How to Create Performance Tasks in K-12 Mathematics

SMCAA Conference

Presented by Deborah Sanchez and Shea Thomas

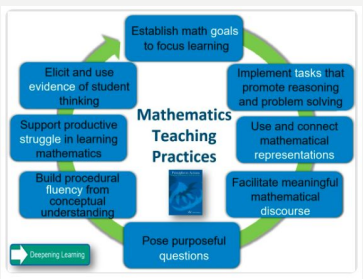
Goals

- Why use performance tasks?
- What makes a task high quality?
- How can I modify existing tasks to make them higher cognitive demand?
- How do I implement rigorous tasks in my instruction?

Why Use Performance Tasks?

NCTM, 2014

NCTM, 2017

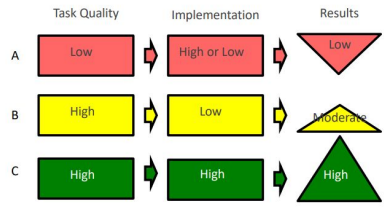


Why Use Performance Tasks?

- A focus on evidence requires attention to more than just right or wrong.
- High-level tasks are needed to reveal student thinking and reasoning.
  - 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)
- Waiting until the quiz on Friday or a test at the end of unit might be too late.

Principles to Actions (NCTM, 2014) pgs 53-54

Considering the Impact of Tasks



Stein, M.K. & Lane, S. (1996). Instructional tasks and the development of student capacity to think and reason: An analysis of the relationship between teaching and learning in a reform mathematics project. *Educational Research and Evaluation* 2(4), 50-80.
Graphic courtesy of Learnzillion.

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What are we asking students to do?

Bloom's Taxonomy

Webb's Depth of Knowledge

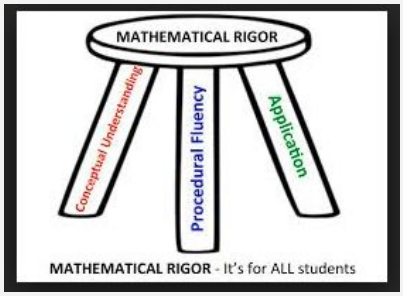
More than a Verb
Same VERB – 3 DOK Levels

DOK 1- Model and draw – lines, rays, angles including right, obtuse, and acute angles.

DOK 2- Model multiplication and division

DOK 3- Determine the formula for the area of a rectangle and model your explanation with equations and diagrams.

From Understanding Depth of Knowledge, Lou Maynas, WVDE
https://wvde.state.wv.us/teach21/documents/UnderstandingDepthofKnowledgeppt.ppt



What Makes a Task High Quality?

- Engages students in mathematical investigations that require thinking and reasoning
- Uses procedures in ways that are meaningfully connected to conceptual understanding
- No prescribed pathway to follow
- "Low Threshold, High Ceiling Tasks" (Multiple entry points)
- Can use varied solutions and strategies to arrive at answer

What Makes a Task Low Quality?

- Requires students to use procedures, rules, formulas or algorithms detached from related concepts
- Consists primarily of memorization or recall
- Limited or no entry point
- Focuses on students producing the right answer vs. developing mathematical understanding

Comparison of Two Multiplication Tasks

Multiples of Ten Task

Solve the following multiplication problems:

7 × 10 = _____
7 × 20 = _____
5 × 50 =_____
40 × 7 = _____
10 × 9 = _____
5 × 20 = _____
3 × 20 = _____
30 × 4 = _____

The Band Concert Task

The third-grade class is responsible for setting up the chairs for the spring band concert. In preparation, the class needs to determine the total number of chairs that will be needed and ask the school's engineer to retrieve that many chairs from the central storage area. The class needs to set up 7 rows of chairs with 20 chairs per row, leaving space for a center aisle. How many chairs does the school's engineer need to retrieve from the central storage area?

Talk Time: Task Quality

Which task is more likely to promote reasoning and problem solving among students? Why?

NCTM, 2017

Comparison of Two Multiplication Tasks

Multiples of Ten Task

- Goal: find the correct answer, NOT on developing mathematical understanding
- Doesn't require students to engage in thinking, reasoning, or problem solving
- Implies students know a procedure or recall facts or rules
- If they don't know, they have limited or NO entry point

The Band Concert Task

- Must expend effort to find a strategy
- Can be solved in multiple ways:
  - use manipulatives or drawings
  - repeated addition
  - skip counting
  - decompose the numbers
- Asks students to justify why their approach makes sense since no solution strategy is stated or implied

NCTM, 2014

Lower-level demands (memorization): • reproducing previously learned facts, rules, formulas, definitions or committing them to memory • Cannot be solved with a procedure • Have no connection to concepts or meaning that underlie the facts rules, formulas, or definitions	**Lower-level demands (procedures without connections):** • are algorithmic • require limited cognitive demand • have no connection to the concepts or meaning that underlie the procedure • focus on producing correct answers instead of understanding • require no explanations
Higher-level demands (procedures with connections): • use procedure for deeper understanding of concepts • broad procedures connected to ideas instead narrow algorithms • usually represented in different ways • require some degree of cognitive effort; procedures may be used but not mindlessly	**Higher-level demands (doing mathematics):** • require complex non-algorithmic thinking • require students to explore and understand the mathematics • demand self-monitoring of one's cognitive process • require considerable cognitive effort and may involve some level of anxiety b/c solution path isn't clear

