DEVELOPING MATHEMATICS LEARNERS AND DOERS

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ICE BREAKER

- Which of the following words are significant to you for math class
- Practices
- Engagement
- Modeling
- Problem solving
- Discourse
- Fluency
- Standards
- Test scores
AGENDA

• LEARNING CULTURE
• PRODUCTIVE STRUGGLE AND PROBLEM BASED LEARNING
• KEY SHIFTS IN MATH INSTRUCTION EXPECTATIONS
• MATH PRACTICES FOR SUPPORTING ENGAGEMENT
• ADDITIONAL RESOURCES EXPLORATION
OBJECTIVES

› IDENTIFY INSTRUCTIONAL MODELS THAT ALIGN WITH THE INSTRUCTIONAL SHIFTS IN MATHEMATICS
› EXPLORE PROBLEM-BASED LEARNING AS AN AVENUE TO PLANNING FOR PRODUCTIVE STRUGGLE
› UNPACK THE MATH PRACTICES AS A TOOL TO PROMOTE ENGAGEMENT IN THE CLASSROOM
› UTILIZE RESOURCES THAT SUPPORT PLANNING FOR PBL
NORMS

- Be honest about your current reality.
- Actively listen and participate.
- Voice and respond to concerns positively and non-judgmentally.
- Love the idea first to embrace its possibilities.
- Slow down to think, reflect, and puzzle about things.
DEFINING A LEARNING CULTURE - 100 NUMBERS

• FORM GROUPS OF 3 OR 4

• PLEASE READ THE DIRECTIONS IN THE HANDOUT ONLY AND WAIT FOR THE PRESENTER TO SIGNAL TIME TO BEGIN.
What does learning look like?
What does learning look like?
What does learning look like?
OBSERVATIONS FROM YOUR WORK

Based on your experience while working in your group, and on your observations in the pictures, discuss the following with your group. Be prepared to share out.

1. What worked or did not work with your group while completing this task?
2. Did you notice a pattern while you worked?
3. Did you make any changes from the first two minutes in order to complete more numbers in the second two minutes?
DEVELOPING CLASSROOM NORMS FOR GROUP WORK

• Based on your discussion about what group work should look like and feel like, develop a list of 3 norms for group work that your group feels are most important so that everyone in the room can be engaged in learning math.

• Write your list on the poster paper and post it on the wall.

Time for a Traffic Light Gallery Walk:

Red – Must have
Yellow – May need
Green – Not needed
What does group work in mathematics class look like?

- All group members are FOCUSED. Members are only talking to members of their group.
- Group members are close (heads are together).
- Every group member participates. All group members are included.
- Everyone uses an appropriate voice (2 foot voice).
- Everyone is working on the assigned task.
- The group makes a plan before beginning the task.
- Group members support each other (help each other).
- Group members are all communicating (ask questions and sharing ideas).
BRAINSTORM SOME OTHER IDEAS FOR THE KINDS OF PROBLEMS THAT CAN BE USED FOR DEVELOPING A CULTURE

• MATH WORK NEEDS TO BE SAFE FOR ALL STUDENTS
• REQUIRES A GROUP TO COMPLETE
• ALLOWS FOR REVISITING TO IMPROVE
Where’s Poly?

CONTINUE TO DEVELOP CULTURE BUT INCREASE THE CHALLENGE
WHERE'S POLY

• WHAT DO YOU NOTICE?
WHERE'S POLY

• EACH DOT IS A VERTEX.

• WHAT DO YOU NOTICE?
WHERE’S POLY

- WHAT DO YOU NOTICE?
WHERE’S POLY

• WHAT DO YOU NOTICE?

Taken from GFLETCHY October 19, 2019 at https://gfletchy.com/2016/12/05/wheres-poly-an-exploration-in-geo-dotting/
COMMON CORE/NJSLS KEY SHIFTS IN MATHEMATICS

● FOCUS - IDENTIFY THE FOCUS (CONTENT) OF THE WHERE’S POLY ACTIVITY?

● COHERENCE – IN THE PROGRESSION OF MATHEMATICS LEARNING, WHERE WOULD THIS ACTIVITY FIT? WHAT MATH KNOWLEDGE DID YOU ACCESS WHILE COLLABORATING WITH OTHERS?

● RIGOR – HOW DOES THIS ACTIVITY PROMOTE PRODUCTIVE STRUGGLE?
STAND UP IF YOU HAVE EVER SHARE THAT YOU ARE NOT GOOD AT MATH.

Stand up if you have shared that you have a difficult time explaining things to others.

Stand up if you have ever shared that you have difficult time reading.

