Guiding Principles to Support Effective Teaching and Learning: Assessment and Professionalism

NCTM Effective Teaching Institute, 2015

John Carter
Principal
Westlake High School
jcarter@eanesisd.net
A Mathematical Task

With the people at your table, use the image at the right to determine the value of $82^2$ and $93^2$.

Be prepared to share your explanation with another group.
Extensions

• Does this only work for “squares”?
• Can you generalize \((A \times 10 + B)(C \times 10 + D)\) with \(A, B, C, D\) integers?
• Can this be extended to \((A + B)(C + D)\) with \(A, B, C, D\) integers?
• Can this be extended to \((A + B)(C + D)\) with \(A, B, C, D\) any rational number?
Mathematics Beliefs Survey

• Reflecting on our beliefs.
• Taking the pulse of the group...
Four Postulates for Change

1. We are being asked to teach in distinctly different ways from how we were taught.
2. The traditional curriculum was designed to meet societal needs that no longer exist.
3. It is unreasonable to ask a professional to change much more than 10% per year, but it is unprofessional to change by much less than 10% per year.
4. If you don’t feel inadequate, you’re probably not doing the job.

Never Say Anything a Kid Can Say

At your tables,

What part of this article affirms your own thinking or practice?

What part of this article challenges your own thinking or practice?
Charting a Path for Improvement

1. Clearly articulated vision for mathematics learning. (Principles to Action)
2. Time for embedded professional learning.
3. Support for teacher collaboration.
4. Make the learning known.
5. Celebrate successes.
Team Actions for Implementation
Before the Unit

1. Make sense of the agreed upon essential learning standards for the unit.
2. Develop common assessment instruments for the unit.
3. Develop scoring rubrics for the common assessment instruments.
4. Identify high cognitive demand tasks for the unit.
5. Plan common homework assignments for the unit.

Kanold & Larson, in press
Team Actions for Implementation During the Unit

6. Implement high cognitive demand tasks effectively.

7. Use in-class formative assessment processes effectively.

8. Use an instructional design process for lesson planning and collective team inquiry.

Kanold & Larson, in press
9. Ensure evidence-based **student** goal-setting and action for the next unit.

10. Ensure evidence-based **adult** goal setting and action for the next unit.

Kanold & Larson, in press
The National Council of Teachers of Mathematics is a public voice of mathematics education, providing vision, leadership, and professional development to support teachers in ensuring equitable mathematics learning of the highest quality for all students. NCTM’s Institutes, an official professional development offering of the National Council of Teachers of Mathematics, supports the improvement of pre-K-6 mathematics education by serving as a resource for teachers so as to provide more and better mathematics for all students. It is a forum for the exchange of mathematics ideas, activities, and pedagogical strategies, and for sharing and interpreting research. The Institutes presented by the Council present a variety of viewpoints. The views expressed or implied in the Institutes, unless otherwise noted, should not be interpreted as official positions of the Council.
Deepening Understanding of the Effective Teaching Practices
NCTM Effective Teaching Institute, 2015

John Carter
Principal
Westlake High School, Austin, TX
jcarter@eanesisd.net
Mathematics Teaching Practices (MTPs)

• Establish mathematical goals to focus learning
• Implement tasks that promote reasoning and problem solving
• Use and connect mathematical representations
• Facilitate meaningful discourse
• Pose purposeful questions
Mathematics Teaching Practices (MTPs) – part 2

- Build procedural fluency from conceptual understanding
- Support productive struggle in learning mathematics
- Elicit and use evidence of student thinking
Establish Mathematics Goals to Focus Learning

• What will teacher be doing?

• What will an observer see or hear from students?
Establish mathematics goals to focus learning.

- The task the students are doing is aligned to a specific, identified goal.
- The goal is aligned to a standard.
- The goal is understood/communicated by the students.

