Next Generation Science Assessment

Designing Assessments for Formative Use

Joseph Krajcik
Michigan State University
CREATE for STEM

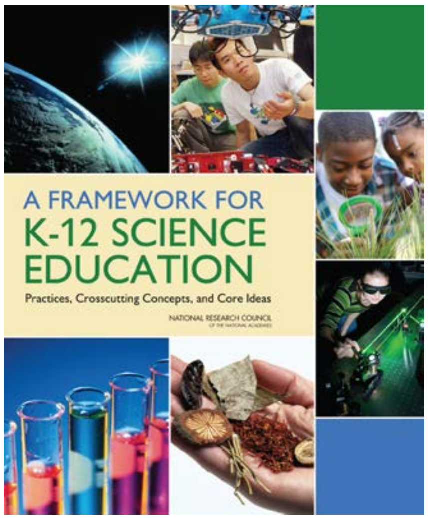
Breakfast Talk
The Council of State Science Supervisors
NSTA 2015

UIC The University of Illinois at Chicago

SRI International

The Concord Consortium

What are the major shifts in the Framework and NGSS?

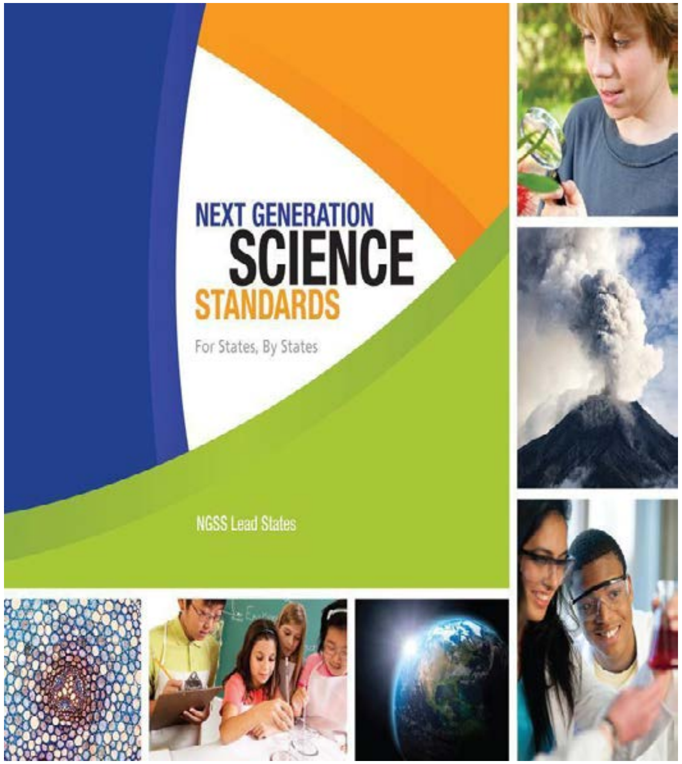


NEXT GENERATION SCIENCE STANDARDS

1. Focus on explaining phenomena or designing solutions to problems
2. 3-Dimensional Learning
    1. Organized around disciplinary core explanatory ideas
    2. Central role of scientific and engineering practices
    3. Use of crosscutting concepts
3. Coherence: building and applying ideas across time

How NGSS impacts design and development of assessment tasks

- Standards expressed as performance expectations – integration of practices, core ideas, and crosscutting concepts into a single statement of ***what is to be assessed***
- Requires students to demonstrate ***knowledge-in-use/***evidence of **three dimensional learning**
- Performance Expectations are not instructional strategies or objectives for a lesson
- Provide a guiding vision of how student should be able to use knowledge at the end of instruction



Overview of EQuIP

for teachers to

I. Alignment to the NGSS	II. Instructional Supports
1. Three dimensional: Supports students in three dimensional learning to makes sense of phenomena or design solutions	Supports learning for all students through meaningful scenarios, supporting practices, supports phenomena and representations
2. Coherence: Lessons fit together	Provides guidance

III. Monitoring student progress

Assessments evaluate three-dimensional learning; include formative; are accessible and unbiased

Pre, formative, and summative aligned

Designing Assessments for 3-Dimensional Learning

Challenges:

- How do we use performance expectations in order to construct tasks that can be used during instruction?
- How do we design tasks that provide evidence of 3-dimensional learning?
- How do we make these tasks formative so that they can be used during instruction to help teachers gauge students' progress toward achieving performance expectations?

