Differentiated Instruction: What Can It Look Like in the Science Classroom?

Jeremy Peacock, Science
Northeast Georgia RESA
1. Start with excellent science teaching.

2. Establish a flexible, supportive, and respectful learning environment.

3. Make decisions based on ongoing formal and informal assessment.

4. Differentiate in a variety of ways and...

5. ...according to a variety of student characteristics.
Questions About Differentiated Instruction

- What does it really mean?
- Is it individualized instruction at all times?
- Differentiation vs. Variety vs. Engagement?
- What is flexible grouping?

Wisdom from Tomlinson & MacMillan

- There’s no one right way.
- DI means that different students are doing different things some times.
- Differentiate when appropriate and necessary based on student needs.
One Last Question…
How Can I Make Time for This?

DI doesn’t always have to be time-consuming…

Higher Prep
Tiered Lessons
Flexible Grouping
Think-Tac-Toe
Multiple Texts

Respond to various student learning needs
Work Together

Lower Prep
Questioning
Reading/Study Buddies
Think-Pair-Share
Choices of Books
## Examples of Differentiated Instruction in Science

<table>
<thead>
<tr>
<th>Content</th>
<th>Process</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiered Review</td>
<td>Leveled Guided Inquiry Questions</td>
<td>Product Choice</td>
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<tr>
<td>Tiered Project</td>
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<td>Rubrics/Checklists</td>
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<tr>
<td>Standards-Based Review</td>
<td>Think-Tac-Toe</td>
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<tr>
<td>Scaffolded Assignments</td>
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</table>
Content/Readiness: Tiered Lesson
Life Science - Six Kingdoms

- Standard/Essential Question
  - *How can we differentiate among the six kingdoms based on variations in their structures and functions?*

- Initial instruction
- Determine mastery of the standard
- Create a learning activity for ‘just ready’ learners
- Adjust learning activity for support & enrichment
  - ‘Not Ready’: Scaffolding to reach standard
  - ‘Ready-To-Go Beyond’ the standard
    - Analyzing evolutionary relationships among the six kingdoms.

Back to examples
Content/Readiness: Tiered Project
Life Science - Cell Structure/Function

● Standard/Essential Question
  o How do the parts of a cell work together to carry out life processes?

● Lesson Activator

● Concept Pretest

● Tiered Project
  o Common Component (Cell Jobs Graphic Organizer)
  o Tiered Components
    ▪ Cell City (Guided Analogy Project)
    ▪ Cell Analogy Project (Student Choice)
    ▪ Cell Pathology Research Project (Advanced)

Back to examples
Content/Readiness: Standards-Based Review

- Based on Formal Assessment Data
- Target Student Weaknesses
- Review Basics & Extend Understanding
- Variety of Learning Activities

Back to examples
Process/Readiness: Investigation/Argumentation Questioning

- Present task
- Students generate questions
  - Patterns
  - Stability & Change
  - Cause & Effect
- Provide support & feedback
- Provide bank of leveled questions, as needed
- Move into investigation
Content/Readiness: Scaffolded Assignments

- Pre-Writing Organizer
- Sentence Starters
- Cloze Notes in Graphic Organizer

Water: Too much of a good thing?
Cell Transport Writing Prompt

Water is essential to life, but it can be deadly. In January 2007, a California woman died of water intoxication following a water-drinking contest on a local talk show. It can also be deadly to drink salt water for an extended time. Use what you know about osmosis to explain how drinking water in these two cases causes cellular damage and death. Be sure to identify each solution as hypotonic, isotonic, or hypertonic, discuss solute concentrations inside and outside of the cell, and explain the direction of water movement.

Pre-writing Organizer

<table>
<thead>
<tr>
<th></th>
<th>Fresh Water</th>
<th>Salt Water</th>
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</thead>
<tbody>
<tr>
<td>Hypo/Hypertonic</td>
<td></td>
<td></td>
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<tr>
<td>Solute Concentration</td>
<td></td>
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<tr>
<td>Outside Cell</td>
<td></td>
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<tr>
<td>Direction Water Moves</td>
<td></td>
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</tr>
<tr>
<td>Water Moves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effect on Cells</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Back to examples
FIGURE 2: Think-Tac-Toe

Logical/Mathematical
- Construct a graph or design a chart that explains how a lever works.
- Describe the relationships among lever components using ratios and proportion.
- What is mathematical about levers? How do you know?

Verbal/Linguistic
- Create a bumper sticker about levers. It should be clever and catchy and summarize today's lesson.

