Consortium on Reaching Excellence in Education®

Putting DOK into Practice with Hess' Cognitive Rigor Matrix

Dr. Karin Hess combined Bloom's taxonomy and Webb's Depth of Knowledge into a single chart which she calls a Cognitive Rigor Matrix. (Hess, Carlock, Jones, and Walkup 2009) We have pulled out math examples from Hess' Cognitive Rigor Matrix and placed them into three general categories, Understand, Apply, and Analyze math concepts, facts, and ideas.

This chart provides a comparison of varying levels or depths of knowledge applied to mathematical understanding and practices by students. Generally speaking, rigor increases as you go from left to right on the chart and as you go from DOK 1 to DOK 4. A second chart, again from Hess, shows student and teacher roles for each DOK level along with question stems that generally fit with that level.

For additional information and insights regarding Hess' Cognitive Rigor Matrix visit www.karin-hess.com.

Suggested activities with teachers:

I. Familiarize Teachers with the Chart

a) Individually: Have teachers spend about 3-5 minutes reading over the charts. While reviewing the charts they should note two things that most stand out to them and one thing they have a question about.

b) In small groups: Teachers discuss things that stand out to them or that they have questions about.

c) In whole group: Have 2-4 individuals share what most stands out to them from the charts. Record on chart paper or the board a list of questions teachers have about the information on the charts.

II. Analyze a Video

a) In whole group: Choose a short classroom video to watch of a math lesson and have teachers analyze the lesson to decide where the lesson fits on the charts. (A selection of videos is shown on the next page. Choose one of these or find others.)

b) In small groups: Discuss where the part of the lesson shown best fits on the chart and why.

c) In whole group: Share/discuss thoughts on the video lesson.

III. Use the Chart for Instruction

a) Individually: Each teacher think of a recent lesson or a lesson soon to be taught. Where does the lesson primarily fit on the charts? Explain. What can be done to improve the lesson in terms of depth of knowledge — what question(s) can be asked, how might the lesson be adjusted, etc.? Create a specific plan for improving the lesson and explain how the changes increase the rigor of the lesson.

A sample of videos on math instruction

Grade Level	Video length (min:sec)	Link	Synopsis	Strategies Used
Grade 1	**5:36**	http://www.insidemathematics.org/index.php/classroom-video-visits/formative-assessment-lesson-base-ten-menu/558-part-2	*How Many Are Hiding?* Teacher sets up "discourse" by providing sentence frames and clear directions for students to determine hidden quantity. Students explain to each other how they know.	• Sentence frames • Partner talk
Grade 3	**7:11**	https://www.teachingchannel.org/videos/teaching-number-patterns?fd=1	*Discover Number Patterns with Skip Counting: Teacher asks "What is the next number?"* Teacher provides individual think time, then students share with each other, then share with whole class, and make math concepts explicit. Teacher asks process/reasoning questions and has whole class discourse to explain thinking. Video includes teacher commentary that explains the process of the lesson.	• Agree, disagree, add-on • Think time, • Turn and talk • Clear introduction • Explicitly connect mathematical ideas • Choral counting • Use of color coding • Identify patterns
Grade 7	**6:44** total in two parts	http://www.insidemathematics.org/index.php/7th-grade-whats-the-savings Go to "Clip 2: Number Talk"	• **Show 0:00–5:00:** Teacher gives class a word problem, requires think time, then has pair-share time with directions about who talks first, and circulates around the room to monitor and facilitate discourse • **Show 17:45–19:29:** Teach creates opportunity for meaningful discourse and thinking about the math by asking about "distractor" answers in multiple-choice problem.	• First understand the problem. • Assign talking turns • Think time • Use visual signals • Teacher moving around room • Analyze distractors
Grade 10	**7:11**	https://www.youtube.com/watch?v=BVCB-w05iM74&list=UU5mN2B-2JYc9X-iK1qFQjeSg&index=36	Geometry lesson with explicit set-up for writing proofs that moves into good group work with discourse and reasoning. The purpose is clear and the teacher establishes the purpose at the outset of the lesson and returns to the purpose at the end of the lesson.	• Explicit directions • Colored pens to monitor participation • Collaboration and sharing reasoning. • Discourse on wrap-up of lesson

