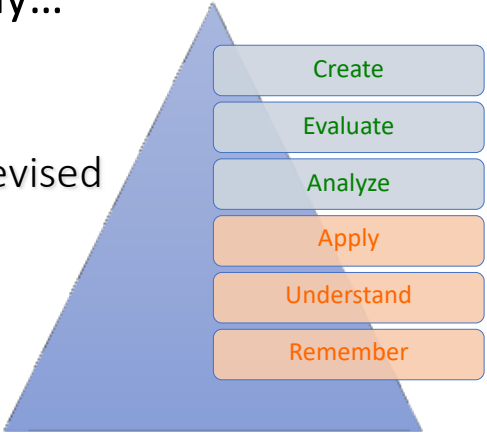


Bump Up

Increasing Cognitive Complexity:
Webb's Depth of Knowledge

1



Bump Up

Previously...

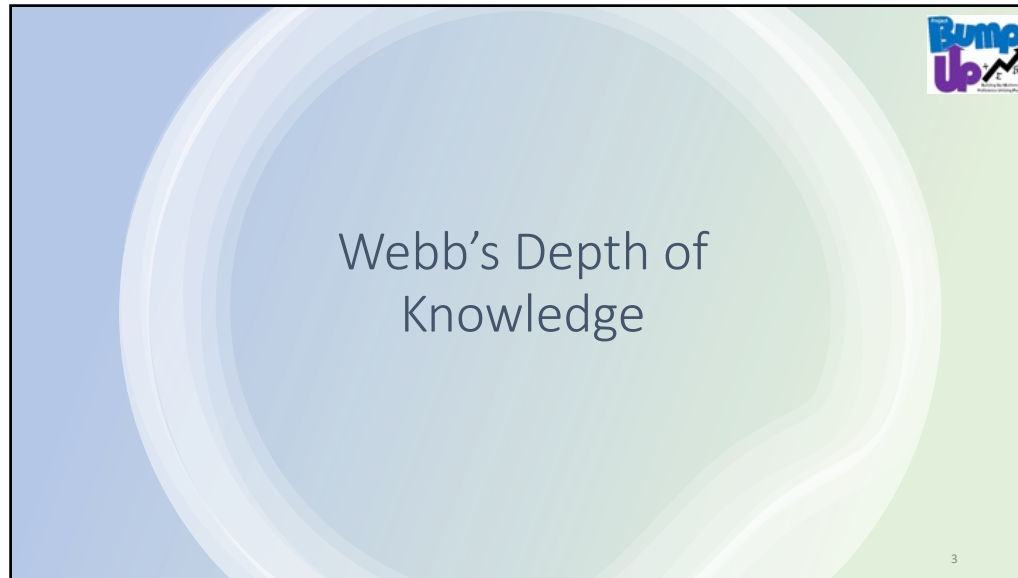
Bloom's Revised Taxonomy
Anderson & Krathwohl, 2001

Higher Order Thinking Skills: Create, Evaluate, Analyze

Lower Order Thinking Skills: Apply, Understand, Remember

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2



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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

<p>Level 1: Recall</p>	<p>Level 2: Basic Application of Skills & Concepts</p>	<p>Level 3: Strategic Thinking & Complex Reasoning</p>	<p>Level 4: Extended Thinking & Complex Reasoning</p>
Low Complexity		High Complexity	

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Depth of Knowledge Criteria in Expectations

(Webb, 1997, p. 17)

Rating of most cognitively demanding expected performance for a topic and for all students as determined by

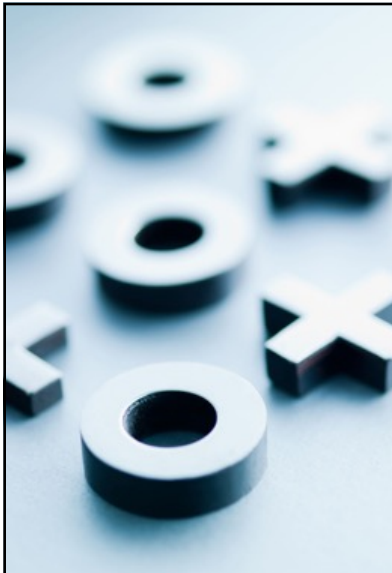

The number of ideas integrated	Depth of reasoning required	Knowledge transferred to new situations	Multiple forms of representation employed	Mental effort sustained
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Clarification of level by analyze the verbs used

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Clarifying Webb's DOK

Misconceptions vs. Truths

(Francis, 2017; Hess, n. d.; Webb, 2002)

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Clarifying Webb's DOK

<p>Misconception</p> <ul style="list-style-type: none"> • More steps or longer tasks relate to higher DOK levels. 	<p>Truth</p> <ul style="list-style-type: none"> • Number of steps or length of tasks does not relate to DOK level. <ul style="list-style-type: none"> • DOK 2 – 4 may have more than one step or be long, but it is the context of what those steps require
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Hess, n. d.

