Developing Assessments of Science Proficiency: Recommendations of NRC Report (2014)

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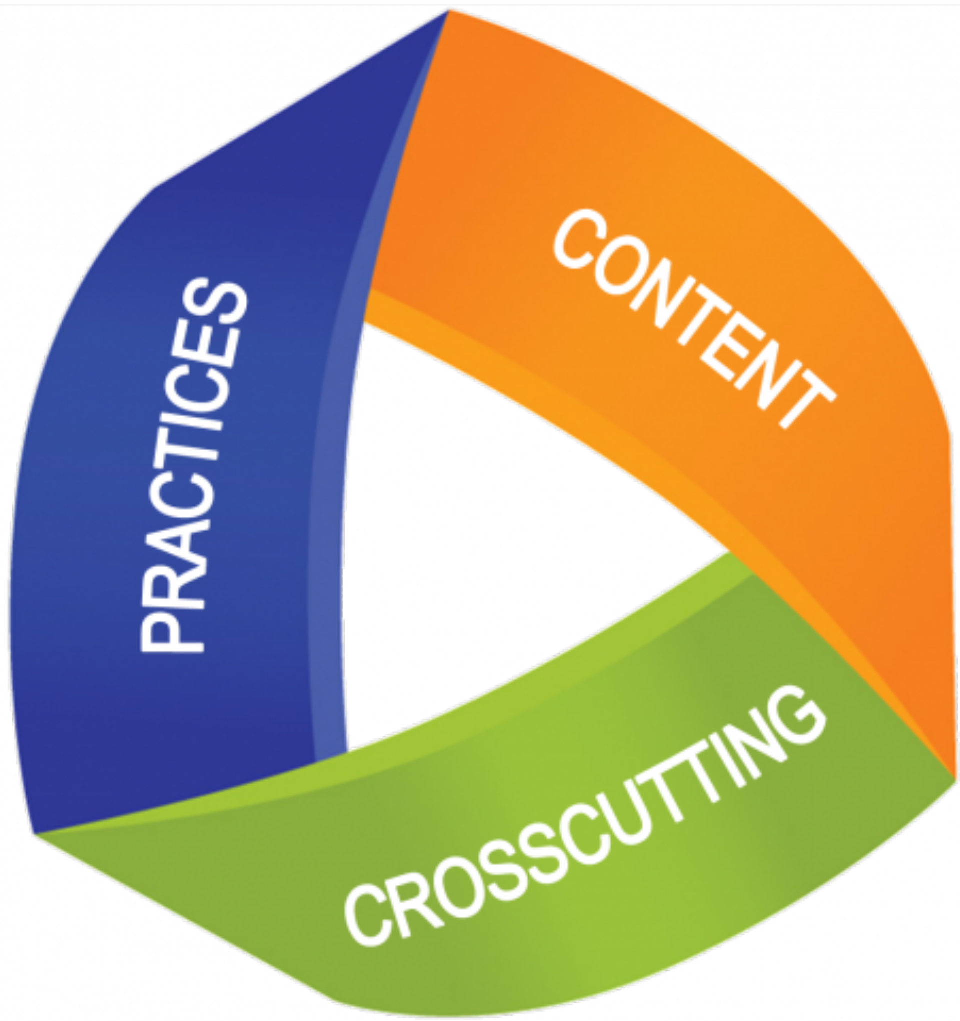
CHALLENGE:
Developing an Assessment System Aligned to the Vision of the *Framework*

