Increasing Cognitive Complexity: Webb’s Depth of Knowledge

Previously...

Bloom’s Revised Taxonomy
Anderson & Krathwohl, 2001
Webb’s Depth of Knowledge (Webb, 1997)

- Related to number of connections of concepts and ideas a student needs to make
- Other factors that influence the cognitive demands of performance
Clarification of level by analyze the verbs used

Clarifying Webb’s DOK

Misconceptions vs. Truths

Clarifying Webb’s DOK

**Misconception**
- More steps or longer tasks relate to higher DOK levels.

**Truth**
- Number of steps or length of tasks does not relate to DOK level.
  - DOK 2 – 4 may have more than one step or be long, but it is the context of what those steps require

Hess, n.d.

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Clarifying Webb’s DOK

**Misconception**
- Not all students can reach all levels.

**Truth**
- All students can reach all levels with scaffolds.
  - Supports/ scaffolding
  - Vygotsky’s ZPD

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Context: What are students expected to do? (Francis, 2017)

Are students expected to
• Acquire knowledge (DOK-1)?
• Apply knowledge (DOK-2)?
• Analyze knowledge (DOK-3)?
• Augment knowledge (DOK-4)?
Comparison

BLOOM’S TAXONOMY
- Classifying learning; levels of cognitive complexity.
- Verbs

WEBB’S DEPTH OF KNOWLEDGE
- Level of thinking required to answer questions/complete activities
- Context; What follows the verb

Math Content Standards & Math Practices

<table>
<thead>
<tr>
<th>Depth + Thinking</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recall &amp; Reproduction</td>
<td>Skills &amp; Concepts</td>
<td>Strategic Thinking</td>
<td>Extended Thinking</td>
</tr>
<tr>
<td>Remember</td>
<td>Know facts, terms</td>
<td>Model with mathematics</td>
<td>Construct viable arguments</td>
<td>Integrate concepts across domains</td>
</tr>
<tr>
<td>Understand</td>
<td>Attend to precision</td>
<td>Evaluate expressions, plot point</td>
<td>Estimate, predict, observe, explain relationships</td>
<td>Geometry proof</td>
</tr>
<tr>
<td>Apply</td>
<td>Calculate, measure, make conversions</td>
<td>Make sense of routine problems</td>
<td>Make sense of non-routine problems</td>
<td>Design &amp; conduct a project</td>
</tr>
<tr>
<td>Analyze</td>
<td>Identify a pattern</td>
<td>Locate information in table</td>
<td>Use tools strategically</td>
<td>Reason abstractly</td>
</tr>
<tr>
<td>Evaluate</td>
<td>Critique the reasoning of others</td>
<td>Design a complex model</td>
<td>Generalize a pattern</td>
<td>Analyze multiple sources of evidence</td>
</tr>
<tr>
<td>Create</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hess, n. d.
Identifying and Adjusting Depth of Knowledge of Levels

Standards: Webb’s Depth of Knowledge Levels

- Grade 4
  - 28 Standards
    - Level 1 — 9
    - Level 2 — 18
    - Level 3 — 1
    - Level 4 — 0

- Grade 5
  - 26 Standards
    - Level 1 — 8
    - Level 2 — 17
    - Level 3 — 1
    - Level 4 — 0
**Level 1 Recall DOK in Math**

- Recall
- A simple algorithm or a formula
- Key words “identify,” “recall,” “recognize,” “use,” and “measure.” [Webb, 2002, p. 3]

**EXAMPLE:**

DOK Level 1: **Recognize** that 700 ÷ 70 = 10 by applying concepts of place value and division

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**Level 2 Skill/Concept DOK in Math**

- Some mental processing beyond a habitual response
- Requires some decisions on solving
- Keywords “classify,” “organize,” “estimate,” “make observations,” “collect and display data,” and “compare data.”

- **Not just more than one step; more than one concept**
- Not only numerical skills, but also visualization skills and probability skills [Webb, 2002, p. 4]

**EXAMPLE:**

DOK Level 2: Jess uses powers of 10 and exponents to find the product of the following terms. **What are the products?**

0.5 x 10^5 = __________ 0.05 x 10^6 = __________
Level 3 Strategic Thinking DOK in Math

- Requires reasoning, planning, using evidence, and a higher level of thinking
- Complex and abstract cognitive demands
- More than one possible answer
- Requiring students to justify the response they give would most likely be a Level 3
- Drawing conclusions; citing evidence and developing a logical argument; explaining phenomena
  (Webb, 2002, p. 4)

EXAMPLE:
DOK Level 3: **Explain why 700 ÷ 70 = 10**, including the role of place value in doing the division.

Level 4 Extended Thinking DOK in Math

- Involves complex reasoning, planning, developing, and thinking
- Extended period of time
- High cognitive demands; Complex work
- Requires making several connections
- Connecting a finding and related concepts; combining and synthesizing ideas into new concepts
  (Webb, 2002, p. 4)

EXAMPLE:
DOK Level 4: For our annual food drive, we must figure out how to ship over 400 cans. Decide the best shipping method (crates, cases, or individual boxes) to use as few packages as possible. Write a letter to the principal projecting the amount of money the school will spend shipping the packages. Justify the most efficient packaging and shipping methods. (DeKalb County School District, n.d.)
Standards and Samples
DOK 1-4

Whole Numbers – Gr. 4

Express how the value of a digit in a multi-digit whole number changes if the digit moves one place to the left or right.

