A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas

Overview of the Framework

Developed by

The Council of State Science Supervisors

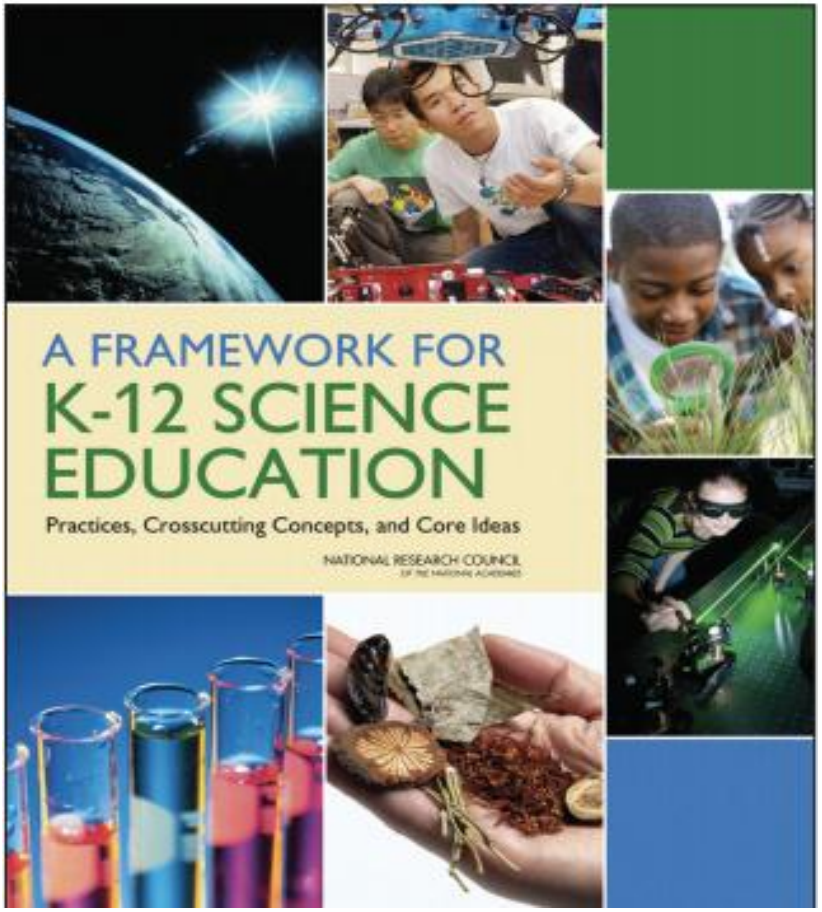
Science Education for a New Generation

Produced by the Council of State Science Supervisors www.csss-science.org

Objectives

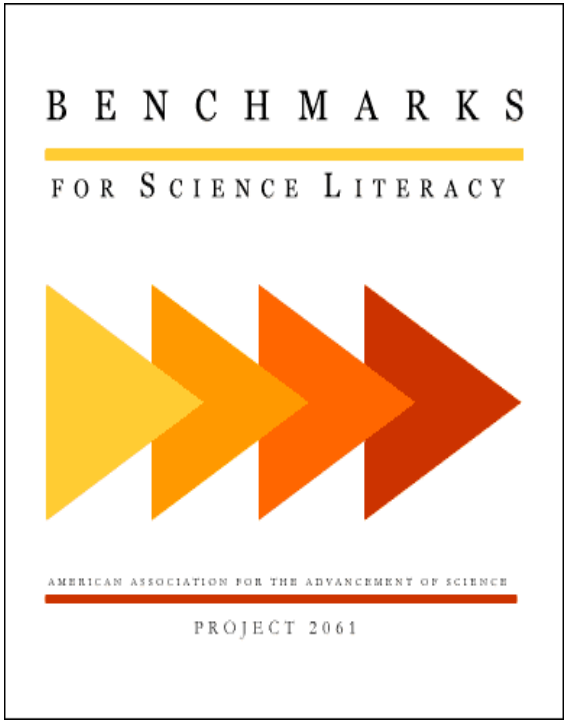
1. Investigate The National Research Council's (NRC) Framework on Science Education
2. Understand the Three Key Dimensions of the NRC Framework: Science and Engineering Practices, Crosscutting Concepts, Core Ideas
3. Investigate the Implications for Science Education
4. Relationship to Next Generation Science Standards
5. Discussion