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Clarifying Webb's DOK

<p>Misconception</p> <ul style="list-style-type: none"> • Not all students can reach all levels. 	<p>Truth</p> <ul style="list-style-type: none"> • All students can reach all levels with scaffolds. <ul style="list-style-type: none"> • Supports/ scaffolding • Vygotsky's ZPD
--	--

Hess, n.d.

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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**)?

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Bloom and Webb

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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

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Math Content Standards & Math Practices

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

Hess, n. d.

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Identifying and Adjusting Depth of Knowledge of Levels

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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

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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 $700 \div 70 = 10$ 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)

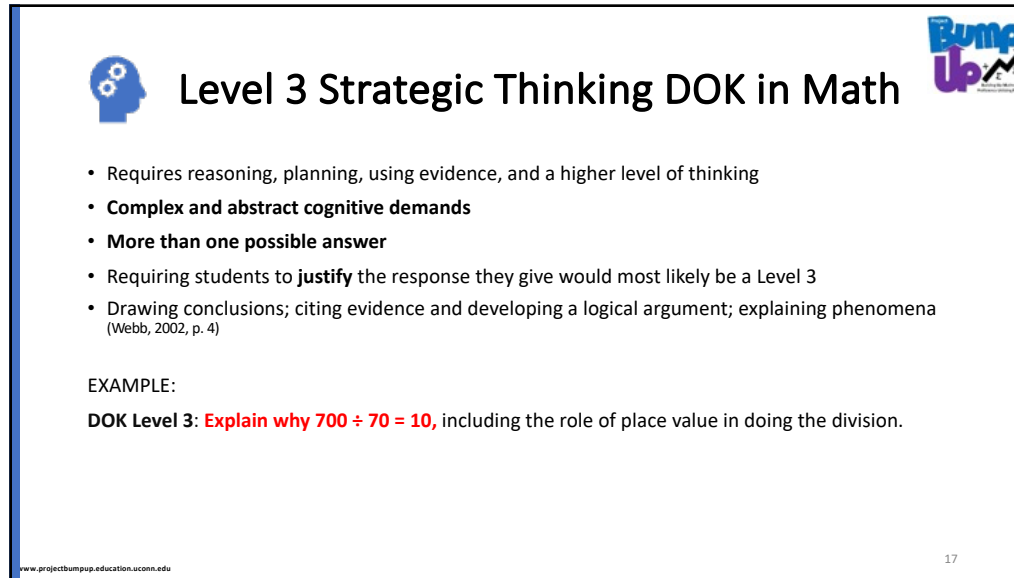
EXAMPLE:



DOK Level 2: Jess uses powers of 10 and exponents to find the product of the following terms.
What are the products?
 $0.5 \times 10^2 = \underline{\hspace{2cm}}$ $0.05 \times 10^5 = \underline{\hspace{2cm}}$

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 **Level 3 Strategic Thinking DOK in Math** 

