

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

Strategies for Modifying Tasks

Increasing the cognitive demands of tasks.

- Ask students to **create real-world stories** for “naked number” problems.
- Include a prompt that asks students to **represent the information another way** (with a picture, in a table, a graph, an equation, with a context).
- Use a task “out of sequence” **before students have memorized a rule** or have practiced a procedure that can be routinely applied.
- **Eliminate components** of the task that confine student thinking or provide too much scaffolding.
- Create opportunities for **repeated reasoning or pattern finding**
- Create a prompt that asks students to **write about the meaning** of the mathematics concept.
- Add a prompt that asks students to make **note of a pattern** or to **make a mathematical conjecture** and to test their conjecture.
- Include a prompt that requires students to **make a generalization**.
- Include a prompt that requires students to **compare solution paths** or mathematical relationships and write about the relationship between strategies or concepts.
- Select numbers carefully so students are more inclined to **note relationships between quantities** (e.g., two tables can be used to think about the solutions to the four, six, or eight tables).

Table 2.1:
Factors Associated With the Maintenance or Decline of High-Level-Cognitive Demand

Maintenance of High-Cognitive-Demand Student Behavior	Decline of High-Cognitive-Demand Student Behavior
<ul style="list-style-type: none"> • Scaffolding of student thinking and reasoning • Pressing for justifications, explanations, or meaning through questions, comments, or feedback • Modeling of high-level performance by teacher or capable students • Selecting tasks that build on students' prior knowledge • Drawing frequent conceptual connections • Providing a means by which students can monitor their own progress • Providing sufficient time to explore 	<ul style="list-style-type: none"> • Routinizing problematic aspects of the task • Failing to hold students accountable for high-level products or processes • Providing insufficient time to wrestle with the demanding aspects of the task or so much time that students drift into off-task behavior • Shifting the emphasis from meaning, concepts, or understanding to the correctness or completeness of the answer • Having classroom management problems • Selecting a task that is inappropriate for a given group of students

Source: Adapted from Stein & Smith, 1998, p. 27.

Resources for Tasks and Lesson Plans

(not a comprehensive listing)

National Council of Teachers of Mathematics:

REASONING AND SENSE MAKING TASK LIBRARY – high school tasks that engage students in reasoning and sense making that are linked directly to focus in high school: reasoning and sense making (nctm, 2009) along with suggestions for facilitating student work on the task and insights into how students might think about the task

<http://www.Nctm.Org/rsmtasks/>

ILLUMINATIONS – LESSONS AND ACTIVITIES (k-12) that are aligned with nctm's principles and standards for school mathematics (2000) and the common core state standards for school mathematics (2010).

<http://illuminations.Nctm.Org/>

ACTIVITIES WITH RIGOR AND COHERENCE (arcs) – sequences of lessons (k-12) that address a specific mathematical topic and support the implementation of the eight effective mathematics teaching practices (nctm, 2014) and the five practices for orchestrating productive discussions (smith and stein, 2018).

<http://www.Nctm.Org/arcs/>

PROBLEMS OF THE WEEK – tasks per grade band (k-2, 3-5, 6-8) and content strand (algebra, geometry, trig & calculus) plus solution strategies, rubrics, and teaching suggestions

<http://www.Nctm.Org/classroom-resources/crcc/math-forum-problems-of-the-week-resources/>

Other Resources:

ILLUSTRATIVE MATHEMATICS CURRICULUM – a 6-8 problem-based curriculum that is free – you need to sign up to access the curriculum

<https://im.Openupresources.Org>

INSIDE MATHEMATICS – a k-12 resource for educators that includes video lessons, problems of the month, performance assessment tasks, and a range of resources

<http://www.Insidemathematics.Org/>

PARK CITY MATHEMATICS INSTITUTE RESOURCES FOR EDUCATORS

<http://mathforum.org/pcmi/hstp/resources.html>

MATHALICIOUS - real world lessons, aligned to ccss, designed to build proficiency in mathematical practices and build conceptual understanding; some lessons are free but access to all resources requires membership and a fee

<http://www.Mathalicious.Com>

ACHIEVE EXAMPLES OF INSTRUCTIONAL MATERIAL

<https://www.achieve.org/equip/examples>

MATHEMATICS ASSESSMENT PROJECT

<http://map.mathshell.org/materials/index.php>

ROBERT KAPLINSKY'S LESSONS – lessons for k-8, algebra 1, algebra 2 and geometry built around visual images and general questions that are intended to engage students in further exploration

<http://robertkaplinsky.Com/lessons/>

DAN MEYER'S THREE-ACT LESSONS – lessons for 6-12 that follow a particular structure – show students an image or video that depicts an interesting situation; engage students in asking questions about and identifying information in the image or video; creating models to answer the questions

<http://blog.Mrmeyer.Com/2011/the-three-acts-of-a-mathematical-story/>