Are We There Yet? Increasing Rigor in the Mathematics Classroom

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- Welcome
- Part I: Depth of Knowledge (DOK) Overview
- Part II: It's Not About the Verb!
- Part III: Sort – Check Your Knowledge
- Part IV: Leveled Questions

Objectives:

- Gain a stronger understanding of the Depth of Knowledge (Webb, 1997; 2005) model
- Transform lower level mathematical questions to higher level application questions through guided practice
- Discover strategies to immediately integrate into classroom instruction to engage students in critical thinking

Depth of Knowledge (DOK)

Depth of Knowledge

- Norman Webb
- Indicates the cognitive demand (thinking) for the state assessment.
- Defines the "ceiling" or highest DOK level for each Core Content standard for the state assessment.
- Guides item development for the state assessment.

Depth of Knowledge

- Determined in the Core Content for Assessment.
- Every item that is **assessed** will have a DOK ceiling level.

CCSSM: 7.G.3

Students will describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.

DOK 2

4 Levels of DOK

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

Remember: DOK….

- …is descriptive.
- …focuses on how **deeply** a student has to **know** the content in order to respond.
- …is **NOT** the same as difficulty.
- …is **NOT** the same as Bloom's Taxonomy.

Recall and Reproduction: Level 1

- DOK 1 requires recall of information, such as a fact, definition, term, or performance of a simple process or procedure.
- Answering a Level 1 item can involve following a simple, well-known procedure or formula. Simple skills and abilities or recall characterize DOK 1.

Recall and Reproduction: DOK 1 Examples

- Determine the perimeter or area of a rectangle given a drawing or label
- Graph the point (-2, 8) in the quadrant plane.
- Convert 8.23×10^{-6} to decimal form.
- One angle of a triangle measures 81^0 and another angle measures 52.92^0. What is the measure of the third angle?

Skills/Concepts: Level 2

- DOK 2 includes the engagement of some mental processing beyond recalling or reproducing a response. Items require students to make some decisions as to how to approach the question or problem.
- These actions imply more than one mental or cognitive process/step.

Skills/Concepts: DOK 2 Examples

- Classify plane and three dimensional figures
- Compare two sets of data using the mean, median, and mode of each set.
- Organize a sample set of data and construct an appropriate graphical display.
- Create a graph based on the information in the table.

Strategic Thinking: Level 3

- DOK 3 requires deep understanding as exhibited through planning, using evidence, and more demanding cognitive reasoning. The cognitive demands at Level 3 are complex and abstract.
- An assessment item that has more than one possible answer and requires students to justify the response they give would most likely be a Level 3.

Strategic Thinking DOK 3 Examples

- Solve a multiple-step problem and provide support with a mathematical explanation that justifies the answer
- Create your own problem based on a real-world scenario.
- Explain how changes in the dimensions of a figure affect the area and volume of geometric figures.
- Provide a mathematical justification when a situation has more than one possible outcome.

Extended Thinking: Level 4

- DOK 4 requires high cognitive demand and is very complex. Students are expected to make connections—relate ideas *within* the content or *among* content areas—and have to select or devise one approach among many alternatives on how the situation can be solved.
- Due to the complexity of cognitive demand, DOK 4 often requires an extended period of time.

However, extended time alone is not the distinguishing factor.

Task	*Thinking*
Collecting data samples over several months	**Recall**
Organizing the data in a chart	**Skills/ concepts**
Using this chart to make and justify predictions	**Strategic Thinking**
Developing a generalized model from this data and applying it to a new situation	**Extending Thinking**

Identify and graph ordered pairs on a coordinate system

DOK 1	DOK 2	DOK 3	DOK 4
Graph the point (-4 ½, -2 ¼)	Graph the vertices of a rectangle and compare the diagonals.	Graph the vertices of a quadrilateral and determine its classification.	Graph a variety of two-dimensional figures and analyze them to determine classifications.

Extended Thinking: DOK 4 Examples

- Specify a problem, identify solution paths, solve the problem, and report the results.
- Develop a rule for a complex pattern and find a phenomenon that exhibits that behavior.
- Model a social studies situation with many alternatives and select one approach to solve with a mathematical model.
- Go back in time and pretend you are Euclid and have just discovered …. Create a presentation to present to the mathematical council validating your findings.

CAUTION!!!!!

The Depth of Knowledge is **NOT** determined by the verb, **but by the context in which the verb is used and the depth of thinking required.**

Apply ratios and proportional reasoning to solve real world problems (DOK Level 3)

Same verb— four DOK levels

DOK 1	DOK 2	DOK 3	DOK 4
The price of gasoline was $2.159 per gallon last week. This week the new price is $2.319 per gallon. **Describe** the percent of increase.	On a trip across the country, Justin determined that he would have to drive about 2,763 miles. **Describe** the speed would he have to average to complete the trip in no more than 50 hours of driving time?	A sweater that you really want has just been placed on sale. The original cost was $63.99. The sale price is $47.99. What is the percent of decrease from the original price? You do not have enough money to purchase the sweater but can wait just a little longer and the store now has an ad that states that all items currently on sale have been reduced by 1/3 of the sale price. **Describe** the new sale price and the overall percent of decrease from the original price?	Visit 3 local grocery stores and find the prices of three different sizes of the same product at the three stores. Then, **describe t**he unit price for each size item at each store and make a decision as to which is the best buy. You will then write a report **describing** your work and which is the best buy, justifying your decision with your mathematical work.

