

INTRODUCTION TO WEBB'S DEPTH-OF-KNOWLEDGE LEVELS

Mathematics Depth-of-Knowledge 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 a 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 a 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 the objects or phenomenon 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, if an item required students to explain how light affects mass by indicating there is a relationship between light and heat, this is considered a Level 2. Interpreting information from a simple graph, requiring reading information from the graph, also is a 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 a Level 3. Caution is warranted in interpreting Level 2 as only skills because some reviewers will interpret skills very narrowly, as primarily numerical skills, and such interpretation excludes from this level other skills such as visualization skills and probability skills, which may be more complex simply because they are less common. Other Level 2 activities include 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 a 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 a 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 using concepts to solve problems.

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; making connections between a finding and related concepts and phenomena; combining and synthesizing ideas into new concepts; and critiquing experimental designs.

The following pages look at the relationship between:

- **Bloom's Taxonomy**
- **Marzano's Dimensions of Thinking**
- **Webb's Depth of Knowledge Levels**



Bloom Taxonomy

Knowledge	Recall of specifics and generalizations; of methods and processes; and of pattern, structure, or setting.
Comprehension	Knows what is being communicated and can use the material or idea without necessarily relating it.
Applications	Use of abstractions in particular and concrete situations.
Analysis	Make clear the relative hierarchy of ideas in a body of material or to make explicit the relations among the ideas or both.
Synthesis	Assemble parts into a whole.
Evaluation	Judgments about the value of material and methods used for particular purposes.



Marzano's Dimension of Thinking (Wisconsin DPI) (1989)

- **Gathering Information**
Observe, recall, question
- **Organizing Information**
Represent, compare, classify, order
- **Analyzing Information**
Attributes and components, patterns and relationships, main points, accuracy and adequacy
- **Generating Information**
Infer, predict, elaborate
- **Integrating Information**
Summarize, restructure
- **Evaluating Information**
Establish criteria, verify



Depth of Knowledge (1997)

Level 1 Recall

Recall of a fact, information, or procedure.

Level 2 Skill/Concept

Use information or conceptual knowledge, two or more steps, etc.

Level 3 Strategic Thinking

Requires reasoning, developing plan or a sequence of steps, some complexity, more than one possible answer.

Level 4 Extended Thinking

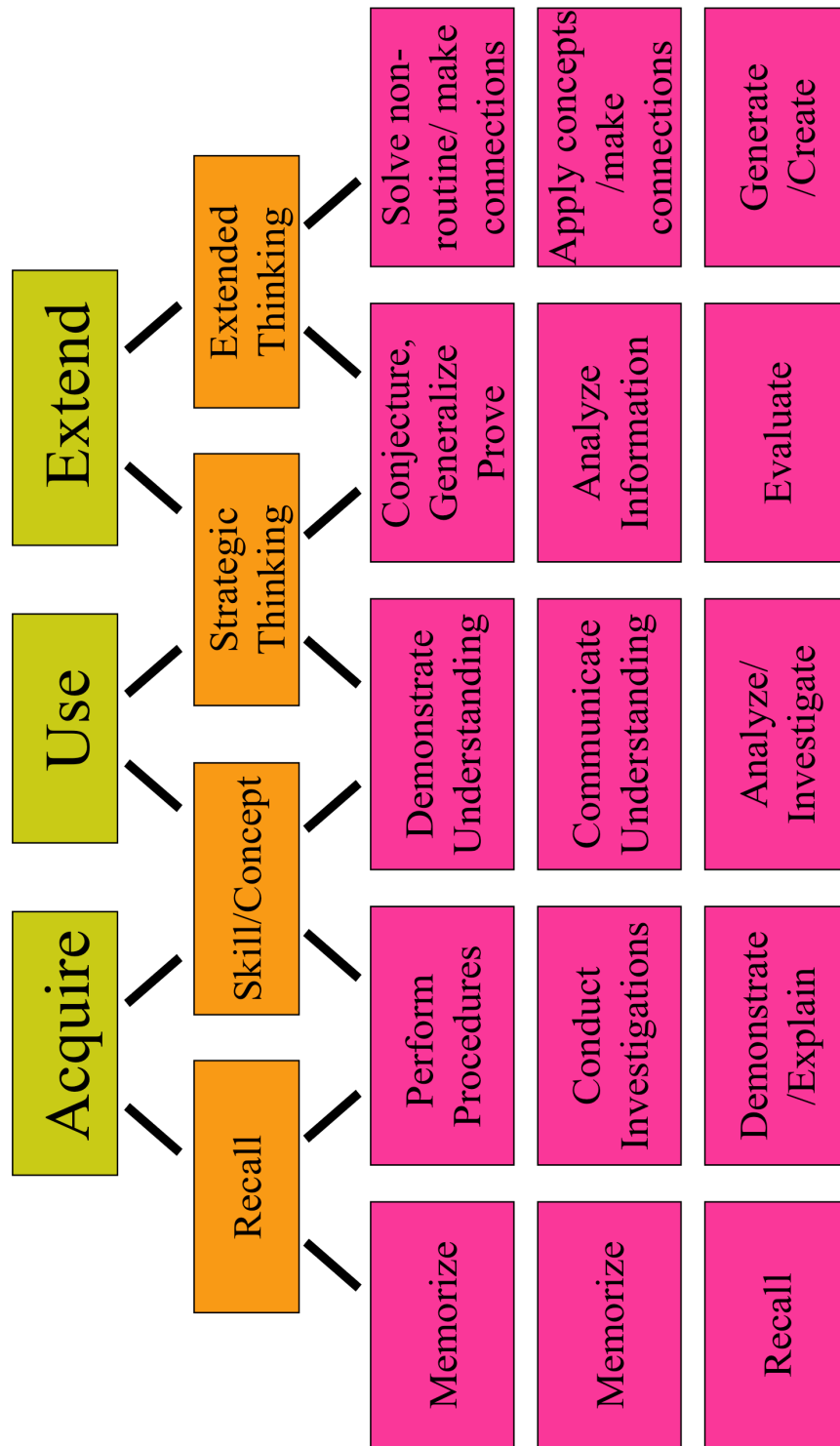
Requires an investigation, time to think and process multiple conditions of the problem.