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Identifying High-Quality Tasks

The purpose of the task is to teach or assess:

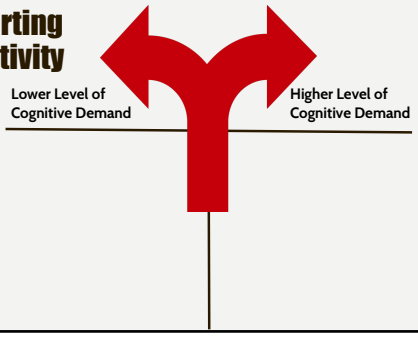
☐ Conceptual understanding	☐ Procedural skill and fluency	☐ Application

Rating Scale:
2 - Fully Meets the Characteristic
1 - Partially Meets the Characteristic
0 - Does Not Meet the Characteristic

The mathematics task	Rating
Aligns to mathematics content standards I am teaching.	
Encourages my students to use representations.	
Provides my students with an opportunity for communicating their reasoning.	
Has multiple entry points.	
Allows for different strategies for finding solutions.	
Makes connections between mathematical concepts, between concepts and procedures, or between.	
Prompts cognitive effort.	
Is problem-based, authentic, or interesting.	

SanGiovanni, John (2016). Mine the Gap for Mathematical Understanding. Thousand Oaks, CA: Corwin SanGiovanni, John and Jennifer Novak (2016). Mine the Gap for Mathematical Understanding (6-8). Thousand Oaks, CA: Corwin

Sorting Activity



Review Your Sort.

- What do higher-level tasks have in common?
- What do lower-level tasks have in common?
- Where do you see evidence of procedure, concept, and application in these tasks?

Talk Time: Modifying Tasks

Choose a lower-level task. Discuss how to modify the task to make it higher level.

Implementation

- Plan time for students to complete the task as well as time to debrief and discuss the intended learning.
- Anticipate student responses, questions, and potential errors.
- Plan class check-in points for longer tasks (catch and release).
- Don't give too much away.
  - Match the level of support with the level of need.
- Plan your scaffolding.
  - What information will you provide at certain points of the task?
  - What questions will you ask students about their thinking to guide them to the next step?

Scaffolding Support

"Provide scaffolding when it becomes evident that they need it. Do just-in-time scaffolding (when it is no longer productive) rather than just-in-case scaffolding."

-Juli Dixon

"If we over scaffold, there is no need for struggle at all."

"Linger on important common errors, ones that have traction- you can't just hear one right answer and move on."

Talk Time: Scaffolding Support

Choose a higher-level task. Develop 3 questions you could ask students to provide scaffolded support.

NCTM, 2014

A Destructive Struggle	Productive 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.	• 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.

Strategies to Support Productive Struggle

	Teaching Strategies	Student Indicators of a Productive Struggle
Question	Teachers ask questions that help students focus on their thinking and identify the source of their struggle, then encourage students to build on their thinking or look at other ways to approach the problem.	Students ask questions to identify the source of their struggle, write down their ideas, clarify ideas with others, and consider alternative strategies or representations to address their struggle.
Encourage	Teachers encourage students to reflect on their work and support student struggle in their effort and not just in getting the correct answers.	Students use their effort to solve problems and try to make sense of their work, not only satisfied with a correct answer or that they perceive themselves as smart or not.
Give Time	Teachers give time and support for students to manage their struggles through adversity and failure by not stepping in too soon or too much, thereby taking the intellectual work away from the students.	Students use their time to develop and follow through on their strategies, evaluate their progress, and understand what they can do and what still remains to be done.
Acknowledge	Teachers acknowledge that struggle is an important part of learning and doing mathematics.	Students persist in their work to make sense of and to solve their problem and not give up or get discouraged easily.

(Warshauer, 2015)

Class Debrief and Discussion

- Organize student responses for share out from entry-level thinking to higher-level thinking (see Graham Fletcher's recording sheet).
- Celebrate all thinking and highlight various entry points.
- Discuss different strategies used that lead to viable solutions and those that do not.
- Encourage student-to-student questioning.
- Put names and labels to the mathematics.
- Ask students to self-assess their understanding or performance (metacognition).

Our Contact Info

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Resources

National Council of Teachers of Mathematics (2014). *Principles to Action.* Reston, VA: Author.

National Council of Teachers of Mathematics (2017). *Taking Action.* Reston, VA: Author.

SanGiovanni, John (2016). Mine the Gap for Mathematical Understanding. Thousand Oaks, CA: Corwin

Warshauer, Hiroko (2015). Strategies to Support Productive Struggle. *Mathematics Teaching in the Middle School, 20*(7), 390-393. https://www.jstor.org/stable/10.5951/mathteacmiddscho.20.7.0390