The NGSS and New Challenges for Instruction and Assessment

Brian Gong, Center for Assessment

Mary Norris, Virginia Tech

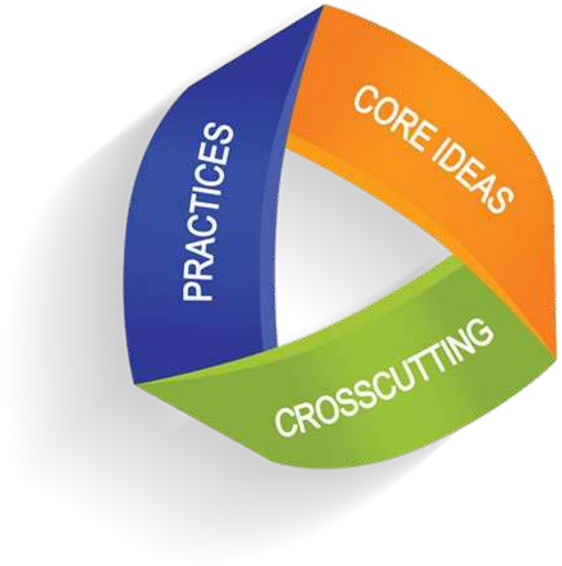
NCME Classroom Assessment Conference

10/09/18

Next Generation Science Standards

- NGSS or NGSS-like—45 states
- Few operational, many field tests
- Old to new—monumental differences

Intro to NGSS



Science and Engineering Practices (SEPs)

- Doing science--not meant to be isolated
- Skills

Disciplinary Core Ideas (DCIs)

- The *BIG IDEAS* that guide scientific reasoning *within each discipline*
- Content

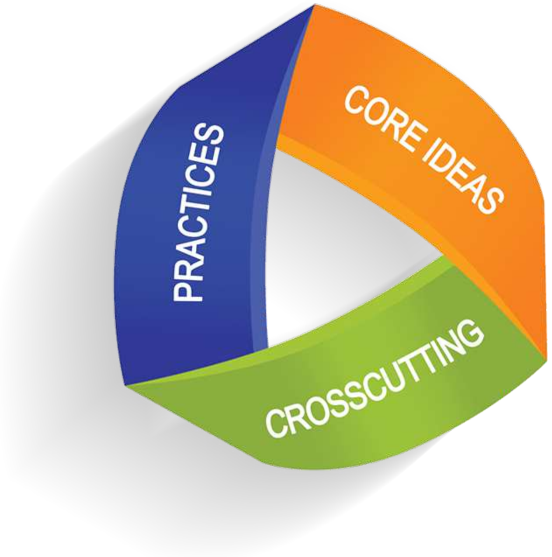
Crosscutting Concepts (CCs)

- Need to made explicit
- Link disciplines into a coherent view

SEP x DCI x CC = PE*

****Performance Expectation***

Dimensions of NGSS



Science and Engineering Practices (SEPs)

- Doing science--not meant to be isolated
- Skills

Disciplinary Core Ideas (DCIs)

- The *BIG IDEAS* that guide scientific reasoning *within each discipline*
- Content

Crosscutting Concepts (CCs)

- Need to made explicit
- Link disciplines into a coherent view

SEP x DCI x CC = PE*

****Performance Expectation***

How many PEs?

Coarse: (8 SEPs) x (11 DCIs) x (7 CCs) = 616 possible PEs

Fine: (45 SEPs) x (38 DCIs) x (7 CCs) = 12,320 possible PEs

The PEs of the Standards are a subset of these.

"If implemented properly, the NGSS will lead to coherent, rigorous instruction that will result in students being able to acquire and apply scientific knowledge to ***unique situations*** *& to think and reason scientifically." (NGSS, Vol. 1, p. xvi)*