Pose purposeful questions

- Higher Order Thinking questions
- See/Hear Wait time
- Students supporting or refuting other’s ideas
- Adjustments in teacher questions/instruction based on responses to questions
- Variety of questions
Implement Tasks that Promote Reasoning and Problem Solving

• What will teachers be doing?

• What will an observer see or hear from students?
- Selecting a task with multiple entry points.
  - Inquiry or discovery based.
  - Teacher doesn’t say what the students could say.
  - Teachers are asking probing questions.
  - Encouraging students.
  - Creating a safe environments

  you will hear class discussion.
  - productive struggle
  - defending answers
  - explaining reasoning
Use and Connect
Mathematical Representations

• What will teachers be doing?

• What will an observer see or hear from students?
<table>
<thead>
<tr>
<th>Teachers</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Provide tasks that promote mathematical representations.</td>
<td>1. Use multiple representations for task representations.</td>
</tr>
<tr>
<td>2. Provide tools/time</td>
<td>2. Can support their thinking</td>
</tr>
<tr>
<td>3. Listen to students' reasoning</td>
<td>3. Use tools to aid thinking/ modeling</td>
</tr>
<tr>
<td>4. Introduce models, or previously learned models, that might aid student thinking</td>
<td>4. Consider advantages/disadvantages of the representations</td>
</tr>
<tr>
<td>5. Design task that elicit/assess student ability to use representations</td>
<td>5. Connect representations to real world</td>
</tr>
</tbody>
</table>

*Use and Connect Mathematical Representations*
Facilitate Meaningful Mathematical Discourse

• What will teachers be doing?

• What will an observer see or hear from students?
4) Facilitating Meaningful Discourse

Teachers are Doing:

1. Teachers are asking open-ended questions to guide students towards the goal.
2. Moving around to listen to each group, providing feedback or pose more questions to give more direction.
   - Monitoring and Adjusting
3. Teachers provide a "safe" atmosphere to facilitate students to take risks and learn from mistakes.
4. Teachers probe students to make connections.

Students are doing:

1. Students are explaining, and being actively engaged and individually accountable.
2. Students are challenging other students’ thinking.
3. Students are exploring connections and motivated to ask questions for clarification and extending beyond.
4. Students ask the "why's and why nots"?
Pose Purposeful Questions

• What will teachers be doing?

• What will an observer see or hear from students?
Pose Purposeful Questions

* Teacher
  - Open Ended Questioning
  - Probing Questions/Feedback
  - Wait Time (for student answering)
  - Monitoring Students (moving around)

* Students
  - Giving answers/Feedback
  - Questioning of Teacher/Peers
  - Group Conversations/Dialogue
  - Constructive Movement
Support Productive Struggle in Learning Mathematics

• What will teachers be doing?

• What will an observer see or hear from students?
Teacher Actions

• provide opportunities for students to create their own strategies
• use problem-solving tasks
• provide connections through context
• ask students to explain their thinking/strategy
• use tools/models

What does it sound like?

• student-to-student discourse is teacher talk
• student focus on more than the correct answer (justification)
• academic language is heard & developed
• students choose the tools/strategies to problem-solve
• students feel comfortable developing their own strategies

Building Procedural Fluency from Conceptual Understanding.
Support Productive Struggle in Learning Mathematics

• What will teachers be doing?

• What will an observer see or hear from students?
#7 Productive Struggle

**Teachers**

- Facilitating
- Tasks that requires reasoning & thinking
- Patient, time
- Direct groups to discuss with peers
- Asking ?, no students
- Plan for misconceptions
- Manipulations

**Students**

- Collaborating / Discussing
- Explaining work: reasoning
- (Process)
- Strategy vs. Solution
- Many Solution Paths
- Excitement / Commitment
- Perseverance / Motivation
- Asking Questions
Elicit and Use Evidence of Student Thinking

• What will teachers be doing?

