Assessing Next Generation Science

Jonathan Osborne

Stanford University

ELICITATION OF PRIOR KNOWLEDGE

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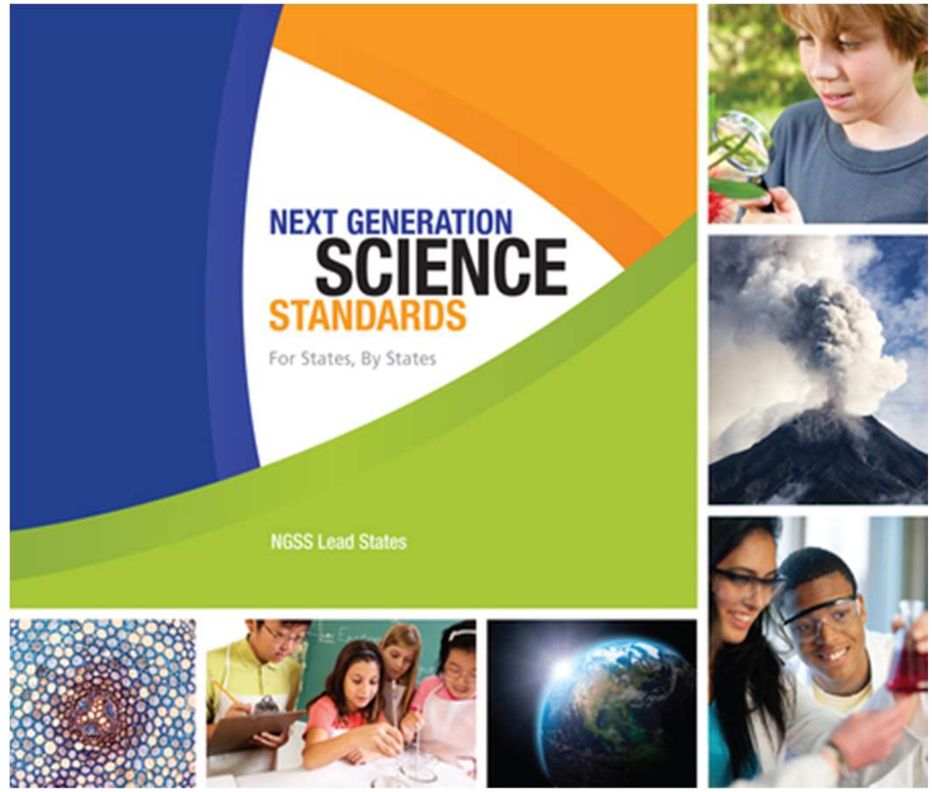
Three dimensions of science education

- Science and Engineering Practices
- Disciplinary Core Ideas
- Crosscutting Concepts



Science as a Set of 8 Practices

1. Asking Questions
2. Planning and Carrying out Investigations
3. Analyzing and Interpreting Data
4. Using Mathematical Tools
5. Constructing Explanations
6. Developing and Using Models
7. Constructing and Evaluating Arguments
8. Communicating and Interpreting Scientific Information

Consisting of 7 Cross-Cutting Concepts

- Patterns.
- Cause and effect: Mechanism and explanation
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter: Flows, cycles, and conservation
- Structure and function
- Stability and change

A Major Change in NGSS

Outcomes Specified as a **PERFORMANCE EXPECTATION**:

MS-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.

NGSS: Middle school life science, Strand 4

MS-LS4 Biological Evolution: Unity and Diversity

PERFORMANCE EXPECTATIONS

Students who demonstrate understanding can:

MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. [*Clarification Statement*: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in rock layers.] [*Assessment Boundary*: Assessment does not include the names of individual species or geologic eras in the fossil record.]

MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. [*Clarification Statement*: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarities or differences of the gross appearance of anatomical structures.]

MS-LS4-3. Analyze displays of pictorial data to compare patterns of similarities in embryological development across multiple species to identify relationships not evident in the fully formed anatomy. [*Clarification Statement*: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [*Assessment Boundary*: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]

MS-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. [*Clarification Statement*: Emphasis is on using simple probability statements and proportional reasoning to construct explanations.]

MS-LS4-5. Gather and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms. [*Clarification Statement*: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, and gene therapy) and on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]

MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. [*Clarification Statement*: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [*Assessment Boundary*: Assessment does not include Hardy-Weinberg calculations.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze displays of data to identify linear and non-linear relationships. (MS-LS4-3) • Analyze and interpret data to determine similarities and differences in findings. (MS-LS4-1) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to	**LS4.A: Evidence of Common Ancestry and Diversity** • The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1) • Anatomical similarities and differences between various organisms living today, and between them and organisms in the fossil record enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2)	**Patterns** • Patterns can be used to identify cause and effect relationships. (MS-LS4-2) • Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1), (MS-LS4-3) **Cause and Effect** • Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4), (MS-LS4-5), (MS-LS4-6)

MS-LS4 Biological Evolution: Unity and Diversity

See connections to MS-LS4 on page 150.

Performance expectations (PEs)

Links between PEs and practices, DCIs, and CCs

Slide 7

1 This slide is animated - upon the click of mouse/pointer, the front images will disappear and the following page (continuation of this particular strand) will appear. It only serves to emphasize the bewildering presentation of the standards.
Stephanie Rafanelli, 8/18/2017

PERFORMANCE EXPECTATIONS

Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

Performance Expectations

- NOT A SET OF STANDARDS
- ILLUSTRATIONS OF THE KINDS OF PERFORMANCES EXPECTED
- UNCERTAIN IF ONLY THESE WILL BE TESTED?
- ARE DIFFICULT TO ASSESS

TASK 2

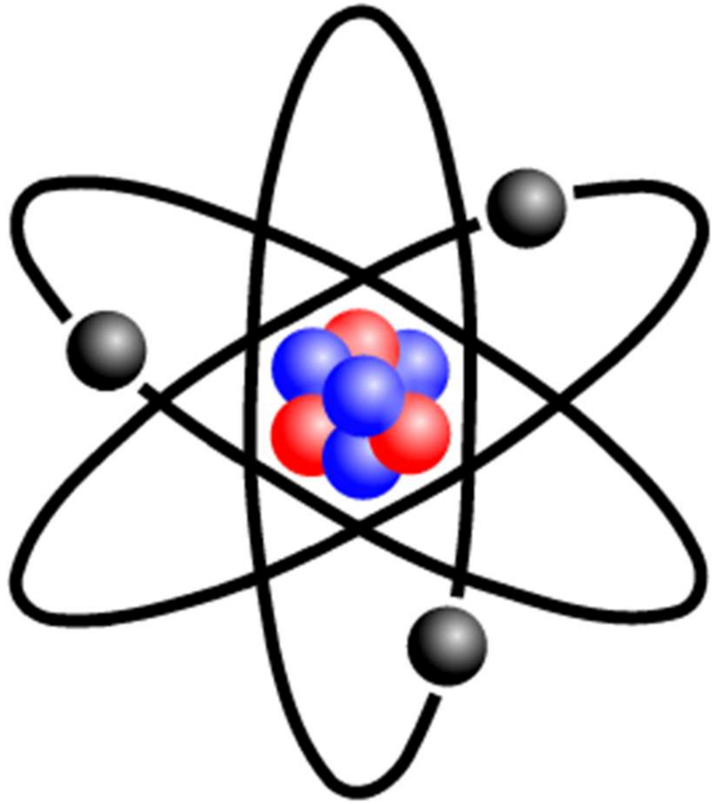
MS-PS1-5.