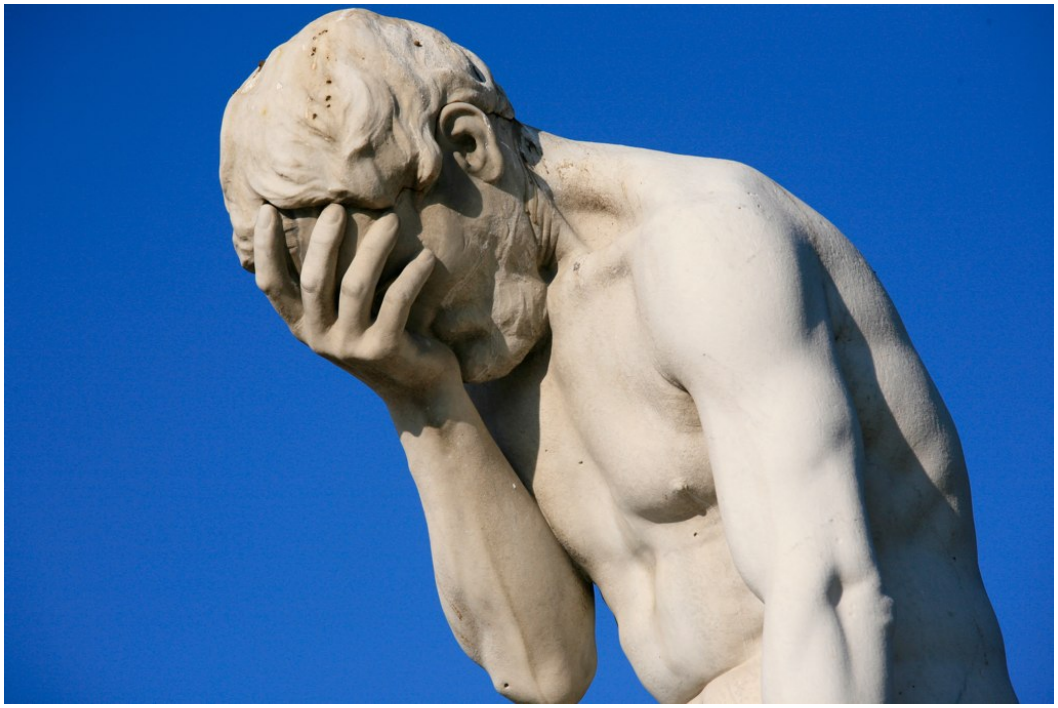


Driving Question for Today

- How do we begin to develop an assessment system that:
  - Is consistent with the vision of the *Framework?*
  - Makes use of examples, conclusions, and recommendations of the *NRC* report to develop an assessment system?
  - Is transparent and visible to educators?
  - Helps educators and educational leaders learn about developing three-dimensional assessment tasks?

Start Small

Conclusion 2.3: It will not be feasible to assess all of the performance expectations for a given grade level with any one assessment.



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Start Small

- One approach: Take a single grade level and imagine the multiple assessments that will be needed to assess those performance expectations.
  - How might PEs be bundled?
  - How might students' proficiency develop?
  - What assessments will be designed an administered by teachers? Districts? States?
  - How will assessments be scored?
  - What reports will be generated, and how will they be used?

Define Intended Users and Uses

- Beginning with a definition of intended users and users can help you decide how to allocate resources for building the system.
  - "We encourage policy makers to take a balanced approach in allocating resources for each component of an assessment system." (NRC, 2013, p. 6-18)
  - Supporting classroom uses of assessment is likely to require professional development for both teachers and educational leaders.

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  - How will coaches and principals use assessment evidence to allocate PD resources?
  - How will districts use assessment evidence to improve science programs in their district?

Formative Uses in Classrooms

- Require imagining assessment as a *process* and not a *test* (or items and tasks bundled as tests)
- Present multiple challenges, each of which requires tools to help teachers address
- Require extensive professional development

Formative Uses in Classrooms

Requirement	Challenges
Posing questions that require deep thinking	Developing questions that ask students to "know that" and "know how" is easier than developing questions that ask students to "know why" and to "know when and where to apply knowledge"
Giving students time to think and pose questions	There are few built-in supports for wait-time; slowing down instruction can create opportunities for distraction
Providing students with feedback	In the middle of class, teachers can only give feedback to those students who respond orally to questions
Engaging students in discussing their ideas	The default pattern of communication – ask a question, get an answer, evaluate it – doesn't encourage revision or debate
Adjusting instruction	There may be few other ways to teach the content, other than what the curriculum provides

Interim Uses of Assessments

- Benchmark or interim assessments are common tools in districts intended to be used to
  - Provide rapid feedback to teachers, principals, and district leaders
  - Inform teachers of student understanding of concepts and skills
  - Pinpoint areas where students need support
- Often intended to serve multiple purposes: summative, formative, accountability
- Challenge: Creating multi-component tasks that can meet the need for rapid turnaround

