Science Assessment Item Collaborative (SAIC) and the Next Generation Science Standards (NGSS)

Assessment Framework and Item Cluster Prototypes: New Tools to Support NGSS Large-Scale Assessment Development

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CSSS

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Goals for Presentation

- What are the primary characteristics of NGSS-aligned items?
- What are the challenges in designing a 3D assessment and some strategies for working through those challenges?
- How do we report students’ results on these types of assessments?

History Leading Up to SAIC

- *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC, 2012)
- *Next Generation Science Standards: For States, by States* (NGSS Lead States, 2013)
- Joint TILSA and Science SCASS, November 2014
- *Developing Assessments for the Next Generation Science Standards* (NRC, 2014)
- CCSSO established a collaborative, the Science Assessment Item Collaborative (SAIC), January 2015
- SAIC resources made available, November 2015

The Opportunity

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Unless otherwise specified, "descriptions" referenced in the evidence statements could include but are not limited to written, oral, pictorial, and kinesthetic descriptions.

4-PS3-4 Energy

Students who demonstrate understanding can:

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [*Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education:*

Science and Engineering Practices

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Apply scientific ideas to solve design problems.

Disciplinary Core Ideas

PS3.B: Conservation of Energy and Energy Transfer

- Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.

PS3.D: Energy in Chemical Processes and Everyday Life

- The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.

ETS1.A: Defining Engineering Problems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.*(secondary)*

Crosscutting Concepts

Energy and Matter

- Energy can be transferred in various ways and between objects.

- - - - - - - - -

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World

- Engineers improve existing technologies or develop new ones.

- - - - - - - - -

Connections to Nature of Science

Science is a Human Endeavor

- Most scientists and engineers work in teams.
- Science affects everyday life.

Observable features of the student performance by the end of the grade:

1	Using scientific knowledge to generate design solutions		
	a	Given a problem to solve, students collaboratively design a solution that converts energy from one form to another. In the design, students:	
		i.	Specify the initial and final forms of energy (e.g., electrical energy, motion, light).
		ii.	Identify the device by which the energy will be transformed (e.g., a light bulb to convert electrical energy into light energy, a motor to convert electrical energy into energy of motion).
2	Describing* criteria and constraints, including quantification when appropriate		
	a	Students describe* the given criteria and constraints of the design, which include:	
		i.	Criteria:
			1. The initial and final forms of energy.
			2. Description* of how the solution functions to transfer energy from one form to another.

Background on SAIC

- In response to requests from chiefs, in January 2015, CCSSO established a collaborative, the Science Assessment Item Collaborative (SAIC), to support states in moving to assessments aligned to the Next Generation Science Standards (NGSS).
- The ultimate goal of this collaborative is to develop high-quality assessment items, aligned to the NGSS, that are accessible to states.
- 14 states and the U.S. Virgin Islands joined the Collaborative and provided input and feedback on the resources developed.
  - AR, CA, CT, DE, HI, IL, KY, MD, MA, MI, NV, OR, WA, WV, and USVI

SAIC Resources
Step 1 Toward the Goal

- A hard earned starting point.
- During the first phase of this work, the Collaborative, in partnership with WestEd, developed several resources:
  - SAIC Assessment Framework*
  - SAIC Item Specifications Guidelines*
  - Grade 5 Item Cluster Prototype*
  - High School Item Cluster Prototype*
- Rooted in three seminal resources:
  - *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC, 2012)
  - *Next Generation Science Standards: For States, by States* (NGSS Lead States, 2013)
  - *Developing Assessments for the Next Generation Science Standards* (NRC, 2014)

Supporting Documentation: Assessment Framework

- Presents a starting point for the implementation of a large-scale assessment measuring the NGSS
- Not intended to provide a full assessment solution for states
- Focus is on large-scale summative assessment, with applications to other types of assessments