DEVELOP AND USE A MODEL TO DESCRIBE HOW THE TOTAL NUMBER OF ATOMS DOES NOT CHANGE IN A CHEMICAL REACTION AND THUS MASS IS CONSERVED. [CLARIFICATION STATEMENT: EMPHASIS IS ON LAW OF CONSERVATION OF MATTER AND ON PHYSICAL MODELS OR DRAWINGS, INCLUDING DIGITAL FORMS, THAT REPRESENT ATOMS.] [ASSESSMENT BOUNDARY: ASSESSMENT DOES NOT INCLUDE THE USE OF ATOMIC MASSES, BALANCING SYMBOLIC EQUATIONS, OR INTERMOLECULAR FORCES.]

1. How might you assess this?
2. What learning experiences do your students need to have to develop their ability to meet this performance expectation

Develop and Use a Model

REQUIRES
CRITIQUE



Traditional Items

1: STRUCTURE OF AN ATOM

WHICH OF THE FOLLOWING BEST DESCRIBES AN ATOM?

A PROTONS AND ELECTRONS GROUPED TOGETHER IN A RANDOM PATTERN

B PROTONS AND ELECTRONS GROUPED TOGETHER IN AN ALTERNATING PATTERN

C A CORE OF PROTONS AND NEUTRONS SURROUNDED BY ELECTRONS

D A CORE OF ELECTRONS AND NEUTRONS SURROUNDED BY PROTONS

Traditional Questions

The following table shows properties of four different sample materials. One of these material is cork, a type of wood that floats in water

Physical Properties

Sample Number	Mass	Volume
1	89 g	10 mL
2	26 g	10 mL
3	24 g	100 mL
4	160 g	100 mL

Given that the density of water is 1 g/mL, which of the samples is most likely cork?

A 1

B 2

C 3

D 4

California Decisions (March 2016)

GRADE FIVE ASSESSMENT, CONSISTING OF GRADE FIVE PERFORMANCE EXPECTATIONS AND MATRIX SAMPLING OF PERFORMANCE EXPECTATIONS FROM KINDERGARTEN THROUGH GRADE FOUR;

GRADE EIGHT ASSESSMENT, CONSISTING OF MIDDLE SCHOOL (GRADES SIX THROUGH EIGHT) PERFORMANCE EXPECTATIONS AND MATRIX SAMPLING;

GRADE **TWELVE** ASSESSMENT, CONSISTING OF HIGH SCHOOL PERFORMANCE EXPECTATIONS.

FIELD TEST WILL INCLUDE

- ALL grade 12 students
- any grade 10 or 11 students who have completed their last high school science course.

California Decisions-Mandated Fed Tests

THREE COMPONENTS (ALL ADMINISTERED BY COMPUTER, 2 HOURS, CAN BE OVER MULTIPLE DAYS)

SEGMENT A (INDIVIDUAL AND GROUP SCORE)

- 32-45 Discrete items,

SEGMENT B (INDIVIDUAL AND GROUP SCORE)

- 2-3 Performance Tasks

SEGMENT C (GROUP SCORE ONLY)

- Measures full range of standards

California Decisions-Mandated Fed Tests

THREE COMPONENTS (ALL ADMINISTERED BY COMPUTER, 2 HOURS, CAN BE OVER MULTIPLE DAYS)

SEGMENT A (INDIVIDUAL AND GROUP SCORE)

- 32-45 Discrete items,
- Machine scorable
- Stage 1
  - ~16 items
  - Mix of easy, medium, and difficult items
- Stage 2
  - ~16-29 items
  - Difficulty of these items dependent on Stage 1 performance

California Decisions-Mandated Fed Tests

THREE COMPONENTS (ALL ADMINISTERED BY COMPUTER, 2 HOURS, CAN BE OVER MULTIPLE DAYS)

SEGMENT B (INDIVIDUAL AND GROUP SCORE)

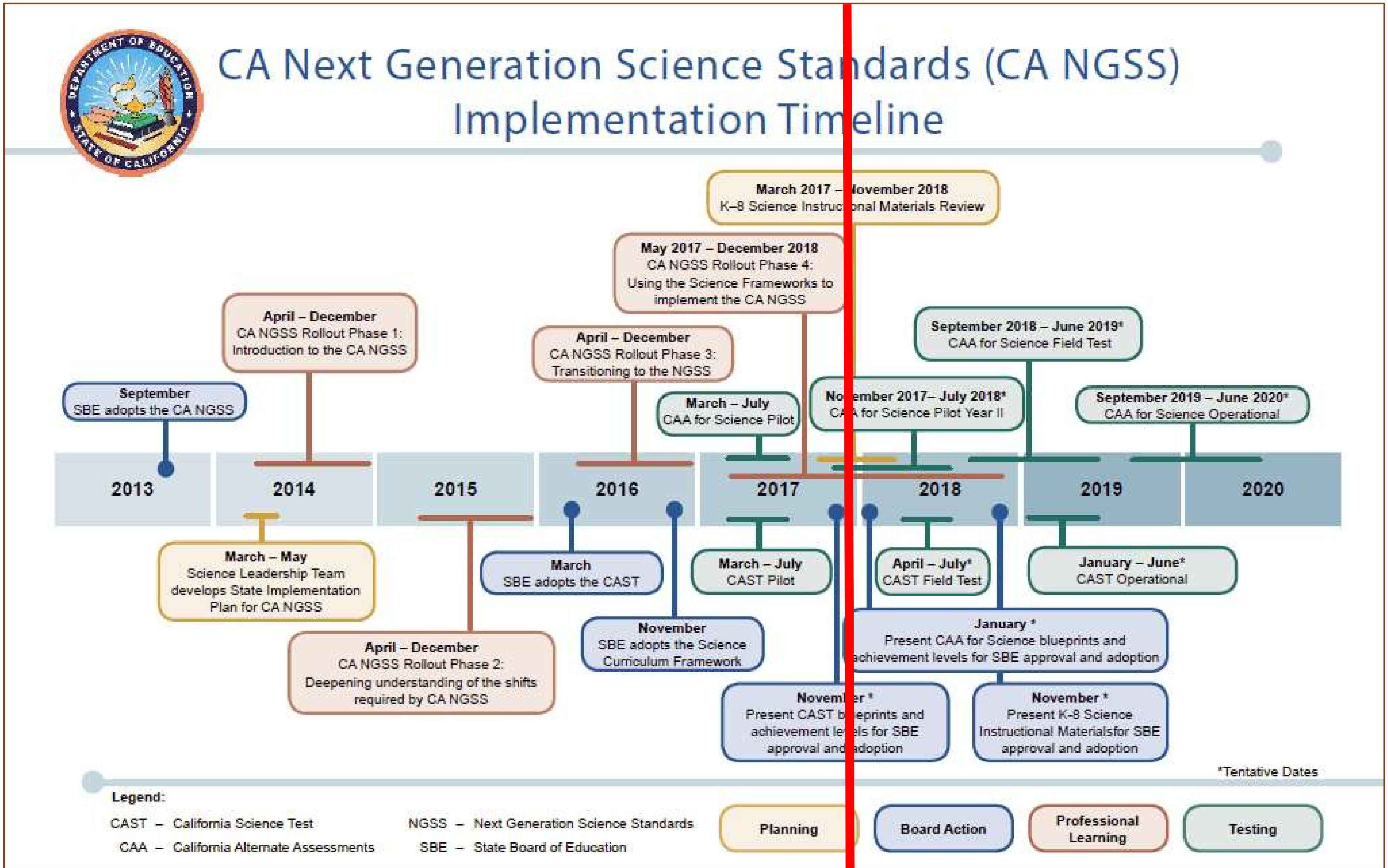
- 2-3 Performance Tasks
- Variable Content
- Randomly assigned
  - EXCEPTION: Poor performance on one discipline in Segment A, they will receive a performance task for a different discipline on Segment B. This will apply to a very small number of students.

