Developing Three-Dimensional Assessment Tasks

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OFFICE OF EDUCATIONAL ASSESSMENT AND ACCOUNTABILITY
Agenda

- Introductions
- Analyzing Assessment Tasks
- Unpacking

- Designing an Assessment Task
- Peer Review and Feedback
Introductions

- Talk with your partner
  - Introduce yourself
  - Develop a shared goal for the workshop
  - Write your goal on a sticky note

- Share out with group
  - Name
  - Current teaching placement
  - Your shared goal for the workshop
Objectives for the Day

- Professional Learning
  - Understand:
    - What counts as a 3D assessment task?
    - How do I adapt a task to make it 3D?
  - Deeply explore:
    - NGSS and NGSS Appendices E, F, G
    - NRC Framework for K-12 Science Education
    - Additional Science Assessment Resources

**Topic Bundle:** A group of 2-6 standards written in the MSS adoption documentation.

**Item Cluster:** A stimulus and set of 5-8 items focused on a common phenomenon or design problem in which all of the PEs in one topic bundle are assessed.
An Assessment System for Science

“The idea of an assessment system begins with a commonsense point: no one assessment – or assessment occasion – can meet all the needs for information about what student know and can do in science” (p.21 NASEM, 2017).

“Large-scale assessments, particularly the yearly tests used by districts and states, play a key role in shaping both expectations for student learning and public discussion and perceptions of science education. Therefore, it is critical that these test be adapted along with instruction” (p. 24, NASEM, 2017)

Science Assessment System Goals

- Science assessments in Michigan must be a coherent system of assessment to support both classroom learning and policy/monitoring functions.

- Michigan monitoring (accountability) science assessments must move beyond traditional forms; testing as usual will NOT suffice.

- Opportunity to learn science is an essential system component.

- Classroom science teaching and assessment come first.

NRC, 2014

“Changing large-scale accountability tests may be the most challenging piece of the puzzle, but teachers can proceed even while system-wide changes are evolving” (p.22, NASEM, 2017).
Opportunity to Learn for Teachers

Opportunity to Learn for Students

Vision for Balanced Assessment System for Michigan K-12 Science Standards

Classroom Formative Assessment
A process providing feedback to students and teachers to inform ongoing learning and instruction.

Classroom Summative Assessment
Tests, Quizzes, Projects, Performance Assessments, etc.

District Benchmarks
Common assessments - Quarterly/trimester

Interim Assessment
Tests for student growth or predictive purposes

M-STEP Assessment
Grades 5, 8, & 11

Curriculum

Flow of Data

“*The idea of an assessment system begins with a commonsense point: no one assessment – or assessment occasion – can meet all the needs for information about what student know and can do in science*” (p.21 NASEM, 2017).
Evidence Centered Design: Michigan Science Assessment Claims

**Equity Claim:** Non-dominant and dominant groups of students have the opportunity to demonstrate grade band proficiency through the use of engineering, local contexts, and relevant phenomena.

**Scientific Literacy Claim:** Students demonstrate grade band proficiency in using the three dimensions to critically evaluate scientific and technological information in order to design solutions to problems and investigate phenomena.

**Student Level Claim:**
Student has demonstrated grade band proficiency in:
- Life Science,
- Earth Science,
- Physical Science
Topic Bundles using all dimensions represented in the standards.

**District/State Level Claim:**
Students have demonstrated grade band proficiency to explain the presented phenomenon (local or global) and design solutions to problems using all dimensions represented in the given topic bundle.
Example Item Cluster Map

Topic Bundle
Structure and Properties of Matter

Phenomenon

5-LS1-1
LS1.C SEP 7 CC 5

5-LS2-1
LS2.A SEP 2 CC 4
LS2.B SEP 2 CC 4

5-PS3-1
PS3.D SEP 2 CC 5
LS1.C SEP 7 CC 5

Stimulus

Item 1
Item 2
Item 3
Item 4
Item 5

CC 5
SEP 2
LS1.C
LS1.C
SEP 2
SEP 7

LS2.A
CC 4
LS2.B
SEP 7
CC 4
Release Annotated Item Clusters

https://wbte.drcedirect.com/MI/portals/mi/
Item Cluster Development for New Michigan Science Standards
PE Bundle – Topic Bundles

- Bundles should mirror how PEs are presented and taught in classrooms.
- Bundled PEs should reflect the structure of the adopted standards.
- Bundles should enable assessment via a **single natural phenomenon** presented within a stimulus.

