

### Depth of Knowledge

#### Level 1 -

- Requires students to recite or recall of information including fact, formula, or simple procedure.
- May be asked to demonstrate a rote response, use a well-known formula, follow a set procedure (like a recipe), or perform a clearly defined series of steps.

#### Level 2 -

- Requires some mental processing beyond a habitual response.
- Requires students to make some decisions on how to approach a task or problem

#### Level 3 -

- Requires reasoning, planning, using evidence and in most cases to “explain their thinking.”
- Requires students to go beyond; to explain, to generalize, or connect ideas

#### Level 4 -

- Requires some complex reasoning, planning, developing and thinking over an extended period of time.
- May be asked to develop a hypothesis and perform complex analysis

### Mathematics Depth of Knowledge Descriptions

*Four levels of depth-of-knowledge are used in this analysis. The levels represent a hierarchy based on complexity (rather than difficulty). This difference takes some time to ponder and refine. 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 assessment items have a low depth-of-knowledge level because the knowledge required is commonly known and student with normal instruction at a grade level should have had the opportunity to learn how to routinely perform what is being asked*

#### Level 1 (Recall)

Includes the recall of information such as a fact, definition, term, or a simple procedure, as well as performing a simple algorithm or applying a formula. That is, in mathematics, a one-step, well-defined, and straight algorithmic procedure should be included at this lowest level.

Other key words that signify Level 1 include “identify,” “recall,” “recognize,” “use,”

and “measure.” Verbs such as “describe” and “explain” could be classified at different levels, depending on what is to be described and explained.

### **Level 2 (Skill/Concept)**

Includes the engagement of some mental processing beyond an habitual response. A Level 2 assessment item requires students to make some decisions as to how to approach the problem or activity, whereas Level 1 requires students to demonstrate a rote response, perform a well-known algorithm, follow a set procedure (like a recipe), or perform a clearly defined series of steps.

Keywords that generally distinguish a Level 2 item include “classify,” “organize,” “estimate,” “make observations,” “collect and display data,” and “compare data.” These actions imply more than one step. For example, to compare data requires first identifying characteristics of objects or phenomena and then grouping or ordering the objects. Some action verbs, such as “explain,” “describe,” or “interpret,” could be classified at different levels depending on the object of the action.

For example, interpreting information from a simple graph, or reading information from the graph, also are at Level 2. Interpreting information from a complex graph that requires some decisions on what features of the graph need to be considered and how information from the graph can be aggregated is at Level 3. Level 2 activities are not limited only to number skills, but may involve visualization skills and probability skills.

Other Level 2 activities include noticing or describing non-trivial patterns, explaining the purpose and use of experimental procedures; carrying out experimental procedures; making observations and collecting data; classifying, organizing, and comparing data; and organizing and displaying data in tables, graphs, and charts.

### **Level 3 (Strategic Thinking)**

Requires reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. In most instances, requiring students to explain their thinking is at Level 3. Activities that require students to make conjectures are also at this level.

The cognitive demands at Level 3 are complex and abstract. The complexity does not result from the fact that there are multiple answers, a possibility for both Levels 1 and 2, but because the task requires more demanding reasoning. An activity, however, that has more than one possible answer and requires students to justify the response they give would most likely be at Level 3.

Other Level 3 activities include drawing conclusions from observations; citing

evidence and developing a logical argument for concepts; explaining phenomena in terms of concepts; and deciding which concepts to apply in order to solve a complex problem.

### **Level 4 (Extended Thinking)**

Requires complex reasoning, planning, developing, and thinking, most likely over an extended period of time. 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, if a student has to take the water temperature from a river each day for a month and then construct a graph, this would be classified as a Level 2. However, if the student is to conduct a river study that requires taking into consideration a number of variables, this would be a Level 4. At Level 4, the cognitive demands of the task should be high and the work should be very complex.

Students should be required to make several connections—relate ideas within the content area or among content areas—and have to select one approach among many alternatives on how the situation should be solved, in order to be at this highest level. Level 4 activities include designing and conducting experiments and projects; developing and proving conjectures, making connections between a finding and related concepts and phenomena; combining and synthesizing ideas into new concepts; and critiquing experimental designs.