California Decisions-Mandated Fed Tests

Three components (All administered by computer, 2 hours, can be over multiple days)

Segment C (Group Score Only)

- Group likely to be entire state for field test, possibly smaller groups at implementation
- Students will be randomly assigned:
  - Breadth: Discrete items (as in Segment A)
  - Depth: One performance task (as in Segment B)
- Measures full range of standards



CA Next Generation Science Standards (CA NGSS)
Implementation Timeline
2013
2014
2015
2016
2017
2018
2019
2020
September
SBE adopts the CA NGSS
April – December
CA NGSS Rollout Phase 1:
Introduction to the CA NGSS
March – May
Science Leadership Team
develops State Implementation
Plan for CA NGSS
April – December
CA NGSS Rollout Phase 2:
Deepening understanding of the shifts
required by CA NGSS
April – December
CA NGSS Rollout Phase 3:
Transitioning to the NGSS
March
SBE adopts the CAST
November
SBE adopts the Science
Curriculum Framework
May 2017 – December 2018
CA NGSS Rollout Phase 4:
Using the Science Frameworks to
implement the CA NGSS
March 2017 – November 2018
K–8 Science Instructional Materials Review
March – July
CAA for Science Pilot
March – July
CAST Pilot
November 2017– July 2018*
CAA for Science Pilot Year II
April – July*
CAST Field Test
September 2018 – June 2019*
CAA for Science Field Test
January – June*
CAST Operational
September 2019 – June 2020*
CAA for Science Operational
January *
Present CAA for Science blueprints and
achievement levels for SBE approval and adoption
November *
Present CAST blueprints and
achievement levels for SBE
approval and adoption
November *
Present K-8 Science
Instructional Materialsfor SBE
approval and adoption
*Tentative Dates
Legend:
CAST – California Science Test
CAA – California Alternate Assessments
NGSS – Next Generation Science Standards
SBE – State Board of Education
Planning
Board Action
Professional Learning
Testing

CAST Schedule

2016-17 Pilot Testing

2017-18 Field Test

2018-19 Fully operational testing

2019-20 Fully operational testing

California Alternative Assessment Schedule

2016-17 Pilot Testing

2017-18 Year two Pilot testing

2018-19 Field testing

2019-20 Fully operational testing

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Stanford NGSS Assessment Project (SNAP)

https://snapgse.stanford.edu/

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The charge of the Stanford NGSS Assessment Project is to envision a blueprint for California's future science standards. In this website you will find resources produced as part of our work. Our goal is to help states, local educational agencies, and teachers seeking to implement and assess the Next Generation Science Standards in their schools.

To navigate this site please explore the menu bar above. You will find links about what we do, who we are, sample work we've produced, and other resources that might be useful to the task of implementing and assessing the Next Generation Science Standards. We welcome you to browse through the pages of this website and to contact us with any insights or questions you might have.

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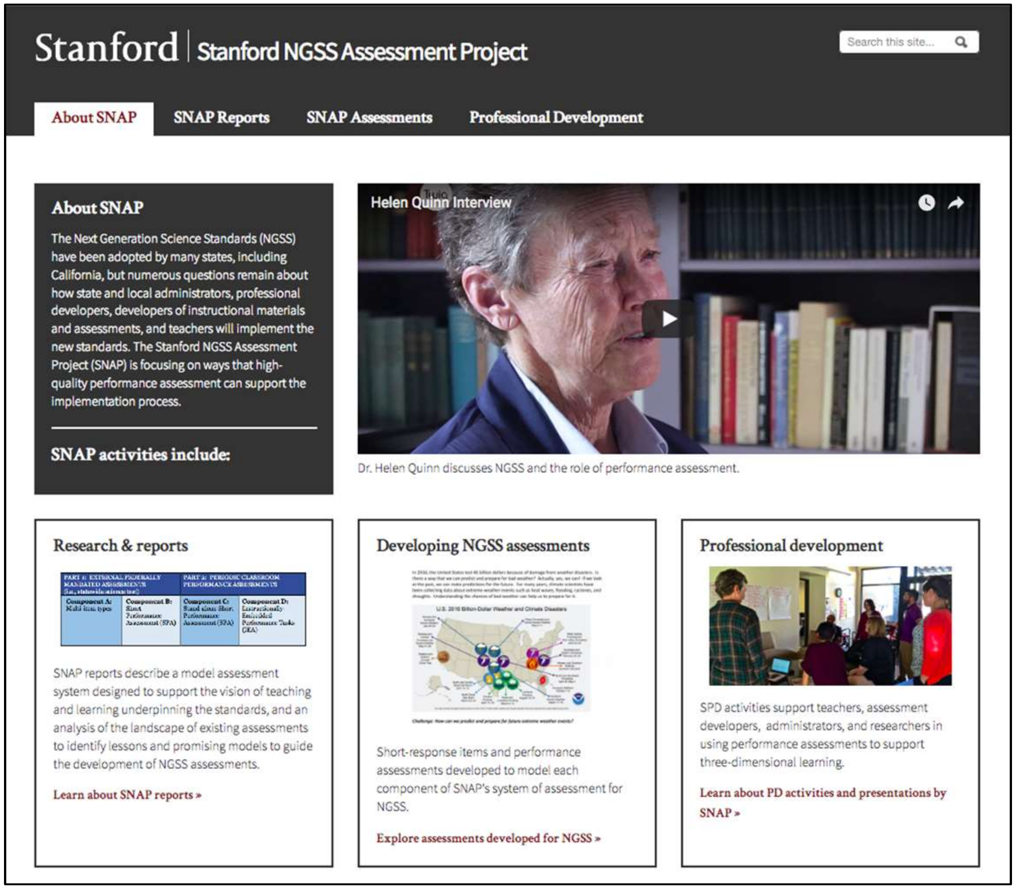

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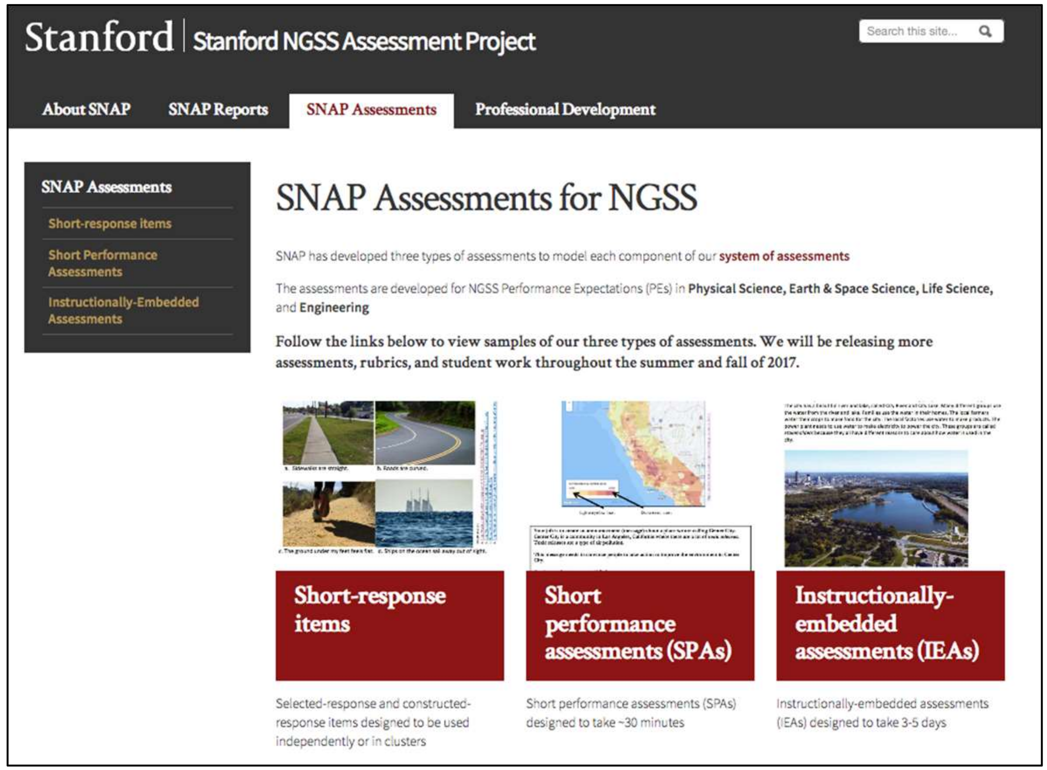

