Transforming Science Instruction and Assessment

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THE CENTER ON
STANDARDS & ASSESSMENT IMPLEMENTATION
WestEd CRESST

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The need for new science standards

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- Both documents are ~20 years old.
- Science education “is not organized systematically across multiple years of school, emphasizes discrete facts with a focus on breadth over depth, and does not provide students with engaging opportunities to experience how science is actually done.”

Most states based their current K-12 science standards on reports dating back nearly twenty years! Since that time, we've made major advances in science and technology and gained a better understanding of how students learn these subjects.

HOW CAN U.S. STUDENTS RECEIVE A HIGH-QUALITY SCIENCE EDUCATION IF STATES' STANDARDS ARE STUCK IN THE '90S?

1995 — **TEXT MESSAGING** becomes more popular with T9 or "predictive" typing[i]

1996 — **DVDS CHANGE HOME ENTERTAINMENT WITH DIGITAL OPTIC STORAGE.**[ii]

1997 — **NASA** lands first successful Mars rover[iii]

1999 — Toyota unveils Prius, the first **HYBRID** on the market[iv]

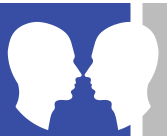
Wavefront analysis makes **LASIK** corrective eye surgery more popular[v]

2000

2001 — Apple releases the **IPOD**[vii]

2003 — **HUMAN GENOME** Project is complete[ix]

2005 — French doctors perform the first successful **FACE TRANSPLANT**[x]



2006 — **PLUTO** is reclassified as a dwarf planet[xi]

2008 — **HUBBLE SPACE TELESCOPE OBSERVES FIRST PLANET OUTSIDE OF OUR SOLAR SYSTEM**[xii]

2010 — The first **SYNTHETIC GENOME** for a bacterial cell is created[xiii]

VERS

N[xv]

2014

The need for new science standards

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- More than a third of eighth-graders scored below basic on the 2011 NAEP Science assessment.
- 69% of high school graduates failed to meet the ACT's college readiness benchmark levels in science.

Development of the Next Generation Science Standards

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1. Developed *A Framework for K–12 Science Education*, which identifies the science all K–12 students should learn by the end of high school (led by NRC and released July 2011)
2. Developed the Next Generation Science Standards (NGSS) – new science standards that are based on the K-12 Framework, *and* which emphasize both science content ***and*** practices (state-led and released April 2013)

NGSS Conceptual Shifts

"A goal of the NGSS is to make science education more closely resemble the way scientists actually work and think." (NRC, 2011 p. 1)

"… learning about science and engineering involves integration of the knowledge of scientific explanations (i.e., content knowledge) and the practices needed to engage in scientific inquiry and engineering design. Thus the framework seeks to illustrate how knowledge and practice must be intertwined in designing learning experiences in K–12 science education." (NRC, 2011. p .11)

Emphasis is on deep understanding and application, **not** on the memorization of facts.

NGSS Conceptual Shifts

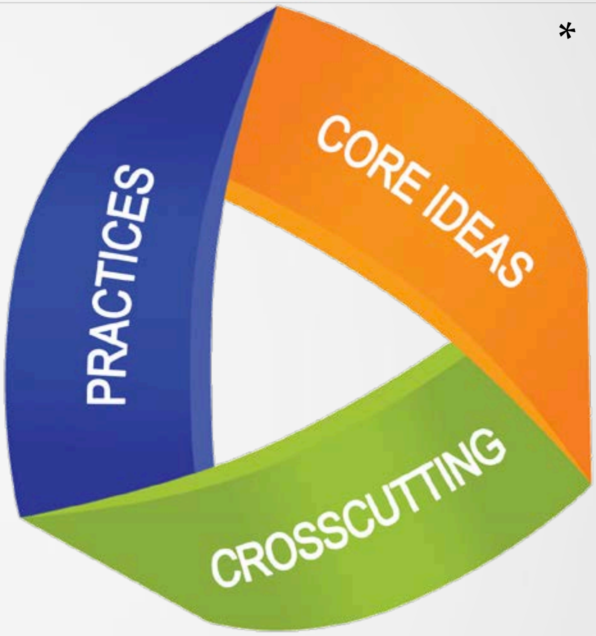
1. K–12 science education should reflect the real world interconnections in science.
2. The Next Generation Science Standards are student outcomes and are explicitly **not** curriculum.
3. Science concepts build coherently across K–12.
4. The NGSS focus on deeper understanding and application of fewer core ideas.
5. Science and engineering are integrated in science education from K–12.
6. The NGSS are designed to prepare students for college, career, and citizenship.
7. Science standards coordinate with English Language Arts and Mathematics Common Core State Standards.

Three Dimensions of the NGSS

Disciplinary Core Ideas

Science and Engineering Practices

Crosscutting Concepts



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*The NGSS logo is a registered trademark of Achieve.

NGSS 101

06-ESS2-4 Earth's Systems		
Students who demonstrate understanding can: 06-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] *[Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]*		
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	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • *Develop a model to describe unobservable mechanisms.*	**ESS2.C: The Roles of Water in Earth's Surface Processes** • Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. • Global movements of water and its changes in form are propelled by sunlight and gravity.	**Energy and Matter** • Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.

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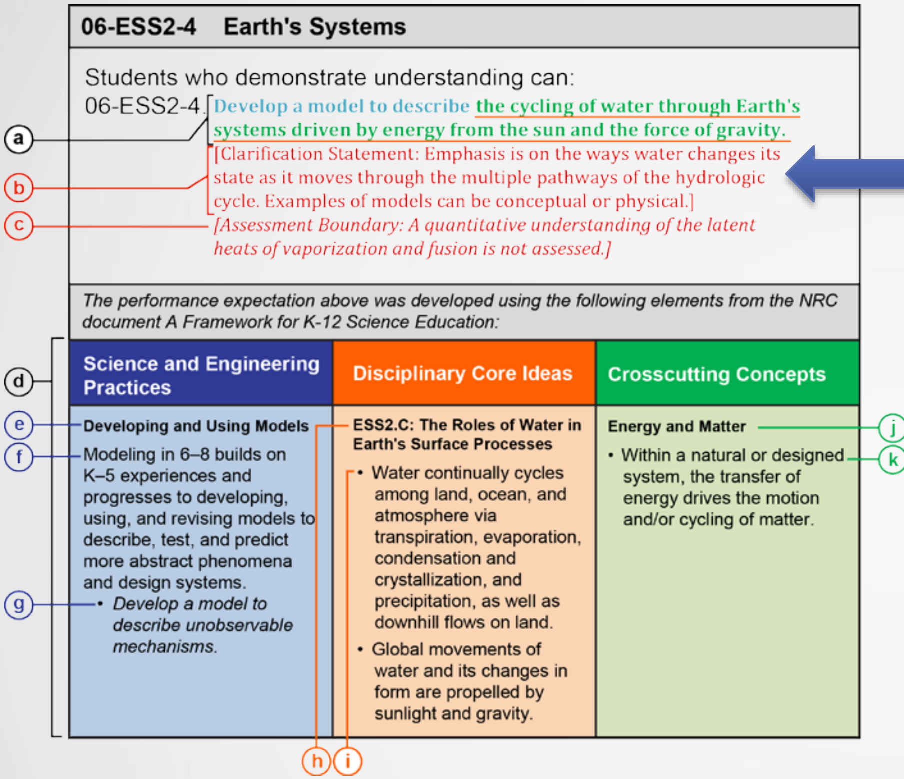
Performance Expectation (PE)

