Developing the *Principles to Actions* Effective Mathematics Teaching Practices

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Overview of the Session

- Overview of Principles to Actions and the 8 Effective Mathematics Teaching Practices
- Solve and Discuss the S-Pattern Task
- Watch video clips and discuss what the teacher does to support his students engagement in and understanding of mathematics
- Discuss the effective mathematics teaching practice of support productive struggle
A 25-year History of Standards-Based Mathematics Education Reform

1989 *Curriculum and Evaluation Standards for School Mathematics*

2000 *Principles and Standards for School Mathematics*

2006 *Curriculum Focal Points*

2009 *Focus in High School Mathematics*

2010 *Common Core State Standards for Mathematics*
Standards have led to higher achievement...

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<thead>
<tr>
<th></th>
<th>1990</th>
<th>2012-2013</th>
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<tbody>
<tr>
<td>4th grade NAEP</td>
<td>13% proficient</td>
<td>42% proficient</td>
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<tr>
<td>8th grade NAEP</td>
<td>15% proficient</td>
<td>36% proficient</td>
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<tr>
<td>Mean SAT-Math</td>
<td>501</td>
<td>514</td>
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<tr>
<td>Mean ACT-Math</td>
<td>19.9</td>
<td>21.0</td>
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...but challenges remain.

- The average mathematics NAEP score for 17-year-olds has been essentially flat since 1973.
- Among 34 countries participating in the 2012 Programme for International Student Assessment (PISA) of 15-year-olds, the U.S. ranked 26th in mathematics.
- While many countries have increased their mean scores on the PISA assessments between 2003 and 2012, the U.S. mean score declined.
- Significant learning differentials remain.
From Standards to Pedagogy

High-quality standards are necessary for effective teaching and learning, but not sufficient. The Common Core does not describe or prescribe the essential conditions required to make sure mathematics works for all students.
The primary purpose of *Principles to Actions* is to fill the gap between the adoption of rigorous standards and the enactment of practices, policies, programs, and actions required for successful implementation of those standards.

NCTM. (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: NCTM.
Organization of P2A

Guiding Principles for School Mathematics
1. Teaching and Learning
2. Access and Equity
3. Curriculum
4. Tools and Technology
5. Assessment
6. Professionalism

For each principle…
• Productive and Unproductive Beliefs are Listed
• Obstacles to Implementing the Principle are Outlined
• Overcoming the Obstacles
• Taking Action
  o Leaders and Policymakers
  o Principles, Coaches, Specialists, Other School Leaders
  o Teachers
Teaching and Learning Principle

Eight High-Leverage 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

The challenge: How to support meaningful change in classrooms around these eight practices?
Principles to Actions Professional Development Modules

• High-quality classroom video from the University of Pittsburgh Institute for Learning
• Focus on one or more of the P2A Mathematics Teaching Practices
• High cognitive demand mathematical task
• Designed to be used by departments, districts, and cross-district teacher professional learning communities
• [http://www.nctm.org/PtAToolkit](http://www.nctm.org/PtAToolkit)
Principles to Actions
Effective Mathematics Teaching Practices

The Case of Jeffery Ziegler and the S-Pattern Task

11th - 12th Grade

This module was developed by Margaret Smith and Victoria Bill at the University of Pittsburgh. Video courtesy of Pittsburgh Public Schools and the Institute for Learning.

These materials are part of the Principles to Actions Professional Learning Toolkit: Teaching and Learning created by the project team that includes: Margaret Smith (chair), Victoria Bill (co-chair), Melissa Boston, Fredrick Dillon, Amy Hillen, DeAnn Huinker, Stephen Miller, Lynn Raith, and Michael Steele.
The S Pattern Task

1. What patterns do you notice in the set of figures?
2. Sketch the next two figures in the sequence.
3. Describe a figure in the sequence that is larger than the 20th figure without drawing it.
4. Determine an equation for the total number of tiles in any figure in the sequence. Explain your equation and show how it relates to the visual diagram of the figures.
5. If you knew that a figure had 9802 tiles in it, how could you determine the figure number? Explain.
6. Is there a linear relationship between the figure number and the total number of tiles? Why or why not?

1 This task was adapted from Visual Mathematics Course II, Lessons 1-10 published by The Math Learning Center, Salem, OR.
The S-Pattern Task
Video Context

School: Langley High School, Pittsburgh Public Schools
Teacher: Mr. Jeffrey Ziegler
Principal: Linda Baehr
Class: 11th-12th Grade Students

At the time the video was filmed, Jeffery Ziegler was a teacher at Langley High School in the Pittsburgh Public School District. The students are 11th and 12th graders who struggle with mathematics.

(Jeffrey Ziegler is currently a curriculum supervisor for grades 6-12 mathematics in the Pittsburgh Public School district.)
Mr. Ziegler’s Mathematics Learning Goals

Students will understand that:

1. An equation can be written that describes the relationship between 2 quantities;

2. Different but equivalent equations can be written that represent the same situation; and

3. The symbolic and pictorial representations can be connected.
Connections to the CCSS Content Standards

Creating Equations★

Create equations that describe numbers or relationships.