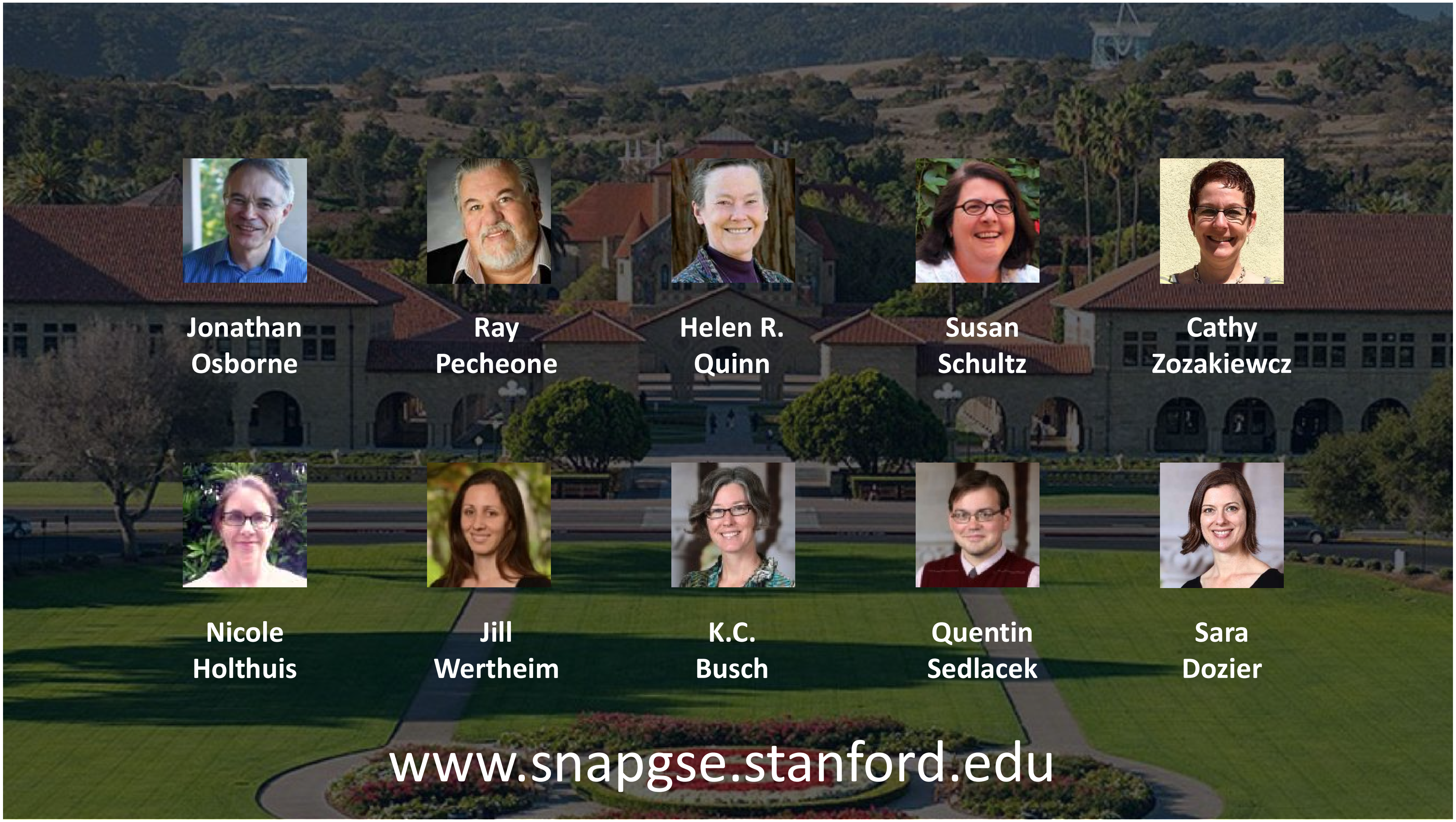
Jonathan Osborne
Ray Pecheone
Helen R. Quinn
Susan Schultz
Cathy Zozakiewcz
Nicole Holthuis
Jill Wertheim
K.C. Busch
Quentin Sedlacek
Sara Dozier
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Phases of Work

PHASE 1: RESEARCHING ITEMS AND DEVELOPING A VISION OF WHAT ASSESSMENT FOR NGSS SHOULD BE

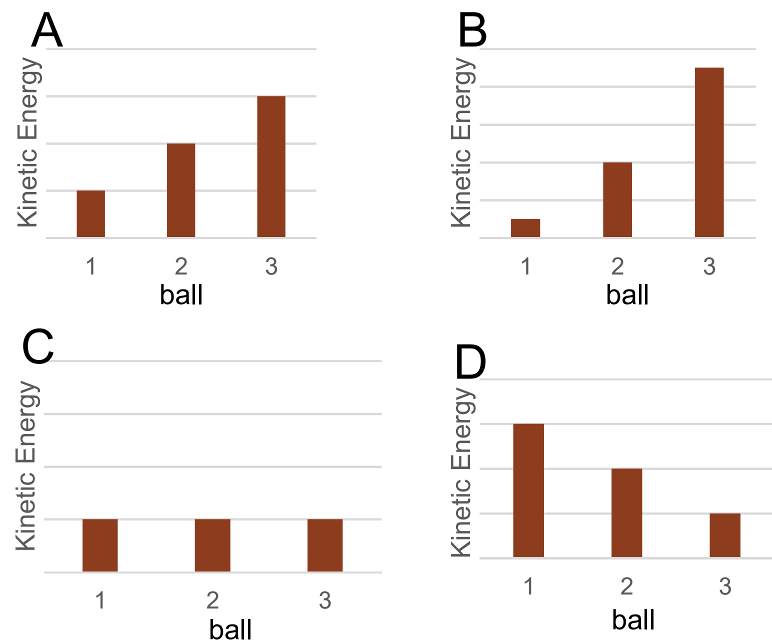
PHASE 2: DEVELOPING ITEMS, TESTING AND TRIALLING

PHASE 3: COMPLETING DEVELOPMENT AND DEVELOPING MOOCS FOR PROFESSIONAL TRAINING

Better MC Questions?

Which graph best represents the kinetic energy of the three objects represented in the table below? Use the mass and speed of each object to help you decide.

	Object 1	Object 2	Object 3
mass	0.1 kg	0.2 kg	0.3 kg
speed	2 m/s	2 m/s	2 m/s



Better MC Questions?

Jose says: "I think the Earth is shaped like a ball."

Anne says: "I think the Earth is shaped like a plate."

Consider the following observations:

a. Sidewalks are straight.

b. Roads are curved.

c. The ground under my feet feels flat.

d. Ships appear to sink as they sail far away.

