Realizing the Development of Mathematical Practice in Higher Education

Presented by:

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Session Overview

- What are Mathematical Practices for students and Mathematical Practices for Teaching
  - *Principles to Actions: Ensuring Mathematical Success for All, NCTM 2014*
  - *http://www.nctm.org/PrinciplestoActions/*
- Focus on problem solving, perseverance, and reasoning in teacher education (PST and IST)
- Sample problems, activities, and resources
- Brainstorm and discuss ways of incorporating MPs and MTPs

Principles to Actions: Ensuring Mathematical Success for All

Polya
(from a lecture on teaching)

"Mathematics is not a spectator sport. To understand mathematics means to be able to do mathematics. And what does it mean to be doing mathematics? In the first place, it means to be able to solve mathematical problems."

Question to Consider

- What are ways that we as MTEs can approach or include the development of MPs in our programs for PSTs and ISTs?
- What are mathematical practices for teaching (MTPs) that we can include to support PSTs and ISTs?
- What is the role of reasoning, perseverance in PS and use of technology as related to the development of MPS and MTPS?
- What are exemplary tasks, tools, and activities we can include in our programs?
- What are the available resources to support this work?

Mathematical Practices

Represent what students are doing as they learn mathematics

- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Construct viable arguments and critique the reasoning of
- others.
- Model with mathematics.
- Use appropriate tools strategically.
- Attend to precision.
- Look for and make use of structure.
- Look for and express regularity in repeated reasoning.

CCSS-M 2010

Mathematical Practices: TEKS

- Problem-solving in meaningful context
- Language and communication
  - communicate mathematical ideas using language, efficient tools, appropriate units, and graphical, numerical, physical, or algebraic mathematical models;
- Formal and informal reasoning (justification and proof)
  - validate his/her conclusions using mathematical properties and relationships.
- Make connections within and outside mathematics.
  - apply mathematics to problems arising in everyday life, society, and the workplace
- Use multiple representations, technology, manipulatives, applications and modeling, and numerical fluency in problem-solving contexts.
  - select tools such as real objects, manipulatives, paper/pencil, and technology or techniques such as mental math, estimation, and number sense to solve problems.

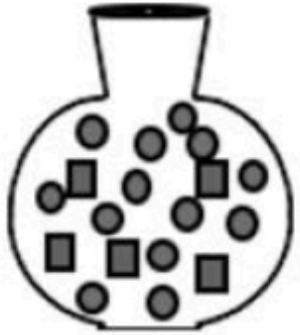
Mathematics Teaching Practices

1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical representations.
4. Facilitate meaningful mathematical discourse.
5. Pose purposeful questions.
6. Build procedural fluency from conceptual understanding.
7. Support productive struggle in learning mathematics.
8. Elicit and use evidence of student thinking.

(NCTM, PtA 2014, p. 10)

Candy Jar Problem

Suppose you have a new candy jar with the same ratio of Jolly Ranchers (JR) to jawbreakers (JB) as shown in the picture, but it contains 100 Jolly Ranchers.



How many jawbreakers do you have?

Justify your answer.

Note: In the picture, Jolly Ranchers are represented by 5 rectangles, and jawbreakers are shown by 13 circles.

Fig. 12. The Candy Jar task. Adapted from Smith et al. (2005).

Candy Jar Problem-Potential Student answers!

- 260
- 360
- 40
- 26
- 340
- 50
- 240
- 270
- I do not know
- 2600
- 65
- 100
- 38.14
- 82.3
- 30
- 87
- 250
- I do not understand
- 108
- 325
- 35
- 61
- 6.9
- 38
- 160
- 13
- 20
- 36
- 7 R 9
- 50/50
- Less than 78 but more than 65

Other Examples

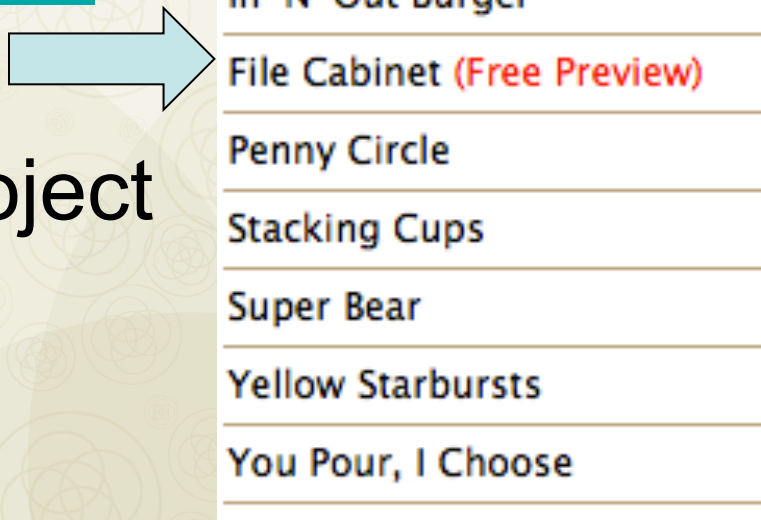
- Analysis of case studies (video and written)
- Identifying in lesson plans
- Element of Observation Assessments
- Analysis of student work
- Analysis of tasks

What are MTEs doing?

