

# Preparing Teachers to Support Three-Dimensional Science and Engineering Learning

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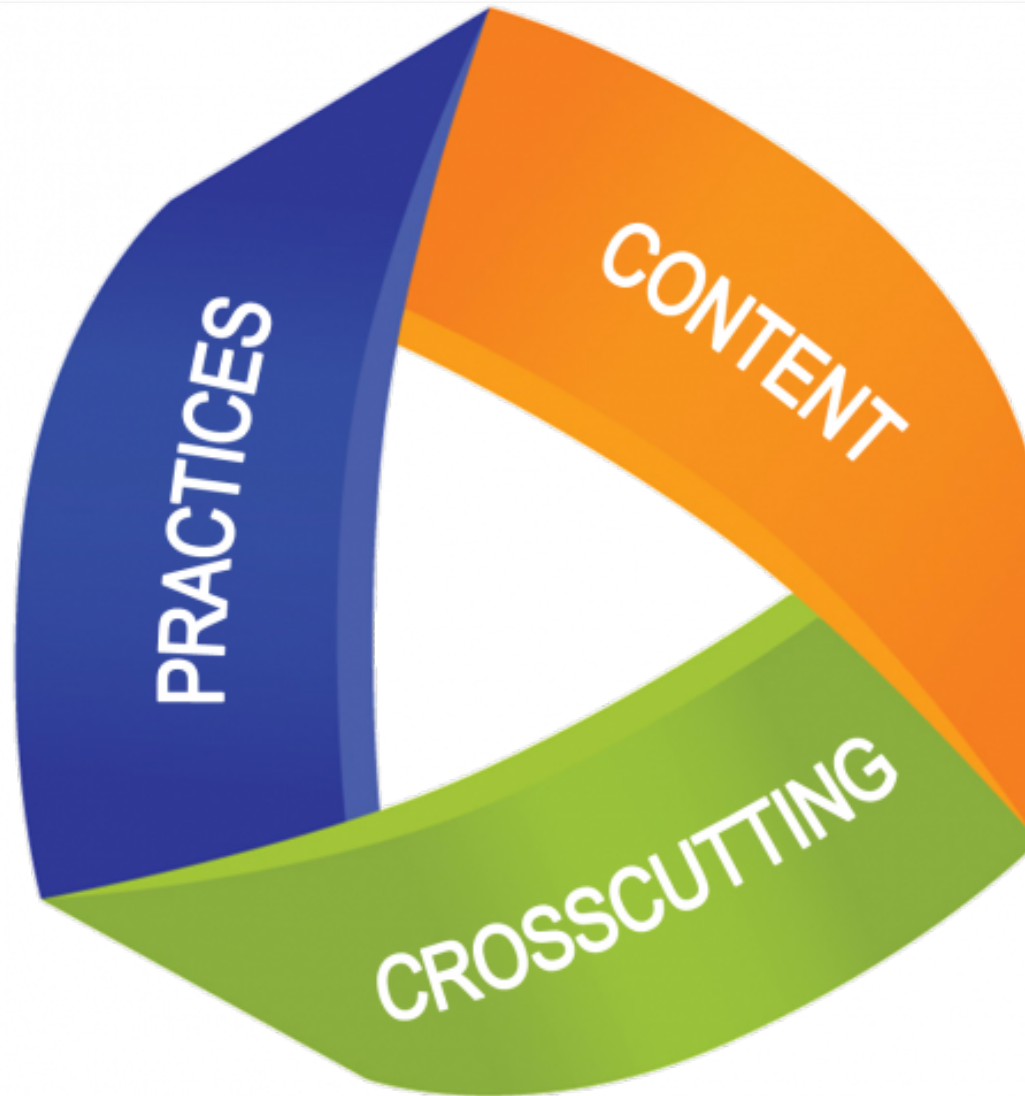
*University of Colorado Boulder*

Presentation at "Sharing the Adventure with the Student: Exploring the  
Intersections of NASA Space Science and Education, A Workshop"

