What to Look for in an Effective 21st-century Mathematics Classroom?
Characteristics and Support

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Imagine you’re standing by the water’s edge.

Briefly describe your water’s edge to a seat neighbor.
water’s edge
share
1) Take a look at the picture on the next slide.

2) Hold up your fingers to show me the quantity you see.
1) Take a look at the picture on the next slide.

2) Hold up your fingers to show me the quantity you see.
Talk to a different seat neighbor and briefly compare your experiences.

- water’s edge
- dot card quantities
Take a quick look at the next slide.
Ask one seat neighbor what quantity s/he saw and how s/he saw it.
And take one more quick look.
Ask a different seat neighbor what s/he saw and how s/he saw it.
Compare your dot card activity experiences.

- Showing your answer to the teacher
- Sharing thinking with your neighbor
Quick recap of activity
Mathematics Content
Perceptual Subitizing
Conceptual Subitizing

2 + 2 + 3 = 7
3 + 3 + 1 = 7
3 + 2 + 2 = 7
3 + 4 = 7
4 + 3 = 7
5 + 5 + 4 + 4 = 18
4 + 5 + 4 + 5 = 18
6 + 6 + 3 + 3 = 18
9 + 9 = 18
20 – 1 – 1 = 18
20 – 2 = 18
Overview
Rationale
Standards
Depth of understanding
Students’ needs
Ambitious learning and ambitious teaching
Professional development
21st-century mathematics requires thinking that is
- Conceptual and representational
- Flexible and fluent
- Enlarging and empowering
- Accurate, effective, efficient
Numeracy is as important as Literacy
Numeracy, like literacy, is important.

Number sense: Mathematics
as Phonemic awareness: Reading

Fluency: Computation
as Fluency: Comprehension
Mathematics TEKS include Content and Process Standards
Process Standards

- “…describe ways in which students are expected to engage in the content.”

- “The placement of the process standards at the beginning of the knowledge and skills listed for each grade and course is intentional.”

http://ritter.tea.state.tx.us/rules/tac/chapter111/index.html
Process Standards

- Apply mathematics to problems
- Use a problem-solving model that involves analyzing, formulating, determining, justifying, and evaluating
- Communicate mathematical ideas, reasoning, and multiple representations

http://ritter.tea.state.tx.us/rules/tac/chapter111/index.html
What this looks like in the classroom:

- Teachers emphasizing both mathematical content and process standards
- Students increasingly able to communicate mathematical ideas orally and in writing
- Teaching through problem solving rather than teaching problem solving/application in isolation
Depth of understanding

Engaged through real-world contexts and experiences
Norms for Students Building Depth of Understanding

- Explaining thinking, not just procedures
- Understanding relationships among strategies
- Using errors to rethink, explore, and learn
- Emphasizing collaboration with mathematical discourse and individual accountability (agree/disagree to consensus)

Kazemi and Stipek, 2010
Inquiry-based instruction positively predicts student achievement which supports decades-long efforts to refocus mathematics on inquiry and conceptual understanding.

Blazar, 2015
What this looks like in the classroom:

- Students work with manipulatives (*not just watching the teacher use manipulatives*)
- Teachers model how to talk about mathematical thinking and ideas and how to hold students accountable for math talk
- Teachers plan learning for all stages of the instructional sequence, which includes scaffolding and differentiating
Students’ needs

Cognitive
Affective
Experiential
Working with manipulatives empowers students to reflect on their mathematics learning experience and greatly reduces anxiety.

Boggan, Harper, & Whitmire, 2010
Instructional tools

- Manipulatives
  - Commercially purchased
  - Classroom available or found objects
  - Teacher-made
- Virtual Manipulatives
What this looks like in the classroom:

- Range and variety of activities to make student thinking and learning visible
- Learning along the instructional sequence
- Questioning that redirects or expands thinking and opens learning (rather than closes learning)
- Mathematical conversations including dis/agreements with reasoning and justification
Ambitious Learning Goals require Ambitious Teaching

Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010
Ambitious Learning Goals

- Mathematical proficiency
- Conceptual understanding
- Procedural fluency
- Strategic competence
- Adaptive reasoning
- Productive disposition

Kilpatrick, Swafford, & Findell, 2001
Rand Mathematics Study Panel, 2003
Ambitious Teaching

- Connects process and content standards
- Manages social aspects of ambitious learning goals
- Develops ongoing structures to support students constructing deeper understanding
  - Well-designed procedures
  - Complex learning goals
  - Ongoing judgments and adjustments

Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010
37 + 48 = 30 + 7 + 40 + 8
= 30 + 40 + 7 + 8
= 70 + 15
= 85

(11x + 4) + (5x + 17) = 11x + 5x + 4 + 17
= 16x + 21
What this looks like in the classroom:

- Co-creating mathematical thinking (Leinhart & Steele, 2005)
- Eliciting information from students while maintaining clarity of mathematics
- Supporting and encouraging productive struggle (disequilibrium and discomfort)
What this looks like in the classroom:

- Teacher circulating around the classroom
- Teacher sitting/kneeling to interact at student’s level whenever possible
- “Never Say Anything a Kid Can Say” (Reinhart, 2000)
Professional Development that Supports Ambitious Teaching and Ambitious Learning Goals

Darling-Hammond and Richardson, 2009
Professional Development

Ambitious Teaching

Ambitious Learning Goals
What high-quality mathematics PD looks like:

- Focuses on content and process standards
- Provides hands-on learning (like students!)
- Includes time for reflection
- Is sustained and job-embedded (Hammond and Richardson, 2009)
RICE UNIVERSITY
School Mathematics Project

Effective 21st-century Mathematics Classrooms for all!


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