CCSSO
Council of Chief State School Officers

Science Assessment Item Collaborative

Assessment Framework

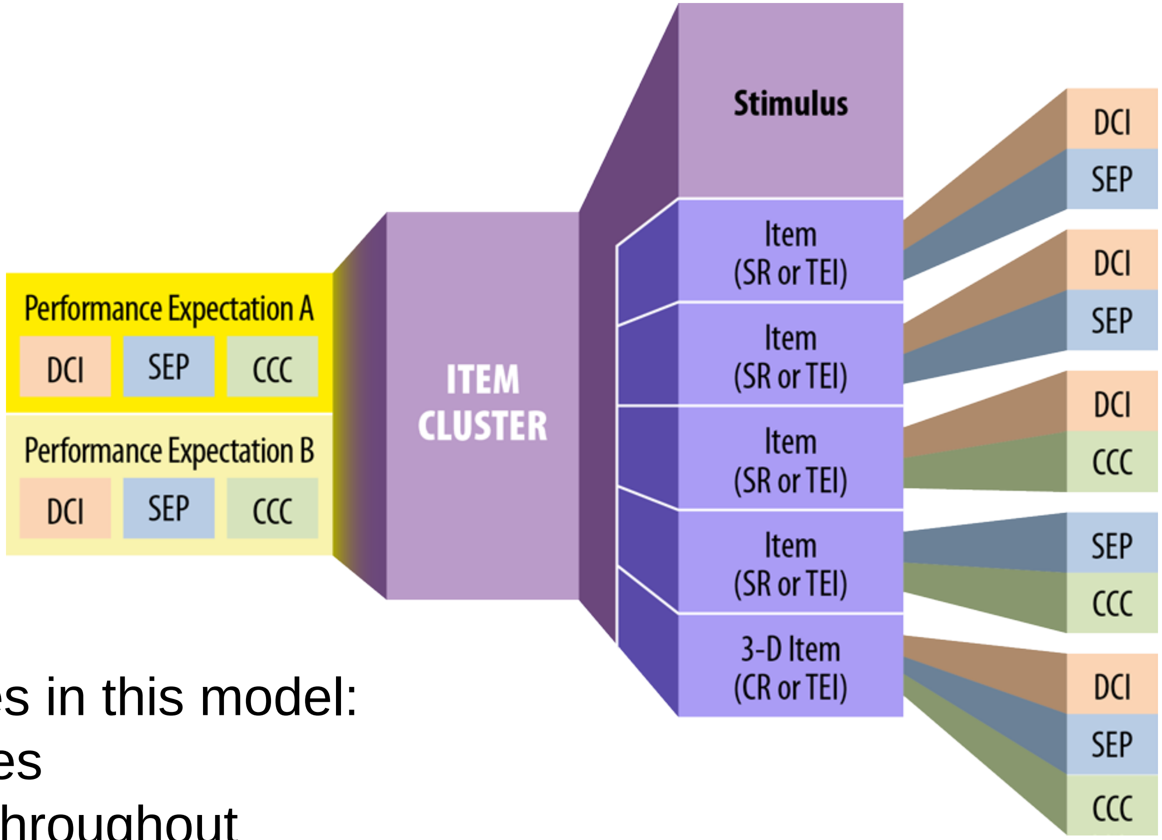
for the

Next Generation Science Standards

September 2015

Developed by WestEd in collaboration with
CCSSO, state members, and content experts.

Item Cluster Structure for Two PEs



Hidden values in this model:

- PE Bundles
- Stimulus throughout
- Items not isolated from one another
- 3-D alignment across the cluster

Supporting Documentation: Assessment Framework

- The Assessment Framework presents an approach to item development that takes into consideration the following premises:
  - Item clusters, not individual items, are the base unit for SAIC test development.
  - Item clusters are the primary focus for developers in terms of alignment to the NGSS.
    - That is, each item cluster must demonstrate strong three-dimensional alignment to the NGSS.
  - To qualify as NGSS-aligned, item clusters must be aligned to one or more PEs and must be inclusive of all of the dimensions associated with the PE(s) (i.e., DCI, SEP, CCC).
  - Each individual item within the cluster must align with at least two dimensions of the NGSS (e.g., DCI, SEP, and/or CCC) to qualify for inclusion in an item cluster.