Read and write multi-digit whole numbers from 0 to 1,000,000 using standard form, expanded form and word form.

Plot, order and compare multi-digit whole numbers up to 1,000,000.
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- Cognitive Complexity: Level 2: Basic Application of Skills & Concepts

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**Whole Numbers – Gr. 4**

**DOK Level 1**: Complete the table.

<table>
<thead>
<tr>
<th>Number</th>
<th>Two Numbers Greater Than (&gt;)</th>
<th>Two Numbers Less Than (&lt;)</th>
<th>Numbers Equal To (=)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: 356</td>
<td>368, 526</td>
<td>245, 18</td>
<td>305</td>
</tr>
<tr>
<td>70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>145</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>342</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>62</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DOK Level 2**: Tito and Luis are stuffed with pizza. Tito ate 2 slices of cheese pizza. Tito ate 3 slices of a pepperoni pizza. Luis ate 4 slices of mushroom pizza. Tito also ate 4 slices of mushroom pizza. Luis at 5 slices of cheese pizza, and 4 slices of mushroom pizza. All the pizzas had 8 slices and were the same size. Tito says he ate more pizza than Luis because Luis did not eat any pepperoni pizza. Luis says they ate the same amount of pizza. **Who is correct? Show all your mathematical thinking.** (New York City Department of Education, n. d.)

**DOK Level 3**: A photographer has picture files saved in three online albums. The Wedding album has 2,073 files. The Birthday album has 1,860 files. The Pets album has 2,370 files. **Order the files from least to greatest.** Then, describe how you came up with an order for the numbers. **Now, come up with another way to compare the number of files in each album. What makes this way different than the first way you solved this problem? After ordering the number of files, which album has the greatest (or most) number of files? Which album has the least (or smallest) number of files?** (Curriculum Associates, 2015)

**DOK Level 4**: Find a division problem in our school or community. Formulate the necessary questions, devise a plan, collect the data, analyze the data, and prepare a report describing and justifying your conclusions.
Whole Numbers – Gr. 4
• NB.1.2 Use place value understanding to round multi-digit whole numbers to any place.
Whole Numbers – Gr. 4

• **Use** place value understanding to round multi-digit whole numbers to any place.

• **Cognitive Complexity:** Level 1: Recall

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**DOK Level 1:** What is 62,891 rounded to the nearest thousands?
(a) 60,000
(b) 62,000
(c) 62,900
(d) 63,000
(e) 70,000

**DOK Level 2:** Round the following numbers to the nearest tenth: 10.892 and 112.429

**DOK Level 3:** A teacher asked her students to use estimation to decide if the sum of the problem below is closer to 4,000 or 5,000.

496 + 1,404 + 2,605 + 489 =

One student replied that she thinks the sum is closer to 4,000. She used the estimation shown below to support her reasoning:

Is the student’s reasoning correct? Explain why or why not. If the reasoning is incorrect, explain how she should have estimated it.

**DOK Level 4:** Create a plan to reach out to family, friends, and neighborhood members to gather data about the number of pictures they have hanging in their homes. Create a table to display the information you collect. Then decide what place value you should round to that would allow you to showcase who has most pictures and least pictures hung up in their house. Construct a poster to share your findings.
Whole Numbers – Gr. 4
• Fluently add and subtract multi-digit whole numbers using the standard algorithm.
Whole Numbers – Gr. 4

- Fluently add and subtract multi-digit whole numbers using the standard algorithm.
- Cognitive Complexity: Level 1: Recall

DOK Level 1: Solve: 562 – 58.

DOK Level 2: You and a few friends decided to go around town and pick up any loose trash because it was Earth Day. Each of you collected trash in two rounds. The table below shows data for you and your two friends, but round two’s information is missing. Fill in the missing data from the table.

<table>
<thead>
<tr>
<th>Person</th>
<th>Round 1 Trash Pick Up</th>
<th>Round 2 Trash Pick Up</th>
<th>Total Trash Cleaned Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>You</td>
<td>40</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Friend A</td>
<td>50</td>
<td></td>
<td>105</td>
</tr>
<tr>
<td>Friend B</td>
<td>35</td>
<td></td>
<td>95</td>
</tr>
</tbody>
</table>

DOK Level 3: Q2: After Kasey gets out of bed in the morning, she completes several activities to get ready for school. The list below shows the number of minutes she needs in order to complete all tasks.
- 35 minutes: Brush teeth, shower, and get dressed
- 15 minutes: Eat breakfast
- 30 minutes: Travel to school
Kasey must be at school by 8:00 am. What is the latest time Kasey can wake up and allow enough time for her to complete her tasks and get to school on time? Explain. (Curriculum Associates, 2015)

DOK Level 4: Adding whole numbers & deriving a rule
“Use each of the digits 2 through 8 once to write a 4-digit number plus a 3-digit number that gives the greatest possible sum and support your case that it will be the largest.
Use the same digits to find the sum of a 4-digit number and a 3-digit number that gives the smallest sum.
Generalize rules for producing the greatest and least sums for a 4-digit plus a 3-digit number. How would the rules differ, if any, when adding a 4-digit number to another 4-digit number?” (Pelfrey, 2000)
References


References

Hess, K. (n. d.). How to “go deep” to meet the new math standards. http://media.wix.com/ugd/5e86bd_6db65a2fffc9f4f38b439af0e5a85051df.pdf


References

