

Depth of Knowledge Definitions for Science

Level 1 (Recall and Reproduction) requires the recall of information, such as a fact, definition, term, or a simple procedure, as well as performance of a simple science process or procedure. Level 1 only requires students 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. A “simple procedure” is well defined and typically involved only one step. Verbs such as “identify,” “recall,” “recognize,” “use,” “calculate,” and “measure,” generally represent cognitive work at the recall and reproduction level. Simple word problems that can be directly translated into and solved by formulas are considered Level 1. Verbs such as “describe,” and “explain” could be classified at different DOK levels, depending on the complexity of the content.

A student answering a Level 1 item either knows the answer or does not. The question does not require the student to “figure out” the answer. If the knowledge necessary to answer the question automatically provides the answer, then the item is a Level 1.

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

- Recall a science fact, term, definition, property, tool, structure, or function
- Recognizing/providing a traditional scientific representation in words or diagrams
- Measuring length or any other routine procedure
- Calculating by merely substituting numbers and units into a given formula

Level 2 (Skill and Concepts) includes the engagement of some mental processes beyond recalling or reproducing a response. The content knowledge or process is more complex than in Level 1. Items require students to make some decisions as to how to approach the question or problem. 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 the objects of phenomena and the grouping or ordering the objects. Level 2 activities include making observations and collecting data; classifying organizing, and comparing data; and organizing and displaying data in graphs and tables. Some action verbs, such as “explain,” “describe,” or “interpret,” could be classified at different DOK levels depending on the complexity of the task. For example, interpreting information from a simple graph, requiring reading information from the graph, is a Level 2. An item that requires interpretation from a complex graph, such as making decisions about features of the graph and how information in the graph can be aggregated, is at a level 3. Some examples that represent, but do not constitute all of, Level 2 performance, are:

- Specify and explain the relationship between facts, terms, properties, or variables.
- 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) 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.
- Solve non-routine problems.
- Develop a scientific model for a complex situation.
- Form conclusions from experimental data.

Level 4 (Extended Thinking) involves high cognitive demands and complexity. Students are required to make several connections—relate ideas within the content area or among content areas—and have to select or devise one approach among many alternatives to solve the problem. Many on-demand assessment instruments will not include any assessment activities that could be classified as Level 4. However, standards, goals, and objectives can be stated in such a way as to expect students to perform extended thinking. “Develop generalizations of the results obtained and the strategies used and apply them to new problem situations,” is an example of a grade 8 objective that is a Level 4. Many, but not all, performance assessments and open-ended assessment activities requiring significant thought will be Level 4.

Level 4 requires complex reasoning, experimental design and planning, and probably will require an extended period of time either for the science investigation required by an objective, or for carrying out the multiple steps of an assessment item. However, 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 activity. However, if the student conducts a river study that requires taking into consideration a number of variables, this would be a Level 4. Some examples that represent, but do not constitute all of, a Level 4 performance are:

- Based on data provided from a complex experiment that is novel to the student, deduct the fundamental relationship between several variables
- Conduct an investigation, from specifying a problem to designing and carrying out an experiment, to analyzing its data and forming conclusions.