Bodily/Kinesthetic
- Act out each class of lever with your body.
- There are at least five levers in your body; demonstrate them and explain why they are levers.

Visual/Spatial
- Draw a cartoon, such as a comic strip, that describes how a very large lever could be used to help someone. Correctly use at least four vocabulary words to describe levers.
- Create a flipbook that demonstrates the action of a lever.

Interpersonal
- Find a partner. Interview your partner to discover what he or she already knows about levers. Together, create a quiz to test others' knowledge of levers. Include at least three examples of levers in the quiz.

Intrapersonal
- Write a journal entry describing your favorite lever and explaining how it works. Brainstorm ways you might use this lever at home.
- Read about the historical use of levers. Are they a new invention or have they been used for a long time? Add some of your new ideas to your journal.

Musical
- Demonstrate with sound what happens to load and the effort when the length of the lever arm doubles.

Bodily/Kinesthetic
- Given a tongue depressor and a small piece of dowel rod, design a lever that can lift the most weight.
- Demonstrate your lever to three other classmates.

Naturalistic
- Create a photo essay of levers in use in everyday life. Label the parts of the levers and explain why they are levers. Describe the patterns you see in the different types of levers.

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Human Body

Tic-Tac-Toe Student Choice Activities

Standards/Objectives: Identifies major body systems and their functions. Names and describes important parts of the body.

1. Create a two minute public service announcement that addresses things people can do to their bodies that have a negative influence on the skeletal or muscular system or both. Make this announcement in your class or to the entire school during the time for school wide announcements. (Skeletal & Muscular systems)

2. Make a poster showing five different exercises that address five different muscles. For each exercise include:
   - Name of exercise
   - Name of muscle
   - Illustration of muscle
   - Illustration of exercise
   - Written steps to perform the exercise (Skeletal & Muscular systems)


4. Make a graph showing the percentages of red blood cells, white blood cells, and platelets in blood. Write an explanation of the function of each. (Circulatory system)

5. Draw a diagram showing how the circulatory system works. Label all major parts. (Circulatory system)

6. Research diseases of the circulatory system such as angina, high blood pressure, heart disease, or heart attacks. Do a three minute oral report explaining the causes of these diseases and how they can be prevented. (Circulatory system)

7. Write a paragraph explaining how the digestive and excretory systems are related to one another. Include a diagram. (Digestive & Excretory systems)

8. Write a short story describing life without teeth or gums. Include effects on the digestive and excretory systems. (Digestive & Excretory systems)

9. Create a set of ten interview questions about the digestive and excretory systems. Interview a doctor or nurse and write down their answers to your questions. (Digestive & Excretory systems)
Product/Interest/Learning Style
Life Science: Macromolecules

- **Standard/Essential Question**
  - How do macromolecules help maintain cellular structure & function?

- **Common learning goal**

- **Common rubric**

- **Different ways to demonstrate understanding**

- **Closed vs. Open Options**

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**Macromolecules Mini-Project**

**Extending/Refining Task – Biology, MAHS**

Directions: You will complete one of the assignment options below to demonstrate your understanding of macromolecules and their cellular functions. All assignments will assessed based on the rubric below.

**Essential Question:** How do macromolecules help maintain cellular structure and function?

**Georgia Performance Standard:** SB1c. Identify the function of the four major macromolecules (i.e. carbohydrates, lipids, proteins, & nucleic acids).

**Assignment Options:**

**Option 1:** Call Factory Letter
You are the plant manager at the Cells-R-Us factory, and you are in charge of ordering supplies for the factory. Sales are down for your company and the budget is tight. The owner of the company is questioning whether or not you really need to order all those carbohydrates, lipids, nucleic acids, and proteins. Write a letter to your boss explaining why each of these macromolecules is necessary for building a cell. Be sure that your letter describes in detail the functions that each group of macromolecules plays in the cell.

**Option 2:** Macromolecules Analogy Poster
Create an analogy that explains the major cellular function of each of the types of macromolecules, and create a poster that displays the four analogies. For each analogy, your poster should include an illustration of the analogy, an illustration of the structure of the macromolecule, and a clear description of the function of each group of macromolecules.

**Option 3:** Building the Perfect Meal
Your job is to feed cells – specifically your cells. Think back to your means options at the beginning of this lesson. Were they balanced? Did they provide all the molecules a cell needs to grow? Your challenge – you can choose only one meal to eat for the rest of your life. Don’t think about your favorite foods or what you would most like to eat. Choose carefully because you have to not only eat this the rest of your life, but you have to SURVIVE and grow on this meal. Also, you have to justify your decision. Explain how your choice provides all the four groups of macromolecules and explain how these groups help the cell survive and grow.