Webb's Depth of Knowledge with Descriptions from Hess' Cognitive Rigor Matrix

	Understand	Apply	Analyze	*Examples*
DOK 1 Recall & Reproduction	• Recall, observe, and recognize facts, principles, properties • Solve a one-step problem • Represent math relationships in words, pictures, or symbols • Read, write, compare numbers	• Follow simple procedures • Calculate, measure, apply a rule • Apply an algorithm or formula • Solve linear equations	• Retrieve information from a table or graph to answer a question • Identify whether specific information is contained in graphic representations • Identify a pattern/trend	*Multiply 29 × 56* *Graph y = 2x + 5*
DOK 2 Basic Application of Skills/ Concepts	• Explain relationships (e.g., cause-effect, nonexamples/ examples) • Summarize results or concepts • Use models/diagrams to represent or explain math concepts • Make or explain estimates	• Solve routine problems, applying multiple concepts or decision points • Retrieve information from a table, graph, or figure to solve a problem • Translate between tables, graphs, words, and symbolic notations	• Categorize, classify, and/or organize materials, data, or figures based on characteristics • Compare/contrast figures or data • Organize data and select appropriate display • Extend a pattern	• *Estimate 29 × 56.* • *Explain your reasoning for how you made your estimate.* • *Use an area model to demonstrate 29 × 56.* *Compare the graphs of y = 2x + 5 and y = –2x + 5*
DOK 3 Strategic Thinking and Reasoning	• Explain, generalize, or connect and build on mathematical ideas/concepts using evidence • Make and justify conjectures • Explain thinking when more than one response/solution is possible • Explain real world phenomena in terms of math concepts or models	• Solve nonroutine problems • Use and show reasoning and evidence • Translate between problem and mathematical modeling when not a direct translation • Develop a mathematical model for a complex situation	• Generalize a pattern • Analyze similarities/differences between procedures or solutions • Analyze and draw conclusions from data, citing evidence • Cite evidence and develop a logical argument for solutions	• *Compare two different methods for determining the product for 29 × 56.* • *When is each method the "best" to use? Why?* *Create an equation to model the approximate speed of a runner during an 800 km race.*
DOK 4 Extended Thinking	• Relate mathematical concepts to other content areas, other domains, or other concepts	• Conduct a project that specifies a problem, identifies solution paths, solves the problem, and reports results	• Apply understanding in a novel way, provide argument or justification for the application	*Create a graph showing the distance of the moon from your home over a three month period.*

Descriptions from Hess' Cognitive Rigor Matrix

	DOK 1 Recall & Reproduction	DOK 2 Skills & Concepts	DOK 3 Strategic Thinking/ Reasoning	DOK 4 Extended Thinking
Teacher Role	Questions to direct or focus attention, shows, tells, demonstrates, provides examples, examines, leads, breaks down, defines	Questions to differentiate, infer, or check conceptual understanding, models, organizes/reorganizes, explores possible options or connections, provides examples and nonexamples	Questions to probe reasoning and underlying thinking, asks open-ended questions, acts as a resource and coach, provides criteria and examples for making judgments and supporting claims, encourages multiple approaches and solutions; determines when/where (text, concept) depth and exploration is most appropriate	Questions to extend thinking and broaden perspectives; facilitates teaming, collaboration, self-evaluation
Student Role	Recognizes, responds, remembers, memorizes, restates, absorbs, describes, demonstrates, follows directions, applies routine processes, definitions, and procedures	Recognizes, responds, remembers, memorizes, restates, absorbs, describes, demonstrates, follows directions, applies routine processes, definitions, and procedures	Uncovers and selects relevant and credible supporting evidence for analyses, critiques, debates, claims, and judgments; plans, initiates questions, disputes, argues, tests ideas/solutions, sustains inquiry into topics or deeper problems, applies to the real world	Designs, takes risks, researches synthesizing multiple resources, collaborates, plans, organizes, and modifies, creates concrete tangible product
Question Stems	• Can you recall_____? • What is____? • Can you select____? • How would you write___? • What might you include on a list about___? • What is the formula for___? • Can you identify___? • How would you describe___?	• How or why would you use ____? • Can you explain how ____ ? • What was the cause of ____? • How would you compare ____? Contrast_____? • How would you classify____? What would you use to classify___? • How are____alike? Different? • What can you say about____? • How would you summarize ____? • How would you estimate___? • What examples/ nonexamples can you find to ____?	• How is ____ related to ____? • What conclusions can you draw ___? • How would you adapt ____to create a different____? • How would you test____? • Can you predict the outcome if____? • What is the best method? Why? • Support your rationale. • What facts would you select to support____? • Can you elaborate on the reason____? • What would happen if___? • Can you formulate a prediction for___?	• What could be done to minimize/ maximize __ ? • In what way would you design or redesign ___ and why? • How would you evaluate ___? • How would you prioritize criteria for making this decision . . . and why? • What information would you use to support a differing perspective___? • Can you formulate and test a conjecture for__? • Can you construct a model that would change __? • What information can you gather to support your idea about___?