Levels of Depth of Knowledge for Science

Interpreting and assigning Depth of Knowledge levels to objectives within science standards and assessment items is an essential requirement of alignment analysis. Please note that, in science, “knowledge” can refer to content knowledge, knowledge of science processes, and nature of science.

Level 1 (Recall) is the recall of information such as a fact, definition, or term, as well as performing a simple science process or procedure. Level 1 only requires students to demonstrate a rote response, use a well-known formula, follow a set well-defined procedure (like a recipe), or perform a clearly defined series of steps. Standards that lend themselves to simple word problems that can be directly translated into and solved by a formula are considered Level 1.

Some examples that represent but do not constitute all of Level 1 performance are:

•Recall or recognize a fact, term, or property.

•Represent in words or diagrams a scientific concept or relationship.

•Provide or recognize a standard scientific representation for simple phenomena.

•Perform a routine procedure such as measuring length.

•Identify familiar forces (e.g. pushes, pulls, gravitation, friction, etc.)

•Identify objects and materials as solids, liquids, or gases.

Level 2 (Basic Application of Concepts & Skills) includes the engagement of some mental processing beyond recalling or reproducing a response. The content knowledge or process involved is more complex than in Level 1. Level 2 requires that students make some decisions as to how to approach the question or problem. Level 2 activities include making observations and collecting data; classifying, organizing, and comparing data; representing and displaying data in tables, graphs, and charts.

Some action verbs, such as “explain,” “describe,” or “interpret,” maybe classified at different DOK levels, depending on the complexity of the action. For example, interpreting information from a simple graph, requiring reading information from the graph, is at Level 2. An activity that requires interpretation from a complex graph, such as making decisions regarding features of the graph that should be considered and how information from the graph can be aggregated, is at Level 3.

Some examples that represent, but do not constitute all of Level 2 performance, are:

•Specify and explain the relationship among facts, terms, properties, and variables.

•Identify variables, including controls, in simple experiments.

•Distinguish between experiments and systematic observations.

•Describe and explain examples and non-examples of science concepts.

•Select a procedure according to specified criteria and perform it.

•Formulate a routine problem given data and conditions.

•Organize, represent, and interpret data.

Level 3

(Strategic Thinking& Complex Reasoning) requires reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. The cognitive demands at Level 3 are complex and abstract. The complexity does not result only from the fact that there could be multiple answers, a possibility for both Levels 1 and 2, but because the multi-step task requires more demanding reasoning.

In most instances, requiring students to explain their thinking is at Level 3; requiring a very simple explanation or a word or two should be at Level 2. An activity that has more than one possible answer and requires students to justify the response they give would most likely be a Level 3. Experimental designs in Level 3 typically involve more than one dependent variable. 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 using concepts to solve non-routine problems.

Some examples that represent, but do not constitute all of Level 3 performance, are:

•Identify research questions and design investigations for a scientific problem.

•Design and execute an experiment or systematic observation to test a hypothesis or research question.

•Develop a scientific model for a complex situation.

•Form conclusions from experimental data.

•Cite evidence that living systems follow the Laws of Conservation of Mass and Energy.

•Explain how political, social, and economic concerns can affect science, and vice versa.

•Create a conceptual or mathematical model to explain the key elements of a scientific theory or concept.

•Explain the physical properties of the Sun and its dynamic nature and connect them to conditions and events on Earth.

•Analyze past, present, and potential future consequences to the environment resulting from various energy production technologies.

Level 4 (Extended Thinking &Complex Reasoning) standards and assessment items have the same high cognitive demands as Level 3 with the additional requirement that students work over an extended period of time or with extended effort. Students are required to make several connections—relating ideas within the content area or among content areas

—and have to select or devise one approach among many alternatives for how the situation or problem can be solved. Standards, goals, and objectives can be stated in such a way as to expect students to perform extended thinking. Many, but not all, performance assessments and open-ended assessment activities requiring significant thought will be level 4. Level 4 requires complex reasoning, and an extended period of time either for a science investigation relevant to a standard, or for carrying out the complex analysis and synthesis required of an assessment item.

For example, a standard or performance task that calls for the student to use evidence from multiple fields of scientific inquiry in supporting a scientific claim might represent a level 4, depending upon the complexity of the analysis. In any event, an activity or performance task associated with a level 4 standard will require an extended period of time for a student to accomplish. It is important to reiterate that the extended time period is not a distinguishing factor if the required work is only repetitive and does not require the application of significant conceptual understanding and higher-order thinking. For example, an activity that calls upon a student to measure the water temperature from a river each day for a month before constructing a graph would be classified as a level 2. On the other hand, an activity that calls upon a student to conduct a complex river study that requires taking into consideration a number of variables would be a level 4.

Some examples that represent but do not constitute all of a Level 4 performance are:

•Based on provided data from a complex experiment that is novel to the student, deduce the fundamental relationships among several variables.

•Conduct an investigation, from specifying a problem to designing and carrying out an experiment, to analyzing its data and forming conclusions.

•Explain how a particular scientific theory (e.g., evolution, plate tectonics, atomic theory, etc.) is supported by evidence from multiple lines of inquiry.

•Produce a detailed report of a scientific experiment or systematic observation and infer conclusions based upon evidence obtained.

•Write a detailed history of the development of an important scientific concept (e.g., atomic theory, gravitation) and explain how current conceptions developed from prior ones.