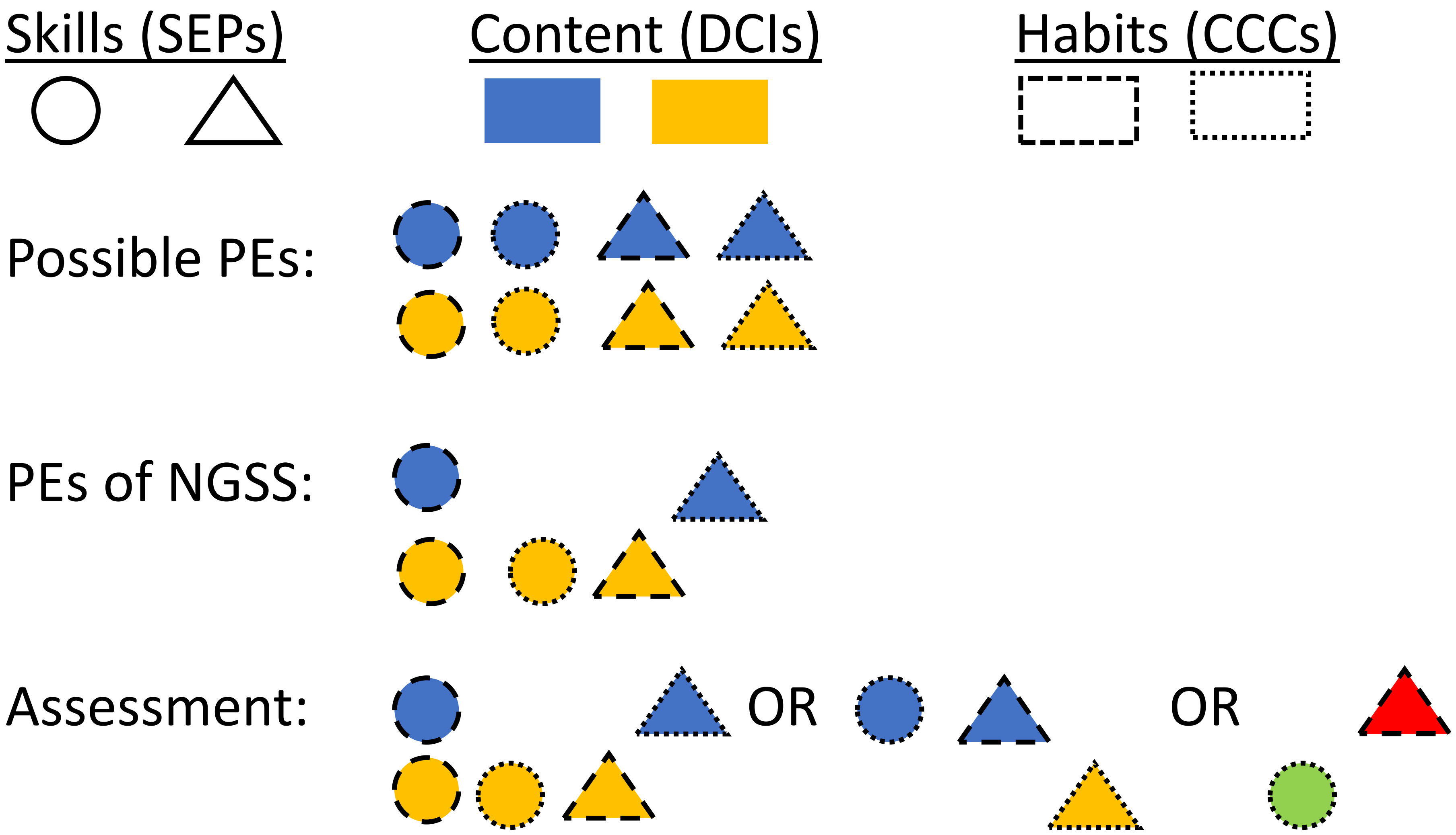
Performance Level Descriptors (PLDs)

- From ECD perspective, assessments are designed to support claims and uses.
- Claims come before assessment.
- PLDs make the claims explicit
- Help to define what types of evidence are needed

What types of claims?

- According to the Framework, the intentions of the Standards include for all students to be prepared to engage in public discussions and debate about science and engineering issues; to continue their science and engineering education if desired; to be informed consumers of science and engineering in their lives; and to appreciate the "beauty and wonder of science" by the end of the twelfth grade (National Research Council, 2012, p. 2).