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**Rubric**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Possible Points</th>
<th>Points Earned</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Major cellular functions of each group of macromolecules are identified and explained</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Assignment follows particular guidelines for option selected</td>
<td>5</td>
<td></td>
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<tr>
<td>3. Work is neat and professional</td>
<td>5</td>
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<tr>
<td><strong>Final Score</strong></td>
<td></td>
<td></td>
<td>30</td>
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</tbody>
</table>

**Lesson Assessment:** After completing this assignment, you will take a quiz on the functions, characteristics and examples of macromolecules.
Product/Readiness: Rubrics/Checklists Evidence-Based Writing

- Match & extend varied readiness levels
- Presentation
- Supporting Student Reflection & Self-Assessment
- Differentiated Assessment

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Differentiation Resources

RESA/GaDOE
- Differentiated Instruction Lesson Planner
- TKES DI Teacher Self-Assessment Checklist (p. 32)
- Gilda Lyons’ DI Sessions (December 10th/15th)

Other Resources
- Differentiated Instruction in Science
- Teaching by Tiering in Science
- Differentiated Science Inquiry ($)
- Leveled Texts for Science ($)
- Differentiation Strategies for Science ($$)
- Carol Ann Tomlinson
- Differentiated Instructional Strategies
- Tiering How-To Videos
- Differentiation Central
Translating DOK & Rigor for Practical Use in Assessment

Jane Berger, Social Studies
Jeremy Peacock, Science
Northeast Georgia RESA
Webb’s DOK Wheel: Too Simple...
DOK is more than just verbs...

- **Describe** the difference between metamorphic and igneous rocks.
- **Describe** a model you might use to represent the relationship that exists within the rock cycle.
- **Describe** three characteristics of metamorphic rocks.

_The intended student learning outcome determines the DOK level. What mental processing must occur?_ - K. Hess
### Hess’ Cognitive Rigor Matrix:
Too Complicated...