Survey of Enacted Curriculum Mathematics Cognitive Levels

- Memorize
 - Recall basic mathematics facts; etc.
- Perform procedures
 - Do computational procedures or algorithms; etc.
- Demonstrate understanding
 - Communicate mathematical ideas; use representations to model mathematical ideas; etc.
- Conjecture, generalize, prove
 - Determine the truth of a mathematical pattern or proposition; write formal or informal proof; etc.
- Solve non-routine problems, make connections
 - Apply and adapt a variety of appropriate strategies to solve problems; etc.

Expectations for Student Performance



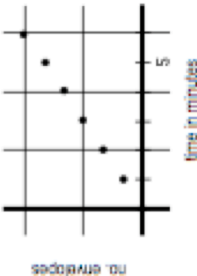
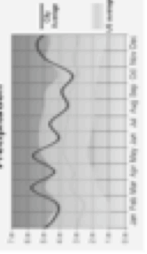
Depth of Knowledge			
I: Recall	II: Skill/Concept	III: Strategic Thinking	IV: Extended Thinking
<p>Depth I includes the recall of information such as fact, definition, term, or a simple procedure, as well as performance of a list of known steps or application of a formula. This depth merely requires that students demonstrate a rote response, perform a well-known algorithm, or follow a set procedure (like a recipe), or perform a clearly defined series of steps.</p> <p>Key words that signify Depth I include identify, recall, recognize, use, and measure. Verbs such as describe and explain could be classified at different levels, depending upon what is to be described and explained.</p> <p>Examples of Depth I:</p> <p>a. Which set of numbers is not a Pythagorean triple? A. 5, 12, 13 B. 3, 4, 5 C. 4, 6, 10 D. 9, 40, 41</p> <p>b. What is the place value of 9 in the number 74,295? A. hundreds B. tenths C. hundredths D. thousandths</p> <p>c. The word that names the relationship between the angles in a linear pair is _____.</p> <p>d. T-F When the determinant formed by the coefficients in a system of linear equations equals zero, the system is inconsistent.</p>	<p>Depth II includes the engagement of mental processing beyond a habitual response. A Depth II assessment item requires students to make some decisions as to how to approach the problem or the activity. Depth II activities are not limited to routinely practiced skills; they may involve additional visualization skills, probability skills, etc. The actions required at this depth imply more than one step (e.g. comparing data requires first identifying characteristics of objects or phenomena and then grouping or ordering the objects.)</p> <p>Keywords that generally distinguish a Depth II item include classify, organize, estimate, collect and display data, make observations, and compare data. Some action verbs, such as explain, describe or interpret could be classified at different levels depending upon the object of the action.</p> <p>Examples of Depth II:</p> <p>a. All of the terms in the list to the right depict _____ A. isometries B. transformations C. symmetries D. similarity</p> <p>b.</p> <div data-bbox="797 1073 899 1220" data-label="Text"> <p>rotation reflection translation dilation</p> </div>  <p>The graph shows the number of envelopes Jo addressed as a function of time. Find her rate. A. one envelope per minute B. two envelopes per minute C. two envelopes per three minutes D. three envelopes per two minutes</p>	<p>Depth III requires reasoning, planning, using evidence, and a higher level of thinking than the previous two depths. In most instances, requiring students to explain their thinking is at Depth III as are activities that require students to make conjectures. The complexity does not result from the fact that there are multiple answers; however, an activity that has more than one possible answer and requires students to justify the response they give would most likely be Depth III.</p> <p>Keywords that signify Depth III: draw a conclusion, make a generalization, support with an argument, cite evidence, explain phenomena in terms of concepts, determine which concept applies and then apply it, solve a complex or non-routine problem.</p> <p>Examples of Depth III:</p> <p>a. Using exactly five 3's and mathematical symbols, write expressions for all of the whole numbers from 1 to 20, inclusive. Include the simplification that leads to the appropriate integer as well as the number properties being applied in the simplification process.</p> <p>b. The area of the triangle with vertices at the points (1,4), (6,9), (8,1) is 25 square units. Find as many different ways to get this area as you can. Explain each method in a clear and concise manner using terminology correctly. Show all work including diagrams, theorems/formulas, and equations with solutions so that the reader can follow the method used.</p>	<p>Depth IV requires complex reasoning, planning, developing and thinking, most likely over an extended period of time. Extensive 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. The cognitive demands of the task should be high and the work complex; students should be required to make connections (within or among content areas) and have to select one approach among many alternatives.</p> <p>Keywords that signify Depth IV: design and conduct the experiment, develop and carry out the project, create and prove conjectures, make connections between discoveries and related concepts/phenomena, combine and synthesize ideas into new concepts, critique plans and designs.</p> <p>Examples of Depth IV:</p>  <p>Determine an approximate total number of inches of precipitation for Franklin for 1 year using this graph. Include the work that supports that this is a good estimate of the annual total inches of precipitation and explain.</p> <p>b. George Smith charges \$4.00 an hour for his services to walk/feed/water outdoor pets when his clients take weekend trips. Charles Wood charges \$45.00 for weekly lawn care - mowing, weeding, raking. Marty Rogers cleans and organizes items in sheds/garages at the rate of \$6.50 per hour. If each of these boys' families needs the services of the other two boys, determine a fair way (as far as is possible) to arrange for services to be rendered among the three families without the exchange of money.</p>