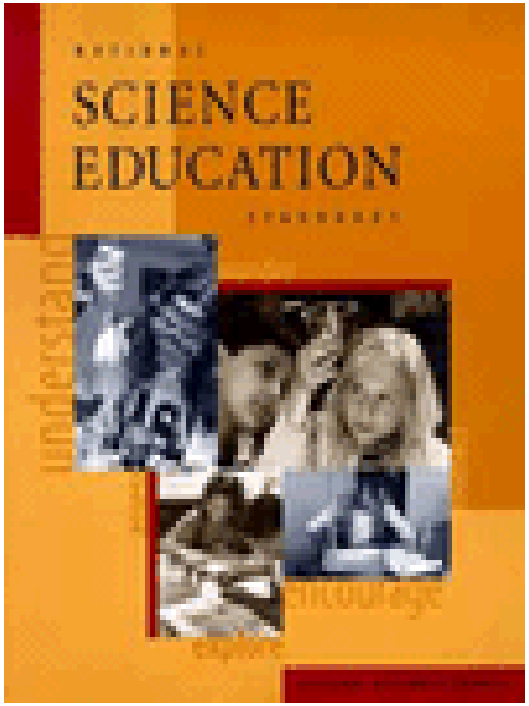
The Framework has a New Vision of Science Learning that Leads to a New Vision of Teaching

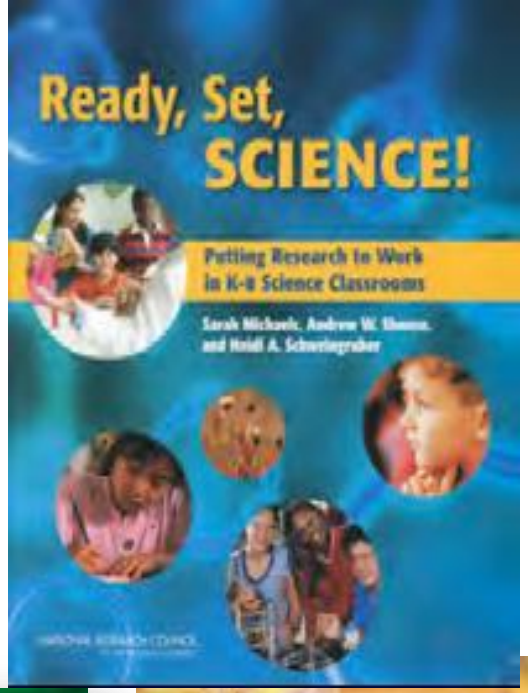


Vision for Science Education

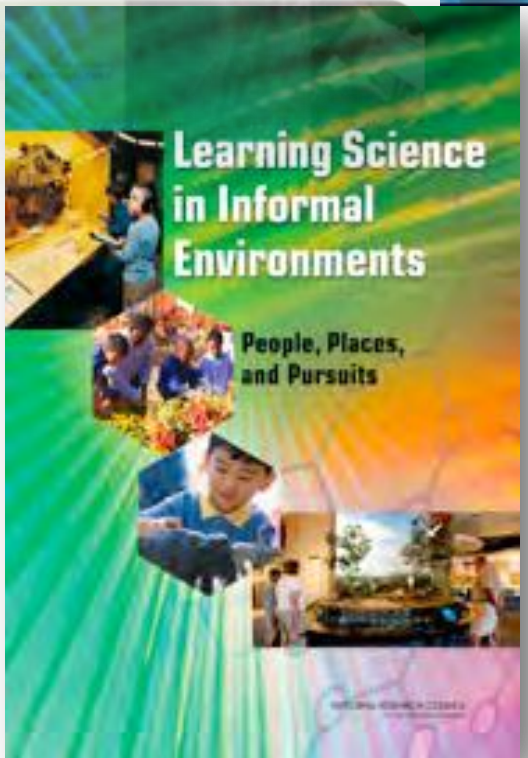
Builds on existing national science education efforts