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>HS. Inheritance and Variation of Traits</td>
<td>HS. History of Earth</td>
<td>HS. Chemical Reactions</td>
</tr>
<tr>
<td>HS. Matter and Energy in Organisms and Ecosystems</td>
<td>HS. Earth's Systems</td>
<td>HS. Forces and Interactions</td>
</tr>
<tr>
<td>HS. Interdependent Relationships in Ecosystems</td>
<td>HS. Weather and Climate</td>
<td>HS. Energy</td>
</tr>
<tr>
<td>HS. Natural Selection and Evolution</td>
<td>HS. Human Sustainability</td>
<td>HS. Waves and Electromagnetic Radiation</td>
</tr>
<tr>
<td>Topic Bundle</td>
<td>Domain</td>
<td>No. PEs</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
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<td>---------</td>
</tr>
<tr>
<td>Structure and Function</td>
<td>Life Science</td>
<td>3</td>
</tr>
<tr>
<td>Matter and Energy in Organisms and Ecosystems</td>
<td>Life Science</td>
<td>6</td>
</tr>
<tr>
<td>Interdependent Relationships in Ecosystems</td>
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</tr>
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<td>Inheritance and Variation of Traits</td>
<td>Life Science</td>
<td>4</td>
</tr>
<tr>
<td>Space Systems</td>
<td>Earth Science</td>
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</tr>
<tr>
<td>History of Earth</td>
<td>Earth Science</td>
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<td>Earth’s Systems</td>
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<td>5</td>
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<tr>
<td>Weather and Climate</td>
<td>Earth Science</td>
<td>2</td>
</tr>
<tr>
<td>Human Sustainability</td>
<td>Earth Science</td>
<td>5</td>
</tr>
</tbody>
</table>
**PE Bundles High School Continued**

<table>
<thead>
<tr>
<th>Topic Bundle</th>
<th>Domain</th>
<th>No. PEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure and Properties of Matter</td>
<td>Physical Science</td>
<td>4</td>
</tr>
<tr>
<td>Chemical Reactions</td>
<td>Physical Science</td>
<td>5</td>
</tr>
<tr>
<td>Forces and Interactions</td>
<td>Physical Science</td>
<td>5</td>
</tr>
<tr>
<td>Energy</td>
<td>Physical Science</td>
<td>5</td>
</tr>
<tr>
<td>Waves and Radiation</td>
<td>Physical Science</td>
<td>5</td>
</tr>
<tr>
<td>Engineering Design</td>
<td>Engineering</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total Topic Bundles</strong></td>
<td><strong>16</strong></td>
<td><strong>71</strong></td>
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</tbody>
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Activity: Analysis of Assessment Tasks + Debrief
Activity: Assessment Task Analysis

1. Review and discuss with a partner the sample assessment tasks provided, all of which aim to assess the Performance Expectation.

2. Rate each task in terms of how well you think it assesses the three dimensions integrated in the performance expectation (1 = not at all effective, 5 = highly effective)

3. Use the Chart paper to track the ratings using small sticky notes

4. Prepare to share your process, thoughts, and criteria you applied for rankings with the whole group.
Whole Group Discussion

How did our ratings compare? (review the data)

What are some criteria for deciding when a task is 3D?
Uh huh. Uh huh. Got it...

Your meeting comprehension

About 45 minutes in

Time

BLUH...... WHAT?...
Unpacking Relevant Documents
Unpacking
Why Unpack??

The unpacking process enables:

- Understanding what the dimension really means
- Defining how students can provide evidence of their understanding
- Describing proficiency levels
- Focus on Student-Centered instruction and assessment

This process is of high value because it:

- Promotes consistency in your use of dimensions
- Sustains the essential aspects of the dimension
Unpacking Examples

### Unpacking the Core Idea

<table>
<thead>
<tr>
<th>Step 1: Select the Performance Expectation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit: Energy and Change in the Properties of Objects</td>
</tr>
<tr>
<td>Performance: Understand, describe, and determine the properties of objects</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2: Unpack the Core Idea</th>
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<tbody>
<tr>
<td>Systemic Strategy: Consider the Big Idea</td>
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<tr>
<td>Stated Concepts: Consider the Big Idea</td>
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<tr>
<td>Questions to think about:</td>
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<td>What are the main ideas that are present?</td>
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<td>What additional ideas are critical for the concept to understand?</td>
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</table>

2.3 Select and Examine the Core Idea for the Component Idea

Questions to think about:
- What are the main ideas that are present?
- What additional ideas are critical for the concept to understand?