Goals in Rhode Island

- Develop NGSS-Aligned assessment items that
  - will support an NGSS aligned curriculum but
  - target concepts and skills defined in curricula aligned to the previous RI Science Standards (Grade Span Expectations)
  - will inform teachers of student understanding of concepts and skills
  - provide rapid turnaround in results
  - pinpoint areas where students need support

Using Evidence Centered Design

Claim Space	*Exactly what knowledge and skills do you want students to have and how do you want them to know it? (This is the Performance Expectation)*
Evidence	*What will you accept as evidence that a student has the desired knowledge?* *How will you analyze and interpret the evidence?*
Task	*What task(s) will the student perform to communicate their knowledge?*

Claim Space

Exactly what knowledge and skills do you want students to have and how do you want them to know it? (This is the Performance Expectation)

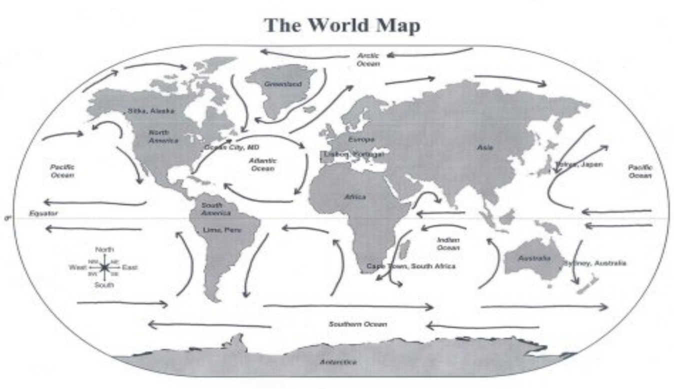
MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]

Evidence

- (SEP) Develop a model to describe phenomena.
- (SEP) Use a model to describe phenomena.
- (DCI) Variations in density due to variations in temperature and salinity drive the global pattern of interconnected ocean currents.
- (DCI) Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things.
- (DCI)These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.
- (XCC) Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—energy, matter, and information flows within systems.
- (CS) Coriolis effect. Latitudinal Banding, variance of patterns by latitude, altitude, and geographic land distribution

Tasks

- For instance – Give students a map of ocean currents (using a model). Have students describe the patterns they see. Let students work in groups to determine why (what cause) the currents move in the patterns they describe (DCI connections).
- From there have students make a comparison between the Coriolis effect map and the ocean current map to determine how they are different.
- Etc…Etc… [**We'll elaborate in a moment!**]



Create Templates for Task Design

- To adequately cover the three dimensions, assessment tasks will need to contain multiple components (e.g., a set of interrelated questions).
- Specific components may focus on individual practices, core ideas, or crosscutting concepts, but, together, the components need to support inferences about students' three-dimensional science learning as described in a given performance expectation.

Create Templates for Task Design

- Tasks are required for all kinds of assessment (classroom, interim, state, etc.).
- Good task design is good task design.
- When lots of people need to design tasks, a template can facilitate consistency and understanding.

Design Pattern

- A tool within *Evidence Centered Design (ECD)* that can guide the design of multicomponent tasks that integrate three dimensions
- Can help states:
  - Adapt or re-design tasks used in classroom-based, interim, and summative assessments
  - Develop leaders' and teachers' understandings in particular of science practices and how to elicit them

An Organizing Structure: The Design Pattern

- Focal Knowledge, Skills, Abilities / Claims
- Potential Observations / Evidence
- Characteristic Features
- Variable Features

Plus

- Additional Knowledge, Skills, and Abilities
- Work Products
- Potential Rubrics

What do we expect students to know and be able to do?

- Articulating Claims / Focal Knowledge, Skills, and Abilities (Focal KSAs)

FKSA 1.	Ability to construct a model and use the model to explain a phenomenon
FKSA 2.	Ability to construct a model and use the model to make a prediction about a phenomenon
FKSA 3.	Ability to evaluate the quality of the model for explaining a phenomenon
FKSA 4.	Ability to use a given model to make a prediction about a phenomenon

How do we know it when we see it?