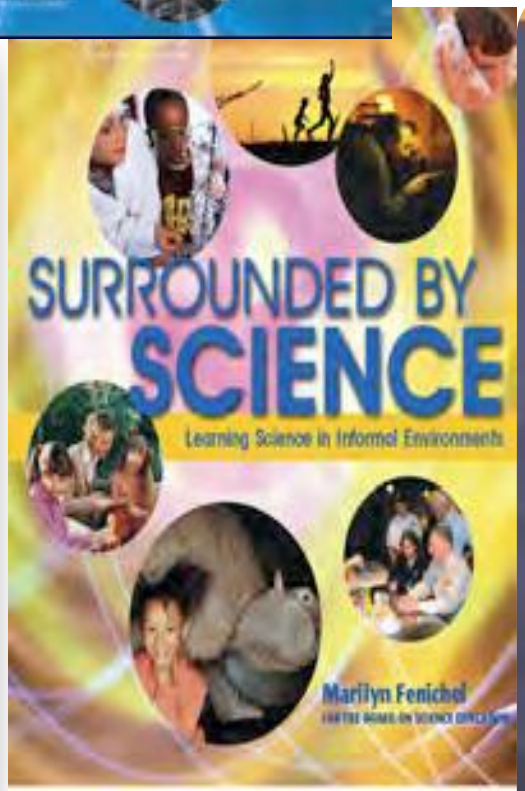


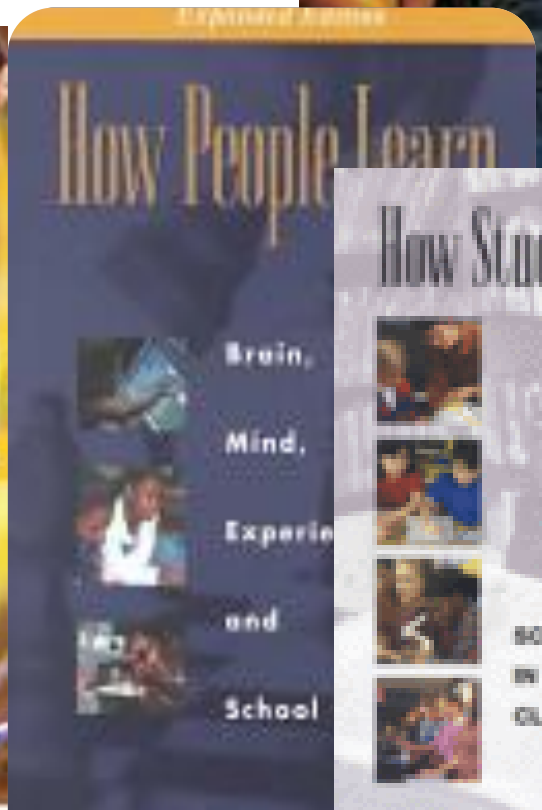


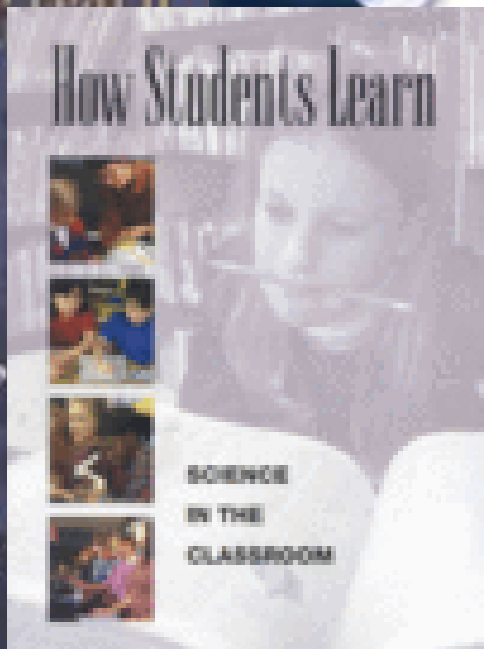


The Framework builds on the NRC research supported reports









Framework Goals and Purpose

1. Framework Purpose
    a. Provide a Clear Vision for Science Education
    b. Inform Standards Development
2. Goals of the Framework
3. Goals for Science Education

A Framework for K-12 Science Education:
Practices, Crosscutting Concepts, and Core Ideas

What's in a name?

The three dimensions are the distinguishing feature of the new Framework and this is reflected in the title.