IT’S TIME TO CHANGE THIS MESSAGE!
“TO COPE WITH THE DEMANDS OF THE 21ST CENTURY, PEOPLE NEED TO KNOW MORE THAN CORE SUBJECTS. THEY NEED TO KNOW HOW TO USE THEIR KNOWLEDGE AND SKILLS – BY THINKING CRITICALLY, APPLYING KNOWLEDGE TO NEW SITUATIONS, ANALYZING INFORMATION, COMPREHENDING NEW IDEAS, COMMUNICATING, COLLABORATING, SOLVING PROBLEMS, MAKING DECISIONS.”

(PARTNERSHIP FOR 21ST CENTURY SKILLS, 2002, PAGE 11)
NEW MESSAGE

We are **NOT** developing students who are good at math

- WE ARE DEVELOPING STUDENTS FOR THE 21ST CENTURY
- WE ARE DEVELOPING LIFE LONG LEARNERS
- WE ARE DEVELOPING PROBLEM SOLVERS
- WE ARE DEVELOPING HABITS OF MIND THAT CAN BE USED WHEN STRUGGLING WITH A MATH PROBLEM
What learning is happening in this picture?
ENGAGEMENT REQUIRES CHALLENGES

• “EFFECTIVE MATHEMATICS TEACHING USES STUDENTS’ STRUGGLES AS VALUABLE OPPORTUNITIES TO DEEPEN THEIR UNDERSTANDING OF MATHEMATICS. STUDENTS COME TO REALIZE THAT THEY ARE CAPABLE OF DOING WELL IN MATHEMATICS WITH EFFORT AND PERSEVERANCE IN REASONING, SENSE MAKING, AND PROBLEM SOLVING.” PRINCIPLES TO ACTIONS (2014)
# Problem Based Learning Anticipation Guide

<table>
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PBL ENGAGES STUDENTS IN EXPLORATIONS OF MATHEMATICS CONCEPTS BY CHALLENGING THEM WITH ENGAGING TASKS THAT REQUIRE THEM TO ACCESS PRIOR KNOWLEDGE, PARTICIPATE IN MATHEMATICAL DISCOURSE, UTILIZE PROBLEM-SOLVING STRATEGIES, ASSESS ACCURACY AND REASONABILITY OF ANSWERS, CRITIQUE AND EDIT WORK, AND EXPLAIN AND SUPPORT THEIR ARGUMENTS. THIS FUNDAMENTAL SHIFT IN MATH EDUCATION IS SUPPORTED WITH INQUIRY-BASED INSTRUCTION AND MOVES AWAY FROM THE TRADITIONAL MEMORIZATION OF MATH FACTS, ALGORITHMS, AND PROCEDURES, THUS CHANGING THE FOCUS FROM TEACHING TO A FOCUS ON STUDENT-CENTERED LEARNING.

How can we define PBL?

- Use your cell phone or laptop and research a definition.
- Consider the types of learning tasks that students would do.
- Share your definition with a colleague.
- Combine what you found and your knowledge about learning to create a definition to share with the whole group.
DEFINING PRODUCTIVE STRUGGLE

“as students engage with a task, they must be mindful about the strategy they employ and assess whether it is productive. When they find themselves at a dead end, they must be willing to abandon one strategy for another, when students labor and struggle, but continue to try to make sense of a problem, they are engaging in productive struggle.” marian pasquale, “productive struggle in mathematics” (2015)
Teaching Habits that Promote Productive Struggle in Math
THINK ABOUT THE *WHERE’S POLY ACTIVITY*

<table>
<thead>
<tr>
<th>Did you experience productive struggle?</th>
</tr>
</thead>
<tbody>
<tr>
<td>During what part of this task did you experience productive struggle?</td>
</tr>
<tr>
<td>Where do you think your students would experience productive struggle?</td>
</tr>
<tr>
<td>What would you do to support students with their productive struggle during this task?</td>
</tr>
</tbody>
</table>
SUPPORTING PRODUCTIVE STRUGGLE

• FOCUS ON GROWTH MINDSET.

• ACKNOWLEDGE STUDENTS FOR THEIR PERSEVERANCE AND EFFORT IN REASONING AND SENSE MAKING.

• PROVIDE STUDENTS WITH SPECIFIC FEEDBACK ON THEIR PROGRESS. (ADVICE, EVALUATION, AND PRAISE ARE NOT FEEDBACK)

• SUPPORT THE STUDENTS IN CONSIDERING WHAT THEY KNOW AND WHAT THEY NEED TO FIGURE OUT.
TASKS IN PRODUCTIVE STRUGGLE

- Find tasks the students will be interested in.
- Make sure each student has an entry point.
- Find tasks that students believe are worth solving.
- Provide time!
SETTING THE STAGE FOR PBL

• BE TRANSPARENT WITH YOUR STUDENTS AND LET THEM KNOW THAT YOU ARE GOING TO GIVE THEM TASKS THAT THEY ARE GOING TO STRUGGLE WITH.

