Increasing Rigor in Mathematics and Science

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Session Overview

- Review how shifting DOK levels shifts the teacher-student roles

- Explore strategies that shift and support thinking and reasoning

- Practice using tools that support development of planning and reasoning

Choose a math or science topic…

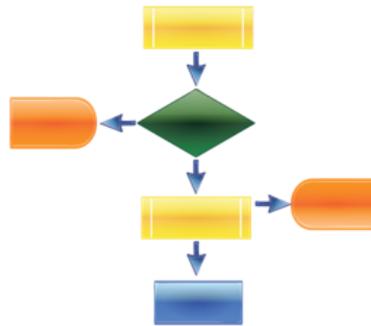| DOK Levels	Teacher Roles	Student Roles
1	• Questions to focus attention *(Who? What? Where? How? When?)* • Directs, leads, demonstrates, defines • Scaffolds for access & focus	• Acquires vocabulary, facts, rules • Memorizes, recites, quotes • Practices, restates
2	• Questions to differentiate/ classify, draw out inferences, check conceptual understanding *(Why? What conditions? Give example/non-example?)* • Builds conceptual schemas	• Explains relationships, sorts, classifies, compares, organizes • Makes predictions based on estimates, observations; proposes
3	• Questions to probe reasoning and underlying thinking *(How do you know? What is the hard evidence?)* • Designs tasks requiring reasoning & proof	• Uncovers relevant, accurate, credible information or flaws in a design • Develops supporting (hard) evidence for conclusions or claims • Tests ideas, solves non-routine problems
4	• Questions to extend thinking, explore alternative sources, broaden perspectives *(What are the potential biases? Can you propose an alternative model?)*	• Transfers and constructs knowledge • Modifies, creates, elaborates based on new sources • Investigates real-world problems and issues

Strategies that support thinking and reasoning – Discourse, Task Cards

6 Ways to Uncover Thinking & Deeper Understanding

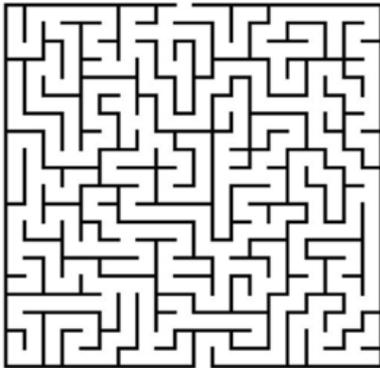|		
Make *and support* a connection – personal, source-based, or global	**Build Schema: Take it apart – name the parts, analyze how (or *how well*) the parts work together**	**Generate open-ended questions that require different sources & *analysis of evidence***
Define the challenge (or problem) and plan a solution pathway	**Engage with peers – Assign individual roles with specific tasks to find a solution or meet a group goal**	**S-T-R-E-T-C-H: Apply this concept or idea to a new situation, scenario, or alternate solution**

Strategies that support thinking and reasoning - Anchor Charts

What Makes Sense?

What is the problem asking?
What numbers do you see?
Does your answer make sense?
How do you know?

- Read the problem
- Act it out/use tools
- Draw a picture label
- Write the number sentence

Sample problem

10 students went to lunch. 7 students had hot lunch. How many students had cold lunch?

→ find numbers

→ find math words

Hot
O O O O O
O O

Cold
O O O

7 + 3 = 10
3 students had cold lunch.