National Academy of Sciences, December 2014

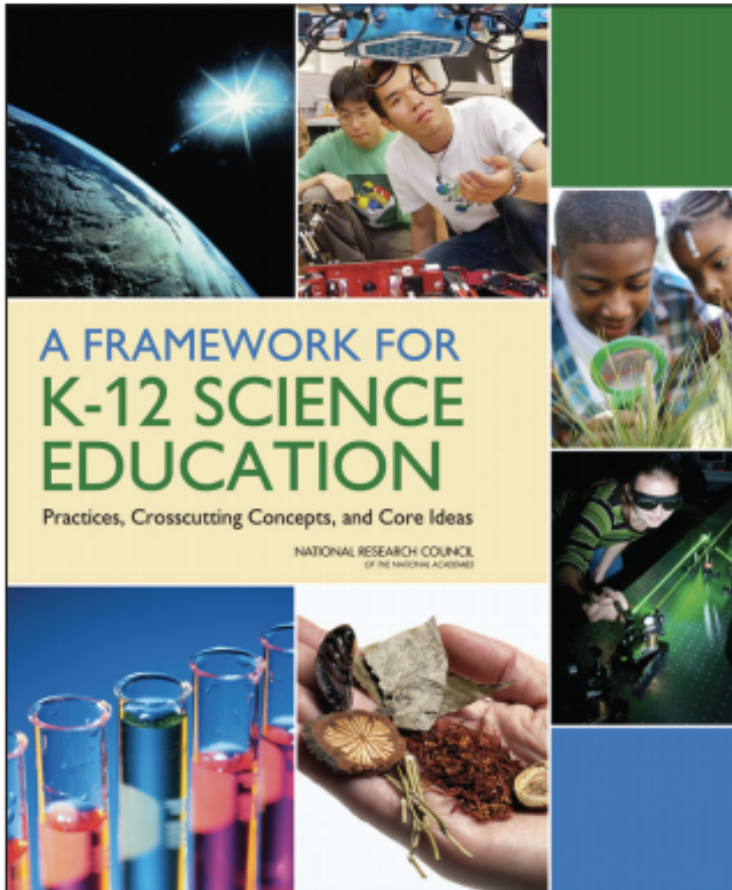
# Defining "3D Learning"

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# Framing the Challenge

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“Alignment of teacher preparation and professional development with the vision of science education advanced in this framework is essential for eventual widespread implementation of the type of instruction that will be needed for students to achieve the standards based on it.” (NRC, 2012, p. 256)

# Instructional Shifts: *Framework*

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- Students need opportunities to learn that:
  - Help them develop understanding of disciplinary core ideas and make connections to crosscutting concepts
  - Engage them in scientific and engineering practices
  - Support the development of their identities as learners of science

# Teachers' Struggles with Shifts

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- Integrating core ideas and practices in instruction is not easy.
  - Strong belief that practices are “just” the scientific method.
- Teachers remain skeptical about making shifts without the right curriculum materials and new assessments.
  - Available materials either do not integrate all practices (e.g., commercial textbooks) or focus on single activities (e.g., Internet).

# Current Conditions

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- Few publishers or funders are making large investments in new curriculum materials.
- Competing initiatives in districts draw science teachers away from investing in their own learning.
- PD providers are diverse, and coordination mechanisms are few and weak.

# Strategy 1: Focus on the Framework

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<b>What Is It</b>	Teachers spend time reading, discussing, and developing shared understanding of key ideas in the Framework with others in their local community
<b>Shift Supported</b>	Focusing on a few disciplinary core ideas and crosscutting concepts Engaging students in scientific and engineering practices
<b>Challenge/Condition Addressed</b>	Limited time for formal professional development

# Developing “Evidence Statements”

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- Provides an opportunity for teachers to discuss and make sense of shifts in the *Framework*
- Highlights differences and provides opportunities for developing shared meanings in a teacher community

<p>3. Identify the evidence that you would expect to see for each component of the practice.</p> <p><b>Questions to think about:</b> <i>What is a high level of performance that you would expect to see for each component?</i></p> <p><i>What are the different levels of performance for each component?</i></p>	<p><b>Evidence for each Component of the Practice</b></p>
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**Questions to think about:**

*What is a high level of performance that you would expect to see for each component?*

*What are the different levels of performance for each component?*

## Complex Systems in Education: Scientific and Educational Importance and Implications for the Learning Sciences

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The multidisciplinary study of complex systems in the physical and social sciences over the past quarter of a century has led to the articulation of important new conceptual perspectives and methodologies that are of value both to researchers in these fields as well as to professionals, policymakers, and citizens who must deal with challenging social and global problems in the 21st century. The main goals of this article are to (a) argue for the importance of learning these ideas at the precollege and college levels; (b) discuss the significant challenges inherent in learning complex systems knowledge from the standpoint of learning sciences theory and research; (c) discuss the “learnability issue” of complex systems conceptual perspectives and re-