What is the purpose of the Framework?

The document represents the first step in a process for creating a new vision for science education and new standards in K-12 science education. This project capitalizes on a unique opportunity that exists at this moment—a large number of states are adopting common standards in mathematics and English/Language Arts and appear to be poised to consider adoption of common standards in K-12 science education.

Framework – Forward ix

Vision

Students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of each fields' disciplinary core ideas.

Framework Page 8

The Framework is built on the notion of learning as a developmental progression. It is designed to help children continually build on and revise their knowledge and abilities, starting from their curiosity about what they see around them and their initial conceptions about how the world works.

Framework Page 10

Framework Goals and Purpose

1. Framework Purpose
2. Goals of the Framework
    a. Support a cohesive science education system nationwide
    b. Provide guidance to improve teaching and learning
3. Goals for Science Education

Framework Goals

- The Framework is motivated in part by a growing national consensus around the need for **greater coherence**—that is, a sense of unity—in K-12 science education.
- Develop students' understanding of the practices of science and engineering, which is as important to understanding science as is knowledge of its content.
- The Framework endeavors to move science education toward a more coherent vision in three ways:

  First – It is built on the notion of **learning as a developmental progression**.

  Second – The expectation is that students **engage in scientific investigations and argumentation** to achieve deeper understanding of core science ideas.

  Third – The Framework emphasizes that learning science and engineering involves integration of the knowledge of scientific explanations (i.e., content knowledge) and the practices needed to engage in scientific inquiry and engineering design. Thus, the Framework seeks to illustrate how **knowledge and practice must be intertwined** in designing learning experiences in K-12 science education.

  Framework Pages 10-11

Framework Goals and Purpose

1. Framework Purpose
2. Goals of the Framework
3. Goals for Science Education

Goals for Science Education

The Framework's vision takes into account two major goals for K-12 science education:

(1) Educating **all students** in science and engineering.

(2) Providing the **foundational knowledge** for those who will become the scientists, engineers, technologists, and technicians of the future.

Framework Page 10

Goals for Science Education

All students will:

- Understand science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge. Both elements—knowledge and practice—are essential.
- Value and use science as a process of obtaining knowledge based upon observable evidence.

The Framework is consistent with the Common Core State Standards for Literacy

All students will gain skills to:

- Communicate effectively using science language and reasoning.
- Use writing as a tool for learning.
- Use writing as a tool to communicate ideas; write for a variety of purposes and audiences.

CCSS Literacy Standards

Standards from the Framework

- One of the goals of the Framework is to **provide guidance** for the development of Standards.
- The Next Generation Science Standards (NGSS) are being developed using the guidance provided in the Framework.
- The NGSS will be subjected to review by the NRC to determine fidelity to the Framework.

Dimensions of the Framework

1. Scientific and Engineering Practices

2. Crosscutting Concepts

3. Disciplinary Core Ideas

Dimension 1: Science and Engineering Practices

1. Asking Questions (Science) and Defining Problems (Engineering)
2. Developing and Using Models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematics and Computational Thinking
6. Constructing Explanations (Science) and Designing Solutions (Engineering)
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information

Science and Engineering Require Both Knowledge and Practice

Science is **not just** a **body of knowledge** that reflects current understanding of the world; it is **also** a set of **practices** used to establish, extend, and refine that knowledge. Both elements—**knowledge and practice**—are essential. In science, knowledge, based on evidence from many investigations, is integrated into highly developed and well-tested theories that can explain bodies of data and predict outcomes of further investigations.

Chief among these features is a commitment to data and **evidence** as the foundation for developing claims. The argumentation and analysis that relates evidence and theory are also essential features of science; scientists need to be able to examine, review, and evaluate their own knowledge and ideas and critique those of others.

Argumentation and analysis include appraisal of data quality, modeling of theories, development of new testable questions from those models, and modification of theories and models as evidence indicates they are needed.

Science and Engineering Practices

- Science Practices are the process and habits of mind specific to doing science.
- Science Practices distinguish science from other ways of knowing.
- When students actively engage in science practices they deepen their understanding of core science ideas.
- This vision of the core ideas and practices in science provides the utility students need to engage in making sense of the natural and design worlds.