Key
O = 1 student

10 ⟨ 7 / 3 ⟩

Create with kids

Use color, visuals for emphasis

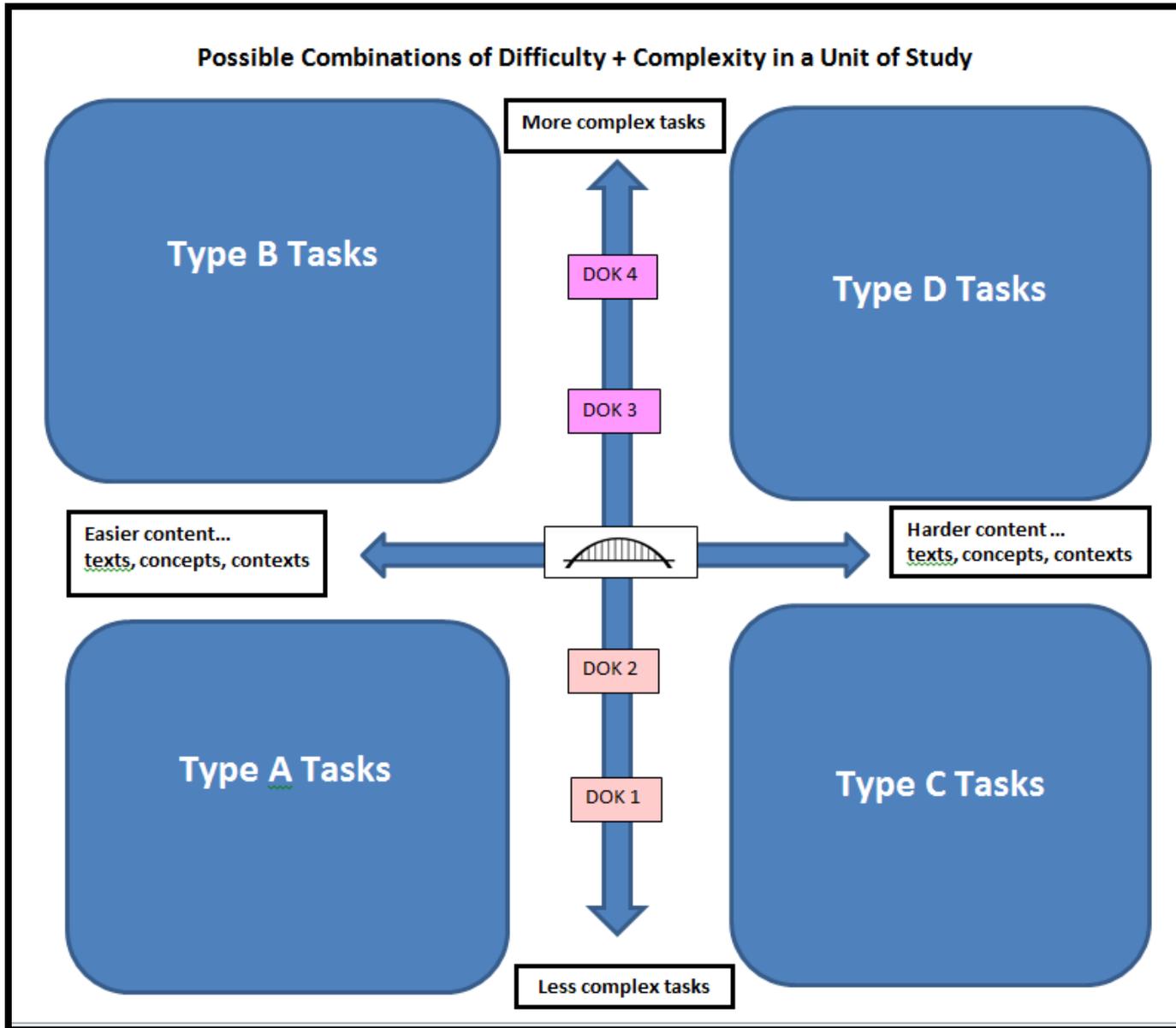Sample problem

What does it look like?
What does it sound like?

Content Standards & Practices

Depth + Thinking	Level 1 Build a Foundation	Level 2 Connect, Conceptualize	Level 3 Deepen, Think Strategically	Level 4 Extend & Broaden
Remember	Know facts, terms, principles, properties			
Understand	**Attend to precision** Evaluate expressions, locate/plot points Represent math or science relationships (words, symbols, visuals)	**Use Models** Estimate, predict, observe Explain relationships: (cause-effect, compare-contrast)	**Construct viable arguments** Geometry proof Develop and justify claims (conclusions) using data/observation/ evidence	Integrate concepts across domains or content areas
Apply	Calculate, measure, make conversions Use formulas, simple procedures	**Make sense of routine problems** Retrieve information to solve a problem	**Make sense of non-routine problems** Design OR conduct investigations	Design AND conduct a new project or investigation
Analyze	Identify a pattern or trend Locate information in table, diagram	**Use tools strategically** Classify, sort, organize data, extend a pattern Select a model to represent data	**Reason abstractly Analyze investigation for flawed designs** Generalize a pattern Test a design	Analyze multiple sources of evidence to solve problem
Evaluate			**Critique the plan or reasoning of others**	Critique multiple perspectives/ solutions/ explanations
Create	**Brainstorm ideas, connections, perspectives**	Generate conjectures or hypothesis to be tested	**Design a model for a new perspective or complex situation**	Design an alternative complex model with multiple constraints

Distinguishing Task from Content Complexity

Possible Combinations of Difficulty + Complexity in a Unit of Study

- More complex tasks
- Type B Tasks
- Type D Tasks
- DOK 4
- DOK 3
- Easier content... texts, concepts, contexts
- Harder content... texts, concepts, contexts
- DOK 2
- Type A Tasks
- Type C Tasks
- DOK 1
- Less complex tasks

Guided Practice:

Planning to Solve a Mathematics Performance Task or
Science Inquiry Task

Word problems versus **Problem solving**
What's the difference?