Image sources:
a. http://mykography.weebly.com/uploads/1/1/0/4/11041387/6565179_orig.jpg
b. http://wtop.com/wp-content/uploads/2015/03/Travel-Trip-Road-to-Hana-1880x1251.jpeg
c. http://heathercaplan.com/realtalk/page/16/
d. http://media.mlive.com/news_impact/photo/dennis-sullivan-tall-ship-on-the-horizonjpg-affa3d8ea7f1727c.jpg

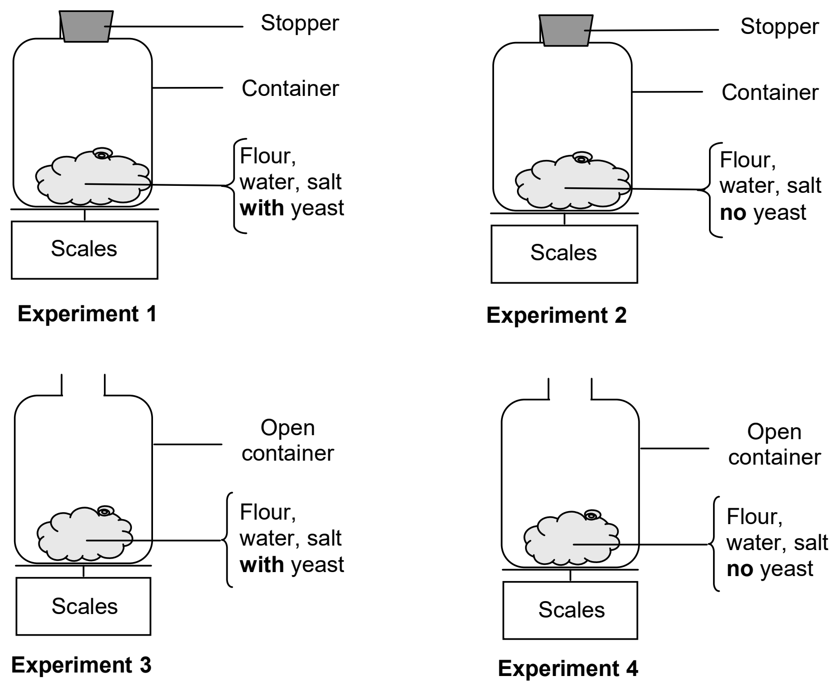
1. Which observations seem to support Jose's idea? (circle all that apply) A B C D
2. Which observations seem to support Anne's idea? (circle all that apply) A B C D
3. Who is right? (circle one) Anne or Jose

Better MC Questions?

Question 2: BREAD DOUGH *S505Q0*

A few hours after mixing the dough, the cook weighs the dough and observes that its weight has decreased.

The weight of the dough is the same at the start of each of the four experiments shown below. Which **two** experiments should the cook compare to test if the **yeast** is the cause of the loss of weight?



A The cook should compare experiments 1 and 2.
B The cook should compare experiments 1 and 3.
C The cook should compare experiments 2 and 4.
D The cook should compare experiments 3 and 4.

A man standing on the South Pole of the Earth drops a ball.

Mike thinks that the ball will move away from the Earth and

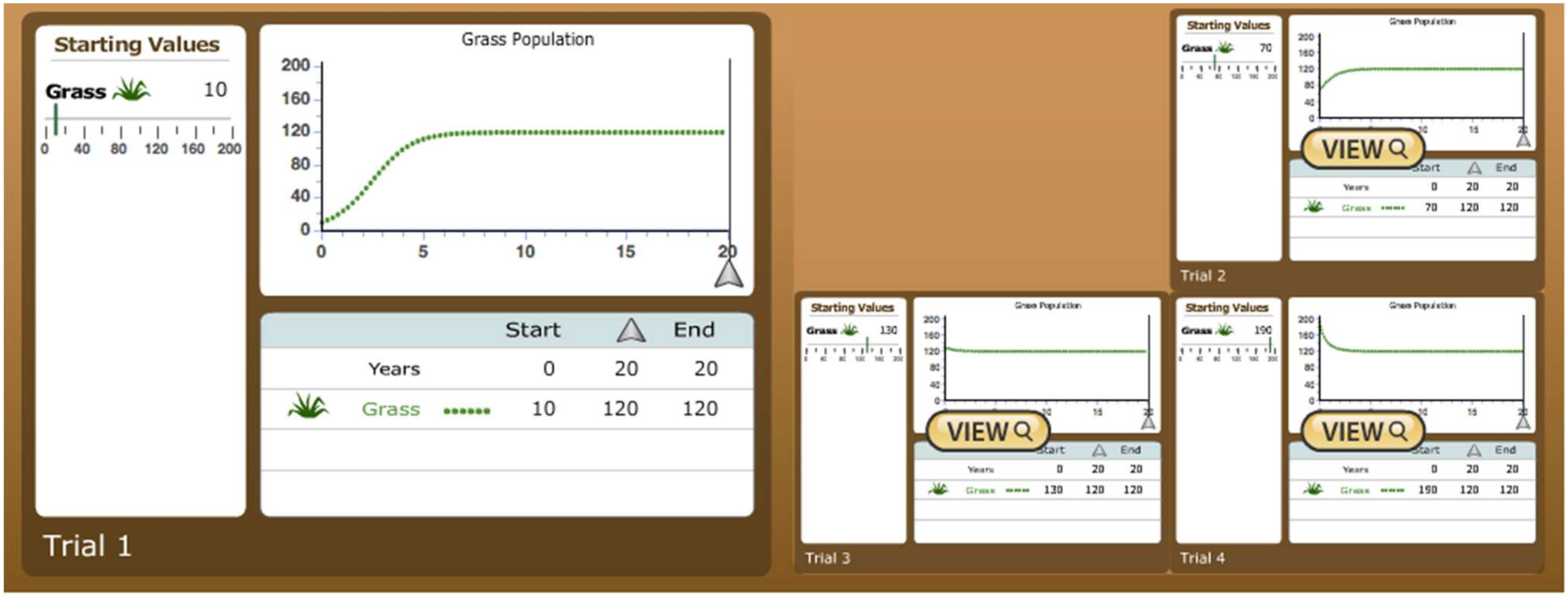
Maria thinks that the ball will move toward the Earth.

Who do you agree with? _______________ Who do you disagree with? _________________

What could you say to that person to convince them that their idea is not correc

Be sure to use evidence to support your idea.

Short performance task (20 min)



Rosa is a tour guide at the visitor center. A visitor asked if the number of grass plants would ever decrease. Rosa used the model to test different starting numbers of grass plants. Carefully analyze her results above.

According to Rosa's results, does the number of grass plants ever decrease?