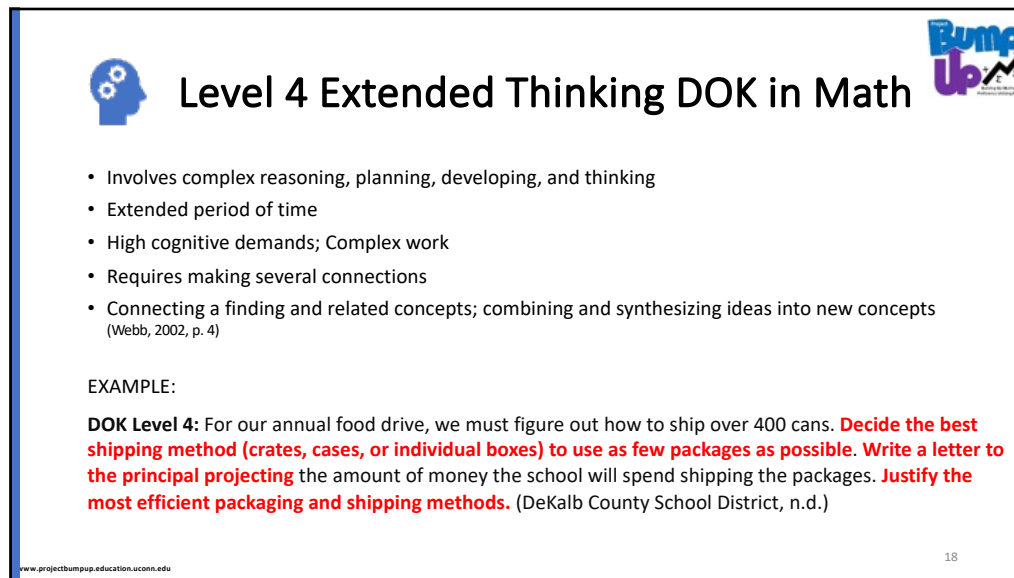
- Requires reasoning, planning, using evidence, and a higher level of thinking
- **Complex and abstract cognitive demands**
- **More than one possible answer**
- Requiring students to **justify** the response they give would most likely be a Level 3
- Drawing conclusions; citing evidence and developing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



EXAMPLE:

DOK Level 3: Explain why $700 \div 70 = 10$, including the role of place value in doing the division.

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 **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.)

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Standards and Samples

DOK 1-4

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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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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.


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Plot, order and compare multi-digit whole numbers up to 1,000,000.

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Whole Numbers – Gr. 4 


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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.

- **Cognitive Complexity: Level 2: Basic Application of Skills & Concepts**



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Whole Numbers – Gr. 4


DOK Level 1: Complete the table.

Number	Two Numbers Greater Than (>)	Two Numbers Less Than (<)	Numbers Equal To (=)
Example: 356	368, 526	245, 18	356
70			
185			
342			
62			

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. Tito also ate 4 slices of mushroom pizza. Luis ate 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)

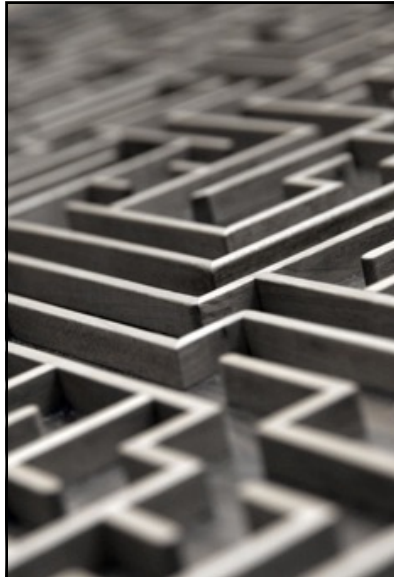
DOK Level 4: **Find a division problem in our school or community. Formulate the necessary questions, devise a plan, collect the data, analyze the data, and prepare a report describing and justifying your conclusions.**




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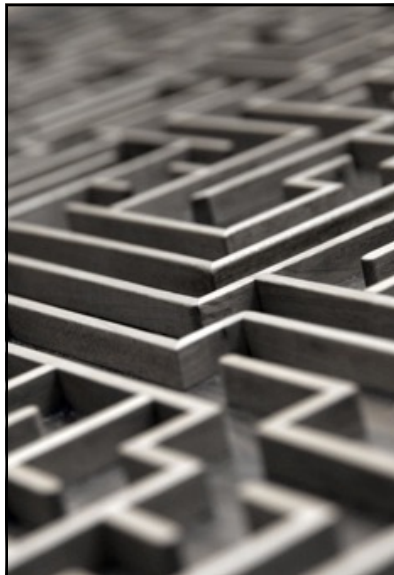
Whole Numbers – Gr. 4




- NB.1.2 Use place value understanding to round multi-digit whole numbers to any place.

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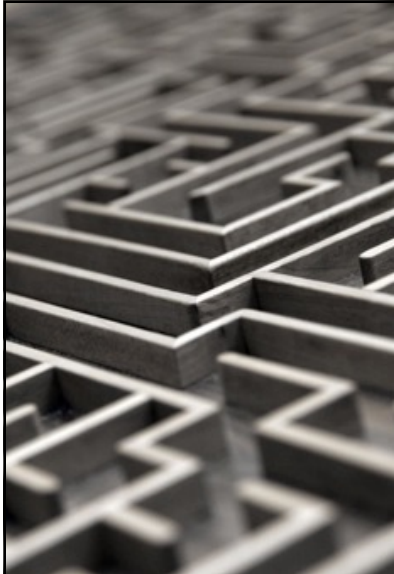
Whole Numbers – Gr. 4