### Unpacking of Science Practices

<table>
<thead>
<tr>
<th>Practice 1: Developing a Model</th>
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<tbody>
<tr>
<td>Questions to think about:</td>
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<tr>
<td>What knowledge and skills are needed to understand a scientific model?</td>
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<table>
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<tr>
<th>Practice 2: Conducting Investigations</th>
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<td>Questions to think about:</td>
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<td>What knowledge and skills are needed to conduct scientific investigations?</td>
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</table>

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<thead>
<tr>
<th>Practice 3: Constructing Explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questions to think about:</td>
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<tr>
<td>What knowledge and skills are needed to construct scientific explanations?</td>
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<tr>
<th>Practice 4: Using Models, Tools, and Technology</th>
</tr>
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<tbody>
<tr>
<td>Questions to think about:</td>
</tr>
<tr>
<td>What knowledge and skills are needed to use models, tools, and technology?</td>
</tr>
</tbody>
</table>

### Knowledge and Skills for Performing the Practice

- **Mental Representation:** Looking representation to ideas, observations, and developing cause or effect relationships.
- **Communicate:** Communicate models, systems, and representations that include drawing and writing.
- **Interpret:** Interpreting and analyzing data from observations.

### Evidence for Each Component of the Practice

- **Diagram:** Visually representing data or models.
- **Text:** Writing descriptions or explanations of observations.
- **Data:** Analyzing and interpreting data from experiments.
- **Technology:** Using technology to enhance understanding of concepts.
Unpacking Examples
Unpacking a Performance Expectation

1. Read the PE
2. Use the Clarification Statements and Assessment Boundaries
3. Read the Foundation Boxes
4. Use the *Framework* to unpack the 3 dimensions of each PE
5. Use Appendices E, F, and G
6. The Evidence Statements are a secondary resource
Modeling Unpacking

- Next Generation Science Official Website

This process has been adapted from the Next Generation Assessment Project
Joe Krajcik, Christopher Harris, Jim Pellegrino, and Dan Damelin
Michigan State University, SRI International, University of Illinois, and Concord Consortium
Unpacking SEPs

- What is the practice?
  - What are the components of the practice?
  - What possible intersections might there be with other practices?

- What knowledge and skills do students need to use in order to show that they can perform the practice?

- What is a high level of performance that you would expect to see for each component?
- What are the different levels of performance of each component?
Unpacking CCCs

- What are the key aspects of this crosscutting concept?
- What explanatory value does this crosscutting concept have?
- How might a student’s understanding of this crosscutting concept grow over time?
- Which practices provide unforced meaningful connections with this crosscutting concept?
- What are some concepts and/or contexts in life, earth, and physical science that would provide good opportunities for students to explore this crosscutting concept?
- What is a high level of performance that you would expect to see for each key aspect?
- What are the different levels of performance for each key aspect?
Unpacking DCI

- What is the DCI?
- What are the main ideas present in the grade band endpoints?
- What are the main ideas present in each element?
- What additional ideas are critical for the learner to understand?
- Is there one idea or several separate ideas in one statement?
- What terminology is explicitly used in the core idea?
- What peripheral terms or ideas are NOT essential for understanding the DCI?
Unpacking DCI

• What other knowledge and skills (both from this topic and from other topics) do students need in order to achieve an understanding of this DCI?

• Are there any commonly-held ideas that differ in important ways from the scientifically accepted understanding?

• What methods can be used to determine students’ current understandings?

• In what ways can instruction directly address or leverage students current understandings?

• What phenomena would provide an example of this core idea?
Resources for Unpacking

- Next Generation Science Official Website
- NGSS@NSTA Website
- Framework for K-12 Science Education
- Appendix E - Disciplinary Core Ideas Progressions
- Appendix F – Science and Engineering Practices
- Appendix G – Cross Cutting Concepts
- http://assessment.aaas.org/topics
Stay Positive!

I TOLD A CHEMISTRY JOKE ONCE

I DIDN'T GET A REACTION.

memegenerator.net
Analysis of Assessment Task

• Does the evidence uncovered by unpacking appear in your assessment task...
  o In the DCIs?
  o In the SEPs?
  o In the CCCs?

• Share some examples of stronger and weaker alignment to the PE from your assessment task.
  o What criteria are you using to determine “strong” vs. “weak” alignment?
Natural phenomena are observable events that occur in the universe and that we can use our science knowledge to explain or predict.

The focus of learning shifts from learning about a topic to figuring out why or how something happens.
Why is phenomena-driven learning important?

