DOK for Cognitive Coding in 6-12 Mathematics

The state of Nevada will soon be using Depth of Knowledge (DOK) cognitive coding in its state assessments, including the mathematics CRTs and HSPEs. There are four levels of DOK, where the levels represent a hierarchy based on cognitive complexity (rather than time on task difficulty). The hierarchy is based on two main factors: 1) sophistication and complexity, and 2) the likelihood that students at the grade level tested would have received prior instruction or would have had an opportunity to learn the content. Some problems or tasks have a low DOK level because the knowledge required is commonly known and students with instruction at grade level should have had the opportunity to learn how to routinely perform what is being asked.

It is vital for student success that mathematics teachers expose their students to activities that represent all DOK levels. For example, consider the activities and associated DOK levels when designing lessons in your mathematics classroom.

DOK Level 1 (Recall and Reproduction)

- Find the area of a rectangle
- Convert scientific notation to decimal form
- Do basic mathematical calculations, routine procedures
- Identify a diagonal in a geometric figure
- Do basic computations, multiply two numbers
- Measure an angle
- Recall of a fact, information, procedure, definition, term
- Perform a simple algorithm
- Follow a set procedure
- Apply a formula
- Perform a clearly defined series of steps
- Habitual response: can be described; can be explained
- Use a routine method
- Recognize patterns
- Retrieve information from a graph
- Use appropriate tools
- Identify, recognize, measure

DOK Level 2 (Basic Reasoning, Skill/Concept)

- Basic application of a skill or concept
- Classify quadrilaterals
- Determine a strategy to estimate
- Solve routine multiple-step problems
- Identify patterns in events or behavior
- Formulate a routine problem given data and conditions
- Make observations
- Collect, organize, classify, display, represent, compare data
- Explain purpose and use of experimental procedures
- Explain, describe or interpret
- Organize and display data in tables, charts and graphs
- Perform more than one step or procedure
- Demonstrate conceptual knowledge through models and explanations
- Extend a pattern
- Explain concepts, relationships, and non-examples
- Demonstrate visualization skills
- Demonstrate probability skills

DOK Level 3 (Strategic Thinking, Complex Reasoning)

- Write a mathematical rule for a non-routine pattern
- Determine the equations and solve and interpret a system
- Provide a mathematical justification
- Interpret information from a series of data displays
- Support ideas with details and examples
- Apply a concept in other contexts
- Requires reasoning, planning using evidence and a higher level of thinking
- Explain/justify your thinking
- Make conjectures

- Cognitive demands are complex and abstract
- Conjecture, plan, abstract, explain
- Draw conclusions from observations
- Interpret information from a complex graph
- Cite evidence and develop logical arguments for concepts
- Explain phenomena in terms of concepts
- Use concepts to solve problems
- Provide justification when more than one possible answer
- Exhibit strategic thinking
- Analyze, synthesize

DOK Level 4 (Extended Thinking/Reasoning)

- Project-based assessment
- Performance tasks; cognitive demands of the tasks are high
- Collect data over time taking into consideration a number of variables and analyze the results
- Develop a rule for a complex pattern and find a phenomenon that exhibits that behavior
- Complete a unit of formal geometric constructions, such as nine-point circles or the Euler line.
- Conduct a project that requires specifying a problem, designing and conducting an experiment, analyzing its data, and reporting results/solutions
- Apply mathematical models to a problem or situation
- Design a mathematical model to inform and solve a practical or abstract situation
- Include complex reasoning, planning, and thinking
- Students make connections within the content area or among content areas
- Select one approach among alternatives
- Design and conduct experiments
- Combine and synthesize ideas into new concepts
- Critique experimental designs

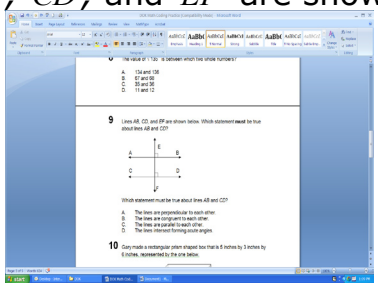
Due to the complex cognitive demands and the possibility of extended time requirements, DOK level 4 questions will not be included on the CRTs and HSPE.

For the mathematics HSPE, two important events will occur in Spring 2010. First, sophomores who take the HSPE will experience a different mathematics portion of the exam. All questions will reflect the 2006 revised math standards and ***only*** at the 9 through 12 grade levels. In the past, students taking the exam had exposure to around 45% of the items from the 7th and 8th grade standards. This is no longer allowed under the Federal Compliance Assessment Agreement. Second, the HSPE questions will be leveled to DOK and not to ability levels. This will require the students to answer 10% of the 60 questions at a DOK Level 3, 47% at a DOK Level 2 and 43% at a Level 1.

Here are some example questions to test your DOK savvy:

1. Evaluate the expression:
$5n - 4$, for $n = 1.2$
A. 2.0
B. 2.2
C. 5.8
D. 56.0

2. Lines $\overleftrightarrow{AB}$, $\overleftrightarrow{CD}$, and $\overleftrightarrow{EF}$ are shown below:

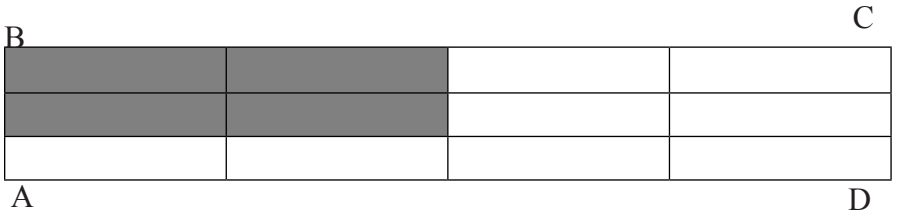


Which statement **must** be true about lines $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$?
A. The lines are perpendicular to each other.
B. The lines are congruent to each other.
C. The lines are parallel to each other.
D. The lines intersect forming acute angles.

3. If $1 < a < 2$, and $b = a$, which of these expressions has the GREATEST value?
A. ab
B. $a + b$
C. $a - b$
D. a/b

4. A car odometer registered 41,256.9 miles when a highway sign warned of a detour 1,200 feet ahead. What will the odometer read when the car reaches the detour? (5280 feet = 1 mile)
A. 41,279.9
B. 41,261.3
C. 41,259.2
D. 41,257.1

5. In the figure below, what fraction of rectangle ABCD is shaded?



A. 1/6
B. 1/5
C. 1/4
D. 1/3

(Answers on page 20)