Preparing Teachers to Support Three-Dimensional Science and Engineering Learning

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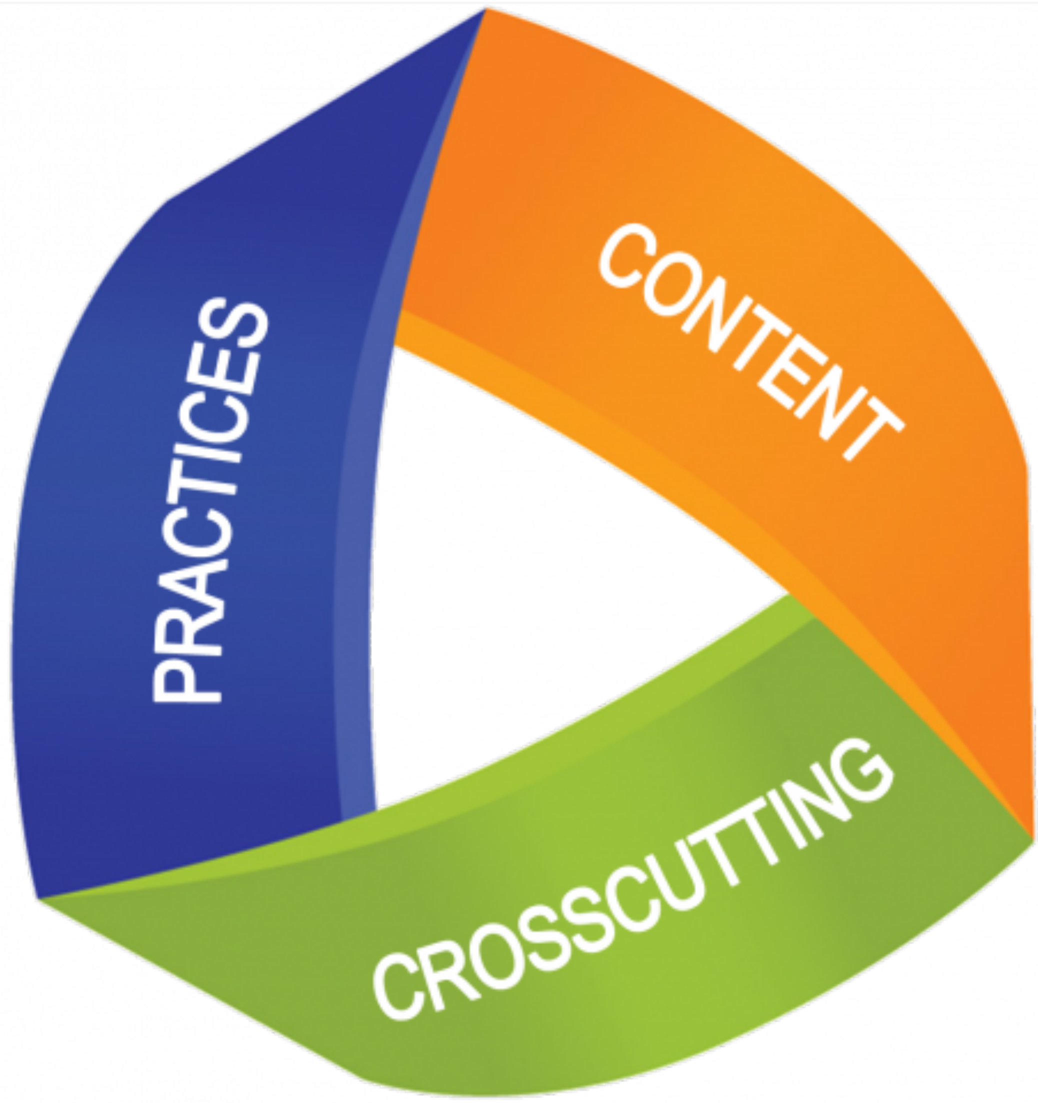
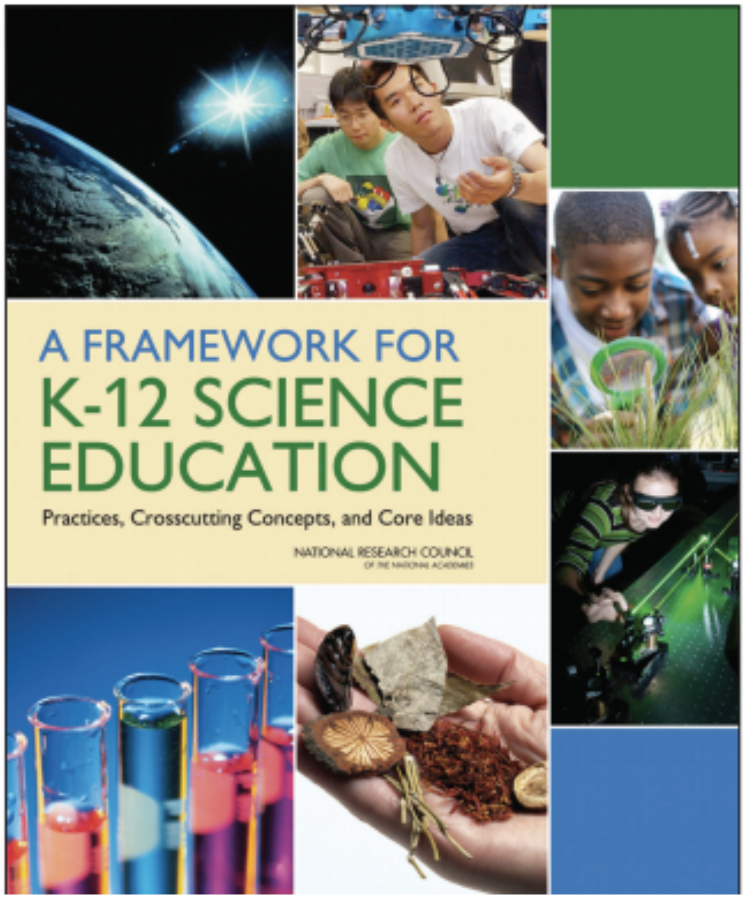
Defining "3D Learning"