• What will an observer see or hear from students?
Elicit + Use Evidence of Student Thinking

Using evidence of student thinking plan
Real time + opportunity to think deeply - not just typical "wait time"

Posing questions to promote thinking + struggle

Models + allows multiple think-alouds

Able to explain each other's thinking

Students are revising their own schema based on other's sharing + thinking

Able to connect current ideas/concepts to previous learning + also know what they don't know

Student discourse of peers
Videos are from:

- http://www.learner.org/resources/series34.html
A Look into a Classroom...

- Debriefing Activity
  - In pairs...
    - One person is the teacher
    - The other person is the coach/administrator
    - The coach engages the teacher in reflection and moves the person toward one or two short-term goals tied to MTPs.
A Look into a Classroom... #2

• Debriefing Activity
  – In pairs...
    • One person is the teacher
    • The other person is the coach/administrator
    • The coach engages the teacher in reflection and moves the person toward one or two short-term goals ties to MTPs.
Reflections...

• What are some take-aways that you have from “coaching” your peers around the practices?
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NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

www.nctm.org
Understanding and Supporting Teachers’ Enactment of the Effective Teaching Practices: Using Tasks
NCTM Effective Teaching Institute, 2015

John Carter
Principal
Westlake High School
jcarte@eanesisd.net
A Task for You

Over the last 10 years, the graduating class of Leonhard Euler High School has increased by the same amount every year. After the 10 years, 6000 students have graduated from LEHS. How many graduated each year?
Day 2 Outcomes

• Session 1: Identify the characteristics of high cognitive demand tasks and how to support the creation and use of them.

• Session 2: Reflect on the role of productive struggle in mathematics and developing a culture that supports it.
Table Talk

What are characteristics of quality mathematics tasks?
1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical expressions.
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.
CCSS: The Standards for Mathematical Practice

1. Makes 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.
CCSS:
The Standards for Mathematical Practice

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8. Look for and express regularity in repeated reasoning.
5 Practices of Productive Discussions
(Smith & Stein, 2011)

- Practice 0: Determine learning goal and choose task
- Practice 1: Anticipating
- Practice 2: Monitoring
- Practice 3: Selecting
- Practice 4: Sequencing
- Practice 5: Connecting
Dimensions and Core Features

- Hiebert et al. (1997, 2000)
  - Nature of Classroom Tasks
  - Role of the Teacher
  - Social Culture of the Classroom
  - Mathematics Tools as Learning Supports
  - Equity and Accessibility
## Dimensions and Core Features

<table>
<thead>
<tr>
<th>DIMENSIONS</th>
<th>CORE FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nature of Classroom Tasks</strong></td>
<td>Make mathematics problematic</td>
</tr>
<tr>
<td></td>
<td>Connect with where students are</td>
</tr>
<tr>
<td></td>
<td>Leave behind something of mathematical value</td>
</tr>
<tr>
<td><strong>Role of the Teacher</strong></td>
<td>Select tasks with goals in mind</td>
</tr>
<tr>
<td></td>
<td>Share essential information</td>
</tr>
<tr>
<td></td>
<td>Establish classroom culture</td>
</tr>
<tr>
<td><strong>Social Culture of the Classroom</strong></td>
<td>Ideas and methods are valued</td>
</tr>
<tr>
<td></td>
<td>Students choose and share their methods</td>
</tr>
<tr>
<td></td>
<td>Mistakes are learning sites for everyone</td>
</tr>
<tr>
<td></td>
<td>Correctness resides in mathematical argument</td>
</tr>
<tr>
<td><strong>Mathematical Tools as Learning Supports</strong></td>
<td>Meaning for tools must be constructed by each user</td>
</tr>
<tr>
<td></td>
<td>Used with purpose—to solve problems</td>
</tr>
<tr>
<td></td>
<td>Used for recording, communicating, and thinking</td>
</tr>
<tr>
<td><strong>Equity and Accessibility</strong></td>
<td>Tasks are accessible to all students</td>
</tr>
<tr>
<td></td>
<td>Every student is heard</td>
</tr>
<tr>
<td></td>
<td>Every student contributes</td>
</tr>
</tbody>
</table>
Task-based instruction

- Make mathematics problematic
- Connect with where students are
- Leave behind something of mathematical value
- Tasks determine the level of thinking in the classroom
The nature of the tasks that students complete define for them the nature of the subject and contribute significantly to the nature of classroom life (Doyle, 1983, 1988).