- Statement of what students should be able to do ***after*** instruction

NGSS 101



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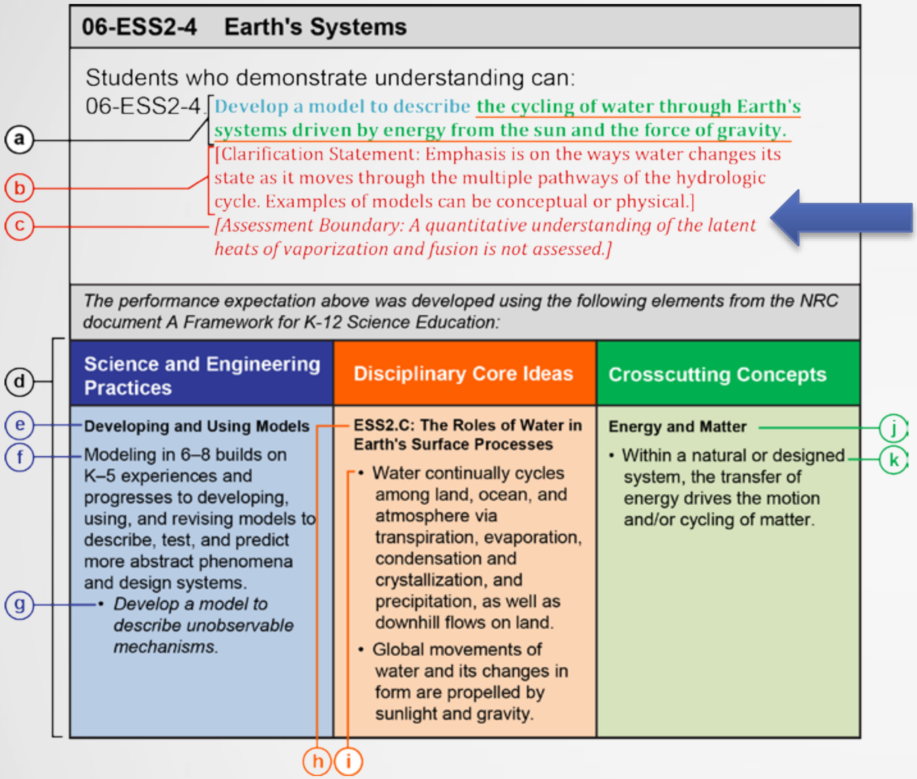
Performance Expectation (PE)

Clarification Statement

- Supplies examples or additional clarification to the performance expectations

NGSS 101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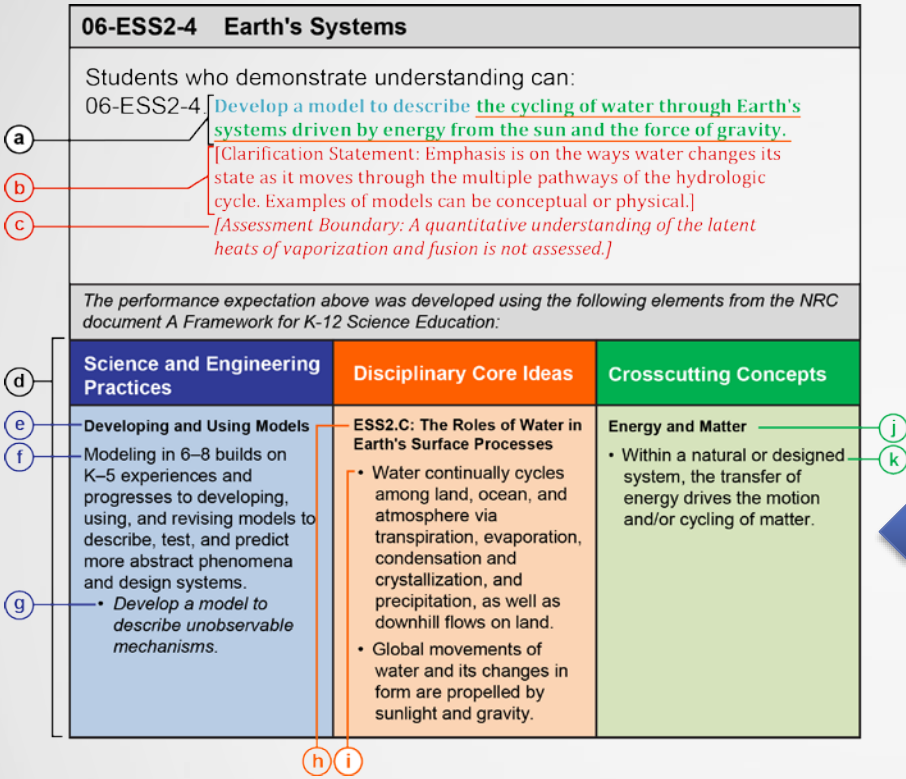
Performance Expectation (PE)

Clarification Statement

Assessment Boundary

- Specifies limits to large-scale assessment

NGSS 101



Performance Expectation (PE)

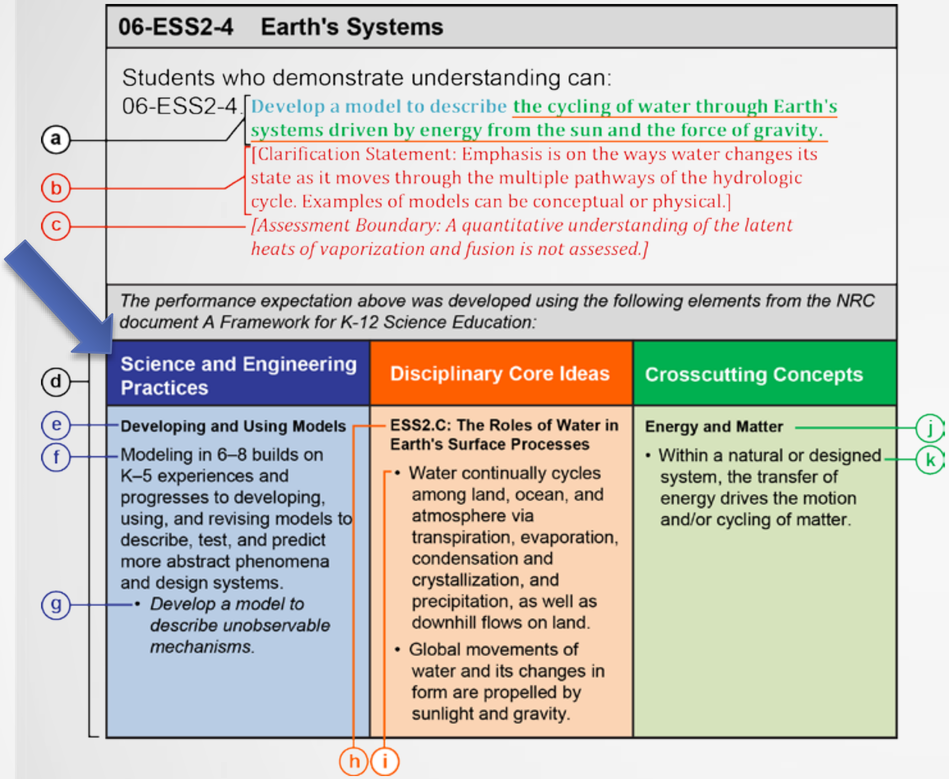
Clarification Statement

Assessment Boundary

Foundation Boxes

- A more coherent and complete view of what students should be able to do; comes when the performance expectations are viewed in tandem with the contents of the foundation boxes

NGSS 101



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Performance Expectation (PE)