Framing the Challenge



"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*

- 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

- 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

- 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*

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

Developing "Evidence Statements"

- 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

3. Identify the evidence that you would expect to see for each component of the practice. ***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?*	**Evidence for each Component of the Practice**

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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.

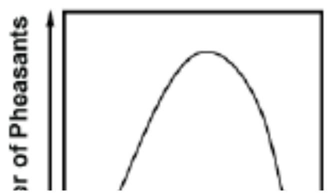
Analyzing Assessment Tasks

TASK 4

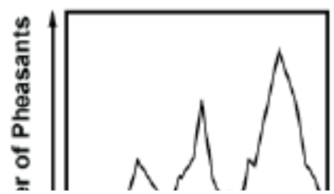
Scientists introduce ten male pheasants and thirty female pheasants to an island on which pheasants have not previously lived. The island has a natural food source and no predators of pheasants.

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

A. **Number of Pheasants over Time**



B. **Number of Pheasants over Time**



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

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

Re-Designing the Biology Curriculum

- 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 *Framework* 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.

Phenomenon/Question	Engage in Practices	What Students Can Explain
Why should I care about trees?	Students plan and carry out an investigations, analyze and interpret data, and use simulations to explore the interdependence of trees with other organisms in their environment.	How changes in tree cover affect biotic and abiotic elements in an ecosystem.
How many trees can we grow in Denver and where can we grow them?	Students will analyze and interpret data from tree rings, construct explanations, and engage in argument from evidence about the resources trees need, and the limitations.	How availability of resources and competition affect carrying capacity of trees and other organisms in an ecosystem
How do trees affect the air we breathe?	Students analyze data and construct and use models of the role of trees within the cycling of carbon in an ecosystem.	How changing the number of trees in an ecosystem affects the air we breathe and changes habitats and feeding relationships in a food web
What kind of trees would provide the most benefit to the ecosystem?	Students plan and conduct investigations of trees in their local area and solve the problem presented in the design challenge, using their models of an urban ecosystem to explain their solution.	What trade-offs are involved in planting trees in terms of benefits to the environment; What species of tree will increase biodiversity while minimizing potential negative consequences.

Strategy 3: Formative Assessment about Student Interest & Experience

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

- 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

Professional Learning Framework

- 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

- 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...

Thank You

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Research+Practice Collaboratory:

http://researchandpractice.org