Using Evidence

- Value and use science as a process of obtaining knowledge based on observable evidence.
- Supporting science argumentation with evidence is a key practice of science.
- Using models and core ideas to make sense of novel phenomena is an essential aspect of science.

Dimension 2: Crosscutting Concepts

- The crosscutting concepts are science concepts that cross all disciplines of science.
- Many of the concepts cross other areas of the curriculum
  - Language Arts (e.g., cause and effect, structure)
  - Math (e.g., patterns, scale, and proportion)
  - Social Studies (e.g., cause and effect, structure and function, systems)

What are Crosscutting Concepts?

- Crosscutting concepts are concepts that cross disciplinary boundaries and contribute to the sense making that leads to students valuing and using science and engineering practices.
- The Framework describes seven crosscutting concepts that appear to have value in supporting understanding of the natural sciences and engineering.
- The crosscutting concepts, when made explicit for students, contribute to their understanding of a coherent and scientifically-based view of the world.
- Crosscutting concepts have instructional utility.

Framework Page 83

Seven Crosscutting Concepts

1. Patterns
2. Cause and Effect
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter
6. Structure and Function
7. Stability and Change

Seven Crosscutting Concepts

Discuss one idea about the crosscutting concepts that is consistent with your thinking.

Discuss one idea about the crosscutting concepts that still challenges your thinking.

Discuss one idea about the crosscutting concepts that requires you to change your thinking.

Share your thoughts

Dimension 3: Disciplinary Core Ideas

Physical Sciences

- PS 1: Matter and Its Interactions
- PS 2: Motion and Stability: Forces and Interactions
- PS 3: Energy
- PS 4: Waves and Their Applications in Technologies for Information Transfer

Life Sciences

- LS 1: From molecules to Organisms: Structures and Processes
- LS 2: Ecosystems: Interactions, Energy, and Dynamics
- LS 3: Heredity: Inheritance and Variation of Traits
- LS 4: Biological Evolution: Unity and Diversity

Earth and Space Sciences

- ESS 1: Earth's Place in the Universe
- ESS 2: Earth's Systems
- ESS 3: Earth and Human Activity

Engineering, Technology, and the Applications of Science

- ETS 1: Engineering design
- ETS 2: Links among engineering, technology, science, and society

Disciplinary Core Ideas

Physical Sciences

- PS 1: Matter and Its Interactions
- PS 2: Motion and Stability: Forces and Interactions
- PS 3: Energy
- PS 4: Waves and Their Applications in Technologies for Information Transfer

Disciplinary Core Ideas

Life Sciences

- LS 1: From Molecules to Organisms: Structures and Processes
- LS 2: Ecosystems: Interactions, Energy, and Dynamics
- LS 3: Heredity: Inheritance and Variation of Traits
- LS 4: Biological Evolution: Unity and Diversity

Disciplinary Core Ideas

Earth and Space Sciences

- ESS 1: Earth's Place in the Universe
- ESS 2: Earth's Systems
- ESS 3: Earth and Human Activity

Disciplinary Core Ideas

Engineering, Technology, and the Applications of Science

- ETS 1: Engineering Design
- ETS 2: Links Among Engineering, Technology, Science, and Society

Core Ideas

- The Framework describes science content essential to understanding natural phenomena.
- The ideas are generally of a large grain size and tend to focus on a specific aspect for making sense of phenomena.

"Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means (e.g., by weighing or by its effects on other objects)."

5th Grade - Grade Band Endpoint Physical Science

Framework Page 108

Specifically, a Core Idea for K-12 Science Instruction Should:

