributions
- Follow up on student ideas

Source: Angela Chan Turrou, UCLA (2009 CGI Conference, San Diego)
Revisiting the Core Practices

### Choral Counting Videos: Practices for Ambitious Teaching

<table>
<thead>
<tr>
<th>Core Practice</th>
<th>Teacher Action</th>
<th>Students’ Actions</th>
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<tbody>
<tr>
<td>Eliciting and responding to students: asking questions and then considering what you do with students’ responses</td>
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<tr>
<td>Orienting students to each other: supporting students to participate in equitable ways with peers and learn from public discourse</td>
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<td></td>
</tr>
<tr>
<td>Orienting students to the content: supporting students to notice the intellectually rich and rigorous work in content</td>
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*From: University of Washington Accelerated Certification for Teachers: U-ACT Program. © 2014 University of Washington. For noncommercial use only. For commercial use please contact license@uw.edu. For all other information contact TEDDinfo@uw.edu.*
Dropping into a Classroom
Unpacking the Activity

1. What is the mathematical content that students are working on in this task? How is this task allowing students to share multiple mathematical ideas and/or provide a variety of access points?

2. How does the teacher use representations to make students’ mathematical thinking more accessible and public?

3. How are the teacher moves and the students’ participation building productive norms for mathematical thinking?

4. How does the teacher orient students to mathematical ideas and/or to each other’s thinking?
Our Process

Plan

Rehearse

Enact

Reflect
Planning

What is important to consider in planning a choral count?

- What was the teacher doing?
- How did learners participate?

Using the “Say Something” protocol, look at each section of the planning template. Pause after each section and “say something” to a partner. How do these steps fit in with what you noticed?
Planning

What is the mathematical goal?
What will you count by? What number will you start with?
How will you record the count?
When will you pause and elicit student thinking? What question(s) will you pose?
What mathematical ideas will you push on?
Rehearsal

Enact your choral count.

Role of teacher: lead us in the task as if we were students.

Role of students: engage in the task as students would.
Rehearsal Debrief

Teacher perspectives
Students perspectives

Teacher and teaching team reflection on feedback
Enactment
Reflection

1. What goals did you have for this specific choral counting task? How did these play out in your enactment?
2. What student understandings surfaced during the count?
3. What ideas do you have for future choral enactments with these students?
Reflect and Connect

Considering the affordances of instructional routines in supporting student learning and teacher learning, how might you use instructional routines in your setting?
Continued Learning for All
Continued Learning - Teacher Learning Community

Teachers must engage in sustained PD with the same colleagues over time - Wei, 2009
Using Artifacts to Learn from Teaching

Analyzing Transcripts

Where in the transcript did the teacher...

- Elicit and respond to student reasoning
- Orient students to each others’ ideas and to the mathematical goal
- Position students competently

What did you notice?

What is important to keep in mind as you plan your next choral count?
Using Artifacts to Learn from Teaching

Video Club (analyzing the teaching of someone else)

- What mathematical ideas could have been pressed?
- What questions would engage students in thinking about those ideas?
- If the discussion was revisited, what would you do next?
Using Artifacts to Learn from Teaching

Video Club (analyzing my own teaching)

- Teachers video record lessons
- Teacher identifies a particular part of the clip to share
- Teacher frames the clip (what happened before the point we’re about to watch)
- Teacher shares lens for noticing
- Group watches clip and discusses lens

When colleagues de-privatize problems of practice and reflect together on student learning, they are more likely to sustain their focus on improvement and show instructional growth. -Horn, Kane & Garner, 2018
How this work has been built upon within the district...

Design of elementary mathematics professional learning

- Multi-year (carefully attending to duration)
- Pedagogies of investigation and enactment
- Attend to development of beliefs, content and pedagogical knowledge, knowledge of student thinking, learning from teaching
- Teacher learning communities intentional and part of professional learning design
- Developing learning systems
Multi-year Experiences

Math Fellows (2 year commitment)

• Year 1 - 6 days of CGI (3-2-1 model) and 2 days of progressions
• Year 2 - 6 days of CGI
  – 2 days + 1 small group lab day
  – 2 days + 1 small group lab day
• Monthly learning community sessions
Pedagogies of investigation and enactment

Noticing student thinking ➔ Attending to student thinking

In PD setting
● Watching video of individual students
● “Noticing” the details of student thinking
● Analyzing student work
● Brainstorming questions to further understand student thinking

At a school site
● Interview individual students
● Notice the details of their strategies
● Asking questions to probe student thinking
Student Interviews...From the voice of teachers

Impact on my practice

“The way I teach. I’m using tools in lessons and supporting kids to use them.”

Belief in students in what they CAN do

“Students had strategies. I saw strategies I didn’t know were possible.”

Wondering/learning from teaching

“It was hard to ask questions. To know what to ask and when.”
Teacher Learning Community - Math Fellows

6 days Cognitively Guided Instruction
2 days CCSS progressions
Monthly teacher learning community

Space for...
- Collaboration
- Connecting learning and practice
- Support of a community
- Network of others who think in similar ways
Teacher Learning Community & Learning System - Rea Elementary

Research Practice Partnership
6 days Cognitively Guided Instruction
Monthly school-wide learning sessions
Administrator learning support

Space for...
- Developing shared understandings, language, and practices
- Ways of thinking and ways of doing
- Learning together...What does it mean to be in a place where children and adults learn?
- Changing a “system”
Reflect and Connect

As you consider the use of artifacts, ongoing learning opportunities, and intentional design of professional learning experiences what ideas are you taking away?

How might some of these ideas be leveraged within your setting?
Planning
In role-based groups:

Why is this important to you?
Why is this critical to your work?

What do you need to know?
What action do you need to take?
Think about a current learning initiative in your setting:

What are your goals in developing

• content knowledge
• pedagogical knowledge
• knowledge of student thinking
• learning from teaching
Making action-oriented goals

Three steps I need to take…

Next week I will…
Thank you!

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