Clarification Statement

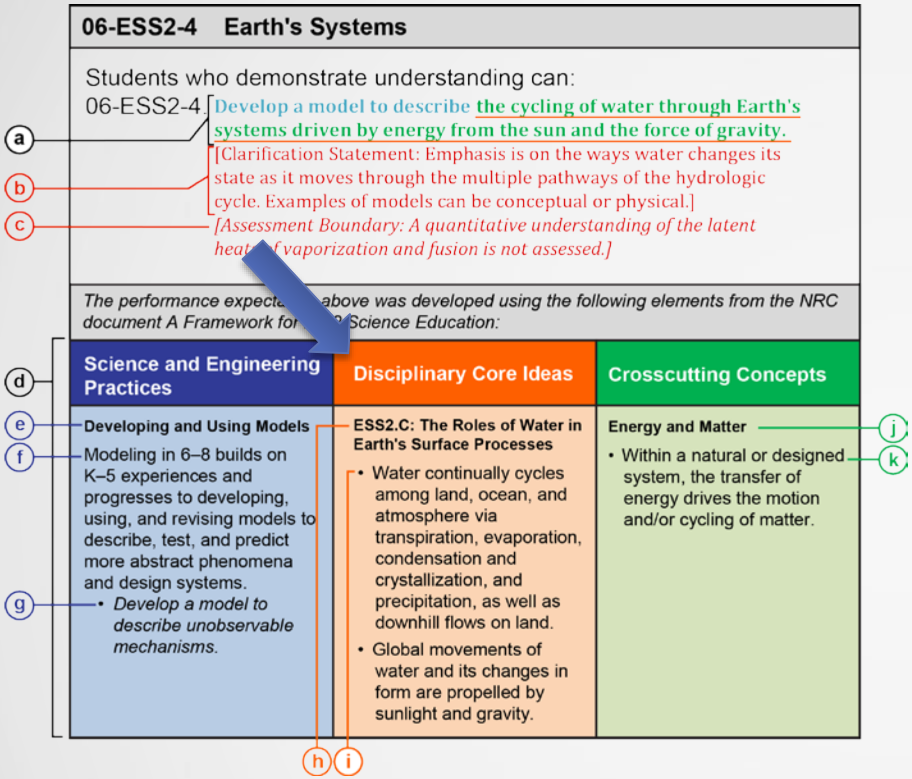
Assessment Boundary

Foundation Boxes

Science and Engineering Practice (SEP)

- SEP grade-band expectation
- SEP grade-band-specific bullet

NGSS 101



Performance Expectation (PE)

Clarification Statement

Assessment Boundary

Foundation Boxes

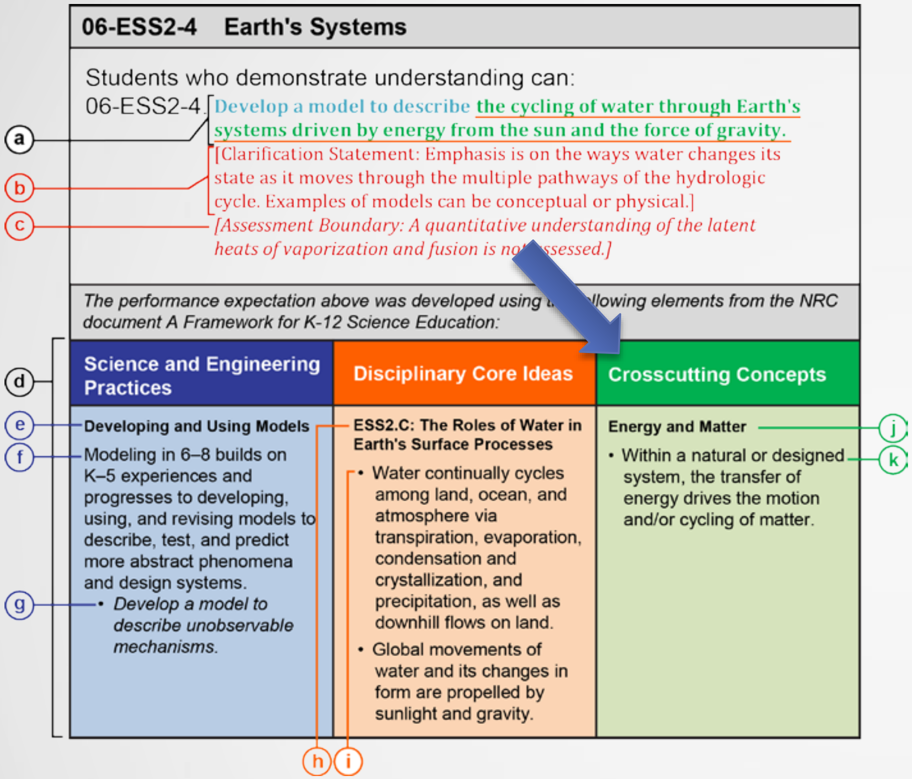
Science and Engineering Practice (SEP)

- SEP grade-band expectation
- SEP grade-band-specific bullet

Disciplinary Core Idea

- DCI grade-band description

NGSS 101



Performance Expectation (PE)

Clarification Statement

Assessment Boundary

Foundation Boxes

Science and Engineering Practice (SEP)

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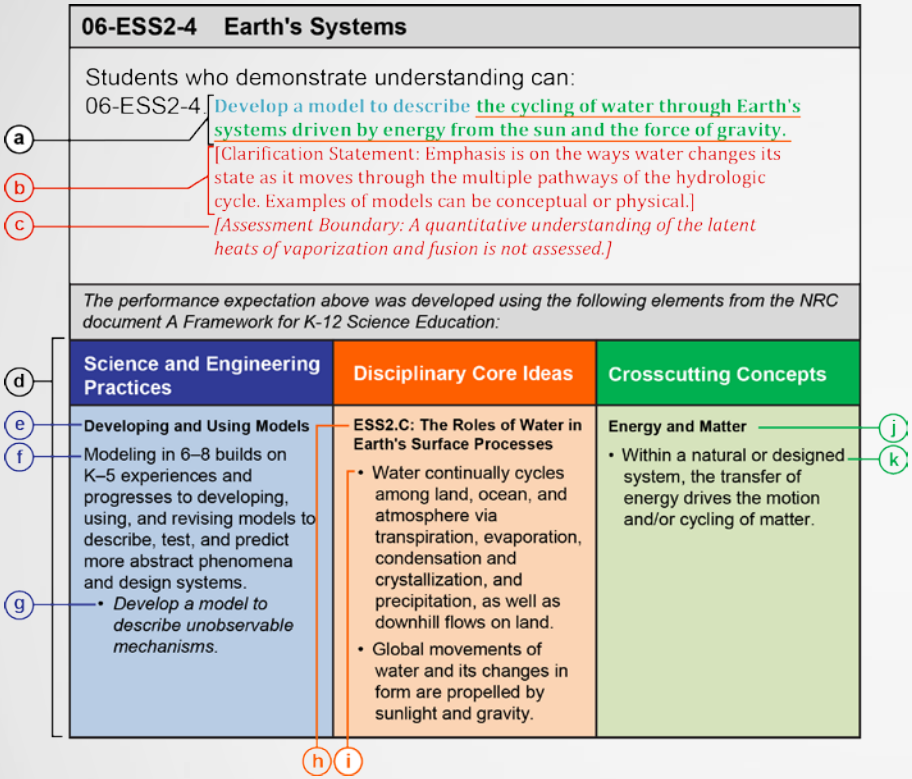
Disciplinary Core Idea

- DCI grade-band description

Crosscutting Concept (CCC)

- CCC grade-band-specific bullet

NGSS 101



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Compare this to a typical state standard about the water cycle (sample):

Water circulates through the Earth's crust, oceans and atmosphere in what is known as the water cycle.