Nature of Claims and PEs



Possible ways to define the domain

- All Performance Expectations
- All Science and Engineering Practices across some set of DCIs and CCCs
- All Disciplinary Core Ideas for some set of SEPs/CCCs

KEY

SEP—Science and Engineering Practice
DCI—Disciplinary Core Idea
CCC—Crosscutting Concept

All PEs

Possible Claims	Implications for Assessment	Implications for Instruction
• The domain of science is sufficiently represent by the NGSS. • The student has mastered the NGSS.	• Assessment items align to single PEs • Only three-dimensional items. • Requires many items.	• Focus may be only on PEs.

California Example

CAST Claims

The CAST has four claims—one overall claim for the entire assessment, and three separate science domain claims. Table 1 shows the claim statements for CAST.

Table 1. CAST Claims

Domains	Description
3D Overall	Students can demonstrate performances associated with the expectations of the California Next Generation Science Standards, through the integration of Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts across the domains of Physical Sciences, Life Sciences, Earth and Space Sciences, and Engineering, Technology, and Application of Science.
3D Physical Sciences	Students can demonstrate performances associated with the expectations in the disciplinary area of Physical Sciences within the California Next Generation Science Standards, through the integration of Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.
3D Life Sciences	Students can demonstrate performances associated with the expectations in the disciplinary area of Life Sciences within the California Next Generation Science Standards, through the integration of Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.
3D Earth and Space Sciences	Students can demonstrate performances associated with the expectations in the disciplinary area of Earth and Space Sciences within the California Next Generation Science Standards, through the integration of Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

From: https://www.cde.ca.gov/ta/tg/ca/documents/castblueprint.pdf

All SEPs

Possible Claims	Implications for Assessment	Implications for Instruction
• The domain of science is represented by any combination of DCIs/CCCs across all SEPs. • The student has demonstrated ability to apply all SEPs with important DCI and CCCs to scientifically investigate and solve important problems.	• May report on groupings of SEPs/CCCs • May require alignment to “new” PEs • May allow for both 2- and 3-dimensional items	• Focus on learning the practices of science and engineering—”doing science” • Still includes important DCIs • Less prescriptive?

Washington Example

Grade 11 Level 3		
An 11th grade student performing at **level 3** effectively applies science and engineering practices and crosscutting concepts to explain phenomena and design solutions to problems in the natural and designed world. The student develops models and uses information and patterns in data to support scientific arguments, describe relationships among variables, and predict how the variables will change over time. The student analyzes patterns in data to evaluate how well a solution meets the criteria and constraints of the problem. The student uses data, mathematical and computational thinking, and scientific principles to construct explanations of scientific processes and arguments about how systems and system parts will change over time.		
CCCs	**In addition to the skills and knowledge demonstrated at Level 2, a student performing at Level 3 can do things like:**	Domain/ DCI
1, 2, 5, 7	1. Develop and use a model of atomic structure and patterns in data to predict properties of matter and to make and support arguments about the effect of temperature on reaction rates.	HS-PS1
2	2. Plan an investigation to collect data that can, with mathematical and computational thinking, support a quantitative argument about the effect of net force and mass on the acceleration of an object.	HS-PS2
2, 4, 5,	3. Design a device that converts energy from one form to another, and develop and use a model to quantitatively describe how energy changes in one part of a system affect other parts of the system.	HS-PS3 HS-ETS1
2, 4, 7	4. Develop and use a model to quantitatively predict how a change in medium will affect amplitude, frequency and wave speed.	HS-PS4
4, 6,	5. Use data to develop a model and construct an explanation of how DNA determines protein structure and how multicellular organisms are organized into interacting systems with specialized functions.	HS-LS1
2, 3, 4, 5, 7	6. Use mathematical and computational thinking to construct a quantitative argument about the cycling of matter and flow of energy among organisms in an ecosystem.	HS-LS2
2	7. Ask questions to describe relationships among DNA, chromosomes, and traits, and use evidence to construct arguments about causes of inheritable genetic variation.	HS-LS3
1, 2	8. Use data to construct an explanation of how given factors result in evolution and to construct an argument about how environmental conditions affect genetic variation within populations.	HS-LS4
1, 3, 5, 7	9. Use mathematical and computational thinking to qualitatively predict the motion of objects in the solar system, and use information to describe that the processes and elements produced within stars depend on the mass and age of the star.	HS-ESS1
2, 4, 5, 7	10. Develop a model that describes how changes in climate are caused by variations in energy flow into and out of Earth's systems.	HS-ESS2
2, 4, 7	11. Use data from climate models to predict the rate of change in climate and whether impacts on Earth's systems are reversible.	HS-ESS3
4	12. Define qualitative and quantitative criteria for a successful solution to a major global problem that takes into account what people need and want.	HS-ETS1