Foldable

Foldable

- Choose any concept you are familiar with.
- Using the verb CREATE, write a question at each DOK level for the concept you have chosen.
- Your questions should ALL address the same concept, just as in the example.

DOK SORT

- Sort each of the questions or objectives in your bag as a Level 1, Level 2, Level 3, or Level 4 to test your skills on recognizing various levels of DOK!
- We will review to check your DOK understanding!

No.	DOK Level	Explanation
1	1	Simple, routine pattern, immediately recognizable, requires no processing
2	2	Non-routine pattern recognition (brings this up to a higher DOK level), some analysis and generalization is required to extend the pattern.
3	2	Identify different numerical representations (Level 1), and manipulate and compare the representations (Level 2).
4	2	Weigh the options to determine the solution NOTE: If the choices were removed, this problems would be at DOK Level 3 because students would have to reason analytically about the missing information.
5	3	Can use a number of strategies, must make choices and assumptions, complex logical chain (MC does not make the task less complex).
6	1	Routine procedure, simple calculations
7	1	Simple recognition of a rotation
8	3	Abstract thinking, multiple steps supported with mathematical explanations and justifications.
9	2	Must recognize and apply a real-world pattern using multiple steps.

Leveled Questions

We must not only challenge students to answer leveled questions, we must also challenge them to write their own to encourage critical thinking.

Max asked 50 students in his school which breakfast cereal they prefer. The table below shows the results of his survey.

Cereal Survey

Breakfast Cereal	Number of Students
Yummy Flakes	12
Choco Crunch	25
Fruit Crunchies	13

1 What decimal represents the fraction of students who prefer Fruit Crunchies?

2 Explain the process you used to convert the fraction to a decimal.

3 Predict what would happen to the results if 100 students were surveyed?

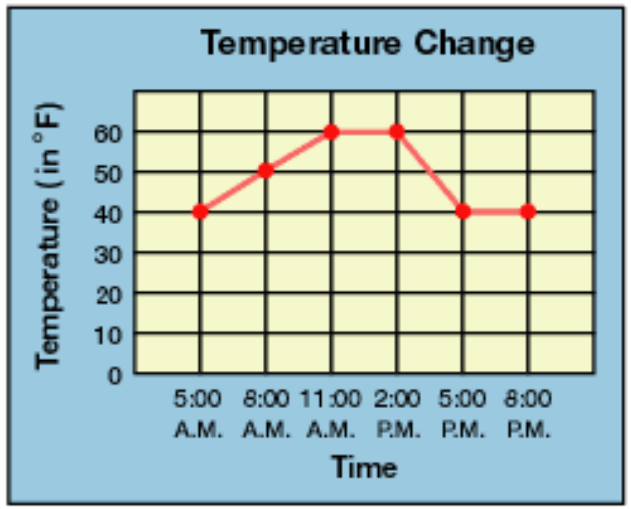
On the back, write a level 1, level 2 and level 3 question about the graph. Be sure you know the answers.

Level One
Define
Describe
Identify
List
Name
Observe
Recite

Level Two
Analyze
Compare
Contrast
Group
Infer
Report
Classify
Sequence
Rank

Level Three
Apply
Evaluate
Hypothesize
Imagine
Judge
Predict
Speculate

Level Ground Math



1

2

3

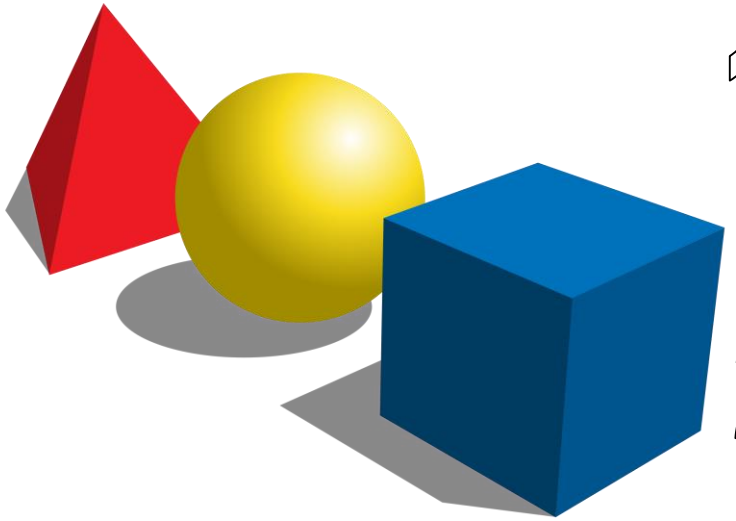
4

Write leveled questions based on the graph.

Level One
Define
Describe
Identify
List
Name
Observe
Recite

Level Two
Analyze
Compare
Contrast
Group
Infer
Report
Classify
Sequence
Rank

Level Three
Apply
Evaluate
Hypothesize
Imagine
Judge
Predict
Speculate



1

2

3

4

Write leveled questions based on the graph.

Level One
Define
Describe
Identify
List
Name
Observe
Recite

Level Two
Analyze
Compare
Contrast
Group
Infer
Report
Classify
Sequence
Rank

Level Three
Apply
Evaluate
Hypothesize
Imagine
Judge
Predict
Speculate

Questions or Comments