• Natural phenomena engage students’ **curiosity** and prior knowledge

• Engages students in the work that **scientists do**

• Explaining the phenomenon leads to a series of activity-level questions that build on each other (**coherence**)

• Orienting classroom discourse around answering scientific questions **naturally integrates** the three dimensions (DCIs, CCCs, and SEPs)
Brainstorm Phenomena

- Return to your task you reviewed
- Determine which task includes a phenomenon that can be used or tweaked
- Brainstorm 8-10 phenomena that can be explained using the DCIs, CCCs, and SEPs in your PE
  - Identify a phenomenon that students could encounter in a real-world scenario (inclusive of the classroom, lab, outdoors)

Remember that *phenomena do not have to be phenomenal*. Often simpler is better.

- Is it relevant?
- Is it relatable?
- What prior knowledge and experiences can students draw on?
Designing an Assessment Task
Steps to Designing 3D Assessments

**Step 1:** Define what you will assess by analyzing relevant sections of *A Framework for K-12 Science Education and NGSS* and then crafting 3D learning performances.

**Step 2:** Brainstorm Possible Scenarios for Eliciting Student Understanding.

**Step 3:** Write a Range of Student Questions using Task Formats for Practices and Prompts for Crosscutting Concepts to construct questions to engage students with the scenario.

**Step 4:** Imagine the Range of Possible Student Responses to the Questions.

**Step 5:** Share, Review, and Revise.
Step 1: Define what you will assess

- Use unpacking process to define what you will assess
- Create Learning Performance

Part of SEP
- Describe the limitations of a model

Part of DCI
- Cycling of matter between air, soil, and plants

Part of CCC
- Framed as a system with components and interactions
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We created a collection of task formats for the science and engineering practices that help with the design of assessment components. They can also be used to guide instruction.

[Image: Integrating Science Practices Into Assessment Tasks]

STEMteachingtools.org/brief/30
Prompts for Assessing Cross-Cutting Concepts

Prompts for Integrating Crosscutting Concepts Into Assessment and Instruction

STEMteachingtools.org/brief/41
## Task Formats for Developing & Using Models

<table>
<thead>
<tr>
<th>Format</th>
<th>Task Requirements for Students</th>
</tr>
</thead>
</table>
| 1      | Present two models to students, *then*  
         | Ask them to compare the models to identify both common and unique model components, relationships, and mechanisms. |
| 2      | Present students with an illustration or drawing of a scientific process or system, *then*  
         | Ask students to label the components, interactions, and mechanisms in the model, *and*  
         | Write a description of what is shown in the drawing. |
| 3      | Present students with a model of an observable scientific process or system and some evidence about how the system behaves that does not fit the model, *then*  
         | Ask students to revise the model to better fit available evidence. |
| 4      | Present students with a textual description of an observable scientific phenomenon, *then*  
         | Ask students to draw and label the model components, interactions among components, and mechanisms in the model, *and*  
         | Ask students to write an explanation for the phenomenon, using the model as supporting evidence. |
Prompts for Assessing Cross-Cutting Concepts

CAUSE AND EFFECT

When drawing conclusions from a simple investigation, Ask students:

What caused the patterns you observed?

Follow up question: How do you know that ________ caused ________?

Does the fact that that the data showed that ________ always happened [after/whenever] ________ occurred mean that ________ causes ________? Why or why not?

Follow up question: How can you test whether ________ caused ________ to happen?

What do you predict would happen if [extrapolate to new, related situation]?

STEMteachingtools.org/brief/41
Whole Group Discussion: Assessment Task Adaptation

What did you come up with?

How did you incorporate practices?

Did you embed prompts to surface reasoning about crosscutting concepts?

How might you use this process for designing or adapting tasks in your school or district?
Equity & Diversity (NRC Framework Chapter 11)

- Equalizing opportunities to learn
- Inclusive science instruction
  - Science Learning as Cultural Accomplishment
  - Relating Youth Discourses to Scientific Discourses
  - Building on Prior Interest & Identity
  - Leveraging Students’ Cultural Funds of Knowledge
- Making diversity visible
- Value multiple modes of expression
Criteria for Assessment Scenarios

- It should allow students from non-dominant communities to fully engage with the task.
  - We should design for them first!
- It should involve a compelling phenomena
  - It should beg for explanation!
- It must be understandable quickly by students.
  - Selecting everyday situations can be useful.
Steps to Designing 3D Assessments

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Steps to Designing a Three Dimensional Assessment

Short Course:

tinyurl.com/3Dassessmentdevelopment
Yep!

HOW MOTIVATED YOU ARE TO WORK.

EAGER - EXCITED! - PANIC! - OVERWHELMED

HOW MUCH WORK YOU HAVE TO DO

BLEAH.

WWW.PHDCOMICS.COM
Thank you!

Let me know how I can help you!

smolekt@michigan.gov

Special Thanks To:
CREATE for STEM at Michigan State University
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Bill Penuel
Phil Bell
Katie Van Horne