Key:
SEP1
SEP2
SEP3
SEP4
SEP5
SEP6
SEP7
SEP8

All Students, All SEPs

Level 2	An 11th grade student performing at **level 2** *applies, with support*, science and engineering practices and crosscutting concepts …
Level 3	An 11th grade student performing at **level 3** *effectively applies* science and engineering practices and crosscutting concepts …
Level 4	An 11th grade student performing at **level 4** *effectively, consistently, and appropriately applies* science and engineering practices and crosscutting concepts …

- Degree of independence
- Degree of correctness

All Students, All SEPs

Differentiating Quality of Performance	
Level 2	Ask questions that help to *identify relationships* among DNA, chromosomes, and traits, and use evidence to *support* an argument about causes of inheritable genetic variation.
Level 3	Ask questions to *describe relationships* among DNA, chromosomes, and traits, and use evidence to *construct* arguments about causes of inheritable genetic variation.
Level 4	Ask questions and use scientific reasoning to *explain relationships* among DNA, chromosomes, and traits, and use evidence to *evaluate and revise* arguments about causes of inheritable genetic variation.

All DCIs

Possible Claims	Implications for Assessment	Implications for Instruction
• The domain of science is represented by DCIs applied in some way(s). • The student has demonstrated knowledge Core Ideas of discipline by scientifically investigate and solving important problems using a selection of SEPs/CCCs.	• Likely that missing SEPs/CCCs would need to be assessed in other ways.	• Heavier focus on core ideas but still includes practices of science and engineering—”doing science” • May be more similar to previous science standards

Kansas Example

Cognitive Complexity Degree of Correctness x Degree of Challenge

Cognitive Complexity

Claim/Target	**Level 2**	**Level 3**	**Level 4**
Claim 1: Physical Science	Students in this range typically comprehend and **describe** scientific ideas, connecting concepts, and procedures or practices (targets A-E), and they apply scientific and engineering knowledge **consistently** to problems of **low complexity** and **inconsistently** to problems of **moderate complexity** in the physical sciences (targets A-F).	Students in this range typically comprehend and **explain** scientific ideas, connecting concepts, and procedures or practices (targets A-E), and they apply scientific and engineering knowledge **consistently** to problems of **moderate complexity** and **inconsistently** to problems of **high complexity** in the physical sciences (targets A-F).	Students in this range typically comprehend and **analyze** scientific ideas, connecting concepts, and procedures or practices (targets A-E), and they apply scientific and engineering knowledge **consistently** to problems of **high complexity** in the physical sciences (targets A-F).
Targets A & B	*Omitted from our example*		
Target C: Forces and Interactions	Students can use Newton's second law to describe force and motion relationships, explain the concept of conservation of momentum, and describe and predict forces that act at a distance. **No SEPs**	Students can compare the effects of forces on an object's motion, use a mathematical representation to support the claim there is conservation of momentum in a system, and use mathematical representations to describe and predict forces that act at a distance. **SEP5**	Students can analyze evidence that supports Newton's second law of motion, use mathematical representations to explain the conservation of momentum, and use models and mathematical representations to describe and predict forces that act at a distance. **SEP2**, **SEP4**, & **SEP5**

Implications for Instruction/Assessment

- The PEs are intentionally written to be assessable, but are not intended to be the curriculum.
- For students to develop the skills and dispositions that are the goals of the *Standards*, they will need to engage with multiple SEPS (often together) to understand the same DCI and to use the same SEPs across different DCIs from multiple disciplines (NRC, 2014).

Implications for Instruction/Assessment

- Strong summative assessments of the NGSS should have the same characteristics as strong classroom assessments of the NGSS--they should elicit student thinking about DCIs and CCCs through engagement in SEPs applied to important phenomena—while sufficiently covering the breadth of the NGSS in a cost-effective manner (National Research Council, 2014).
- The NGSS requires states to make more complex decisions about claims, the test/instructional domains, and what aspect(s) of performance will be used to differentiates levels.
- Requires teacher capacity!