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NGSS Resources from Achieve

- Front Matter
- Evidence Statements
  - Developed by Achieve
- NGSS Appendices
  - 13 in total
- All Resources Available Online
  - http://www.nextgenscience.org/resources

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Evidence Statements

- Identify clear, measurable components that, if met, fully satisfy each PE described within the NGSS
    - Provide additional detail on what students should know and be able to do in order to satisfy each performance expectation (PE).
    - Describe what educators and assessors would observe (not infer) from successful student performance of each PE.
    - Describe how students will use the practices (SEPs), crosscutting concepts (CCCs), and disciplinary core ideas (DCIs) together to demonstrate proficiency on the PEs.
- Not meant to limit or dictate instruction

Evidence Statement Example

5-PS1-1 Matter and Its Interactions
Students who demonstrate understanding can: **5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.** [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [*Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.*]

Observable features of the student performance by the end of the grade:			
1	Components of the model		
	a	Students develop a model to describe a phenomenon that includes the idea that matter is made of particles too small to be seen. In the model, students identify the relevant components for the phenomenon, including:	
		i.	Bulk matter (macroscopic observable matter; e.g., as sugar, air, water).
		ii.	Particles of matter that are too small to be seen.
2	Relationships		
	a	In the model, students identify and describe relevant relationships between components, including the relationships between:	
		i.	Bulk matter and tiny particles that cannot be seen (e.g., tiny particles of matter that cannot be seen make up bulk matter).
		ii.	The behavior of a collection of many tiny particles of matter and observable phenomena involving bulk matter (e.g., an expanding balloon, evaporating liquids, substances that dissolve in a solvent, effects of wind).
3	Connections		
	a	Students use the model to describe how matter composed of tiny particles too small to be seen can account for observable phenomena (e.g., air inflating a basketball, ice melting into water).	

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Appendices of the NGSS

There are 13 appendices (A through M) to support the NGSS.

Three appendices referred to most often during prototype development:

- Appendix E – Learning Progressions (DCIs)
- Appendix F – Science and Engineering Practices (SEPs)
- Appendix G – Crosscutting Concepts (CCCs)

NGSS Summative Assessment

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- All students should be held accountable for demonstrating their achievement of all PEs.
    - Fundamental departure from prior standards documents, especially at high school, where students take courses in some, but not all, science disciplines.
    - A scientifically literate person understands and is able to apply core ideas in each of the major science disciplines and gains experience in the practices of science and engineering and crosscutting concepts.

So how can this be done?

Enter the **CCSSO Science Assessment Item Collaborative (SAIC)**

CCSSO Science Assessment Item Collaborative

- NGSS adoption thus far: 17 states and the District of Columbia
- In response to requests from chiefs, in January 2015, CCSSO established the Science Assessment Item Collaborative (SAIC) to support states in moving to new science 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.

CCSSO Science Assessment Item Collaborative

- The group determined that it would be useful to develop certain resources to establish a shared understanding of the nuances of the new assessments before moving to item development.
- During the first phase of this work, the group, in partnership with WestEd, developed several resources:
    1. Assessment Framework
    2. Item Specifications Guidelines
    3. Prototype Item Clusters
- These resources are freely available to all states.

SAIC Assessment Framework

- Intended to serve as a bridge between instructional standards (the NGSS) and effective assessment of those standards
- A guiding document for states to use in developing their own state-specific assessment frameworks

SAIC Assessment Framework

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Item cluster

SAIC Assessment Framework

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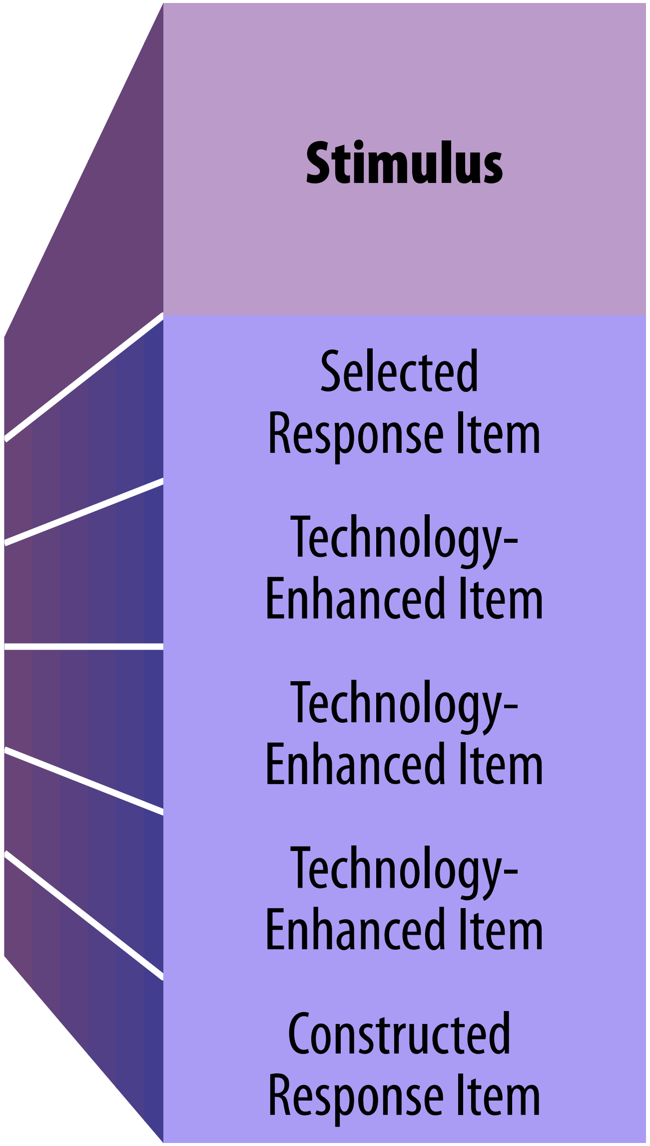
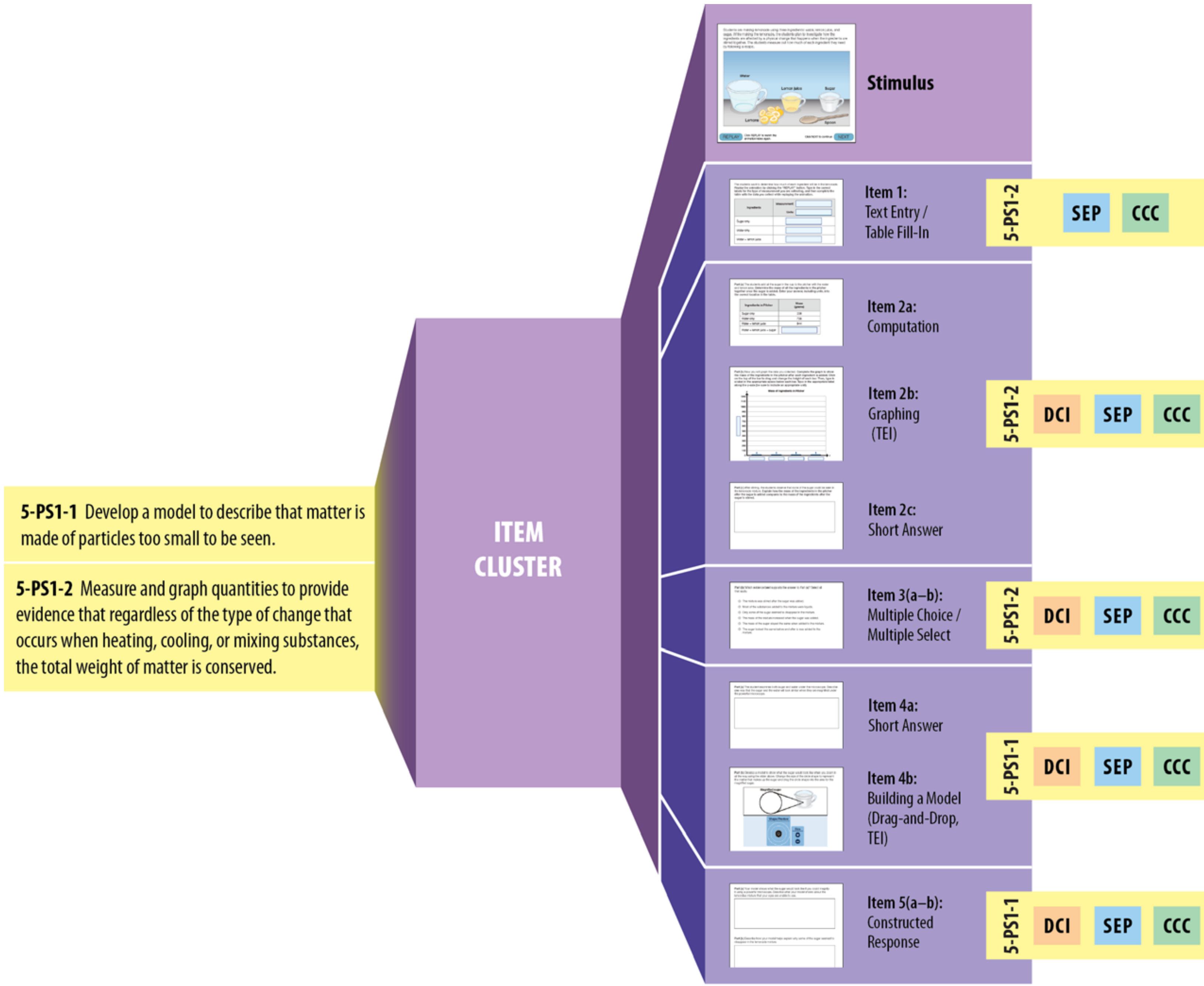
Item cluster: a set of items (usually between four and six items, with some items having more than one part) that are based on at least one common stimulus.