2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

Connections to the CCSS Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.
The lesson begins with Mr. Ziegler engaging students in a brief discussion of the task. They establish the fact that the S-Pattern is growing in two dimensions, getting both “taller” and “bigger”. Before they begin their work, Mr. Ziegler tells students:

“Now there are 6 prompts... Kind of the first one, the second one, third one is to kind of get you started but it is on you guys to work with your groups to come up with a way to find the patterns. You don’t necessarily have to word-for-word answer these questions, but they’re there to help you maybe get started.

The clip begins as small groups begin to work on the task and Mr. Ziegler visits Groups 1 and 2.
As you watch the video, make note of what the teacher does as he interacts with Groups 1 and 2.

In particular, identify any of the **Effective Mathematics Teaching Practices** that you notice Mr. Ziegler using.

*Be prepared to give examples and to cite line numbers from the transcript to support your claims.*
Support Productive Struggle in Learning Mathematics

Productive Struggle should:
- Be considered essential to learning mathematics with understanding;
- Develop students’ capacity to persevere in the face of challenge; and
- Help students realize that they are capable of doing well in mathematics with effort.

By struggling with important mathematics we mean the opposite of simply being presented information to be memorized or being asked only to practice what has been demonstrated.

Hiebert & Grouws, 2007, pp. 387-388
Lens for Watching the Video Clip 2

In the second video clip Mr. Ziegler visits Groups 1 and 2 for a second time.

Considering the teacher’s actions and interactions with Groups 1 and 2 in both clips, identify what the teacher does to support his student’s productive struggle.
Effective 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.
Support Productive Struggle In Learning Mathematics:
Teacher and Student Actions

What are teachers doing?
• Anticipating what students might struggle with during a lesson and being prepared to support them productively through the struggle.
• Giving students time to struggle with tasks, and asking questions that scaffold students’ thinking without stepping in to do the work for them.
• Helping students realize that confusion and errors are a natural part of learning, by facilitating discussions on mistakes, misconceptions, and struggles.
• Praising students for their efforts in making sense of mathematical ideas and perseverance in reasoning through problems.

What are students doing?
• Struggling at times with mathematics tasks but knowing that breakthroughs often emerge from confusion and struggle.
• Asking questions that are related to the sources of their struggles and will help them make progress in understanding and solving tasks.
• Persevering in solving problems and realizing that it is acceptable to say, “I don’t know how to proceed here,” but it is not acceptable to give up.
• Helping one another without telling their classmates what the answer is or how to solve the problem.
Consider the Teacher and Student Actions Required to Support Productive Struggle

• What will you need to work on in order to support productive struggle in your own classroom?
• Where will you start?
Getting Started with P2A

- Learn more about the effective teaching practices from reading the book, exploring other resources, and talking with your colleagues and administrators.
- Engage in observations and analysis of teaching (live or in narrative or video form) and discuss the extent to which the eight practices appear to have been utilized by the teacher and what impact they had on teaching and learning.
- Co-plan lessons with colleagues using the eight effective teaching practices as a framework. Invite the math coach (if you have one) to participate.
- Observe and debrief lessons with particular attention to what practices were used in the lesson and how the practices did or did not support students’ learning.
Getting Started with P2A PD modules

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Using the Principles to Actions Professional Development Modules

• Book Clubs around P2A:
  – Teachers can read about an effective teaching practice, then meet to engage in a PD module highlighting that practice.

• On-line access to videos and PD materials:
  – Enable collaboration between teachers in different districts and geographic locations.
  – Optimize use of limited face-to-face meeting time (though we recommend face-to-face interaction for solving the task, when possible).
Using the Principles to Actions Professional Development Modules

• Provide PD materials for teacher-based groups within or across schools and districts:
  – For school-based teams during common meeting time.
  – To support a District-wide focus on a specific effective teaching practice.
  – For vertical groups: Teachers across different grade-levels could read and discuss an effective teaching practice, then engage with the PD materials for their specific grade-band.
  – For horizontal groups: Teachers in common grade-bands or subjects (across schools or districts) could collaborate in face-to-face or on-line groups.
Start Small, Build Momentum, and Persevere

The process of creating a new cultural norm characterized by professional collaboration, openness of practice, and continual learning and improvement can begin with a single team of grade-level or subject-based mathematics teachers making the commitment to collaborate on a single lesson plan.
Thus, teachers of mathematics must take the following actions:

For the Teaching and Learning Principle:

- Consistently implement the eight Mathematics Teaching Practices.
- Elicit, value, and celebrate varied approaches and solution paths that students take to solve mathematics problems, explain their thinking, and critique the arguments of others.
- Give priority to the mathematical practices, including problem solving, reasoning, and constructing viable arguments in every aspect of classroom practice—including teaching, assessment, curriculum decisions, and the use of tools and technology.
This module and many others are available online for free:
http://www.nctm.org/PtAToolkit