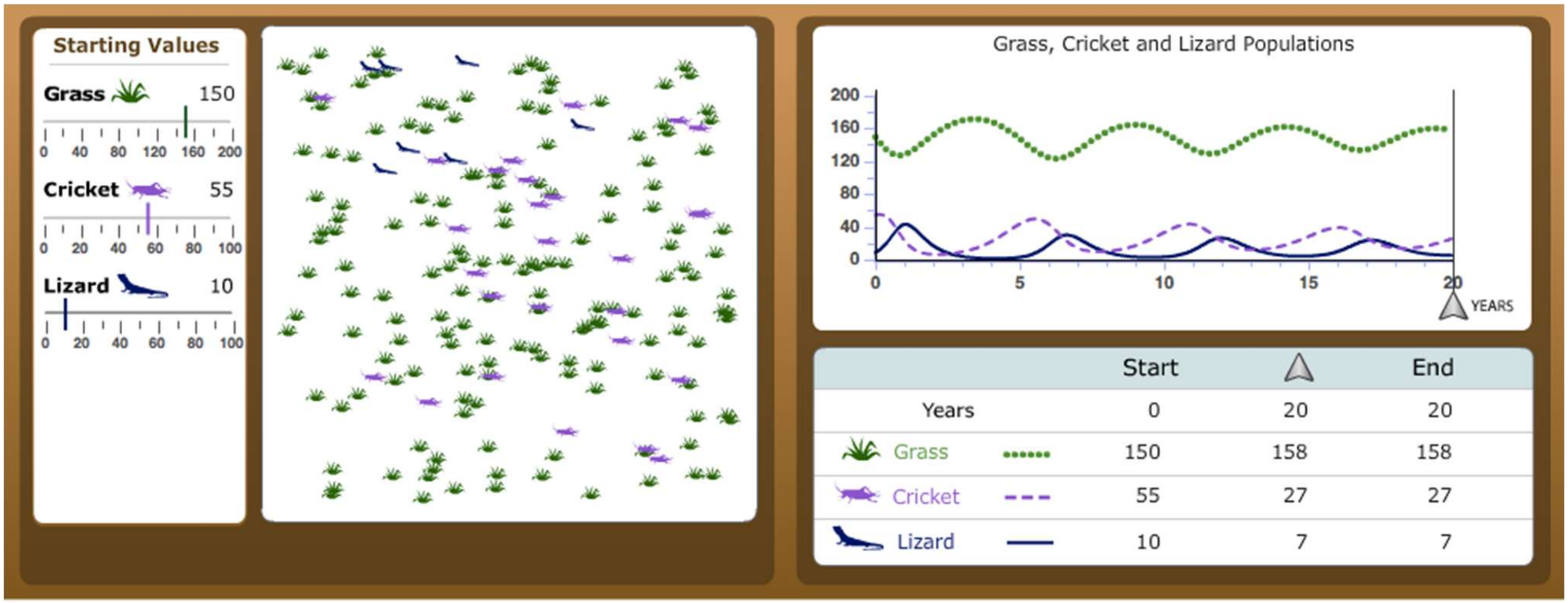
- Yes
- No
- Cannot tell from graphs

Which trial offers the strongest evidence for your answer?

- Trial 1
- Trial 2
- Trial 3
- Trial 4
- Cannot tell

From WestEd's simscientists.org

Component B



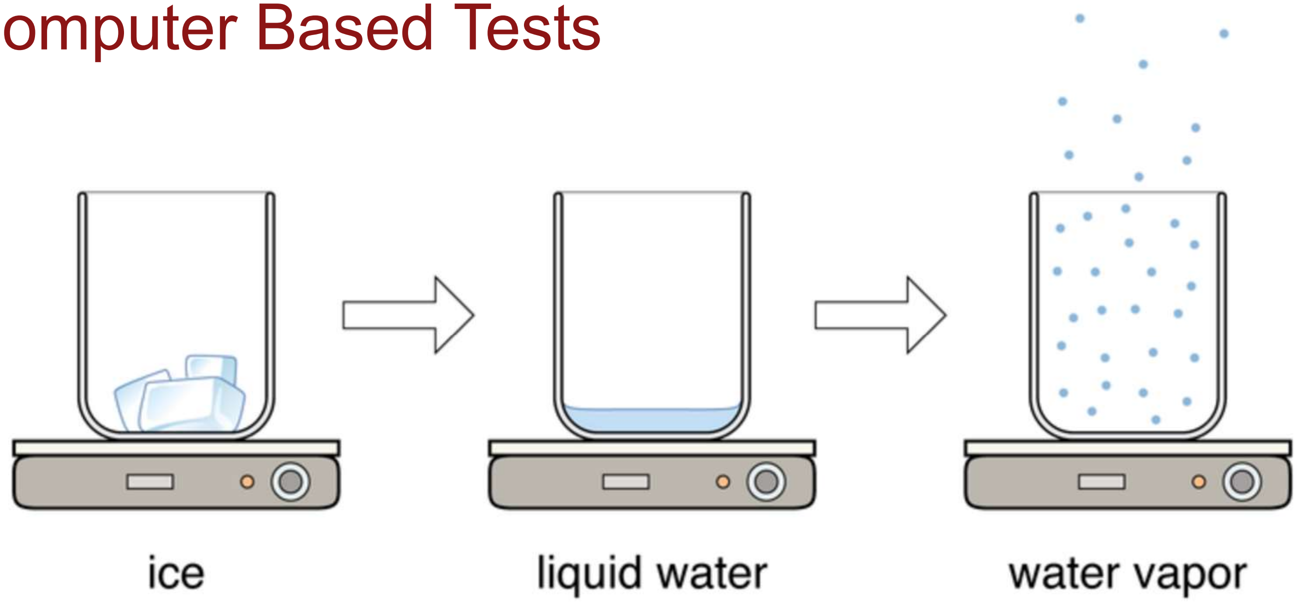
The graph shows changes in organism populations during a period of 20 years. Look carefully at the predator and prey populations between year 10 and year 11.

Which of these sentences correctly explains what is happening between year 10 and year 11?

- The prey population is low because there are so many predators eating them.
- The prey population is increasing because there are few predators eating them.
- The predator population is low because the prey population is increasing.
- The predator population is increasing because the prey population is low.

From WestEd's simscientists.org

Computer Based Tests



Evan and Anna are wondering what happens when ice in a container is heated on a hotplate for 10 minutes. The ice is -5 °C. Evan thinks that the temperature will increase like graph A. Anna thinks it will be more like graph B.

This is what Evan and Anna each say about their graphs:

Evan: The temperature in the container will increase steadily. Heat is supplied by the hot plate at a constant rate. This makes the water particles move faster. When water particles are moving fast enough they will break free and become vapor. When we heated water from 25°C to 75°C in an activity at school, the temperature increased at a constant rate. Since the heat from the hot plate is supplied at a constant rate, the temperature will continue increasing steadily.

Computer Based Tests

For Evan's argument, drag his **claim**, **evidence**, and **reasoning** into the appropriate boxes. Only drag one statement into each box.

The temperature in the container will increase steadily.

Heat is supplied by the hot plate at a constant rate.

This makes the water particles move faster.

When water particles are moving fast enough they will break free and become vapor.

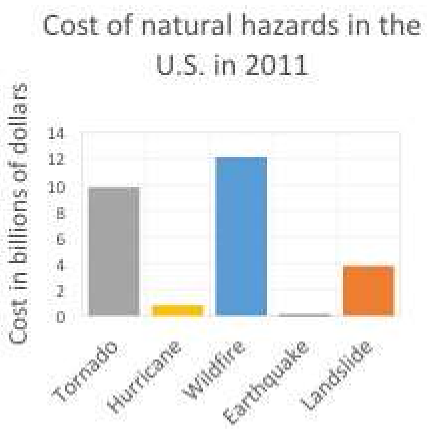
When we heated water from 25°C to 75°C in an activity at school, the temperature increased at a constant rate.

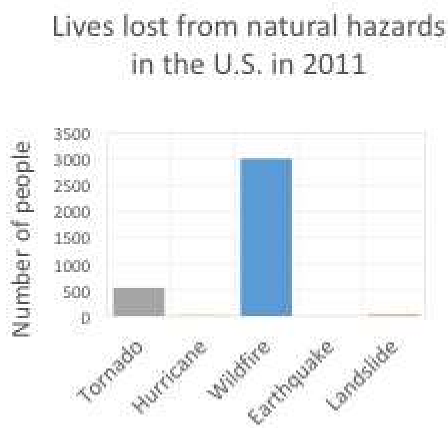
Since the heat from the hot plate is supplied at a constant rate, the temperature will continue increasing steadily.