• BAN CERTAIN PHRASES IN YOUR CLASSROOM.
  • *THIS IS HARD*  • *I CAN'T DO THIS*  • *I AM CONFUSED*

• STRESS THAT THEIR JOURNEY IS WHAT'S MOST IMPORTANT AS THEY WORK, NOT GETTING TO THE CORRECT ANSWER.

• PROVIDE APPROPRIATE SCAFFOLDS TO SUPPORT DISCUSSION, EXPLORATION, LEVEL THE PLAYING FIELD.
EMBRACE MISTAKES

• “IN THIS CLASS, MISTAKES ARE EXPECTED, RESPECTED, INSPECTED, AND CORRECTED.”

• “SOMETHING WONDERFUL HAPPENS WHEN I MAKE A MISTAKE, I LEARN!”
8 Habits of Math Teachers Who Value Productive Struggle

1. Call on students who may NOT have the correct answer.
2. Praise students for perseverance in problem solving, not for being smart.
3. Display work that shows creative problem solving, not the highest scores.
4. Provide non-routine problems that can’t be solved with a memorized formula.
5. Give students informative feedback.
6. Don’t give easier work to struggling students.
7. Allow students time to ask questions and tinker with ideas.
8. Encourage having a growth mindset.
How can teachers plan for productive struggle?

1. Set goals and select appropriate tasks.
2. Prepare ahead of time for possible struggles and misconceptions the students might have.
3. Prepare ahead of time questions NOT to ask.
4. Focusing vs. Funneling questions.
**FOCUSING VS FUNNELING**

<table>
<thead>
<tr>
<th>Funneling</th>
<th>Focusing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Engaged in Cognitive Activity</td>
<td>Student Engaged in Cognitive Activity</td>
</tr>
<tr>
<td>Questions lead student through a procedure</td>
<td>Questions guide students through their own thinking</td>
</tr>
<tr>
<td>Students gets the correct answer, but does not see the connection between the questions</td>
<td>Teacher can understand what the student is thinking</td>
</tr>
</tbody>
</table>
WHAT QUESTIONS COULD YOU ASK THIS STUDENT TO BETTER UNDERSTAND THEIR THINKING?
8 Teaching Habits that Block Productive Struggle in Math Students

1. Calling on students who know the right answer.
2. Praising students for their smarts.
3. Creating bulletin boards to display high achievement.
4. Focusing on teaching procedures and formulas.
5. Making student responses right or wrong.
6. Giving easier work to struggling students.
7. Following a strict schedule for covering new material.
8. Making students feel okay about not being a “math person”.

mindresearch.org
TELL ME AND I FORGET. SHOW ME AND I REMEMBER. INVOLVE ME AND I UNDERSTAND.

CHINESE PROVERB
BENEFITS OF PBL BINGO

<table>
<thead>
<tr>
<th>Collaboration</th>
<th>Science Content</th>
<th>Motivation</th>
<th>Cross-Cultural</th>
<th>Adaptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELA/Literacy</td>
<td>Innovation</td>
<td>Global Awareness</td>
<td>Science and Engineering Practices</td>
<td>Communication</td>
</tr>
<tr>
<td>Use of Media</td>
<td>Social-Emotional Skills</td>
<td>Initiation</td>
<td>Critical Thinking</td>
<td>Problem-Solving</td>
</tr>
<tr>
<td>Leadership</td>
<td>Responsibility</td>
<td>Technology Literacy</td>
<td>Accountability</td>
<td>Appropriate Use of Tools</td>
</tr>
<tr>
<td>Civic Responsibility</td>
<td>Information Literacy</td>
<td>Interdisciplinary</td>
<td>Differentiation</td>
<td>STEM/STEAM</td>
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COMPARE/CONTRAST LEARNING TASKS

Candy Jar vs. Missing Values
https://tinyurl.com/ydhlkduf
Which is more important: the task or the teacher’s role in supporting the task?
DISCUSSION:

WHAT IS THE ROLE OF THE TEACHER IN A PROBLEM-BASED LEARNING CLASSROOM?

WHAT IS THE ROLE OF STUDENTS IN A PROBLEM-BASED LEARNING CLASSROOM?