Table 1: Applying Webb's Depth of Knowledge Levels for Mathematics

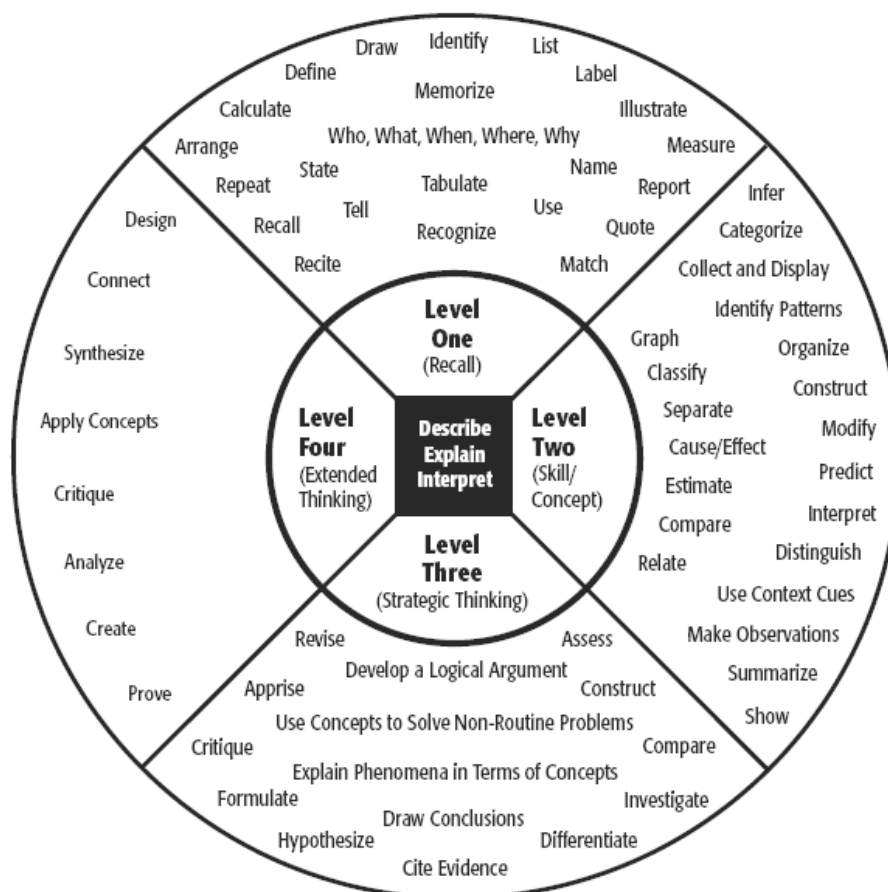
(Adapted from Karin Hess, Center for Assessment/NCIEA
by the Kentucky Department of Education, 2005)