- RCML 2014: Kansas Conrady, Stacy Reeder
  - Developing and Analyzing High Cognitive Demand Tasks through the MPs
- AMTE 2014: Christine Browning, Alden J. Edson, Diane Renee Rogers
  - Video-recorded justifications from a technology-supported algebra classroom focused on the development of preservice teachers' mathematical content knowledge and their use of CCSSM Mathematical Practices.
- AMTE 2014: Jonathan David Bostic
  - Role-playing the Standards for Mathematical Practice: A Professional Development Tool
- AMTE 2014: Jennifer Bay-Williams, Maggie B. McGatha, Beth McCord Kobett
  - Tools for Engaging Preservice and Practicing Teachers in Connecting Mathematical Practices with Strategies for ELLs

Sample Resources

- NCSM: Modeling Tasks
  - http://www.mathedleadership.org/resources/threeacts/index.html



- California Mathematics Project
  - http://caccssm.cmpso.org/
- Rich Tasks (Lai, Kennedy, Sherman, Jacobs
  - http://www.judithrules.com/

NCTM Supporting Resources

- *NCTM Common Core*
- http://www.nctm.org/resources/content.aspx?id=32702
- Hirsch, Martin, Hopfensperger, Zbiek (AMTE 2013)

Core Math Tools Home

Core Math Tools is a downloadable suite of interactive software tools for algebra and functions, geometry and trigonometry, and statistics and probability. The tools are appropriate for use with any high school mathematics curriculum and compatible with the Common Core State Standards for Mathematics in terms of content and mathematical practices. Java required.

General Purpose Tools CAS, Spreadsheet, Geometry, Data Analysis, and Simulation	Custom Apps Focused explorations of specific topics	Advanced Apps Focused explorations of advanced topics
Sample Lessons Problem-based lessons that employ *Core Math Tools*	Data Sets Wealth of data sets organized by data type	How-To Pages Help, hints and steps to do basic tasks

Other Problems

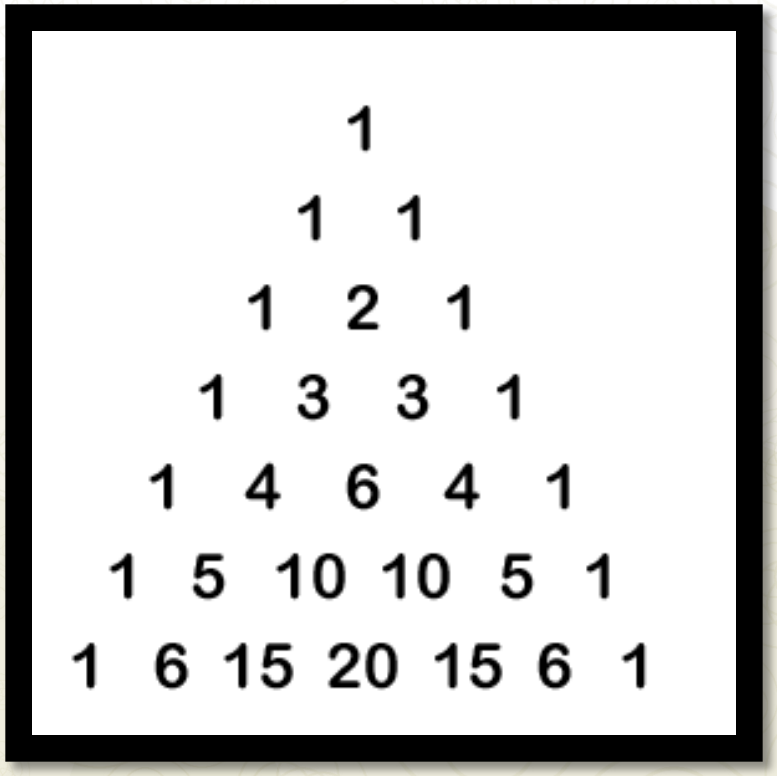
- Puddle Problem
  - Irregular shape
  - Varied tools and approaches, K-12
  - *Puddle Questions: Assessing Mathematical Thinking* by Westley
- Using Literature
  - *The Number Devil* by **Enzensberger**
  - Handshake Problem
  - Pascal's Triangle
  - MORE!

