Depth of Knowledge

Christi Moss, Project Director/Associate in Research
FCR-STEM

cmoss@lsi.fsu.edu
Procedures without Conceptual Understanding or Reasoning

http://www.youtube.com/watch?v=Bfq5kju627c
Overview of Depth of Knowledge
Purpose

- To increase awareness about the cognitive complexity classification scheme employed by the Next Generation Sunshine State Standards for mathematics as well as practice identifying and justifying the classification of student tasks.
Classification Schemes for Cognition

Classification schemes allow communication about the nature and characteristics of thinking and learning.

Examples: Bloom’s Taxonomy; Webb’s Depth of Knowledge
Webb’s Depth of Knowledge

- Alignment method to examine consistency between cognitive demands of standards and assessments
- Specifically developed for mathematics, science, reading, and social studies
- NAEP and FCAT adopted a model based on Webb’s Depth of Knowledge

DOK 1: Recall and Reproduction
DOK 2: Skills and Concepts/Basic Reasoning
DOK 3: Strategic Thinking/Complex Reasoning
DOK 4: Extended Thinking/Reasoning

Norman Webb, University of Wisconsin (www.wcer.wisc.edu)
Webb’s Levels of Cognitive Complexity

- **Level One:** Recall
- **Level Two:** Skill/Concept
- **Level Three:** Strategic Thinking
- **Level Four:** Extended Thinking
FCAT Levels of Cognitive Complexity

Low Complexity
- Recall and recognition

Moderate Complexity
- Flexible thinking; choice

High Complexity
- Abstract reasoning and planning
Item Difficulty vs. Complexity

- **Cognitive Complexity**
  - What the item requires the student to recall, understand, analyze, and do
  - Assumes student is familiar with basic concepts of task

- **Item Difficulty**
  - Percentage students who answer correctly
    - Easy – More than 70%
    - Average – 40% to 70%
    - Challenging – Less than 40%
**Benchmark Information**

--Information about the benchmark, some of which can only be found in the database (e.g. remarks and examples)

--Related courses

--Access points

--FCAT item specifications

**GENERAL INFORMATION**

<table>
<thead>
<tr>
<th>Benchmark Number:</th>
<th>MA.3.A.4.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark Description:</td>
<td>Create, analyze, and represent patterns and relationships using words, variables, tables and graphs.</td>
</tr>
<tr>
<td>Subject Area:</td>
<td>Mathematics</td>
</tr>
<tr>
<td>Grade Level:</td>
<td>3</td>
</tr>
<tr>
<td>Body of Knowledge:</td>
<td>Algebra</td>
</tr>
<tr>
<td>Supporting Idea:</td>
<td>Algebra - Algebra</td>
</tr>
<tr>
<td>Date Adopted or Revised:</td>
<td>09/07</td>
</tr>
<tr>
<td>Date of Last Rating:</td>
<td>06/07</td>
</tr>
<tr>
<td>Cognitive Complexity/Depth of Knowledge Rating:</td>
<td>Moderate - <em>What does this mean?</em></td>
</tr>
<tr>
<td>Status:</td>
<td>State Board Approved</td>
</tr>
<tr>
<td>Remarks/Examples:</td>
<td>Example: Look at the pattern below. Tell in your own words what shape is missing. Explain.</td>
</tr>
<tr>
<td></td>
<td>A possible answer would be a seven sided regular polygon because the number of side is increasing by one from left to right. Another possible answer is some polygon with pointy top because the pattern in the top of the shapes is pointy, flat, pointy, flat, ...</td>
</tr>
<tr>
<td></td>
<td>Example: In the sequence of shapes below, the triangle is shape 1 and the square is shape 2. How many sides would the 10th shape have? How do you know?</td>
</tr>
<tr>
<td></td>
<td>△ □ □ ？ □ →</td>
</tr>
<tr>
<td></td>
<td>△ □ 五 ？ □ →</td>
</tr>
</tbody>
</table>
Mathematics
Depth of Knowledge
Task Rating Activity
Objectives

Be able to identify the Depth of Knowledge of mathematics tasks.

Describe the relationship of the Depth of Knowledge construct as it relates to the Next Generation Standards for mathematics instruction, assessment, and instructional leadership.
DOK Level 1: Low Complexity

Recall and recognition of previously learned concepts and principles. Examples:

- solving a one-step or routine problem
- retrieving information from a graph, table, or figure
- identifying appropriate units or tools for common measurements
- Evaluating an expression, given specific values for variables
Aunt Hanna makes and sells homemade soap and perfume. The diagram below shows a rectangular-prism-shaped mold where oils, perfumes, and other ingredients harden to form a bar of soap.

What is expected?
Recognize the values provided for length, width, and height and compute the volume using the provided formula.

What is the volume, in cubic inches, of this rectangular prism?

Volume = length \times width \times height
DOK Level 2: Moderate Complexity

Involve more flexible thinking and choice among alternatives. Examples:

- solving a problem requiring multiple operations
- selecting and/or using different representations, depending on situation and purpose
- providing a justification for steps in a solution process
- Determining a reasonable estimate
Two sailboats leave Key Largo, Florida. One of the sailboats travels 3 miles east and then 4 miles north. The second sailboat travels 8 miles south and 6 miles west.

What is expected?
Recognize that the distance formula or Pythagorean Theorem may be used. Apply it two times and add the results OR combine the two right triangles to make one larger one and apply the formula once to answer the question.

How far apart, in miles, are the boats?
DOK Level 3: High Complexity

Engage students in more abstract reasoning, planning, analysis, judgment, and creative thought. Examples:

- solving a non-routine problem
- providing a mathematical justification
- formulating a mathematical model for a complex situation
- performing a procedure having multiple steps and multiple decision points
- Describing, comparing, and contrasting solution methods
Students at Park City School get to choose the main dish and side items for lunch. The choices are shown below:

<table>
<thead>
<tr>
<th>Choice of 1 main dish</th>
<th>Choice of 2 side items</th>
</tr>
</thead>
<tbody>
<tr>
<td>tacos</td>
<td>corn</td>
</tr>
<tr>
<td>hamburgers</td>
<td>piece of fruit</td>
</tr>
<tr>
<td></td>
<td>French fries</td>
</tr>
</tbody>
</table>

a. Based on the choices above, what are ALL the different combinations of one main dish and two side items that are possible. Show your work in an organized list, chart, or table.

b. Next week, in addition to the choices of one main dish and two side items, the students will have the choice of one dessert—either cake or ice cream. How many different combinations of one main dish, two side items, and one dessert will there be? Explain or show how you got your answer.
DOK Level 4: Extended Thinking and Reasoning

- Suppose Publix called and asked for our help. They have one million boxes of Chips Ahoy cookies and no place to store them. They asked if they could store them in this room. The principal told us that we can help them, and that we can move all of the chairs and tables out of the room to make space.

Do we have enough space to store 1 million boxes of cookies in this room?
Depth of Knowledge Activity

1. Read the following mathematics items individually and assign each item a Depth of Knowledge rating.
2. Discuss Depth of Knowledge rating for each item and determine the rating of each one as a group.
3. We will vote as a whole group and check our ratings on each item with the experts.
Group Activity:
Characterizing the Cognitive Complexity of Mathematical Tasks
What is the difference between item difficulty and cognitive complexity?
Thank you!