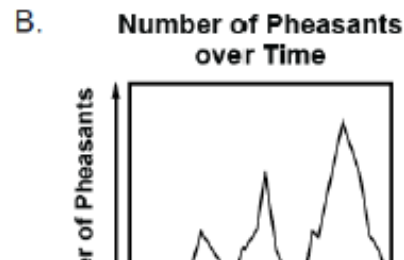
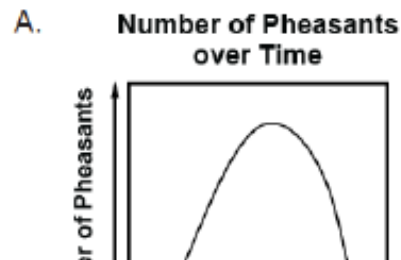
**Research on  
learning is relevant  
to activity of  
unpacking.**

# Analyzing Assessment Tasks

## TASK 4

Scientists introduce ten male pheasants and thirty female pheasants to an island on which pheasants have not previously lived. The island has a natural food source and no predators of pheasants.

Which graph best predicts the number of pheasants on the island 50 years after their introduction to the island?



## TASK 5

\_\_\_\_\_ is the total number of individuals the environment can support over an indefinite period of time.

### HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

**HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.** [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.]

# Strategy 2: Co-Design Curriculum with Teachers

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<b>What Is It</b>	Teachers collaboratively design coherent sequences of curriculum with scientists, curriculum experts, and learning scientists
<b>Shift Supported</b>	Focusing on a few disciplinary core ideas and crosscutting concepts Engaging students in scientific and engineering practices
<b>Challenge/Condition Addressed</b>	Lack of curriculum materials

# Re-Designing the Biology Curriculum

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- We are collaboratively re-designing the biology curriculum, one unit at a time, beginning with ecosystems.
- Our partners include:
  - Denver Public Schools secondary science teachers
  - Denver Public Schools curriculum supervisors
  - CU researchers
  - UCAR software engineers
  - A BSCS curriculum developers
  - Community advisors and scientists