<table>
<thead>
<tr>
<th>Revised Bloom’s Taxonomy</th>
<th>Webb’s DOK Level 1</th>
<th>Webb’s DOK Level 2</th>
<th>Webb’s DOK Level 3</th>
<th>Webb’s DOK Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Remember</strong></td>
<td>Recall &amp; Reproduction</td>
<td>Skills &amp; Concepts</td>
<td>Strategic Thinking/Reasoning</td>
<td>Extended Thinking</td>
</tr>
<tr>
<td>Retrieve knowledge from long-term memory, recognize, recall, locate, identify</td>
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<tr>
<td>Recall/identify conversions among representations or numbers (e.g., customary and metric measures)</td>
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<tr>
<td><strong>Understand</strong></td>
<td>Evaluate an expression</td>
<td>Specify and explain relationships</td>
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<tr>
<td>Construct meaning, clarify, paraphrase, represent, translate, illustrate, give examples, classify, categorize, summarize, generalize, infer a logical conclusion (such as from examples given), predict, compare/contrast, match like ideas, explain, construct models</td>
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<td>Evaluate an expression (e.g., non-examples/examples, cause-effect)</td>
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<td>Make and record observations</td>
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<td>Explain steps followed</td>
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<tr>
<td>Summarize results or concepts</td>
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<tr>
<td>Make basic inferences or logical predictions from data/observations</td>
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<tr>
<td>Use models/idiagrams to represent or explain mathematical concepts</td>
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<td>Make and explain estimates</td>
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<tr>
<td>Use concepts to solve non-routine problems</td>
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<tr>
<td>Explain, generalize, or connect ideas using supporting evidence</td>
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<td>Make and justify conjectures</td>
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<td>Explain thinking when more than one response is possible</td>
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<tr>
<td>Explain phenomena in terms of concepts</td>
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<tr>
<td>Relate mathematical or scientific concepts to other content areas, other domains, or other concepts</td>
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<tr>
<td>Develop generalizations of the results obtained and the strategies used (from investigation or readings) and apply them to new problem situations</td>
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<tr>
<td><strong>Apply</strong></td>
<td>Follow simple procedures</td>
<td>Select a procedure according to criteria and perform it</td>
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<tr>
<td>Carry out or use a procedure in a given situation; carry out (apply to a familiar task), or use (apply) to an unfamiliar task</td>
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<tr>
<td>Calculate, measure, apply a rule (e.g., rounding)</td>
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<tr>
<td>Apply algorithm or formula (e.g., area, perimeter)</td>
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<tr>
<td>Solve linear equations</td>
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<tr>
<td>Make conversions among representations or numbers, or within and between customary and metric measures</td>
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<tr>
<td>Design investigation for a specific purpose or research question</td>
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<tr>
<td>Solve routine problem applying multiple concepts or decision points</td>
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<tr>
<td>Select information from a table, graph, or figure and use it to solve a problem requiring multiple steps</td>
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<tr>
<td>Translate between tables, graphs, words, and symbolic notations (e.g., graph data from a table)</td>
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<tr>
<td>Construct models given criteria</td>
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<tr>
<td>Select or devise approach among many alternatives to solve a problem</td>
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<tr>
<td>Conduct a designed investigation</td>
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<tr>
<td>Use concepts to solve non-routine problems</td>
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<tr>
<td>Use &amp; show reasoning, planning, and evidence</td>
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<tr>
<td>Translate between problem &amp; symbolic notation when not a direct translation</td>
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<tr>
<td><strong>Analyze</strong></td>
<td>Retrieve information from a table or graph to answer a question</td>
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<tr>
<td>Break into constituent parts, determine how parts relate, differentiate between relevant-relevant, distinguish, focus, select, organize, outline, find coherence, deconstruct</td>
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<tr>
<td>Identify whether specific information is contained in graphic representations (e.g., table, graph, T-chart, diagram)</td>
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<tr>
<td>Identify a pattern/trend</td>
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<tr>
<td>Categorize, classify materials, data, figures based on characteristics</td>
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<tr>
<td>Organize or order data</td>
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<tr>
<td>Compare/contrast figures or data</td>
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<tr>
<td>Select appropriate graph and organize &amp; display data</td>
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<tr>
<td>Interpret data from a simple graph</td>
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<tr>
<td>Extend a pattern</td>
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<tr>
<td>Compare information within or across data sets or texts</td>
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<tr>
<td>Analyze and draw conclusions from data, citing evidence</td>
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<tr>
<td>Generalize a pattern</td>
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<tr>
<td>Interpret data from complex graph</td>
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<tr>
<td>Analyze similarities/differences between procedures or solutions</td>
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<tr>
<td>Analyze multiple sources of evidence</td>
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<tr>
<td>Analyze complex/abstract themes</td>
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<tr>
<td>Gather, analyze, &amp; evaluate information</td>
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<tr>
<td><strong>Evaluate</strong></td>
<td>Brainstorm ideas, concepts, or perspectives related to a topic</td>
<td></td>
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<tr>
<td>Make judgments based on criteria, check, detect inconsistencies or fallacies, judge, critique</td>
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<tr>
<td>Generate conjectures or hypotheses based on observations or prior knowledge and experience</td>
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<tr>
<td>Synthesize information within one data set, source, or text</td>
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<tr>
<td>Formulate an original problem given a situation</td>
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<tr>
<td>Develop a scientific/mathematical model for a complex situation</td>
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<tr>
<td>Synthesize information across multiple sources or texts</td>
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<tr>
<td>Design a mathematical model to inform and solve a practical or abstract situation</td>
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<tr>
<td><strong>Create</strong></td>
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<tr>
<td>Reorganize elements into new patterns/structures, generate, hypothesize, design, plan, construct, produce</td>
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<td></td>
</tr>
</tbody>
</table>
Adapted Cognitive Rigor Checklist: Just right...

<table>
<thead>
<tr>
<th>LEVEL 2</th>
<th>Does the question require students to act on the information by .......</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- explaining a relationship; explain why, cause-effect</td>
</tr>
<tr>
<td></td>
<td>- explaining steps</td>
</tr>
<tr>
<td></td>
<td>- summarizing a concept, results, ideas</td>
</tr>
<tr>
<td></td>
<td>- making a prediction or inference</td>
</tr>
<tr>
<td></td>
<td>- using a model/diagram to explain something</td>
</tr>
<tr>
<td></td>
<td>- retrieving information from a table, graph, or figure to solve a multi-step problem</td>
</tr>
<tr>
<td></td>
<td>- comparing/contrasting figures or data</td>
</tr>
<tr>
<td></td>
<td>- interpreting data from a simple graph</td>
</tr>
<tr>
<td></td>
<td>- extending a pattern</td>
</tr>
<tr>
<td></td>
<td>- distinguishing fact/opinion; relevant from irrelevant information</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LEVEL 3</th>
<th>Does the question require students to think strategically by .......</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- using a concept to solve non-routine problems or a new concept</td>
</tr>
<tr>
<td></td>
<td>- using supporting evidence</td>
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<tr>
<td></td>
<td>- making a conjecture</td>
</tr>
<tr>
<td></td>
<td>- comparing information within/across data sets</td>
</tr>
<tr>
<td></td>
<td>- interpreting data from a complex graph</td>
</tr>
<tr>
<td></td>
<td>- analyzing interrelationships among concepts, issues, problems</td>
</tr>
<tr>
<td></td>
<td>- citing evidence &amp; develop a logical argument</td>
</tr>
<tr>
<td></td>
<td>- comparing,contrasting and describing a solution</td>
</tr>
<tr>
<td></td>
<td>- synthesizing information within a data set source or text</td>
</tr>
<tr>
<td></td>
<td>- formulating an original problem given a situation</td>
</tr>
<tr>
<td></td>
<td>- developing an alternative solution</td>
</tr>
</tbody>
</table>