Stimulus
Selected Response Item
Technology-Enhanced Item
Technology-Enhanced Item
Technology-Enhanced Item
Constructed Response Item

Item Cluster

- Item clusters, not individual items, are the base unit for the SAIC summative assessment.
- 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 **and** SEP) to qualify for inclusion in an item cluster.


5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.
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.
ITEM CLUSTER
Stimulus
Item 1: Text Entry / Table Fill-In
5-PS1-2
SEP
CCC
Item 2a: Computation
Item 2b: Graphing (TEI)
Item 2c: Short Answer
5-PS1-2
DCI
SEP
CCC
Item 3(a–b): Multiple Choice / Multiple Select
5-PS1-2
DCI
SEP
CCC
Item 4a: Short Answer
Item 4b: Building a Model (Drag-and-Drop, TEI)
5-PS1-1
DCI
SEP
CCC
Item 5(a–b): Constructed Response
5-PS1-1
DCI
SEP
CCC

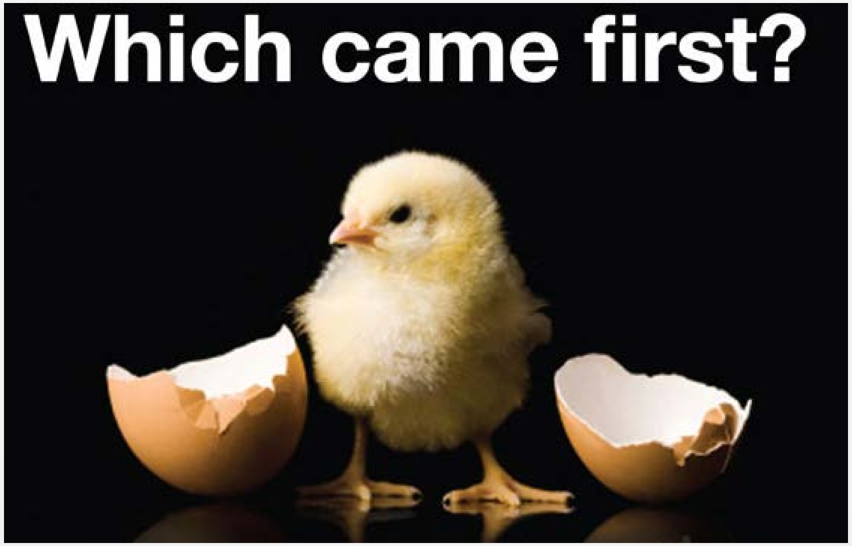
SAIC Item Specifications Guidelines

- Articulates the NGSS-to-item cluster correlations that are necessary for the development of NGSS-aligned items, item clusters, and assessments
- Breaks down how the Evidence Statements can be used in the development of item clusters
- Describes item types and subtypes of items that can be considered for use in item clusters

Developing an NGSS Item Cluster Prototype

Our Approach:

- Identify a natural PE bundle with dimensional overlap.
- Identify a science phenomenon (i.e., what students observe in the real world).



Developing an NGSS Item Cluster Prototype

- Develop a stimulus to support the phenomenon.
- Identify potential item types to appropriately assess different dimensions.
- Identify an appropriate set of interconnected, progressively challenging items to measure the PEs.

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Awareness of constraints:

- Time
- Cost
- Technology

Grade 5 Item Cluster Prototype

- **Phenomenon:** Sugar is no longer visible when it dissolves in water, but the mass of the mixture stays the same.