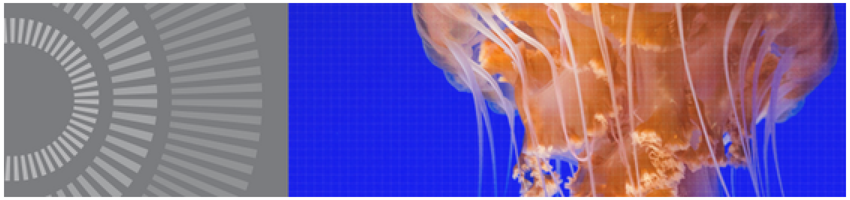
Design and Alignment Expectations

- Large-scale summative assessment application
- Assume computer delivery
- Remain delivery system-agnostic
- Focus on achievement of alignment expectations
- Range of item types is to be representative; not intended as an exhaustive set of item types
- Include some constructed-response items
  - No presumption or use of AI or hand scoring
- Representation of functional items
  - i.e., Functionality is described and represented in item cards
- Additional design decisions explained in prototype front matter

Item Cluster Prototype

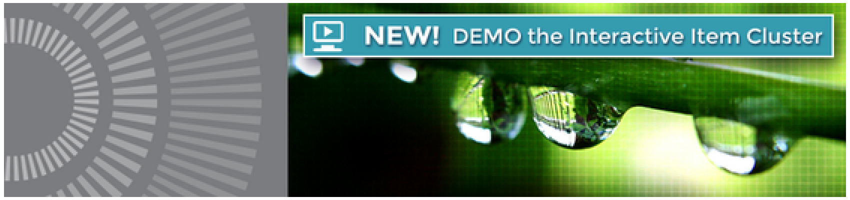
Assessment Framework

The Assessment Framework provides a range of options and accompanying rationales for the development of NGSS-aligned items and summative assessments.



Item Specifications Guidelines

The Item Specifications Guidelines, developed as a companion document to the SAIC Assessment Framework, provides a methodical and practical guide for the development of Item Specifications for the assessment of the NGSS. It discusses issues pertinent to assessment development and provides a road map for the development of clear, comprehensive specifications for NGSS-aligned item clusters.