Webb's DOK Levels			
Recall and Reproduction (DOK 1)	Skills and Concepts/ Basic Reasoning (DOK 2)	Strategic Thinking/ Complex Reasoning (DOK 3)	Extended Thinking/ Reasoning (DOK 4)
<ul style="list-style-type: none"> Recall of a fact, information or procedure Recall or recognize fact Recall or recognize definition Recall or recognize term Recall and use a simple procedure Perform a simple algorithm. Follow a set procedure Apply a formula A one-step, well-defined, and straight algorithm procedure. Perform a clearly defined series of steps Identify Recognize Use appropriate tools Measure 	<ul style="list-style-type: none"> Students make some decisions as to how to approach the problem Skill/Concept Basic Application of a skill or concept Classify Organize Estimate Make observations Collect and display data Compare data Imply more than one step Visualization Skills Probability Skills Explain purpose and use of experimental procedures. Carry out experimental procedures 	<ul style="list-style-type: none"> Requires reasoning, planning using evidence and a higher level of thinking Strategic Thinking Freedom to make choices Explain your thinking Make conjectures Cognitive demands are complex and abstract Conjecture, plan, abstract, explain Justify Draw conclusions from observations Cite evidence and develop logical arguments for concepts Explain phenomena in terms of concepts 	<ul style="list-style-type: none"> Performance tasks Authentic writing Project-based assessment Complex, reasoning, planning, developing and thinking Cognitive demands of the tasks are high Work is very complex Students make connections within the content area or among content areas Select one approach among alternatives Design and conduct experiments Relate findings to concepts and phenomena

Table 1: Applying Webb's Depth of Knowledge Levels for Mathematics

<ul style="list-style-type: none"> Habitual response: Can be described; Can be explained Answer item automatically Use a routine method Recognize patterns Retrieve information from a graph Includes one step word problems Do basic computations 	<ul style="list-style-type: none"> Make observations and collect data Beyond habitual response Classify, organize and compare data. Explain, describe or interpret Organize and display data in tables, charts and graphs. Use of information Two or more steps, procedures Demonstrate conceptual knowledge through models and explanations. Extend a pattern. Explain concepts, relationships, and nonexamples. 	<ul style="list-style-type: none"> Use concepts to solve problems Make and test conjectures Some complexity Provide math justification when more than one possible answer Non-routine problems Interpret information from a complex graph Analyze, synthesize Weigh multiple things. 	<ul style="list-style-type: none"> Combine and synthesize ideas into new concepts Critique experimental designs
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Depth of Knowledge (DOK) Levels



Level One Activities	Level Two Activities	Level Three Activities	Level Four Activities
<p>Recall elements and details of story structure, such as sequence of events, character, plot and setting.</p> <p>Conduct basic mathematical calculations.</p> <p>Label locations on a map.</p> <p>Represent in words or diagrams a scientific concept or relationship.</p> <p>Perform routine procedures like measuring length or using punctuation marks correctly.</p> <p>Describe the features of a place or people.</p>	<p>Identify and summarize the major events in a narrative.</p> <p>Use context cues to identify the meaning of unfamiliar words.</p> <p>Solve routine multiple-step problems.</p> <p>Describe the cause/effect of a particular event.</p> <p>Identify patterns in events or behavior.</p> <p>Formulate a routine problem given data and conditions.</p> <p>Organize, represent and interpret data.</p>	<p>Support ideas with details and examples.</p> <p>Use voice appropriate to the purpose and audience.</p> <p>Identify research questions and design investigations for a scientific problem.</p> <p>Develop a scientific model for a complex situation.</p> <p>Determine the author's purpose and describe how it affects the interpretation of a reading selection.</p> <p>Apply a concept in other contexts.</p>	<p>Conduct a project that requires specifying a problem, designing and conducting an experiment, analyzing its data, and reporting results/solutions.</p> <p>Apply mathematical model to illuminate a problem or situation.</p> <p>Analyze and synthesize information from multiple sources.</p> <p>Describe and illustrate how common themes are found across texts from different cultures.</p> <p>Design a mathematical model to inform and solve a practical or abstract situation.</p>

Webb, Norman L. and others. "Web Alignment Tool" 24 July 2005. Wisconsin Center of Educational Research. University of Wisconsin-Madison. 2 Feb. 2006. <<http://www.wcer.wisc.edu/WAT/index.aspx>>.