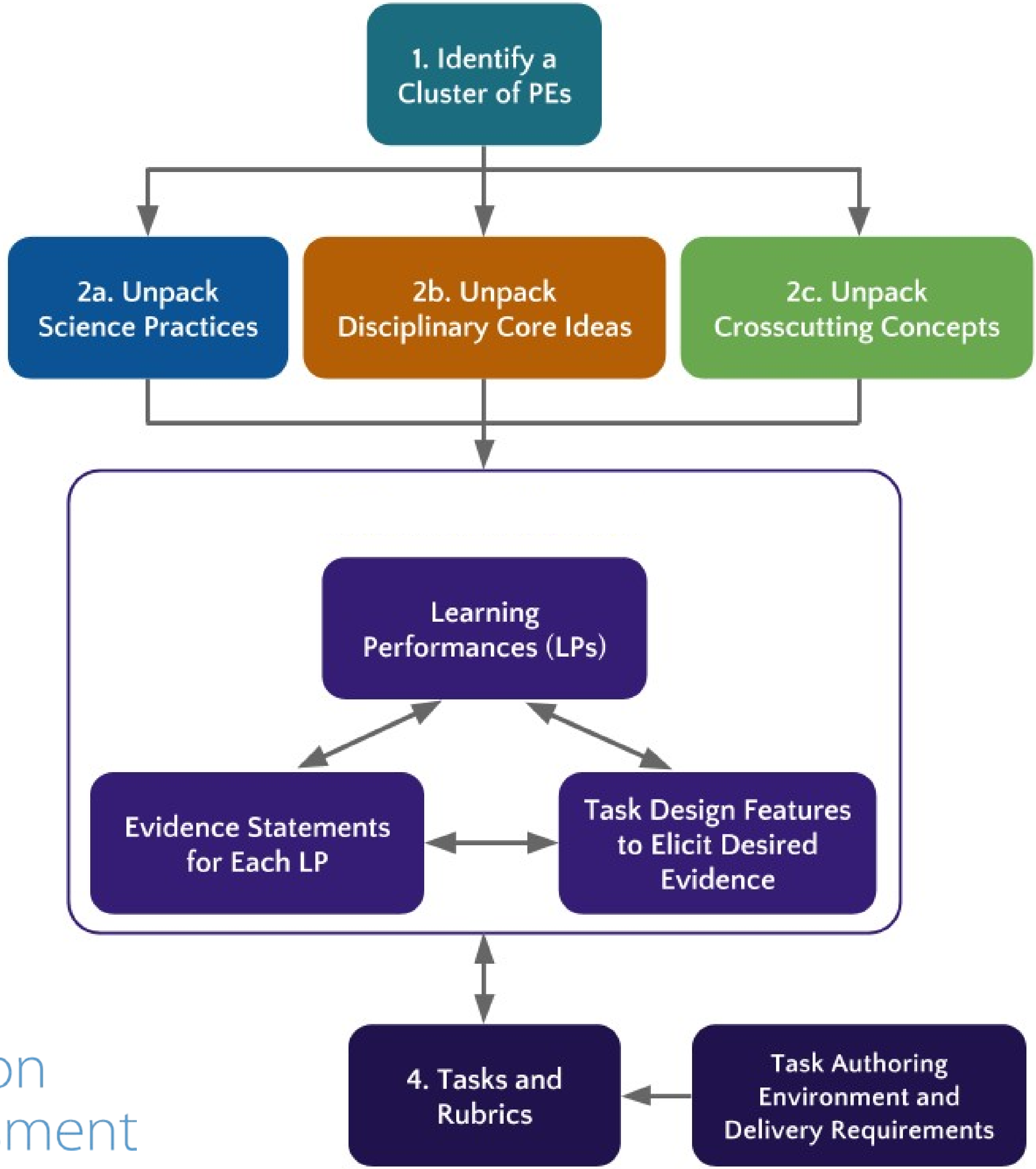
Our Design Approach

Three distinct phases:

Unpacking

Developing learning performances (LP)