Grade 5 Item Cluster Prototype

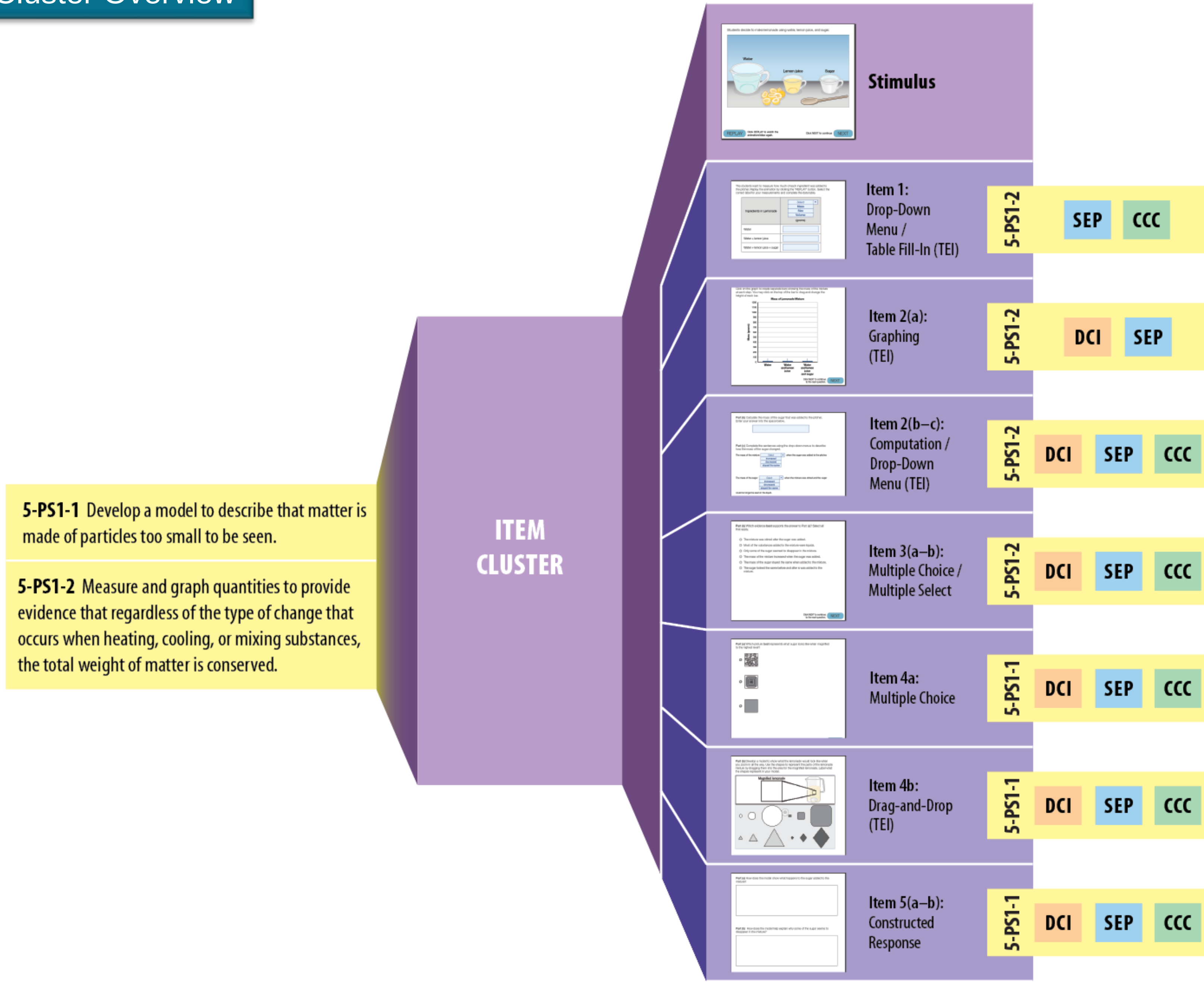
The Grade 5 Item Cluster Prototype was designed to follow the principles and recommendations set forth in the SAIC Assessment Framework and Item Specifications Guidelines for an NGSS-aligned large-scale summative assessment item cluster. The prototype serves as an initial model for measuring the three-dimensional science learning called for in the NGSS and should promote ongoing dialogue about the vision for a truly next-generation science assessment. The item cluster can now be previewed live with interactive items and media.

High School Item Cluster Prototype

The High School Item Cluster Prototype was designed to follow the principles and recommendations set forth in the SAIC Assessment Framework and Item Specifications Guidelines for an NGSS-aligned large-scale summative assessment item cluster. The prototype serves as an initial model for measuring the three-dimensional science learning called for in the NGSS and should promote ongoing dialogue about the vision for a truly next-generation science assessment.

http://www.csai-online.org/spotlight/science-assessment-item-collaborative

Item Cluster Overview

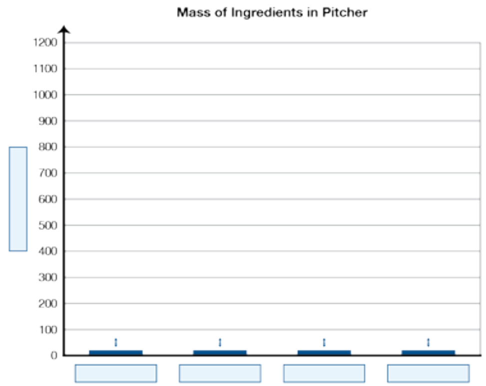


Item Overview—Student View

Part (a) The students add all the sugar in the cup to the pitcher with the water and lemon juice. Determine the total mass of all the ingredients in the pitcher once the sugar is added. Enter your answer, including units, into the correct location in the table.