- Describing the evidence (Potential Observations related to FKSAs)

FKSA 1. Ability to construct a model and use the model to explain a phenomenon	**PO 1.** Given a brief real-world scenario describing an observable phenomenon, student applies scientific concepts appropriately to construct a model (using drawings and words) that explains why the phenomenon occurs. *Physical science example: Given a representation of water molecules in solid form, student accurately constructs a representation of water molecules in liquid form and explains why water as a liquid can flow and change its shape to fit a container.*
FKSA 3. Ability to evaluate the quality of the model for explaining a phenomenon	**PO 3.** Given a model, student accurately describes similarities and differences between the model and a phenomenon *Earth science example : Student identifies accurate similarities and differences between a cracked egg model and a scientist's model of Earth's surface/interior/geologic processes.*

What should all tasks require?

- Characteristic Features (CF)

CF 1.	All items must prompt students to make connections between observed phenomenon or evidence and reasoning underlying the observation/evidence.
CF 2.	All phenomena for which a model is developed must be observable (e.g., difference in temperature as a substance is heated, an erupting volcano) or fit available evidence.
CF 3.	Models provided in stimulus materials must illustrate a process or why a phenomenon exists (e.g., image of volcanoes over hot spot must include hot spot and direction of plate movement).
CF 4.	All items must elicit core ideas as defined in the *Framework for K-12 Science Education* (NRC, 2012).

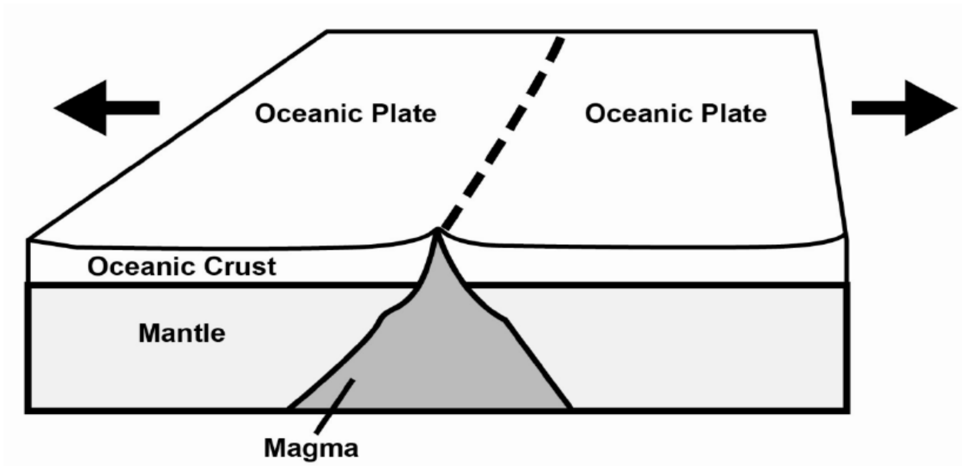
How might tasks vary?

- Variable Features (VF)

VF 1.	Drawing required: none vs. add to existing picture vs. construct model from scratch
VF 2.	Complexity of scientific concept(s) to be modeled
VF 3.	Format of "real-world" phenomenon presented: image, data, text, combination
VF 4.	Core idea targeted in model: physical science core idea vs. Earth science core idea
VF5.	Function of the model: To explain a mechanism underlying a phenomenon, To predict future outcomes, To describe a phenomenon, To generate data to inform how the world works
VF6.	Scale of mechanistic relationships in model: Observable-Macro, Unobservable-Micro, Unobservable-Macro

Earth Science Task: Diverging Plate Boundary

The picture below shows a place on the ocean floor where two plates are moving apart. At this plate boundary (shown at the dotted line), rock material is rising to the surface.