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

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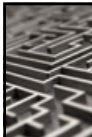
Whole Numbers – Gr. 4

Bump Up

- Use place value understanding to round multi-digit whole numbers to any place.
- **Cognitive Complexity: Level 1: Recall**

27

27



Whole Numbers – Gr. 4

Bump Up

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.
 $496 + 1,404 + 2,605 + 489 =$
 $496 + 1,404 + 2,605 + 489 =$
 One student replied that she thinks the sum is closer to 4,000. She used the estimation shown below to support her reasoning.

$0 + 1,000 + 3,000 + 0 = 4,000$


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.

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Whole Numbers – Gr. 4

- Fluently add and subtract multi-digit whole numbers using the standard algorithm.




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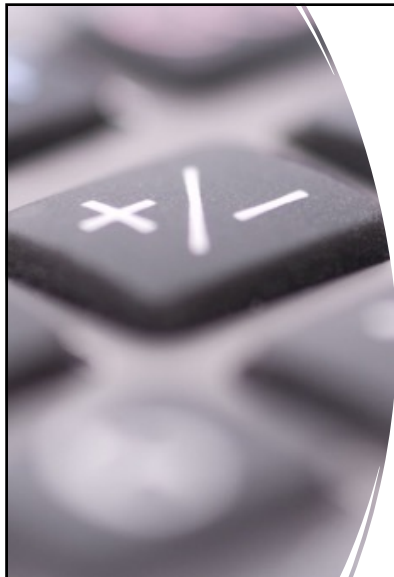
Whole Numbers – Gr. 4

- Fluently add and subtract multi-digit whole numbers **using** the standard algorithm.




30

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Whole Numbers – Gr. 4




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

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Whole Numbers – Gr. 4



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.**

Person	Round 1 Trash Pick Up	Round 2 Trash Pick Up	Total Trash Cleaned Up
You	40		100
Friend A	50		105
Friend B	35		95

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.

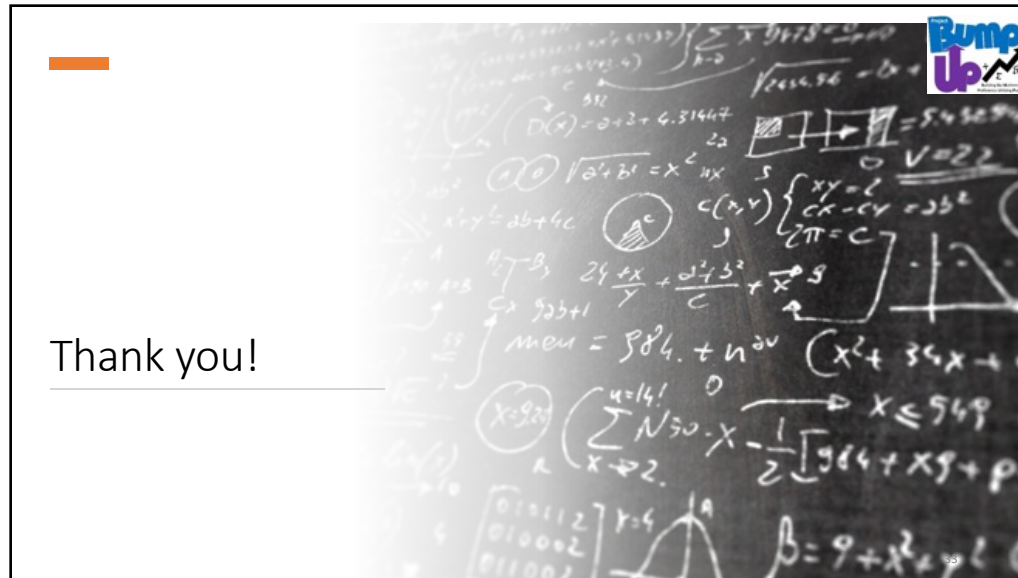
- 35 minutes: Brush teeth, shower, and get dressed
- 15 minutes: Eat breakfast
- 30 minutes: Travel to school

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)