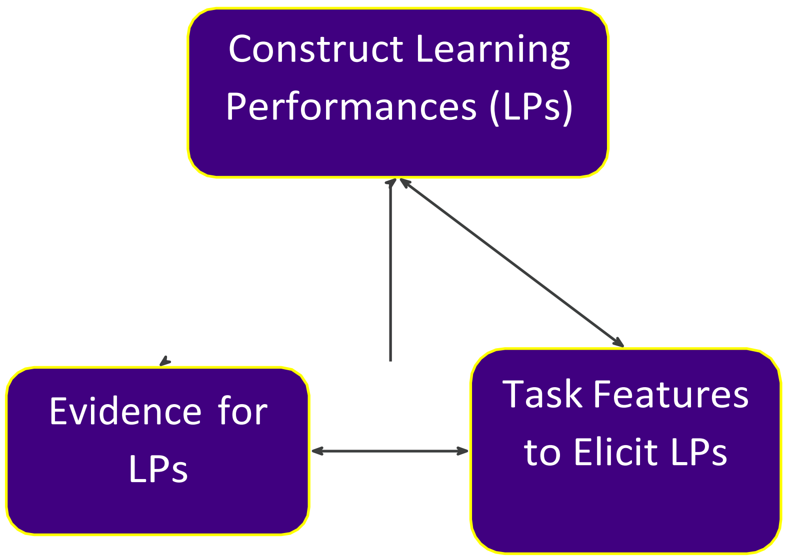
Creating tasks and rubrics



Next Generation Science Assessment

Our Assessment Guidelines

- What claims do we want to be able to make about what students know and can do?
- What kinds of evidence will students need to provide to demonstrate proficiency?
- What kinds of tasks / task features will elicit the desired evidence?



Learning Performances

What are Learning performances?

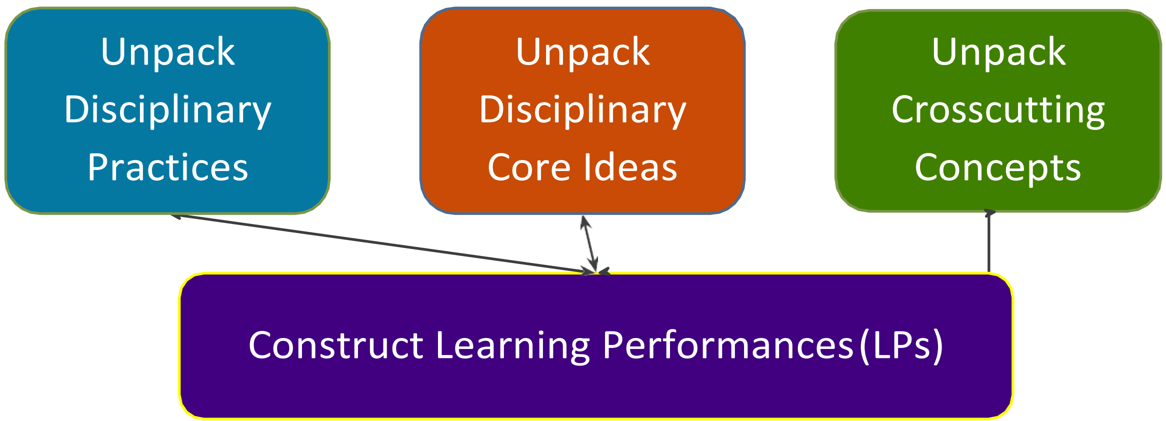
- Builds toward understanding of Performance Expectations
- Combine practices, core ideas and crosscutting concepts at a smaller grain size than the PE (lesson level)

Why use Learning Performances?

- Specifies “knowledge in use”
- Using “know” or “understand” is too vague
- We conceptualize understanding as embedded in practice and not as memorizing static facts
- Assessable in a task

Constructing a Learning Performance

- Identify key aspect(s) of disciplinary knowledge from the disciplinary core unpacking
- Identify key aspect(s) from the practices unpacking
- Identify key aspect(s) from the CCC unpacking
- Construct a statement or "claim" of what a student should be able to do



Constructing a Learning Performance

***Practice:* Constructing explanations**

×

***Core idea:* Chemical Reactions**
Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2), (MS-PS1-5)

×

Crosscutting Concept: Patterns

Learning Performance: Students should be able to construct an explanation about how they determine that substances are the same based upon characteristic properties.

From a Performance Expectation to Learning Performances

MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

- LP C-01: Students should be able to analyze and interpret data to claim that substances are the same or different.
- LP C-02: Students should be able to construct an explanation about how they determine that substances are the same based upon characteristic properties.
- LP C-05: Students should be able to analyze and interpret data to determine whether a reaction has occurred using properties of substances before and after the substances interact.
- LP C-06: Students should be able to construct an explanation about how they determine that a chemical reaction has occurred based on properties of substances before and after substances interact.

Explanation Assessment Task

Maria found four different bottles filled with unknown pure liquids. She measured the properties of each liquid. The measurements are displayed in the data table below. Maria wonders if any of the liquids are the same substance.