A. Draw on the picture to show what is happening in the mantle that causes the plates to move apart.

B. What is happening in the mantle that helps to explain why the two plates are moving apart?

C. Put an X on the places in the picture above where the oldest rock can be found in the crust.

D. Explain your answer.

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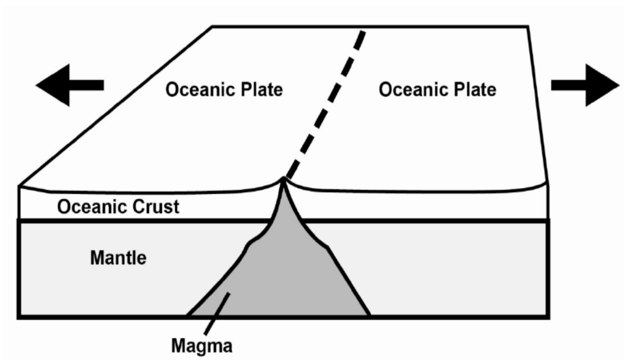

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FKSA 1. Ability to construct a model and use the model to explain a phenomenon

Conceptual Model. Student adds to and uses a model of a mid-ocean ridge including convection currents to explain the movement of diverging ocean plates over time and where new and old rocks can be found as a result.

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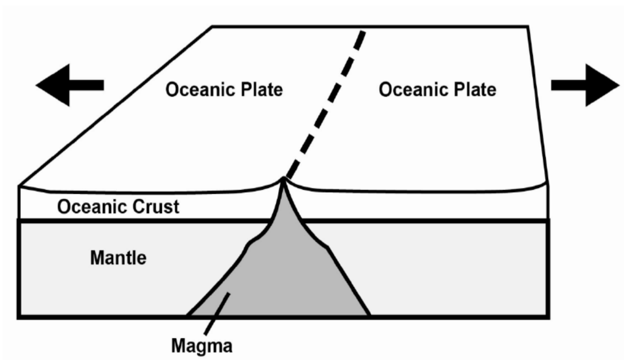

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CF1. [P]rompt for connections between observed phenomenon… and reasoning underlying the observation/evidence.
CF2. All phenomena for which a model is developed must be observable…
CF4. All items must elicit core ideas as defined in the *Framework for K-12 Science Education* (NRC, 2012). DCI: [ADD]

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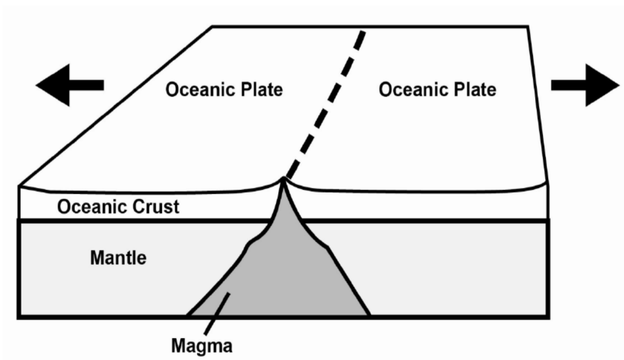

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VF1. Drawing required: add to existing picture
VF3. Format of "real-world" phenomenon presented: combination of text and image
VF4. Core idea targeted in model: physical science core idea vs. Earth science core idea
VF5. Function of the model: To explain a mechanism underlying a phenomenon
VF6. Scale of mechanistic relationships in model: Unobservable-Macro

Now, You Try!

With your colleagues at your table, choose one of the tasks and modify it to integrate the practice of developing and using models, using the design pattern as a guide.

Discussion

- What are some of the modifications your table made? Why did you make them?
- How did you make use of:
  - The Design Pattern?
  - Performance Expectations?
  - Assessment Boundaries?
  - Images and Graphics?
- What are some of the things you discussed and debated at your table?
- What additional supports would you need to do this in your state? In districts? In teacher professional development?

Mapping of Rubric to Modeling Levels

+1	A: Arrows illustrate convection currents.
+1	B: Student explains that convection in the mantle drags/moves/pulls the two plates apart.
+1	C: X's are on both sides of the drawing, on the outermost edge of the crust.
+1	D: Older rock is dragged/moves) away from where the magma pushes up (plates move apart from the boundary). Or magma coming up between the plates and filling the gap with new rock

Total Score	Construct Map Level	
4	4	**…model as a representation** that can explain why a older rock is further away from a divergent plate boundaries …includes **mechanistic features of the observable and unobservable phenomena**.