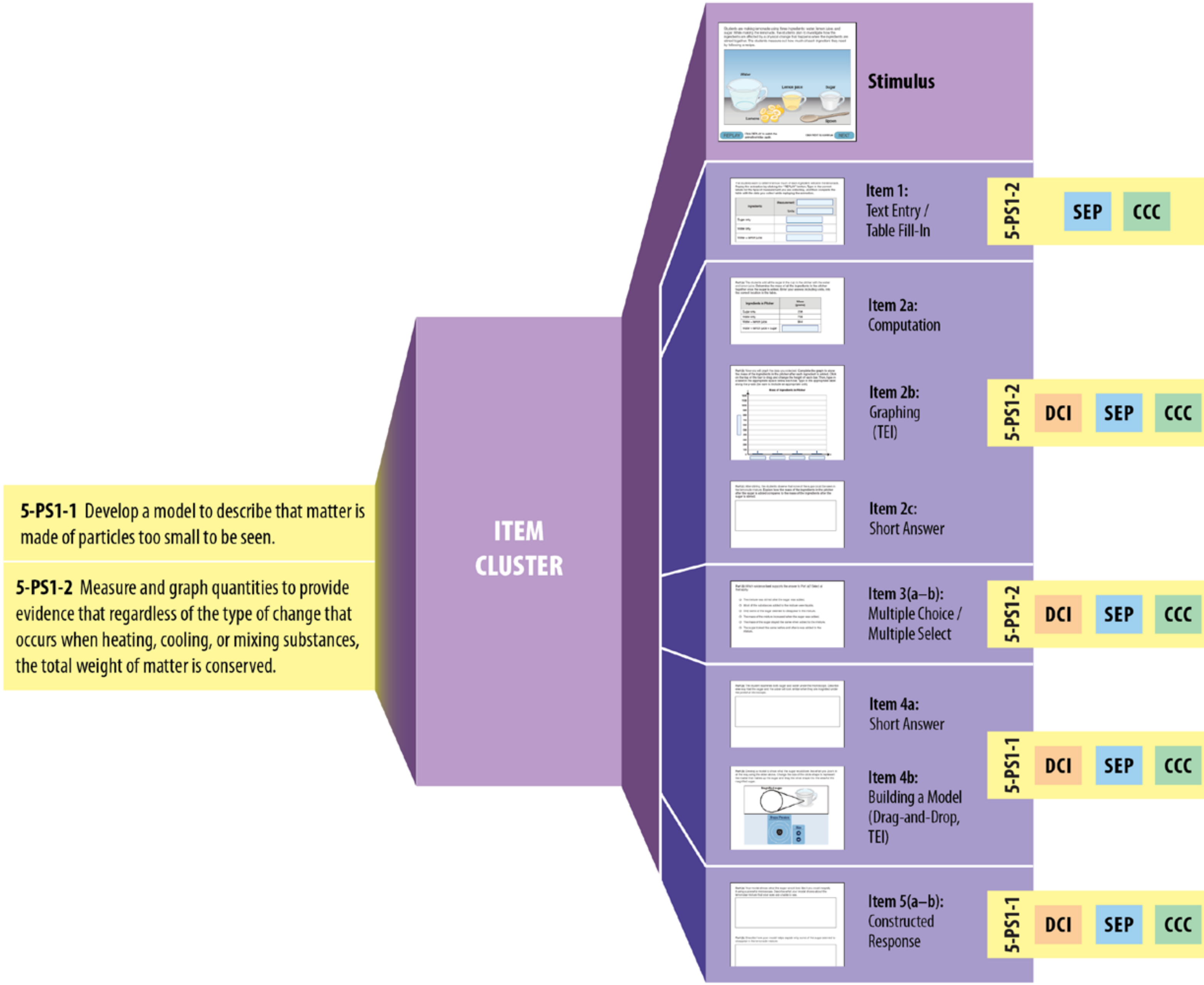
Grade 5 Item Cluster Prototype

- **Phenomenon**: Sugar is no longer visible when it dissolves in water, but the mass of the mixture stays the same.
- Key Prototype Considerations:
  - Items function as an item cluster – no item assessed in isolation
  - Use of technology to assess specific dimensions (e.g., modeling)
  - Alignment to Evidence Statements to assess PEs

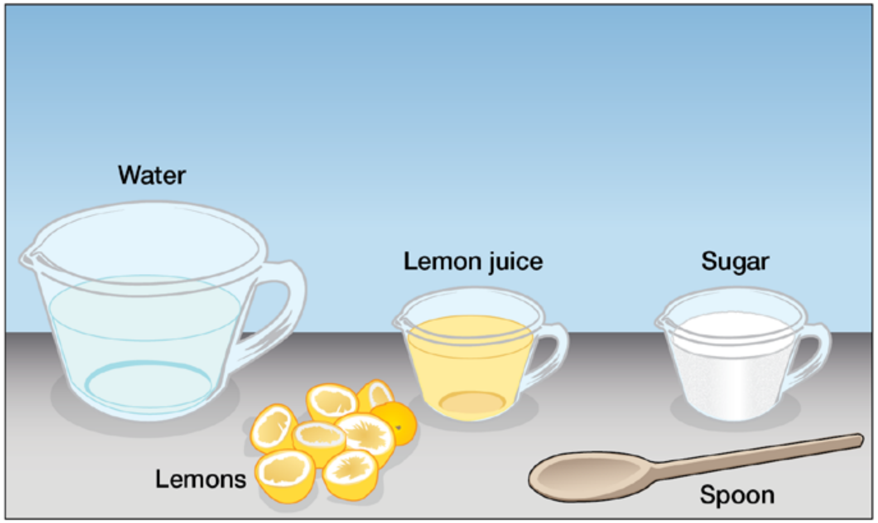
Level:	Grade 5
Primary Target Domain:	Physical Sciences
Target PEs:	5-PS1-1, 5-PS1-2
Crosscutting Concept(s) Focus:	Scale, Proportion, and Quantity
Science and Engineering Practice(s) Focus:	Developing and Using Models, Using Mathematics and Computational Thinking
Reasoning for PE Groupings:	Mass (size micro to macro), and conservation of mass
Phenomenon:	Sugar is no longer visible when it dissolves in water, but the mass of the mixture stays the same
Allowable Item Types:	SR, TE, CR

	5-PS1-1	5-PS1-2
Performance Expectations:	Develop a model to describe that matter is made of particles too small to be seen.	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.
Target Clarifications:	Examples of evidence could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.	Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.
Assessment Boundary:	Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.	Assessment does not include distinguishing mass and weight.

	5-PS1-1	5-PS1-2
Disciplinary Core Idea(s):	**PS1.A: Structure and Properties of Matter** • Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.	**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.)
Science and Engineering Practice(s):	**Developing and Using Models** Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use models to describe phenomena.	**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.
Crosscutting Concept(s):	**Scale, Proportion, and Quantity** • Natural objects exist from the very small to the immensely large.	**Scale, Proportion, and Quantity** • Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. *Connections to Nature of Science* **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes consistent patterns in natural systems.


Stimulus
Item 1:
Text Entry /
Table Fill-In
5-PS1-2
SEP
CCC
Item 2a:
Computation
Item 2b:
Graphing
(TEI)
5-PS1-2
DCI
SEP
CCC
Item 2c:
Short Answer
5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.
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.
ITEM
CLUSTER
Item 3(a–b):
Multiple Choice /
Multiple Select
5-PS1-2
DCI
SEP
CCC
Item 4a:
Short Answer
Item 4b:
Building a Model
(Drag-and-Drop,
TEI)
5-PS1-1
DCI
SEP
CCC
Item 5(a–b):
Constructed
Response
5-PS1-1
DCI
SEP
CCC

Students are making lemonade using three ingredients: water, lemon juice, and sugar. While making the lemonade, the students plan to investigate how the ingredients are affected by a physical change that happens when the ingredients are stirred together. The students measure out how much of each ingredient they need by following a recipe.



REPLAY Click REPLAY to watch the animation/video again.

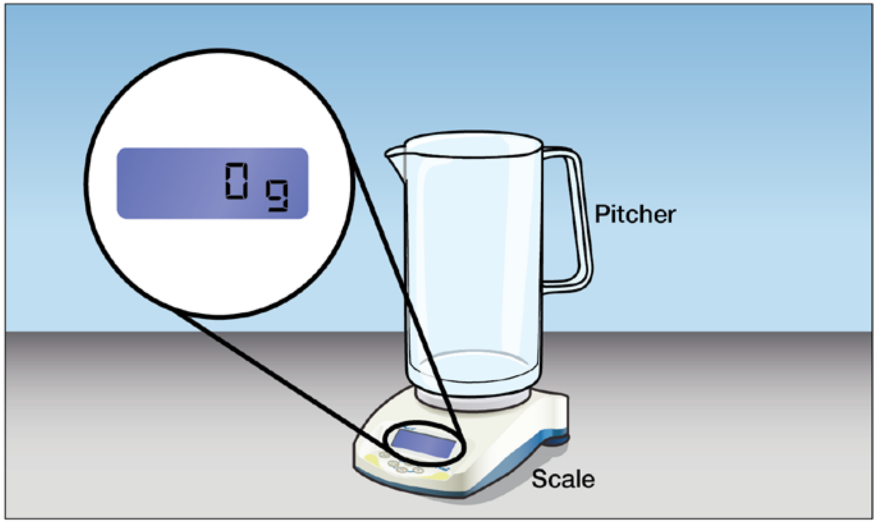
Click NEXT to continue NEXT

Stimulus

Media (animation/video): Stimulus is introduced; zoom in to each ingredient as it is presented to the student. It is recommended that the video include an audio narration.