Liquid	Density	Color	Volume	Boiling Point
1	1.0 g/cm^3	Clear	6.1 cm^3	100 C°
2	0.89 g/cm^3	Clear	6.1 cm^3	211 C°
3	0.92 g/cm^3	Clear	10.2 cm^3	298 C°
4	0.89 g/cm^3	Clear	10.2 cm^3	211 C°

Use the data in the table to:

1) Write a claim stating whether any of the liquids are the same substance.
2) Provide at least two pieces of evidence to support your claim.
3) Provide reason(s) that justify why the evidence supports your claim.

Task Features

- Focus on density and boiling point
- Tasks provide data about characteristic properties of substances
- Tasks provide a motivating context
- Can provide various levels of support

•Learning Performance Expectation

LP C-[illegible] Students sho[illegible] construct an explanation about how they determine that substances are the same based upon characteristic properties

MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

Look for Claim, Evidence Reasoning

Student 1:

I think that Sample 2 and Sample 4 are the same substance. I think this because they have the same density, 0.89g/cm^3. They also have the same boiling point, of 211º C. Having the same density and boiling point provides evidence that Sample 2 and Sample 4 are the same substance because these two pieces of evidence are properties. Properties are unique characteristics that help to identify and distinguish substances, and they do not change based on amount. The same substances have the same properties, so since Sample 2 and Sample 4 have the same properties, it is very likely that they are the same substance. Volume is not a property, because it changes based on amount (it is amount) and so although they have different volumes, it does not matter in terms of being the same substance.

Student 2

None of the samples in the table could be the same substance. Density, volume, and boiling point are all properties of a substance. Properties are unique characteristics of a substance. For two samples to be the same, they have to have the same properties. None of the samples shown in the table have the same properties.

Modeling assessment task

Watch the video clip. Construct a model to explain why the M&M behaved differently in cold, room temperature, and hot water. Your model should include both pictures and words to explain the behavior of M&M particles in the water at different temperatures.

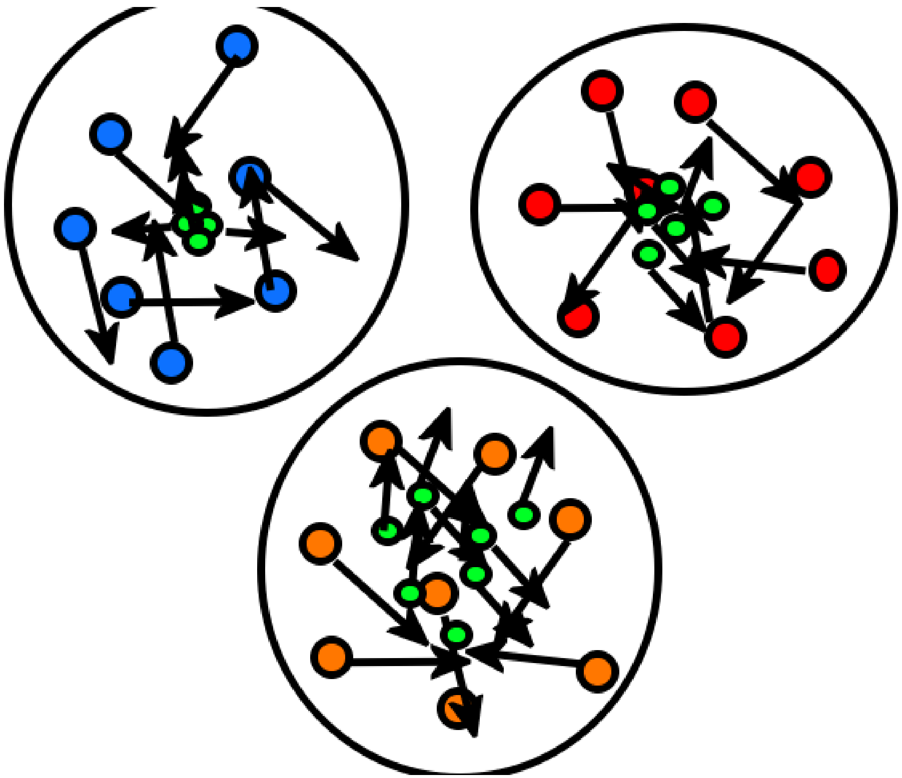
Cold Water (5° C)	Room Temperature Water (20 °C)	Hot Water (80 °C)

Task Features

- Task includes evidence that particles are in motion.
- Task includes evidence for speed of particle motion.
- Task presents addition or removal of thermal energy.
- Tasks provide motivating context.

LP-E-02: Students should be able to **develop a model** that explains how particle motion changes when thermal energy is added or removed in each state of matter.