Ingredients in Pitcher	Mass (grams)
Sugar only	206
Water only	708
Water + lemon juice	944
Water + lemon juice + sugar	

Part (b) Now you will graph the data you collected. Complete the graph to show the mass of the ingredients in the pitcher after each ingredient is added. Click on the top of the bar to drag and change the height of each bar. Then, type in a label in the appropriate space below each bar. Type in the appropriate label along the vertical axis (be sure to include an appropriate unit).



Part (c) After stirring, the students observe that none of the sugar could be seen in the lemonade mixture. Explain how the mass of the ingredients in the pitcher right after the sugar is added compares to the mass of the ingredients after the sugar is stirred.

Click NEXT to continue to the next question. NEXT

5-PS1-2
Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

Full alignment to the PE and targeted dimensions is intended through the entirety of the item cluster. Partial to strong alignment to the dimensions for each item is achieved through alignment to the evidence statements, and is inclusive of all item parts for any given item.

PS1.A: Structure and Properties of Matter
- The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.

PS1.B: Chemical Reactions
- No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.)

Using Mathematics and Computational Thinking
Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.
- Measure and graph quantities such as weight to address scientific and engineering questions and problems.

Scale, Proportion, and Quantity
- Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

Item Card—Before Student Interaction

BEFORE STUDENT INTERACTION

Part (a) The students add all the sugar in the cup to the pitcher with the water and lemon juice. **Determine the total mass of all the ingredients in the pitcher once the sugar is added. Enter your answer, including units, into the correct location in the table.**

Stem

Ingredients in Pitcher	Mass (grams)
Sugar only	206
Water only	708
Water + lemon juice	944
Water + lemon juice + sugar	

*Item 2 Parts (a), (b), and (c) will appear together on the same screen, and students may change their responses to Part (a), Part (b), or Part (c) at their discretion before clicking NEXT and continuing to Item 3. Students may **not** return to Item 1 at this stage in the administration.*

Student enters an alphanumeric response in this field. It is recommended that students have access to a calculator for this item. A character limit will be included for the response field.

Click NEXT to continue to the next question. NEXT

Platform prompt and student control

Item Type: Computation
Estimated Time: 1 min

Evidence Statement Alignment:
(5-PS1-2)
(2) Mathematical/computational analysis: (a) Students measure and/or calculate the difference between the total weight of the substances (using standard units) before and after they are heated, cooled, and/or mixed.

(2) Mathematical/computational analysis: (c) Students use their measurements and calculations to describe that the total weights of the substances did not change, regardless of the reaction or changes in properties that were observed.

Note on Item Alignment:
What is being elicited from the student (evidence)? The student can calculate the mass of the sugar added to the liquid and reason that the mass of the sugar did not change when it was added to the liquid, even though the sugar was no longer visible in the liquid (i.e., it dissolved).

Metadata Table

Item	Item Part	Brief Description	Item Type	PE	DCI	SEP	CCC	EV Level	EVs	Points	Estimated Time (min)	Hand or Automated Scoring
Stimulus		Preparing lemonade	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	N/A
1	**1**	Designing and populating a data table	Text Entry/ Table Fill-In	5-PS1-2	N/A	5	3	1	1.a.i 1.a.ii	2	2	A
	2a	Calculate mass of ingredient	Computation					1	1.a.i 1.a.ii	1	1	A
2	**2b**	Graphing masses of ingredients	Graphing	5-PS1-2	PS1.A PS1.B	5	3	2	2.a	2	2	A
	2c	Describe properties of individual ingredients	Short Answer					2	2.c	1	2	H
3	**3a**	Claim for conservation of mass	Multiple Choice	5-PS1-2	PS1.A PS1.B	5	3	2	2.d	1	1	A
	3b	Identify evidence of conservation of mass	Multiple Select					2	2.d	1	1	A
Stimulus		Investigating ingredients	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A
4	**4a**	Describe that both sugar and water are made up of particles	Short Answer	5-PS1-1	PS1.A	2	3	1	1.a.ii	1	2	H
	4b	Building a model to show particles of matter	Building a Model (Drag-and-Drop)					1	1.a.i 1.a.ii	1	3	A or H
5	**5a–b**	Describing the model and use of model in explaining science phenomenon	Constructed Response	5-PS1-1	PS1.A	2	3	2, 3	2.a.i 3.a	2	6	H
								Total:	9 of 11	12	24	