The kinds of tasks that students are asked to perform set the foundation for the system of instruction that is created. Different kinds of tasks lead to different systems of instruction.
Appropriate Tasks

• Make the MATHEMATICS problematic. That is, is it posed as an interesting problem.
• Connect with where the students are. They have to be able to use their current knowledge and skills to complete the task.
• Engage the students in thinking about important mathematics. They take away something of mathematical value.
• Drive the level of questioning.
Collaborative Classroom Settings

• Students are taught to collaborate
• Tasks require students to work together
• Physical arrangement of classroom communicates the priority of collaboration
• Student-to-student communication is monitored and feedback provided
• Student work as a team is valued, honored, and used to support learning
Moving to Student-centered Classrooms

- Use the class layout and arrangement to convey an acceptance of discussion among students.
- Include student-to-student *structured* talk about mathematics for at least 15 minutes of every lesson.
Reflection and Discussion…

• To what degree are students in mathematics classes engaging in collaborative mathematical tasks on a daily basis?

• To what extent are mathematics teachers using tasks that lead to student articulation of mathematics and mathematical process?
Research on Tasks

• Not all tasks provide the same opportunities for student thinking and learning (Hiebert et al. 1997; Stein et al. 2009).

• Student learning is greatest in classrooms where the tasks consistently encourage high-level student thinking and reasoning and least in classrooms where the tasks are routinely procedural in nature (Boaler and Staples 2009; Hieber and Wearne 1993; Stein and Lane 1996)
High Cognitive Demand

What does rigor look like in mathematics classrooms?
MATHEMATICAL RIGOR

- Conceptual Understanding
- Procedural Fluency
- Application
**BLOOM’S TAXONOMY**

**KNOWLEDGE**
The recall of specifics and universals, involving little more than bringing to mind the appropriate material.

**COMPREHENSION**
Ability to process knowledge on a low level such that the knowledge can be reproduced or communicated without a verbatim repetition.

**APPLICATION**
The use of abstractions in concrete situations.

**ANALYSIS**
The breakdown of a situation into its component parts.

**SYNTHESIS AND EVALUATION**
Putting together elements & parts to form a whole, then making value judgments about the method.

**WEBB’S DOK**

**RECALL**
Recall of a fact, information, or procedure (e.g., What are 3 critical skill cues for the overhand throw?)

**SKILL/CONCEPT**
Use of information, conceptual knowledge, procedures, two or more steps, etc.

**STRATEGIC THINKING**
Requires reasoning, developing a plan or sequence of steps; has some complexity; more than one possible answer

**EXTENDED THINKING**
Requires an investigation; time to think and process multiple conditions of the problem or task.

Can we just look at the verbs to determine the DOK?
Martha was re-carpeting her bedroom which was 15 feet long and 10 feet wide. How many square feet of carpeting will she need to purchase?

Smith, Stein, Arbaugh, Brown, and Mossgrove, 2004
Ms. Brown’s class will raise rabbits for their spring science fair. They have 24 feet of fencing with which to build a rectangular rabbit pen in which to keep the rabbits.

1. If Ms. Brown's students want their rabbits to have as much room as possible, how long would each of the sides of the pen be?
2. How long would each of the sides of the pen be if they had only 16 feet of fencing?
3. How would you go about determining the pen with the most room for any amount of fencing? Organize your work so that someone else who reads it will understand it.
Compare the Two Tasks