Word problems

- Read for key words
- Determine operation
- Perform Operation
- Label your answer

Problem solving

- Read for key words
- Think about ways you could solve it: <u>Steps? Strategies? Visuals?</u>
- <u>List content terms, symbols, operations, concepts</u>
- Perform Operation(s)/ Procedures
- Explain your <u>reasoning</u>
- Make <u>connections</u>

Part 1 - Examine the Task

1. Read the assessment task prompt together. UNDERLINE the question(s) to be answered.

2. **"I/we have to find out _____"** (say it in your own words)

3. Make a plan:
   - ❑ Discuss / list some ways – STRATEGIES – I can use to investigate or find a solution.
   - ❑ Discuss / list some content terms and symbols I will use
   - ❑ Discuss: What CONCEPTS do I need to apply?
   - ❑ What are some possible ways to VISUALLY show the problem? (graph, table, label a picture or diagram, etc.)

Part 2 - Solve It and Explain Your Thinking

4. "I will _____" (what steps or strategies will you use to solve this problem?)

5. Solve it.

6. Use words to communicate your mathematical/scientific thinking about…
- ❑ **My Strategy/Approach?**
- ❑ **My Representations or Models?**
- ❑ **My Operations, Calculations, Data Collection?**
- ❑ **Applying a concept or principle?**
- ❑ **Reasonableness of my solution or conclusions?**
- ❑ **Supporting evidence?**

7. Make some **mathematical/scientific connections**:

      "This shows the concept of _____"
      "This reminds me of _____"
      "This is like _____"
      "This also applies when _____"
      "This only works if _____"
      "This conclusion raises a new question _____"

Suggested Scoring Criteria

(P/S) Problem Solving Approach	(R/P) Reasoning & Proof/Justify	(Com) Communication	(Con) Making Connections	(Rep) Representation
Accurate calculations for operations used	Develops an argument to justify the solution	Used content terms correctly	Connections to prior learning, real-world OR	Appropriate visual used for situation
Used a strategy for situation that leads to a correct solution	Explains <u>how</u> strategy, representation, calculations, etc. support	Used math/ science symbols, equations correctly	Notes any patterns, structures, etc. OR	Correct labels & form (chart, diagram, table, drawing, graph, etc.)
Explains why a strategy was changed or multiple strategies used	Explains <u>why</u> solution is reasonable; checks for accuracy	Clarifies problem and explains processes used	Math connection to concepts OR Big Ideas	

Next Instructional Steps?

1. Analyze another solution to this problem. Look for the reasoning stated in the solution or conclusions:

   – What was the **strategy/approach** and how well did it work?
   – Are **computations/data collection** accurate and reasonable?
   – How do the **representations or models** (table/chart/equation/diagram) support claims or solution?
   – What **connections were** made?

OR

2. Improve upon a given solution to this problem.
3. Use a rubric to score and compare solutions.
4. Teach someone else how to solve this.

Performance Task Resources

Sample STEM Assessments from the University of Buffalo

- **Case studies** – enter topic at http://sciencecases.lib.buffalo.edu/cs/collection/

Math & Science Assessment websites

- **MARS Shell Center: Mathematics Assessment Project** (aligned to Common Core) **https://www.map.mathshell.org/index.php**

- **Dan Meyers blog: 3-Act Math - https://blog.mrmeyer.com/three-act-math/**

- **Noyes K-12** [aligned to CCSS– annotated tasks. I would not call most of them deep/DOK 3, but they are a good start and can be modified for deeper thinking. Some include videos.] http://www.insidemathematics.org/performance-assessment-tasks

- **www.weteachnyc.org** : Assessment tasks with student work and scoring guides

- **PARCC Math Practice Tests** (gr 3-high school): https://parcc.pearson.com/practice-tests/math/