Interactive Prototype

- Intent is to use the prototype documentation in conjunction with the interactive prototype
- Documentation provides details about alignment and scoring
- Interactive prototype demonstrates the feasibility of implementation

Interactive Prototype

Assessment Framework

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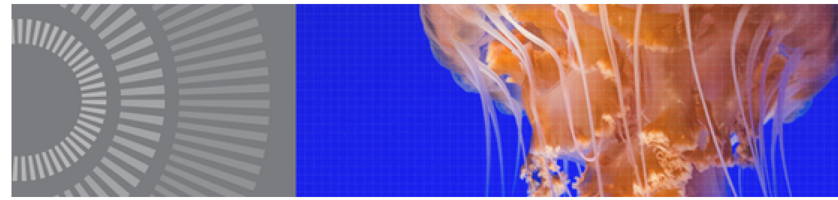

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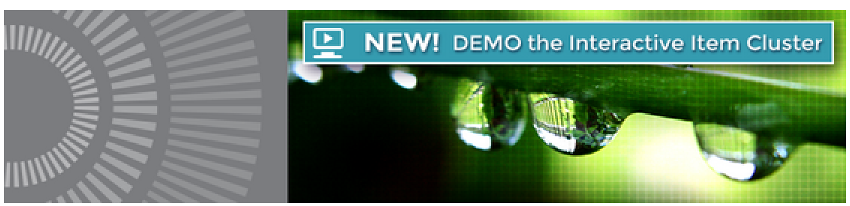

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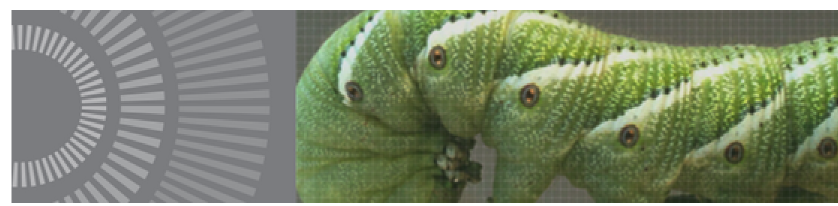

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Interactive Prototype

SAIC Grade 5 Item Cluster Prototype

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We welcome you to experience the item cluster as a student would by interacting with the live items and stimuli. To demo the item cluster, click on the demo button below. The interactive item cluster should be considered in conjunction with the accompanying Grade 5 Item Cluster Prototype PDF, which details the intended interactions, proposed scoring, user interface options, and alignment goals.

DEMO THE INTERACTIVE ITEM CLUSTER

The SAIC Item Cluster Prototypes are intended to serve as models for alignment expectations and explore opportunities for new item types and interactions. Both represent an advancement of next generation science assessments. The interactive item cluster was authored in and rendered by the Learnosity platform. To learn more about Learnosity, visit their website and explore live demos of many additional item types.

Learnosity

DOWNLOAD THE GRADE 5 ITEM CLUSTER PROTOTYPE PDF

Value of the Outcome and the Process

- Needed a starting point
  - But needed a strong starting point
- States needed a joint effort around a starting point
- Input, input, input
- Making vision a reality
- Needed a model to bridge from traditional stand-alone items to something more
- Needed prototypes that honored the innovativeness of the NGSS
- Needed to address the challenge of measuring

  3-dimensional science understanding

Implementing the Assessment Framework

- WA OSPI has begun using the Assessment Framework as a starting point for developing WA's NGSS-aligned assessments
- Bringing to scale many of the ideas of SAIC

Current vs. NGSS Tests

Current	NGSS
Scenario-based, few stand-alone items	**Cluster-based,** but will also include stand-alone items
Paper/pencil format • Available online in grades 5 and 8 • Paper only for high school	**Online only, for all grades** • Delivered on same platform as math and ELA • Many possible item types
Standards assessed • 4/5 band at grade 5 • Middle school band at grade 8 • High school (Bio EOC) • Inquiry, application, systems at all grades • Life, physical, earth/space at grades 5 and 8 • Only life sciences at high school	**Standards assessed** • 3/4/5 band at grade 5 • Middle school band at grade 8 • High school band at grades 10/11 • Comprehensive at all grades