Platform prompt and student control

The students use a digital scale in their investigation. The students will make the lemonade in a pitcher, but the students do not want to include the pitcher in the measurement on the scale. The students put the pitcher on the scale and reset the scale so it reads 0 g before adding any ingredients to the pitcher.



REPLAY Click REPLAY to watch the animation/video again.

Click NEXT to continue. NEXT

Stimulus

Media (animation/video): At the start, the scale reads 0 g to indicate that the scale has been tared.

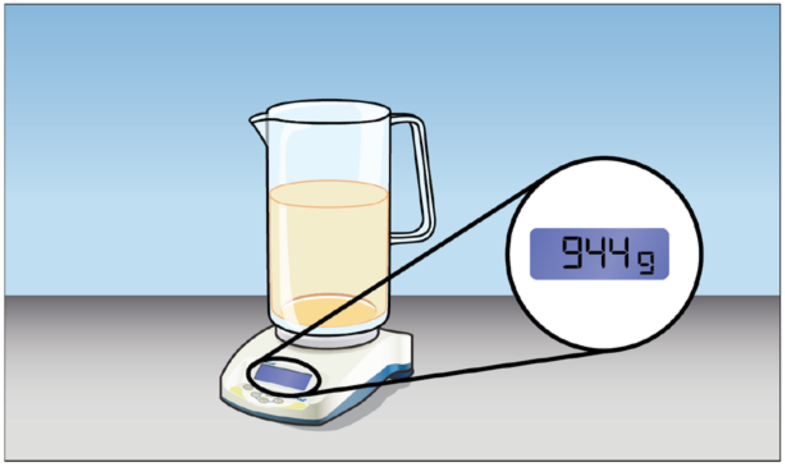
The blowup of the reading on the scale is for illustrative purposes only. The final media will allow students to view/access the reading at any time without cluing the subsequent items.

Platform prompt and student control

The students want to determine how much of each ingredient will be in the lemonade. **Replay the animation by clicking the "REPLAY" button at the bottom of the screen. Type in the correct labels for the type of measurement you are collecting and then complete the table with the data you collect while replaying the animation.**

Ingredients	Measurement: ___ Units: ___
Sugar only	
Water only	
Water + lemon juice	

ANIMATION / VIDEO:



REPLAY Click REPLAY to watch the animation/video again.

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.

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.

The students want to determine how much of each ingredient will be in the lemonade.
Replay the animation by clicking the "REPLAY" button at the bottom of the screen. Type in the correct labels for the type of measurement you are collecting and then complete the table with the data you collect while replaying the animation.

Ingredients	Measurement: ______ Units: ______
Sugar only	
Water only	
Water + lemon juice	

REPLAY Click REPLAY to watch the animation/video again.

Click NEXT to continue to the next question. NEXT

Stem

Student enters one response in each of the text entry fields. If student enters only "g" in the "Units" field and clicks NEXT, a prompt appears instructing students to enter the full name of the unit.

Student populates the table while viewing the animation/video. There is a pause after each ingredient is added in order to allow the student to record the final mass for each ingredient in the data table. Entries in the table should be restricted to numeric only, with an appropriate character limit. (The student can also pause manually.)

Platform prompt and student control: The "REPLAY" button changes to a "PAUSE" button after the animation/video begins playing, and the student can toggle between "PLAY" and "PAUSE" to the end of the animation/video. Upon completion of the animation/video, the "REPLAY" button again appears.

Item Type: Text Entry / Table Fill-In
Estimated Time: 2 min

Evidence Statement Alignment:
(5-PS1-2)
(1) Representation: (a) Students measure and graph the given quantities using standard units, including: (i) The weight of substances before they are heated, cooled, or mixed.

(1) Representation: (a) Students measure and graph the given quantities using standard units, including: (ii) The weight of substances, including any new substances produced by a reaction, after they are heated, cooled, or mixed.

Note on Item Alignment:
What is being elicited from the student (evidence)? The student can measure the mass of the lemonade mixture (or ingredients) in standard units (grams) before and after the mixture is made. Note that students will graph these quantities in Item 2. The student provides the labels in the table in order to achieve alignment to the CCC.

The students want to determine how much of each ingredient will be in the lemonade. **Replay the animation by clicking the "REPLAY" button at the bottom of the screen. Type in the correct labels for the type of measurement you are collecting and then complete the table with the data you collect while replaying the animation.**

Ingredients	Measurement: **Mass** Units: **grams**
Sugar only	**206**
Water only	**708**
Water + lemon juice	**944**

REPLAY Click REPLAY to watch the animation/video again.

Click NEXT to continue to the next question. NEXT

Stem

Student entered one response in each of the text entry fields. If student enters only "g" in the "Units" field and clicks NEXT, a prompt appears instructing students to enter the full name of the unit.

Student populated table

Platform prompt and student control: The "REPLAY" button changes to a "PAUSE" button after the animation/video begins playing, and the student can toggle between "PLAY" and "PAUSE" to the end of the animation/video. Upon completion of the animation/video, the "REPLAY" button again appears.

Item Type: Text Entry / Table Fill-In
Estimated Time: 2 min

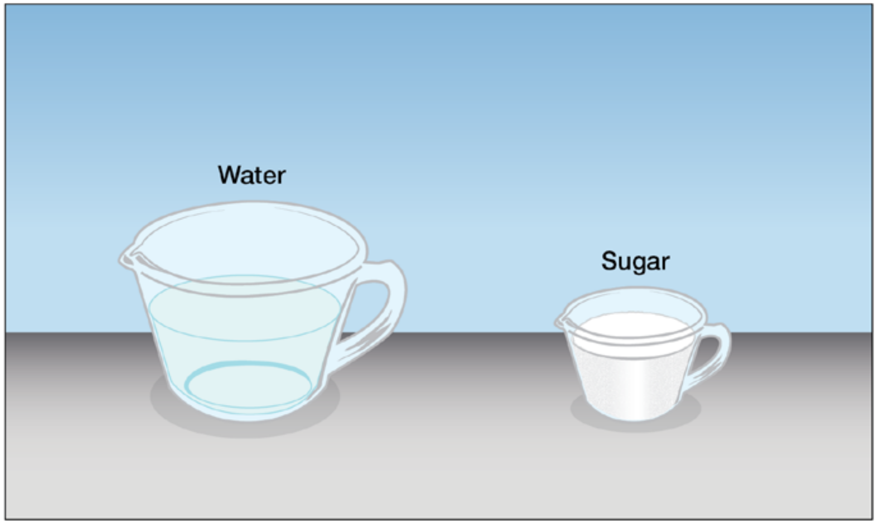
Evidence Statement Alignment:
(5-PS1-2)
(1) Representation: (a) Students measure and graph the given quantities using standard units, including: (i) The weight of substances before they are heated, cooled, or mixed.

(1) Representation: (a) Students measure and graph the given quantities using standard units, including: (ii) The weight of substances, including any new substances produced by a reaction, after they are heated, cooled, or mixed.