Access the Social Studies Checklist
MS Social Studies DOK Workshops

● Full day:
  o 12/2 (6th/7th grades) & 12/3 (8th grade)

● Objectives
  o Use the Leadership and Learning process to develop common formative assessments.
  o Examine the Karin Hess Cognitive Rigor Matrix and use it in the creation of our questions.
  o Write questions that are at DOK level 2 & 3 directly linked to standards.
  o Use resources to find graphs, charts, tables, passages and pictures that will be used in the questions.
  o Provide questions to all districts who participate with a bank of questions at each grade level.
Middle School Earth Science Teacher Academy Action Plan

Jeremy Peacock, Science
Northeast Georgia RESA
Earth Science Teacher Academy: Defining the Need - Students

Student Performance Levels 6th Grade CRCT - Earth Science

Student Subgroup Performance

Domain Performance (% correct)
Earth Science Teacher Academy: Defining the Need - Teachers

Which area(s) would most directly benefit you and your students? (select all that apply)

- Additional content knowledge in the Geology domain
  - 1 person (9%)
- Additional content knowledge in the Hydrology/Meteorology domain
  - 5 people (45%)
- Additional content knowledge in the Astronomy domain
  - 3 people (27%)
- Instructional strategies that support students’ conceptual understanding of content
  - 9 people (82%)
- Instructional strategies to support student engagement
  - 8 people (73%)
- Instructional strategies to support student literacy
  - 5 people (45%)
- Other
  - 1 person (9%)

Which professional learning activities would most benefit you and your students? (select all that apply)

- Participating in model lessons at RESA
  - 6 people (55%)
- Collaborative planning with other Earth Science teachers
  - 6 people (55%)
- Sharing research-based instructional practices
  - 1 person (9%)
- Hearing from content experts and scientists
  - 2 people (18%)
- Observing model lessons in classrooms
  - 4 people (36%)
- Receiving coaching and feedback in your own classroom
  - 1 person (9%)
- Analyzing student data
  - 2 people (18%)
- Other
  - 1 person (9%)
Earth Science Teacher Academy: Goals of the Program

1. Improve student achievement from baseline on EOG
2. Improve teacher PCK & commitment to best practices
3. Provide foundation for learning in future science courses

http://mrsdlovesscience.com/airmasses.html
Earth Science Teacher Academy: Program Overview

- 2 years, with multiple entry points
- Partnerships with UGA, others
- Components
  - Data analysis
  - Professional learning sessions
    - Instructional best practices
    - Model lessons
    - Content knowledge
  - Collaborative planning sessions
    - Develop Framework-aligned lessons
  - School-based support & coaching
Earth Science Teacher Academy: Year 1

- **Day 1 - Instructional Focus @ RESA**
  - Individual data dig
  - Assessment resources
  - Model 3D lesson in target domain
  - Collaborative planning to develop 3D lesson

- **Day 2 - Content Focus @ UGA**
  - Tours, lectures, etc. with experts in target domains
  - Collaborative planning to incorporate advanced content into classroom lessons

- **Ongoing School-Based Follow-Up**
  - Planning & assessment support
  - Coaching based on collaboratively planned lessons

- **Culminating task**
  - Teachers submit new lesson to Regional LOR
Earth Science Teacher Academy: Year 2

- Repeat Year 1 with new learning activities
- Returning teachers serve as mentors
- Opportunity for new teachers to join academy
- Decide on possible extension based on program evaluation
Earth Science Teacher Academy: Summary & Next Steps

Next Steps:

- Expect enrolment announcement within two weeks
- Sessions in winter & spring