Discussion Activities

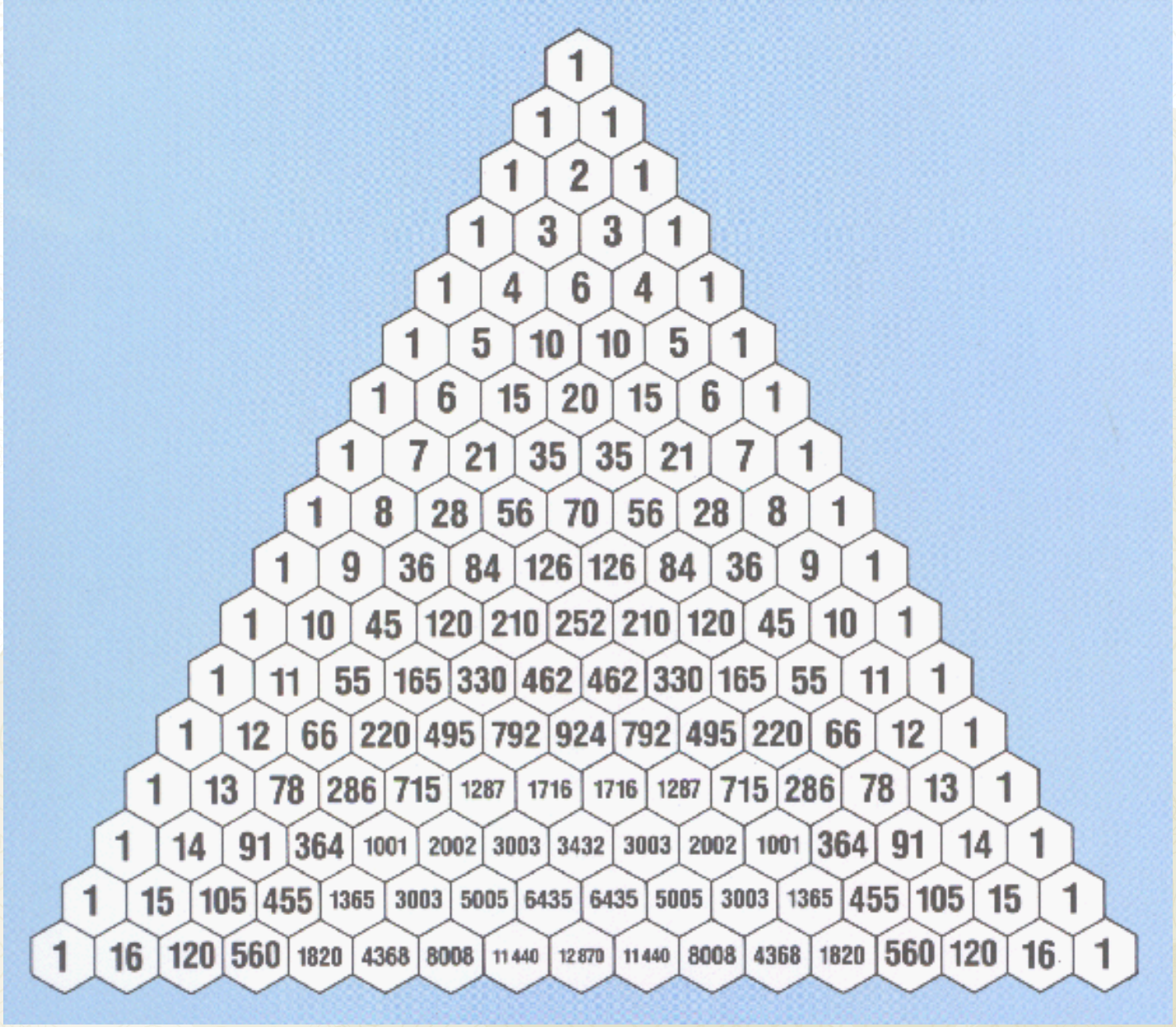
- Mathematical Habits of Mind
- Role of reasoning and sense-making
- Beliefs & Barriers
- What does a mathematical problem solver look like? activity

Let's explore!

- The Problems:
  - Pascal's Triangle



- Individually-Partner-Small Group
  - Observations
  - Conjectures
  - Strategies
  - Connections


1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1
1 8 28 56 70 56 28 8 1
1 9 36 84 126 126 84 36 9 1
1 10 45 120 210 252 210 120 45 10 1
1 11 55 165 330 462 462 330 165 55 11 1
1 12 66 220 495 792 924 792 495 220 66 12 1
1 13 78 286 715 1287 1716 1716 1287 715 286 78 13 1
1 14 91 364 1001 2002 3003 3432 3003 2002 1001 364 91 14 1
1 15 105 455 1365 3003 5005 6435 6435 5005 3003 1365 455 105 15 1
1 16 120 560 1820 4368 8008 11 440 12 870 11 440 8008 4368 1820 560 120 16 1

Sample NCTM Resources

www.nctm.org

- *Implementing the CCSS though Mathematical Problem Solving: For various grade bands*
- *Connecting the NCTM Process Standards and the CCSSM Practices*
- *5 Practices for Orchestrating Productive Mathematics Discussions*
- *Principles to Action: Ensuring Mathematical Success for All*

So what can we do to support MPs & MTPs? What tools will we use?

- Collaborate
- Share
- Network
- Experiment
- Investigate
- Research

Thank you!

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Questions?