Note on Item Alignment:
What is being elicited from the student (evidence)? The student can measure the mass of the lemonade mixture (or ingredients) in standard units (grams) before and after the mixture is made. Note that students will graph these quantities in Item 2. The student provides the labels in the table in order to achieve alignment to the CCC.

Scoring Notes: 2 points – 1 point is awarded for the correct data entered into the table; 1 point is awarded for the correct labels for the type of measurement and units. Use of the term "mass" is to reflect scientific accuracy. Students are not expected to differentiate mass from weight. Students will receive full credit for entering either "Mass" or "Weight" for the type of measurement.

The students gather more water and sugar to investigate each of these ingredients more closely.



Click NEXT to continue. NEXT

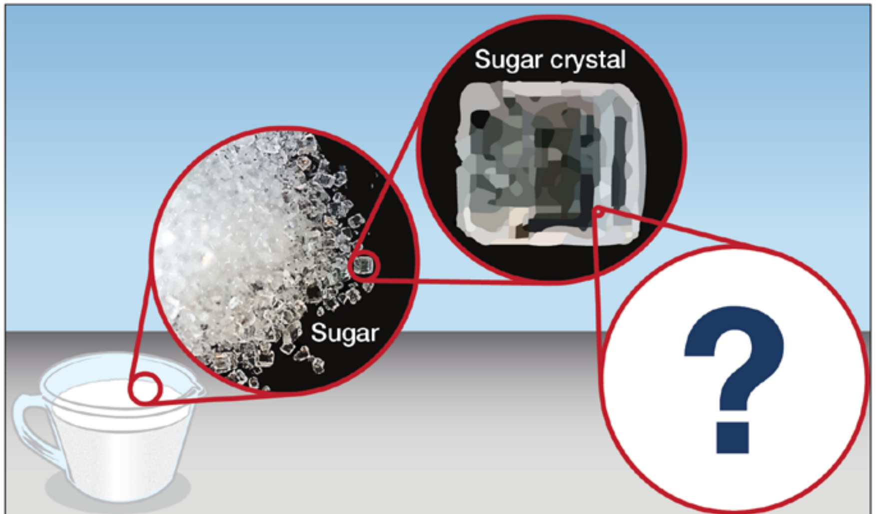
Stimulus

Graphic

Platform prompt and student control

The students look closely at the sugar and water and then research to find images of what the ingredients look like when magnified using a powerful microscope.

Slide the slider to the right and left to observe what sugar looks like at different magnifications.



Slider

Less magnification → More magnification

Click NEXT to continue. NEXT

Stimulus

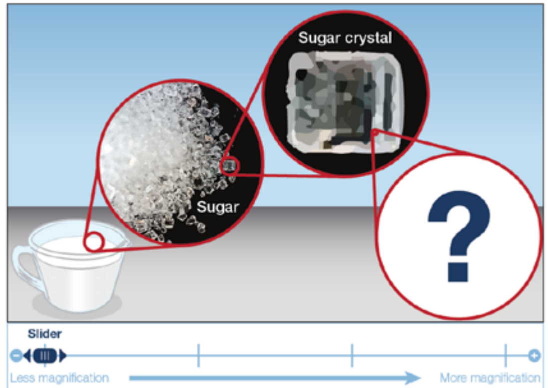
For an example of the slider functionality, visit http://www.numbersleuth.org/universe/magnify/.

Media (interactive image): The previous animation ends by zooming in to the sugar present in the measuring cup.

As the student slides the slider to the right, the image magnifies in a smooth transition. The student may also zoom out by sliding the slider to the left. The slider will automatically snap to the magnification points shown here, with the "?" being the highest magnification possible in this instance. Please note that the zoom circles shown here are for illustrative purposes only; the image for each magnification level will fill the entire student view in the platform.

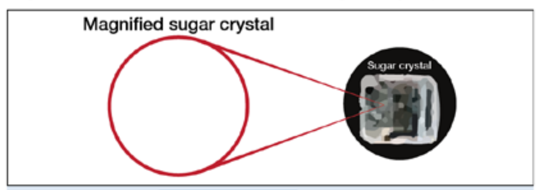
Slider

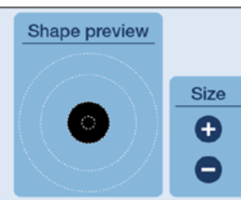
Platform prompt and student control



Part (a) Describe **one** way that the sugar and the water would look similar if they were both magnified under a powerful microscope.

Part (b) Develop a model to show what the sugar would look like when you slide the slider above to the greatest magnification. Change the size of the circle in the "Shape preview" box below to represent the matter that makes up the sugar, and drag one or more of the circles into the area for the magnified sugar crystal.





Click NEXT to continue to the next question. NEXT

5-PS1-1
Develop a model to describe that matter is made of particles too small to be seen.

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
- Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.

Developing and Using Models
Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.
- Use models to describe phenomena.

Scale, Proportion, and Quantity
- Natural objects exist from the very small to the immensely large.

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
2	2a	Calculate mass of ingredient	Computation	5-PS1-2	PS1.A PS1.B	5	3	1	1.a.i 1.a.ii	1	1	A
	2b	Graphing masses of ingredients	Graphing					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	

Evidence Statements for: 5-PS1-1

✓ Included (Item 4b)
1. Components of the model (a) Students develop a model to describe a phenomenon that includes the idea that matter is made of particles too small to be seen. In the model, students identify the relevant components for the phenomenon, including: i. Bulk matter (macroscopic observable matter; e.g., as sugar, air, water).

✓ Included (Item 4a–b)
1. Components of the model (a) Students develop a model to describe a phenomenon that includes the idea that matter is made of particles too small to be seen. In the model, students identify the relevant components for the phenomenon, including: ii. Particles of matter that are too small to be seen.

✓ Included (Item 5a)
2. Relationships (a) In the model, students identify and describe relevant relationships between components, including the relationships between: i. Bulk matter and tiny particles that cannot be seen (e.g., tiny particles of matter that cannot be seen make up bulk matter).

Not Included
2. Relationships (a) In the model, students identify and describe relevant relationships between components, including the relationships between: ii. The behavior of a collection of many tiny particles of matter and observable phenomena involving bulk matter (e.g., an expanding balloon, evaporating liquids, substances that dissolve in a solvent, effects of wind).

✓ Included (Item 5b)
3. Connections (a) Students use the model to describe how matter composed of tiny particles too small to be seen can account for observable phenomena (e.g., air inflating a basketball, ice melting into water).

Evidence Statements for: 5-PS1-2

✓ Included (Items 1, 2a)
1. Representation (a) Students measure and graph the given quantities using standard units, including: i. The weight of substances before they are heated, cooled, or mixed.

✓ Included (Items 1, 2a)
1. Representation (a) Students measure and graph the given quantities using standard units, including: ii. The weight of substances, including any new substances produced by a reaction, after they are heated, cooled, or mixed.

✓ Included (Item 2b)
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.

Not Included
*2. Mathematical/computational analysis (b) Students describe the changes in properties they observe during and/or after heating, cooling, or mixing substances.

✓ Included (Item 2c)
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.

✓ Included (Item 3a–b)
2. Mathematical/computational analysis (d) Students use measurements and descriptions of weight, as well as the assumption of consistent patterns in natural systems, to describe evidence to address scientific questions about the conservation of the amount of matter, including the idea that the total weight of matter is conserved after heating, cooling, or mixing substances.

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THE CENTER ON STANDARDS & ASSESSMENT IMPLEMENTATION

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