The Iowa Core Standards for Mathematics are intended to play a central role in defining what teachers teach. That is, teachers are to <u>align</u> their instruction to the Standards. The Standards not only define the topical, procedural, and conceptual knowledge students are to learn, they also define the type of cognitive processes in which students are to engage. This is known as *cognitive demand* or *cognitive complexity*. *The practical implication of cognitive complexity is that the Standards require teachers to provide students with instructional experiences that not only address the topical and conceptual knowledge of the standards, but the type of thinking called for by the standards as well.* Compelling evidence suggests that when teachers align their instruction to an assessment, students perform better on that assessment. This relationship is better understood when both topical/conceptual knowledge and cognitive complexity are taken into consideration (Gamoran, Porter, Smithson, & White, 1997).

The Iowa Core Standards for Mathematics have been coded for cognitive complexity using Webb's Depth of Knowledge (DOK) approach (Webb, 2005). The DOK called for in each standard reflects the complexity of the standard, not its difficulty. The topical/conceptual knowledge detailed in a standard will be more or less difficult for each student, but requires a consistent level of complexity across students. The DOK of a standard describes the type of work students are most commonly required to perform to demonstrate their attainment of the standard. Webb's DOK has four levels: DOK 1 = Recall, DOK 2 = Skills and Concepts, DOK 3 = Strategic Thinking, and DOK 4 = Extended Thinking. Detailed, verbatim descriptions of each level are provided next (Webb, 2002). These descriptions are intended to provide examples of the type of work students are expected to engage in for each standard.

Webb's DOK Codes Start on Next Page

Mathematics DOK Levels

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.

References

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