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Mathematics DOK Definitions

DOK 1 (Recall)

DOK 1 is defined by the rote recall of information or reproduction of a simple, routine procedure. For example, repeating a memorized fact, definition, or term, performing a simple algorithm, rounding a number, or applying a formula are DOK 1 tasks. Performing a one-step computation or operation, executing a well-defined multi-step procedure or a direct computational algorithm are also included in this category. Examples of well-defined multi-step procedures include finding the mean or median or performing long division. Reading information directly from a graph, plugging data into an electronic device to derive an answer, or simple paraphrasing are all tasks that are considered a level of complexity comparable to recall. A student answering a Level 1 item either knows the answer or does not: that is, the item does not need to be "figured out" or "solved."

At a DOK 1, problems in context are straightforward and the solution path is obvious. For example, the problem may contain a keyword that indicates the operation needed. Other DOK 1 examples include plotting points on a coordinate system, using coordinates with the distance formula, or drawing lines of symmetry of geometric figures.

At more advanced levels of mathematics, symbol manipulation and solving a quadratic equation or a system of two linear equations with two unknowns are considered "routine" and, therefore, comparable to recall – assuming students are expected or likely to use well-known procedures (e.g. factoring, completing the square, substitution, or elimination) to derive a solution. Operating on polynomials or radicals, using the laws of exponents, or simplifying rational expressions are considered routine procedures.

Verbs should not be classified as any category without considering what the verb is acting upon or the verb's direct object. For example, to *describe* by listing the steps used to solve a problem is recall (i.e, *Show your work*). Similarly, to *describe* attributes of a polygon is definitional. In contrast, to *describe* by providing a mathematical argument or rationale for a solution is more complex.

Webb, N. L. *Alignment study in language arts, mathematics, science, and social studies of state standards and assessments for four states*. A study of the State Collaborative on Assessment & Student Standards (SCASS) Technical Issues in Large-Scale Assessment (TILSA). Washington, D. C.: Council of Chief State School Officers, December 2002. Revised in 2014 by Norman Webb and Sara Christopherson with the help of Lynn Raith.

DOK 2 (Skill/Concept)

DOK 2 involves engaging in some mental processing beyond a habitual response as well as decision-making about how to approach the problem or activity. This category can require conceptual understanding and/or demonstrating conceptual knowledge by explaining thinking in terms of concepts.

DOK 2 tasks include distinguishing among mathematical ideas, processing information about the underlying structure, drawing relationships among ideas, deciding among and performing appropriate skills, applying properties or conventions within a relevant and necessary context, transforming among different representations, interpreting and solving problems and/or graphs. When given a problem statement, formulating an equation or inequality, deriving a solution, and reporting the solution in the context of the problem fit within DOK 2. Processes such as classifying, organizing, and estimating that involve attending to multiple attributes, features, or properties also fall into this category.

Even the youngest students can engage in conceptual work. Verifying that the number of objects in one set is larger or fewer than the number of objects in a second set by matching pairs or forming equivalent groups is an example of a DOK 2 task for a Kindergartener. Modeling a mathematical concept or situation pictorially or physically also is in this category.

Skills and concepts include constructing a graph and interpreting the meaning of critical features of a function, beyond just identifying or finding such features as well as describing the effects of parameter changes. Note, however, that using a well-defined procedure to find features of a standard function, such as the slope of a linear function with one variable or a quadratic, is a DOK 1. Graphing higher order or irregular functions is a DOK 2. Basic computation, as well as converting between different units of measurement, are generally DOK 1, but illustrating a computation by different representations (e.g. equations and a base-ten model) to explain the results is a DOK 2. Computing measures of central tendency (applying set procedures) is a DOK 1, but interpreting such measures for a data set within its context or using measures to compare multiple data sets is a DOK 2. Performing original formal proofs is beyond DOK 2, but explaining in one's own words the reasons for an action or application of a property is comparable to a DOK 2. Activities at a DOK 2 are not limited only to number skills, but may involve visualization skills (e.g. mentally rotating a 3D figure or transforming a figure) and probability skills requiring more than simple counting (e.g. determining a sample space or probability of a compound event). Other activities at this category include detecting or describing non-trivial patterns, explaining the purpose and use of experimental procedures, and carrying out experimental procedures.

DOK 3 (Strategic Thinking)

DOK 3 requires reasoning and analyzing using mathematical principles, ideas, structure, and practices. DOK 3 includes solving involved problems; conjecturing; creating novel solutions and forms of representation; devising original proofs, mathematical arguments, and critiques of arguments; constructing mathematical models; and forming robust inferences and predictions. Although DOK 2 also involves some problem solving, DOK 3 includes situations that are non-routine, more demanding, more abstract, and more complex than DOK 2. Such activities are characterized by producing sound and valid mathematical arguments when solving problems, verifying answers, developing a proof, or drawing inferences. Note that the sophistication of a mathematical argument that would be considered DOK 3 depends on the prior knowledge and experiences of the person. For example, problems that could be solved using mathematical logic and reasoning may be more simply and efficiently solved in later grades with use of a taught procedure. Thus, primary school student arguments for number problems can be a DOK 3 activity (e.g. counting number of combinations, finding shortest route from home to school, computing with large numbers) as can abstract reasoning in developing a logical argument by students in higher grades. DOK 3 problems are those for which it is not evident from the first reading what is needed to derive a solution and so require demanding reasoning to work through. Such problems usually can be solved in different ways and may even have more than one correct solution based on different stated assumptions. Paraphrasing in one's own words or reproducing a proof that was previously demonstrated is a DOK 2. Applying properties and producing arguments in proving a theorem or identity not previously seen is a DOK 3. Examples within the DOK 3 category include creating a mathematical model of a situation considering contextual constraints, deriving a new formula, designing and conducting an experiment, and interpreting findings.

DOK 4 (Extended Thinking)

DOK 4 demands are at least as complex as those of DOK 3, but a main factor that distinguishes the two categories is the need to perform activities over days and weeks (DOK 4) rather than in one sitting (DOK 3). The extended time that accompanies this type of activity allows for original, iterative, and reflective work that requires extended and metacognitive thinking to complete. DOK Category 4 activities require complex reasoning, planning, research, and verification of work. Conducting a research project, performance activity, an experiment, and a design project as well as creating a new theorem and proof fit under Category 4. The extended time period is not a distinguishing factor if the required work is only repetitive and does not require applying significant conceptual understanding and higher-order thinking. For example, collecting water temperature from a river each day for a month and then reporting the findings by constructing a graph is a DOK 2 activity. Developing a mathematical model of the flow of water in a river for a particular time period with consideration of a number of variables would be a DOK 4 activity. It is likely that a DOK 4 activity will require making connections among a number of ideas or variables within the area of mathematics or among a number of content areas. DOK Category 4 activities require selecting an appropriate approach among many alternatives to produce a product, conclusion, or finding, such as critiquing a body of work, synthesizing ideas in a new way, or creating an original model.

General Guidelines for Assigning DOK:

- The DOK definitions can be applied to standards, prompts, questions, or tasks.
- Consider the complexity of the cognitive demands, not the difficulty for students.
- Consider the prior knowledge and grade-level expectations of a typical student.
- Do not rely on verbs (describe, explain, evaluate, etc.). Instead, consider the type of cognitive engagement required to produce a correct answer or successfully complete a task.
- Set aside the learning process; focus on the outcome.
- For multiple-choice assessment items, consider the item as a whole—including distractors—to judge complexity.
- An expectation or item that is confusing due to error or wording does not reflect increased complexity—it simply means editorial revisions are needed.