• Work each task.
• Share solution strategies.
• Discuss:
  How are Martha’s Carpeting Task and the Fencing Task the same and how are they different?
Solution Strategies: Martha’s Carpeting Task
Martha’s Carpeting Task
Using the Area Formula

\[ A = l \times w \]

\[ A = 15 \times 10 \]

\[ A = 150 \text{ square feet} \]
Martha’s Carpeting Task
Drawing a Picture

10

15
Solution Strategies:
The Fencing Task
The Fencing Task
Diagrams on Grid Paper

1. Area = 32 ft²
2. Area = 35 ft²
3. Area = 36 ft²
4. Area = 35 ft²
# The Fencing Task

Using a Table

<table>
<thead>
<tr>
<th>Length</th>
<th>Width</th>
<th>Perimeter</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11</td>
<td>24</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>24</td>
<td>27</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>24</td>
<td>32</td>
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<tr>
<td>5</td>
<td>7</td>
<td>24</td>
<td>35</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>24</td>
<td>36</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>24</td>
<td>35</td>
</tr>
</tbody>
</table>
The Fencing Task
Graph of Length and Area
The Fencing Task
Using Calculus

\[ A = lw \]
\[ A = w(12 - w) \]
\[ A = 12w - w^2 \]
\[ A' = 12 - 2w \]
\[ 0 = 12 - 2w \]
\[ 2w = 12 \]
\[ w = 6 \]
Cognitive Level of Tasks

- Lower-Level Tasks
  (e.g., Martha’s Carpeting Task)

- Higher-Level Tasks
  (e.g., The Fencing Task)
# Levels of Demands

<table>
<thead>
<tr>
<th>Lower-level demands (memorization):</th>
<th>Lower-level demands (procedures without connections):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• reproducing previously learned facts, rules, formulas, definitions or committing them to memory</td>
<td>• are algorithmic</td>
</tr>
<tr>
<td>• Cannot be solved with a procedure</td>
<td>• require limited cognitive demand</td>
</tr>
<tr>
<td>• Have no connection to concepts or meaning that underlie the facts rules, formulas, or definitions</td>
<td>• have no connection to the concepts or meaning that underlie the procedure</td>
</tr>
<tr>
<td>• focus on producing correct answers instead of understanding</td>
<td>• focus on producing correct answers instead of understanding</td>
</tr>
<tr>
<td>• require no explanations</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Higher-level demands (procedures with connections):</th>
<th>Higher-level demands (doing mathematics):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• use procedure for deeper understanding of concepts</td>
<td>• require complex non-algorithmic thinking</td>
</tr>
<tr>
<td>• broad procedures connected to ideas instead narrow algorithms</td>
<td>• require students to explore and understand the mathematics</td>
</tr>
<tr>
<td>• usually represented in different ways</td>
<td>• demand self-monitoring of one’s cognitive process</td>
</tr>
<tr>
<td>• require some degree of cognitive effort; procedures may be used but not mindlessly</td>
<td>• require considerable cognitive effort and may involve some level of anxiety b/c solution path isn’t clear</td>
</tr>
</tbody>
</table>

With a Partner:

• Categorize Tasks A – Q into two categories: high level cognitive demand and low level cognitive demand.

• Develop a list of criteria that describe the tasks in each category.
Characterizing Tasks

With a partner,

– Where would the pick-up sticks task from yesterday fall?
– Where does the Euler HS task fit?
Are there any you want to move?

<table>
<thead>
<tr>
<th>Lower-Level Tasks</th>
<th>Higher-Level Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Memorization</td>
<td>• Procedures w/ Connections</td>
</tr>
<tr>
<td>• C</td>
<td>• E</td>
</tr>
<tr>
<td>• K</td>
<td>• I</td>
</tr>
<tr>
<td>• Procedures w/o Connections</td>
<td>• L</td>
</tr>
<tr>
<td>• B</td>
<td>• M</td>
</tr>
<tr>
<td>• D</td>
<td>• O</td>
</tr>
<tr>
<td>• F</td>
<td>• Q</td>
</tr>
<tr>
<td>• G</td>
<td>• Doing Mathematics</td>
</tr>
<tr>
<td>• H</td>
<td>• A</td>
</tr>
<tr>
<td>• N</td>
<td>• J</td>
</tr>
<tr>
<td></td>
<td>• P</td>
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</tbody>
</table>
How can you make it better?