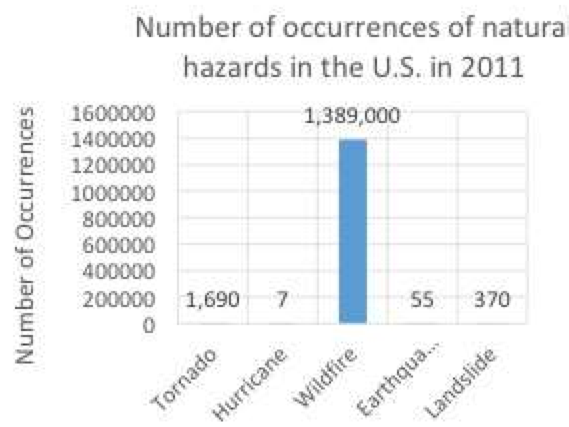
Claim	Evidence	Reasoning

PISA 2015 SCIENCE SIMULATIONS

Sample Short Performance Assessment (20-30 mins)

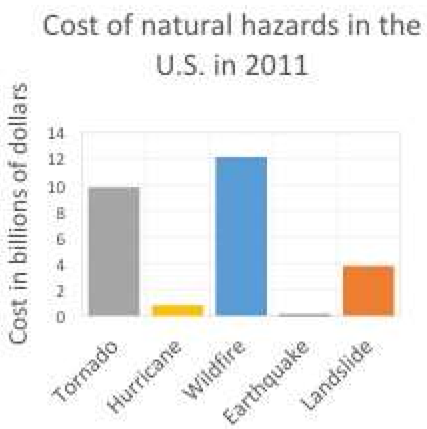


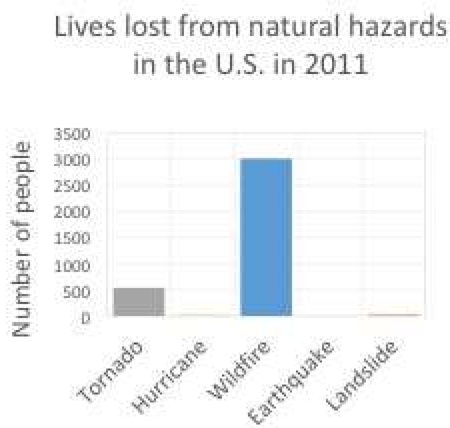


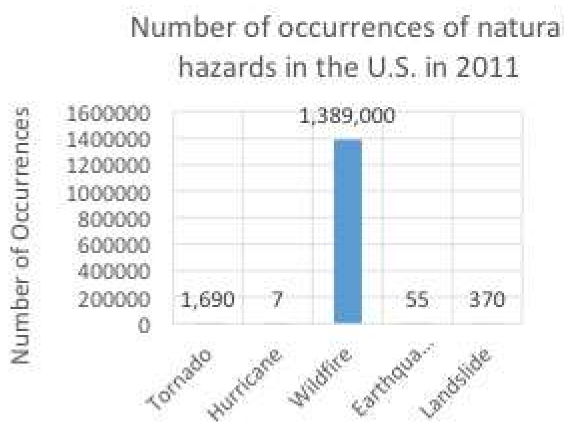


In this task, students help a city use data to inform an emergency plan for natural hazards.

Sample Short Performance Assessment



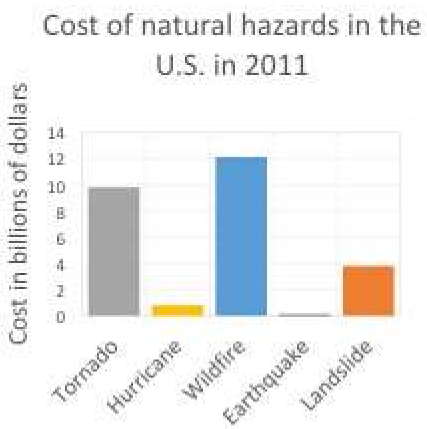


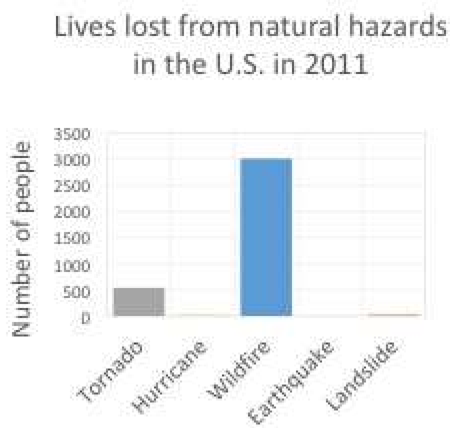


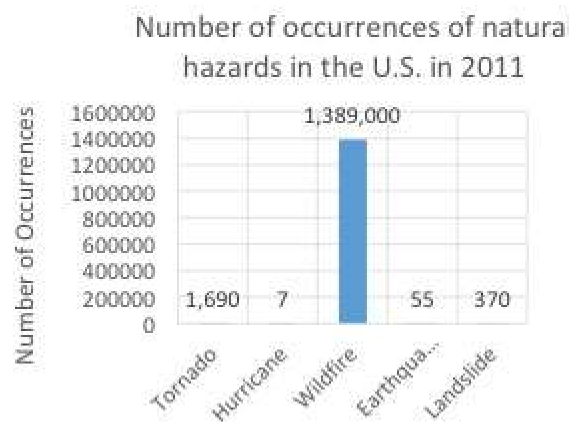
To complete this task, students:

- Analyze data across multiple graphs
- Use what they know about each hazard to interpret the significance of the graphs
- Identify limitations in the data for addressing the problem
- Use what they know about patterns in natural hazards to make a prediction about future hazards

Sample Short Performance Assessment







For example:

Question 4. You have found that you need to know a lot more about the data than what is shown in the three graphs.

Describe additional information about the data in the graphs that city leaders would need before they could use the data to make decisions. Explain why leaders would need that information.

WHAT STUDENTS THINK

Analyze the 3-dimensions of a performance assessment

01

Examine and decide which of the 3-dimensions of the Performance Expectation are being assessed

02

Gather more information from the Framework and Standards about the dimension being assessed.

03

Identify the components of each dimension that are being assessed

Students who demonstrate understanding can:

Performance Expectations

> Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. **5-LS2-1**

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

Developing and Using Models

Modeling in 3–5 builds on K–2 models and progresses to building and revising simple models and using models to represent events and design solutions.

Develop a model to describe phenomena.

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.

Crosscutting Concepts

Systems and System Models

A system can be described in terms of its components and their interactions.

5 Barbara,

I like how only one section is highlighted at a time. Is it possible to lighten the grayed out sections even more so that the section highlighted is even more noticable? This would be the case fo this slide and the next 3 slides.

Also, the color coding here (and on the next 3 slides) is off. Practices = orange, Core ideas = blue, Crosscutting concepts = green
KC Busch, 4/16/2017

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Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 models and progresses to building and revising simple models and using models to represent events and design solutions. ✓ Develop a model to describe phenomena.	**LS2.A: Interdependent Relationships in Ecosystems** The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.	**Systems and System Models** A system can be described in terms of its components and their interactions.

Slide 44

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Science and Engineering Practices

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

SNAP
Stanford NGSS Assessment Project

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems
The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the

Crosscutting Concepts

Systems and System Models
A system can be described in terms of its components and their interactions.

5 Barbara,

I like how only one section is highlighted at a time. Is it possible to lighten the grayed out sections even more so that the section highlighted is even more noticable? This would be the case fo this slide and the next 3 slides.

Also, the color coding here (and on the next 3 slides) is off. Practices = orange, Core ideas = blue, Crosscutting concepts = green
KC Busch, 4/16/2017

Students who demonstrate understanding can:

Performance Expectations

> Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. MS-ESS3-2

Clarification Statement and Assessment Boundary

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
Analyzing and Interpreting Data Analyzing data in 6-8 builds on K-5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis ✓ Analyze and interpret data to determine similarities and difference in findings.	ESS3.B: Natural Hazards Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.	Patterns Graphs, charts, and images can be used to identify patterns in data. Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World ✓ The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

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Slide 46

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KC Busch, 4/16/2017

Students who demonstrate understanding can:

Performance Expectations

> Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]

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Slide 47

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KC Busch, 4/16/2017

Analyze the 3-dimensions of a performance assessment

01

Examine and decide which of the 3-dimensions of the Performance Expectation are being assessed

02

Gather more information from the Framework and Standards about the dimension being assessed.