WILL IT BE DIFFICULT TO BALANCE CLASSROOM ROLES SO THAT THERE IS ENOUGH STRUCTURE AND EXPLORATION?
CHALLENGES IN PROBLEM-BASED LEARNING

- Changing Teacher Role
- Scaffolding for Student Success
- Management Skills
- Training and Support
- Risk Taking
- Learning from Mistakes
- Collaboration
- Confidence with Tools and Resources
- Time Management
- Assessment
- Identifying a Task
- Content/Standards Knowledge

Which will be more difficult for you? Which will be more difficult for your students?
WHAT SHOULD MATH DOERS DO?

YOUCUBED AT STANFORD
PUBLISHED ON JUL 17, 2015

And this fella in my group had a cool idea too.
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FREE LUNCH ANY ONE?
### The Mathematical Task Analysis Guide (TAG)

#### Lower-Level Demands

**Memorization Tasks**
- Involves either producing previously learned facts, rules, formulae, or definitions OR committing facts, rules, formulae, or definitions to memory.
- Cannot be solved using procedures because a procedure does not exist or because the time frame in which the task is being completed is too short to use a procedure.
- Are not ambiguous — such tasks involve exact reproduction of previously seen material and what is to be reproduced is clearly and directly stated.
- Have no connection to the concepts or meaning that underlie the facts, rules, formulae, or definitions being learned or reproduced.

#### Higher-Level Demands

**Procedures With Connections Tasks**
- Focus students' attention on the use of procedures for the purpose of developing deeper levels of understanding of mathematical concepts and ideas.
- Suggest pathways to follow (explicitly or implicitly) that are broad general procedures that have close connections to underlying conceptual ideas as opposed to narrow algorithms that are opaque with respect to underlying concepts.
- Usually are represented in multiple ways (e.g., visual diagrams, manipulative symbols, problems, problem situations). Making connections among multiple representations helps to develop meaning.
- Require some degree of cognitive effort.
- Although general procedures may be followed, they cannot be followed mindlessly. Students need to engage with the conceptual ideas that underlie the procedures in order to successfully complete the task and develop understanding.

#### Procedures Without Connections Tasks

- Are algorithmic. Use of the procedure is either specifically called for or its use is evident based on prior instruction, experience, or placement of the task.
- Require limited cognitive demand for successful completion. There is little ambiguity about what needs to be done and how to do it.
- Have no connection to the concepts or meaning that underlie the procedure being used.
- Are focused on producing correct answers rather than developing mathematical understanding.
- Require no explanation, or explanations that focus solely on describing the procedure that was used.

#### Doing Mathematics Tasks

- Requires complex and non-algorithmic thinking (i.e., there is not a predictable, well-rehearsed approach or pathway explicitly suggested by the task, task instructions, or a worked-out example).
- Requires students to explore and to understand the nature of mathematical concepts, processes, or relationships.
- Demands self-monitoring or self-regulation of one's own cognitive processes.
- Requires students to access relevant knowledge and experiences and make appropriate use of them in working through the task.
- Requires students to analyze the task and actively examine task constraints that may limit possible solution strategies and solutions.
- Requires considerable cognitive effort and may involve some level of anxiety for the student due to the unpredictable nature of the solution process required.
**Task Sort Activity**

**Solution**

Memorization Tasks: F, I  
Procedures without Connections: A, D  
Procedures with Connections: C, E, G, H  
Doing Mathematics: B, J
COMMUNICATING EXPECTATIONS FOR MATH DOERS IN THE CLASSROOM
MATHEMATICAL PRACTICES

- EIGHT PRACTICES
- INTERWOVEN
- MEANS USED BY STUDENTS TO EXPLORE THE ABSTRACT, BIG IDEAS IN MATH

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.

Taken from http://www.ascd.org/ascd-express/vol8/805-parker.aspx on 3/23/19
ASCD Express: Common Core: Now What? December 6, 2012 | Volume 8 | Issue 5
ASSESSING THE PRACTICES

Navigate to: https://tinyurl.com/ydhlkduced

Develop a list of Look-Fors for your assigned practice based on the descriptions of the mathematical practices located on the Padlet.
RESOURCES FOR PBL

- Take time to explore some resources from the list located on the Padlet.

- Be prepared to share out your Oh’s and Ah’s.
PLANNING FOR PROBLEM BASED LEARNING

• IS PBL ENOUGH TO DEVELOP MATH PROFICIENCY?

• WHAT LEARNING ACTIVITIES DO TEACHERS NEED TO PROVIDE FOR STUDENTS TO BECOME PROFICIENT?
Reflection

Think of your favorite activity

Complete this analogy

PBL is like (insert your favorite activity)

Because

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THANK YOU!

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