• Select 2 lower-level tasks.
• Work with a partner to talk about how you could make these tasks higher-level.
• Record your ideas on the back of the task.
Resources for Tasks

- Mathematics Assessment Project also MARS (problem solving tasks tab)
- Dan Meyer’s Site
- Illustrative Mathematics
- Robert Kaplinsky’s site
- Estimation 180
- CPALMS
- SHMOOP
- Inside Mathematics
- TI-Inspired site on the front of the PtA book
- ACHIEVE.org
- Desmos
Teaching Mathematics for Understanding Requires
Engage in Lesson Planning from the Students’ Point of View
Planning from the SPOV

• **Introduction and Learning Target**
  - What will I be expected to do that the beginning of the class period? At what cognitive level will I have to engage? What activities will I be doing?
  - How will my teacher know I am ready for today’s lesson? How will I know?
  - How will the opening activity be connected to what I did yesterday or last night? How will it provide me with feedback on where I stand?
Planning from the SPOV

• Lesson Context: Connecting the Target to an Objective
  – How or why is this particular lesson important to me? How will I know?
  – Which of the mathematical practices will I be focusing on in this lesson?
  – How will I connect the mathematical skill to the mathematical concept?
  – How will I demonstrate my learning so that I know my teacher sees it as the lesson unfolds?
Planning from the SPOV

• Lesson Process: Student Engagement
  – Do I understand the tasks that I am being asked to complete?
  – Am I on the lookout for my daily “Aha” moment where I make connections among concepts?
  – How will technology help me visualize concepts?
Planning from the SPOV

- **Lesson Process: Student Engagement**
  - How will I demonstrate that I can reason, conjecture, and create viable arguments?
  - What higher order questions am I seeking to answer?
  - How will my teacher support my work with peers?
  - If I struggle, how will I get support?
Planning from the SPOV

• Lesson Closure
  – How will I summarize the lesson and my learning for today?
  – How will I know if I have reached the target?
  – What do I need to do to close the gap between what is expected of me and what I have learned?
Key concepts / key ideas

• With a shoulder partner, share your insights or thinking about planning from the SPOV.

• What new thoughts do you have about your daily work?
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Understanding and Supporting Teachers’ Enactment of the Effective Teaching Practices: Productive Struggle

NCTM Effective Teaching Institute, 2015

John Carter
Principal
Westlake High School
jcarter@eanesisd.net
More Research on Tasks

• Tasks with high cognitive demands are the most difficult to implement well, and are often transformed into less demanding tasks during instruction (Stein, Grover, and Henningsen 1996; Stiegler and Hiebert 2004)
Think-Pair-Share

- How do you know when a student is struggling?
- What do you do?
Find the Picture

Which of the following pictures best describes your productive struggle?
Find it?...

Nope.
Which One?

**A Destructive Struggle**
- Leads to frustration.
- Makes learning goals feel hazy and out of reach.
- Feels fruitless.
- Leaves students feeling abandoned and on their own.
- Creates a sense of inadequacy.

**Productive Struggle**
- Leads to understanding.
- Makes learning goals feel attainable and effort seem worthwhile.
- Yields results.
- Leads students to feelings of empowerment and efficacy.
- Creates a sense of hope.
What do students look like when they are engaging in productive struggle?

What do Teachers look like when they are facilitating productive struggle?
Productive Struggle: Student Behaviors

• Struggling at times but know that learning comes from confusion and struggle.

• Asking questions to help them understand the task

• Persevering in solving problems and realizing that is ok to say, “I don’t know how to proceed here,” but it is not ok to give up.

• Helping one another without telling their classmates what the answer is or how to solve the problem.
Productive Struggle: Teacher Behaviors

- Anticipating what students might struggle with and being prepared to support them productively.
- Giving students time to struggle, and asking questions that scaffold students’ thinking without stepping in.
- Helping students realize that confusion and errors are a part of learning, by facilitating discussions on mistakes, misconceptions, and struggles.
- Praising students for their efforts in making sense and perseverance.