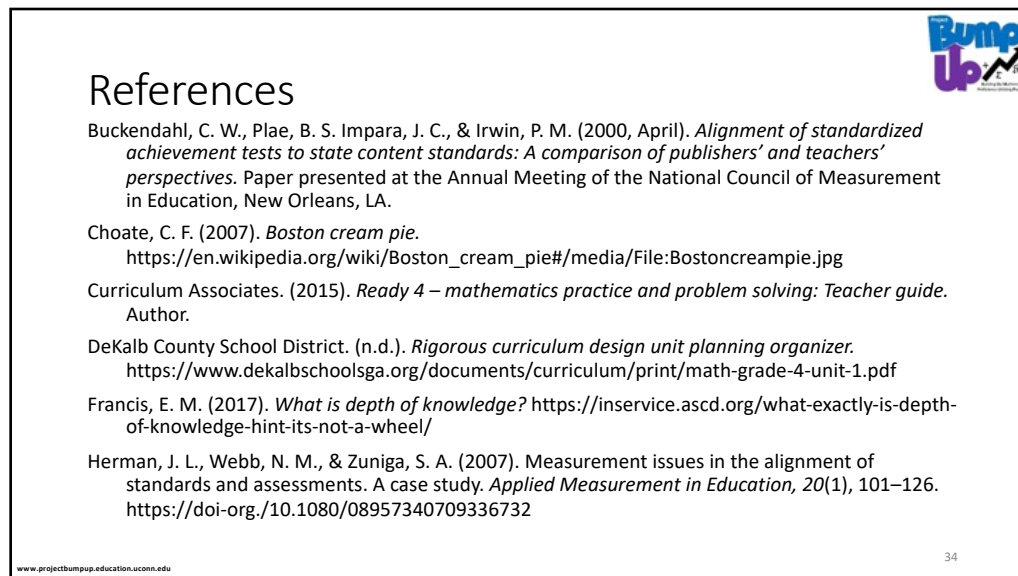
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Thank you!

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References



- Hess, K. (n. d.). *How to “go deep” to meet the new math standards*.
http://media.wix.com/ugd/5e86bd_6db65a2fffc94f438439afe5a85051df.pdf
- Krathwohl, D. (2002). A revision of Bloom’s taxonomy: An overview. *Theory Into Practice*, 41(4), 212–218.
- Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing*. Abridged edition. Allyn and Bacon.
- Martone, A., & Sireci, S. G. (2009). Evaluating alignment between curriculum, assessment, and instruction. *Review of Education Research*, 79(4), 1332–1362.
<https://doi.org/10.3102/00346543093413>
- New York City Department of Education. (n. d.). *Common core-aligned task with instructional supports: Mathematics*. <https://www.mcs4kids.com/documents%5Cmath%5Ck-6%5CCommon%20Core%20State%20Standards%5CCommon%20Core%20-%20Math%5CGrade%205%20-%20Common%20Core%20Math%5CGr.%205%20CCSS%20Math%20Tasks%5CNYC%20DOE%20G5%20Math%20Stuffed%20with%20Pizza.pdf>

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References



- Pelfrey, R. (2000). *Open-ended questions for mathematics*.
<https://www.uky.edu/OtherOrgs/ARSI/www.uky.edu/pub/arsi/openresponsequestions/mathorq.pdf>
- Ray, B. (2018). *Bloom’s Taxonomy and Depth of Knowledge*.
<https://barbarabray.net/2018/11/02/blooms-taxonomy-and-depth-of-knowledge-dok/>
- SMARTER Balanced Assessment Consortium. (2014). *SMARTER balanced assessment—mathematics*.
<https://www.doe.k12.de.us/site/handlers/filedownload.ashx?moduleinstanceid=210&dataid=136&FileName=sbac4.pdf>
- Vanderbilt University Center for Teaching. (n. d.). *Bloom’s taxonomy*.
<https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/>
- Webb, N. L. (1997). *Criteria for alignment of expectations and assessments in mathematics and science* (Council of Chief State School Officers and National Institute for Science Education Research Monograph No. 6). Madison: University of Wisconsin–Madison, Wisconsin Center for Educational Research.

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References



- Webb, N. L. (2002). *Depth-of-knowledge levels for four content areas*.
<http://ossucurr.pbworks.com/w/file/fetch/49691156/Norm%20web%20dok%20by%20subject%20area.pdf>
- Webb, N. L. (2008). *Alignment analysis of mathematics extended grade band standards and assessments* (Final report). Wisconsin Department of Public Instruction.
- Wyse, A. E., & Viger, S. G. (2011). How item writers understand depth of knowledge. *Educational Assessment, 16*(4), 185–206. <https://doi.org/10.1080/10627197.2011.634286>