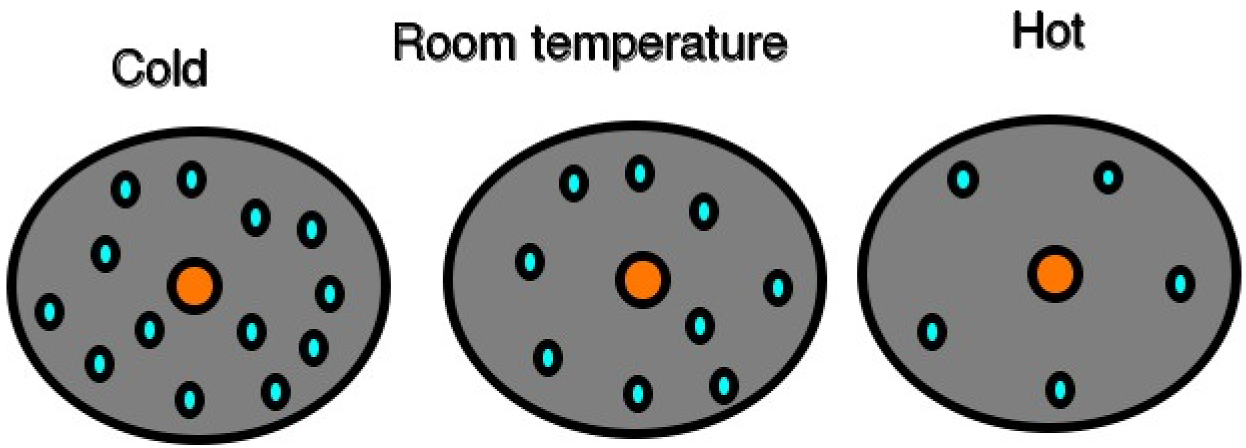
Student response 3 (M&M item)



Key:
green particles:m & m particles
orange particles: hot water particles
Red particles:room temperature particles
Blue particles:cold water particles
Arrows:movement

The m&m particles get more energy in the hot water so they move faster, hit each other harder, and spread farther apart. In the colder water the m&m particles move slower and don't spread apart very far.

Student response 2 (M&M item)



M&Ms are put in water and the particles are spreading out more when they are in hot water, and less when they are in colder water.

Our Next Steps

What questions do we have?

- **Do the tasks support teachers in integrating practices, crosscutting concepts and core ideas in their instruction?**
- **How does using assessment tasks in formative ways inform instructional decisions?**

Investigating these question will help us design the support for teachers using the items

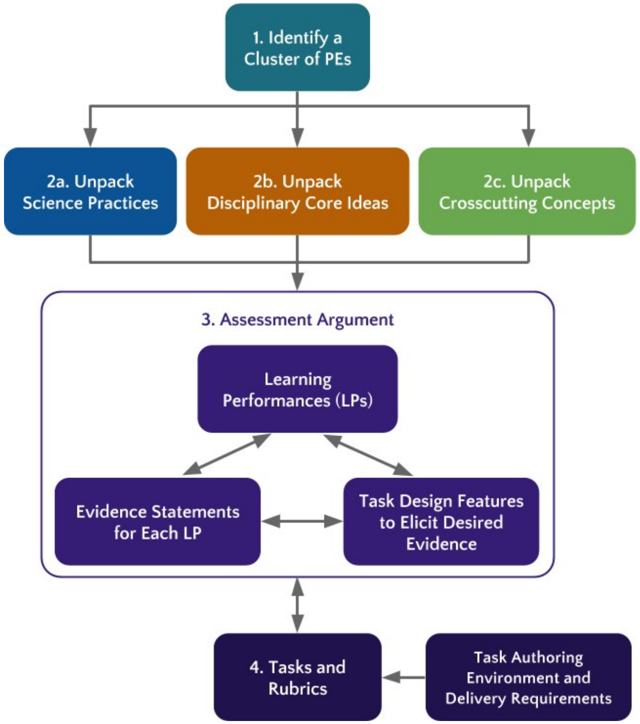
Next Generation Science Assessment

The Value of our Approach

A systematic process to facilitate the design of 3-dimensional assessments that can be used formatively.

Benefits

- Develop a broadly accessible vision of how to design NGSS assessments
- Document principled design decisions
- Create well-aligned formative tasks that are usable across varied classroom environments
- Generalize to other core ideas, crosscutting concepts, and practices



[See Tasks](http://ngss-assessment.portal.concord.org) http://ngss-assessment.portal.concord.org

Next Generation Science Assessment

Partners

MICHIGAN STATE UNIVERSITY

UIC The University of Illinois at Chicago

The Concord Consortium

SRI International

Questions? Contact krajcik@msu.edu