# Organization of Workshop

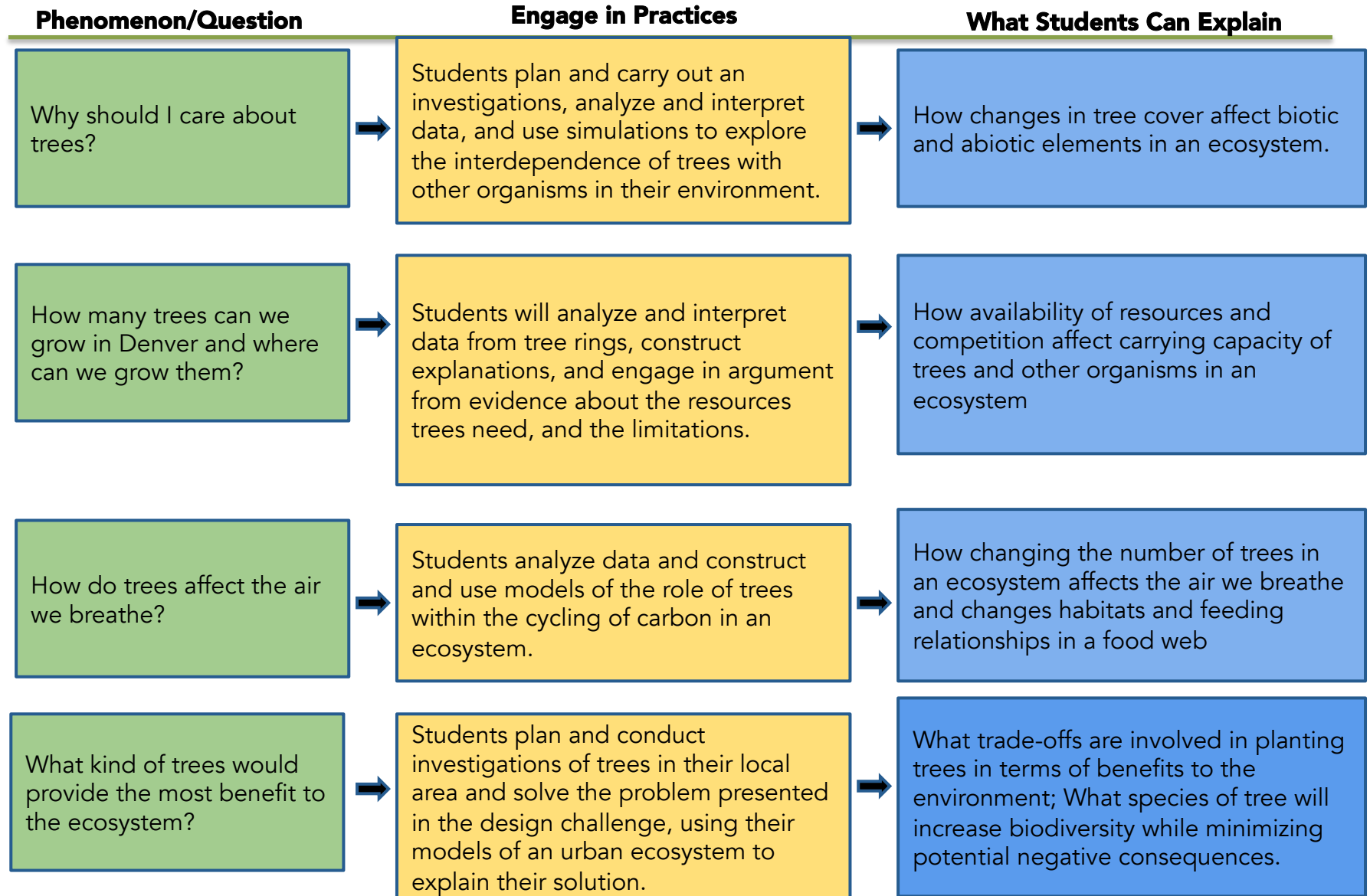
	Wednesday	Thursday	Friday	Monday	Tuesday
Morning	Learning about the <i>Framework</i>  Unpacking HS-LS2	Brainstorming Phenomena  Developing initial unit structure	Revisiting unit structure  Reviewing relevant resources	Revisiting unit structure  Reviewing relevant resources	Lesson design in small groups
Afternoon	Developing a web of concepts	Identifying three-dimensional assessment tasks	Lesson design in small groups  Reconvene, review structure	Lesson design in small groups  Reconvene, review structure	Planning for ongoing work and for unit enactment

**Structured Learning Time about *Framework* and NGSS**

**Structured Feedback Related to Coherence**

**Design Challenge: What kinds of trees should we plant and where to increase biodiversity and maximize benefits to human beings and other organisms?**

Human beings are disrupting the ecosystem in cities by planting trees, with the intention of enhancing the benefits to human beings and other organisms.



# Strategy 3: Formative Assessment about Student Interest & Experience

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**What Is It**

Teachers elicit student experiences and interests related to a phenomenon they will be investigating and adapt instruction accordingly to enable students to pose and answer their own questions.

**Shift Supported**

Supporting the development of their identities as learners of science

**Challenge/Condition Addressed**

Lack of curriculum materials

# *Micros and Me*

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- Curricular aim: Exploring personally consequential biology
- Assessment strategy: Use technique of photo-elicitation to bring young people's everyday practices into the classroom: *What do you do to stay healthy and protect yourself from disease?*
- Students' responses become basis for their own questions in the unit





# Some Implications for NASA

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- Support teacher sensemaking to relate resources to ideas in the *Framework*
- Shift from being a producer to a partner and connector
- Develop tools that can help teachers identify relevant interests to available resources

# Professional Learning Framework

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- An initiative of the Council of State Science Supervisors' Professional Learning Committee
- Charge of Committee:
  - to identify professional learning needs of CSSS members and coordinating professional learning activities that addresses these needs
  - to provide information to CSSS members on best professional development models being used throughout the country
  - to open lines of communication between in-service and pre-service providers and CSSS state members.
- Committee is state-led, includes research support

# Crafting Coherence Among States

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- There are many professional development providers across the states, operating largely independently of one another.
- An updated set of *professional learning standards for science education* can provide:
  - Guidance to providers, educational leaders, and teachers regarding professional development.
  - Foundation for a network of professional development activities to emerge that aligns with the vision of the *Framework*

# Starting Small...

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# Thank You

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