Science Assessment Development Cycle

OSPI and Teachers develop **Test and Item Specifications** (in progress)

OSPI leads Teachers in **Cluster Development Workshops**

Clusters are reviewed for content by OSPI/Vendor

Content Review by OSPI and Teachers **& Bias/Sensitivity Review** by Community

Cluster Pilot Testing (embedded in the operational test or given as a separate test; not counted for points)

Pilot Range Finding of constructed response items by OSPI and Teachers

Pilot Scoring by Vendor under OSPI supervision

Content Review with Data of all items by Teachers, OSPI and Vendor

Items available for Operational Testing

Operational Range Finding OSPI and Vendor confirm pilot range finding sets

Operational Scoring by Vendor under OSPI supervision

Cluster Development Workshops

- Item Cluster Writing
  - Grades 5, 8, and High School
  - 5-day committees with 10-12 writers (6 pairs) per committee
  - Cluster preparation
    - Choosing Performance Expectations (PEs)
      - 1-3 PEs per cluster
      - Bundled PEs should have at least one dimension in common
      - Bundles could cross domains (PS, LS, ESS, ETS)
      - Bundles could cross grade levels for 3-5
    - Initial drafts included the stimuli and items
    - Training and materials
- Content Review
  - Grades 5, 8, and High School
  - 5-day committees with 5 educators per committee

Lessons Learned from Development Work

- **Understanding of NGSS Assessment**
  - Few (if any) of us (SEA, committee members, vendors) are experts yet!
- **Disciplinary Core Ideas**
  - Writers tend to stay at the comfort of content
- **Science and Engineering Practices**
  - Some are more challenging to write to than others
    - Asking Questions and Defining Problems
    - Developing and Using Models
    - Obtaining, Evaluating, and Communicating Information
- **Crosscutting Concepts** are often challenging to write items to
- **Bundling PEs**
  - **Limiting to PEs that** cross in one dimension probably not always essential
  - Some PEs don’t lend themselves to bundling, e.g., MS-ESS1-1, HS-ESS1-2
  - ETS PEs must be bundled with an LS, ESS, or PS PE

Lessons Learned from Development Work

- **Phenomena**
  - Coming up with appropriate phenomena for large-scale assessment
    - Observable events that students can use the three dimensions to explain or make sense of (*NGSS website*)
  - Understanding of phenomena vs. item cluster context
- **Evidence statements**
  - A starting place for thinking about assessment items, but cannot replace item specifications
  - Amount of redundancy from level to level in some evidence statements
  - Often difficult to “hit” each level of an evidence statement for a PE with the items in a cluster
  - Clusters typically only have 3-5 items due to redundancy in the evidence statements and clueing that tends to occur with more items
- **Alignment**
  - Determining alignment to multi-dimensions is a challenging conversation
- New and very different standards, new item types, and accessibility challenges

Technical Challenges/Questions/To Do's

- Claims: Overall and for any reporting categories and at what levels
- Test Blueprint: Content coverage, evaluating assessibility, matrix sampling
- Item Inter-relatedness vs. Item Independence: Balancing 3-D expectations of inter-relatedness with item independence
- Accessibility: New challenges with TEI items that are graphic-dependent, especially in the modeling SEP
- Test Delivery Systems: Ability to deliver items in a way that content envisions, including blocking of items
- Psychometric Unknowns: Equating, item independence, limited score points, SEP/DCI/CCC independence
- "Complete" Assessment System: Non-tested grades, supports and classroom-embedded assessments, etc.

What Lies Ahead?

- Challenges
- Opportunities
- Questions

Access to Resources

- CCSSO website: http://www.ccsso.org/Resources/Resources_Listing.html
- CSAI website: http://www.csaionline.org/spotlight/science-assessment-item-collaborative

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