Principles to Action (2014) pg 52
How Can We Support the Development of Productive Struggle?

• Choose rigorous tasks!
• Determine what it looks like in students.
• Make it an explicit focus in classrooms. (Tell students we are doing this!)
• Focus on productive behaviors instead of intelligence.
• Communicate with families.
Mindset and Productive Struggle

**Fixed Mindset**
- Understanding, proficiency, ability are “set”
- You are good at something or you aren’t

**Growth Mindset**
- Understanding, proficiency, ability are developed regardless of your genes
- You become better at something as you work with it – as you struggle with it

Dweck, 2008
Principles to Actions

Effective Mathematics Teaching Practices

The Case of Jeff Ziegler

High School

Developed by Margaret Smith and Victoria Bill at the University of Pittsburgh. Video courtesy of Pittsburgh Public Schools and the Institute for Learning.
Overview of the Session

- 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
1. What patterns do you notice in the set of figures?

2. How many square tiles are in figure 7? Write a description that could be used to determine the shape of and total number of square tiles in figure 7. Your description should be clear enough so that another person could read it and use it to think about another figure.

3. Determine an equation for the total number of squares in any figure. Explain your rule and show how it relates to the visual diagram of the figures.

4. Find a second way to describe the pattern and write the equation that matches the description. Compare the two equations and show in the visual representation how one equation is equivalent to the other.

5. If you knew that a figure had 9802 squares tiles in it, how could you determine the figure number? Explain.

6. Does the pattern describe a linear relationship between the figure number and the total number of squares? Why or why not?
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 coach at Langley High School in the Pittsburgh Public School District. The students are 11th and 12th grade and 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

1. The symbolic and pictorial representations can be connected.
Creating Equations*  A-CED

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 this was a growth pattern that 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 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
In the second video clip Mr. Ziegler visits Groups 1 and 1 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.
What have you learned and how do these ideas apply to your classroom work?
Session 1 Closing

What are 2 ideas from this session that resonate with you?
The National Council of Teachers of Mathematics is a public voice of mathematics education, providing vision, leadership, and professional development to support teachers in ensuring equitable mathematics learning of the highest quality for all students. NCTM’s Institutes, an official professional development offering of the National Council of Teachers of Mathematics, supports the improvement of pre-K-6 mathematics education by serving as a resource for teachers so as to provide more and better mathematics for all students. It is a forum for the exchange of mathematics ideas, activities, and pedagogical strategies, and for sharing and interpreting research. The Institutes presented by the Council present a variety of viewpoints. The views expressed or implied in the Institutes, unless otherwise noted, should not be interpreted as official positions of the Council.
Understanding and Supporting Teachers’ Enactment of the Effective Teaching Practices: Planning our Work with Others
NCTM Effective Teaching Institute, 2015

John Carter
Principal
Westlake High School
jcarter@eanesisd.net
Charting a Path for Improvement

2. Time for embedded professional learning.
3. Attention to adult learning needs.
4. Support for teacher collaboration.
5. Make the learning known.
6. Celebrate successes.
Team Actions for Implementation
Before the Professional Learning

1. Make sense of the agreed upon essential learning standards for the session.
2. Develop an assessment plan for the session.
3. Develop indicators of success.
4. Identify high cognitive demand tasks for the session.
5. Plan for implementation of learning.
6. Implement high cognitive demand tasks effectively.

7. Use in-session formative assessment processes effectively.

8. Use an professional learning design process for session planning.
Team Actions for Implementation
After the Unit

9. Ensure evidence-based **participant** goal-setting and action for the next steps in learning and implementation.

10. Ensure evidence-based **presenter** goal setting and action for the next steps in learning and implementation.
Action Planning Worksheet

1. Goals
2. Action Steps
   include session planning steps
3. Time frame
4. Success criteria
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