03

Identify the components of each dimension that are being assessed

Practice: Analyzing and Interpreting Data– From NGSS Appendix F

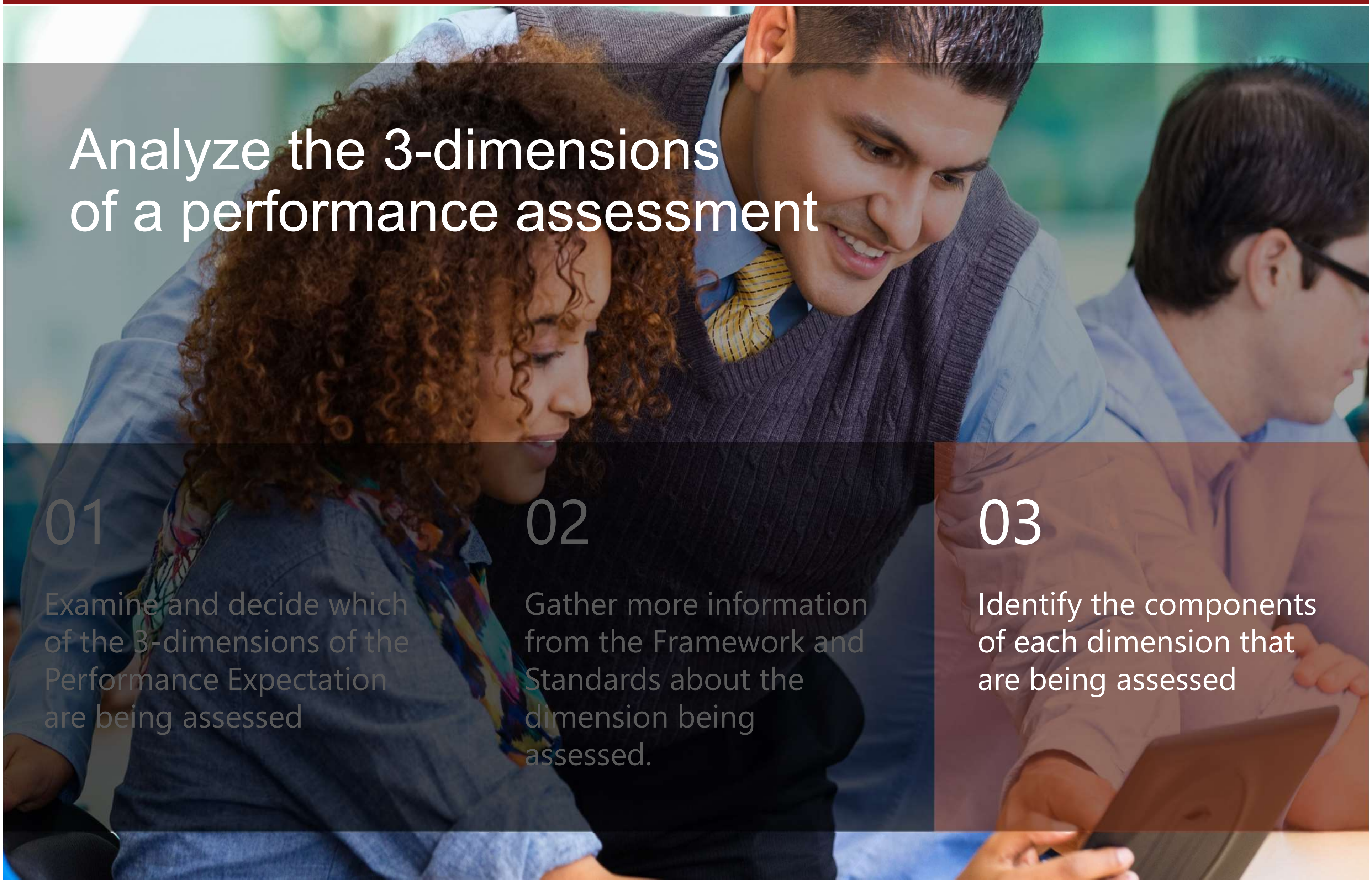
Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious scientists use a range of tools – including tabulation, graphical interpretation, visualization, and statistical analysis – to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier; providing secondary sources for analysis.

Primary School (K-2)	Elementary School (3-5)	Middle School (6-8)	High School (9-12)
Record information (observations, thoughts, and ideas). Use and share pictures, drawings, and/or writings of observations. Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. Compare predictions (based on prior experiences) to what occurred (observable events). Analyze data from tests of an object or tool to determine if it works as intended	Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships. Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings. Analyze data to refine a problem statement or the design of a proposed object, tool, or process. Use data to evaluate and refine design solutions.	Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. Use graphical displays (e.g., maps, charts graphs, and/or tables) of large data sets to identify temporal and spatial relationships. Distinguish between causal and correlational relationships. Analyze and interpret data to provide evidence for phenomena. **Analyze and interpret data to find similarities and differences.** Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible. Consider limitations of data analysis (e.g., measurement error) and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials).	Analyze data using tools, technologies, and/or models (e.g., computational, mathematics) in order to make valid and reliable scientific claims or determine an optimal design solution. Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. Analyze data to identify design features or

DCI:Interdependent Relationships in Ecosystems. From NGSS Appendix E & the Framework

ESS3.B: Natural Hazards			
Primary School (K-2)	Elementary School	Middle School	High School (9-12)
Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events	A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts.	**Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.**	Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)
		8th Grade Endpoint: Some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions. Others, such as earthquakes, occur suddenly and with no notice, and thus they are not yet predictable. However, mapping the history of natural hazards in a region, combined with an understanding of related geological forces can help forecast the locations and likelihoods of future events.	

CCC: Systems and System Models– From in NGSS Appendix G			
Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.			
Primary School (K-2)	Elementary School	Middle School (6-8)	High School (9-12)
Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.	Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products. Patterns of change can be used to make predictions. Patterns can be used as evidence to support an explanation.	Macroscopic patterns are related to the nature of microscopic and atomic-level structure. **Graphs, charts, and images can be used to identify patterns in data.** Patterns in rates of change and other numerical relationships can provide information about natural systems. Patterns can be used to identify cause-and-effect relationships.	Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. Empirical evidence is needed to identify patterns. Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments. Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system. Mathematical representations are needed to identify some patterns.



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How can we use performance outcomes to help us decide which part of a PE a task is assessing?

Part C: Design your Biosphere:
Based on your research about Mars and your review of the parts of an ecosystem, identify what needs to be included in the biosphere you design.

Questions to Ask:

- What are the non-living (abiotic) things that you need in your biosphere?
- What are the living (biotic) things that you need in your biosphere?
- How do the biotic and abiotic things work together in your biosphere?
- How is matter recycled in your biosphere?
- **Describe how all of these parts of the ecosystem work together interacting components of a system**
- How does your biosphere meet all the needs for human life?

Performance Outcome: Describe how an ecosystem functions as a system, including describing the components of the system and how they interact.

SNAP's free hybrid online/face-to-face courses about performance assessment Fall, 2017

Course 1: Performance Assessment in the NGSS Classroom: Implications for Practice

Online: 4 sessions provide instruction about using short performance assessments to support NGSS teaching and learning

Individual

Face-to-face: 2 sessions for collaborative completion of the assignments and discussion

With a group of colleagues

Course runs Oct 30 – Dec 31
Approximately 10 hrs

See the SNAP website for more information or to register today!
snapgse.stanford.edu

SNAP's free hybrid online/face-to-face courses about performance assessment Fall, 2017

Course 2: Developing Performance Assessments for the NGSS Classroom

Online: 3 sessions provide instruction about developing instructionally-embedded assessments

Teams of 2-3 collaboratively develop an assessment while watching the videos

Face-to-face: 2 sessions for peer feedback

2 or more development teams provide feedback to each other on assessment-in-progress

Course runs Nov. 15 – Jan 30
Approximately 20 hrs (highly variable)

See the SNAP website for more information or to register today!
snapgse.stanford.edu