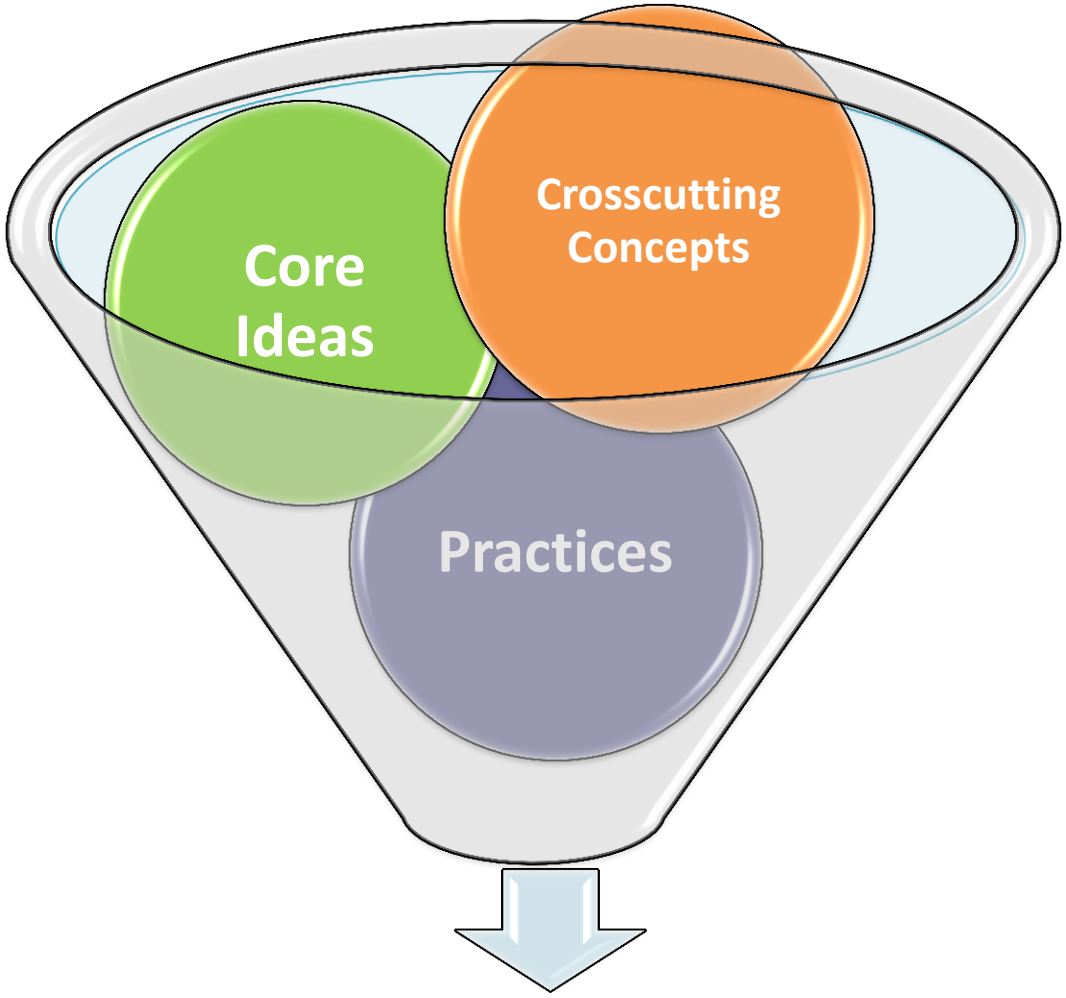
1. Have broad importance across multiple sciences or engineering disciplines or be a key organizing principle of a single discipline.

2. Provide a key tool for understanding or investigating more complex ideas and solving problems.

3. Relate to the interests and life experiences of students or be connected to societal or personal concerns that require scientific or technological knowledge.

4. Be teachable and learnable over multiple grades at increasing levels of depth and sophistication. That is, the idea can be made accessible to younger students but is broad enough to sustain continued investigation over years.

Framework Page 25



Framework → Standards

Standard

- Crosscutting Concepts
- Core Disciplinary Ideas
- Crosscutting Concepts

Developing the Next Generation Science Standards

Public Feedback

- The standards will be open for two rounds of public feedback to help guide the writing team.
- Feedback will be aggregated and made public.
- The first draft of the standards will be available on nextgenscience.org in May 2012.

NEXT GENERATION SCIENCE STANDARDS

Vision

- The vision described in the Framework is consistent, but different from Inquiry in NSES.
- The vision described in the Framework is consistent, but different from Habits of the Mind from AAAS Science Benchmarks.
- Merging the Science Practices, Core Ideas and Crosscutting Concepts into student performance expectations is an essential element of the Framework vision.
- The role of evidence in science is significantly more emphasized in the Framework's vision of science than in other descriptions of the goals for science learning

EQUITY AND DIVERSITY IN SCIENCE AND ENGINEERING EDUCATION

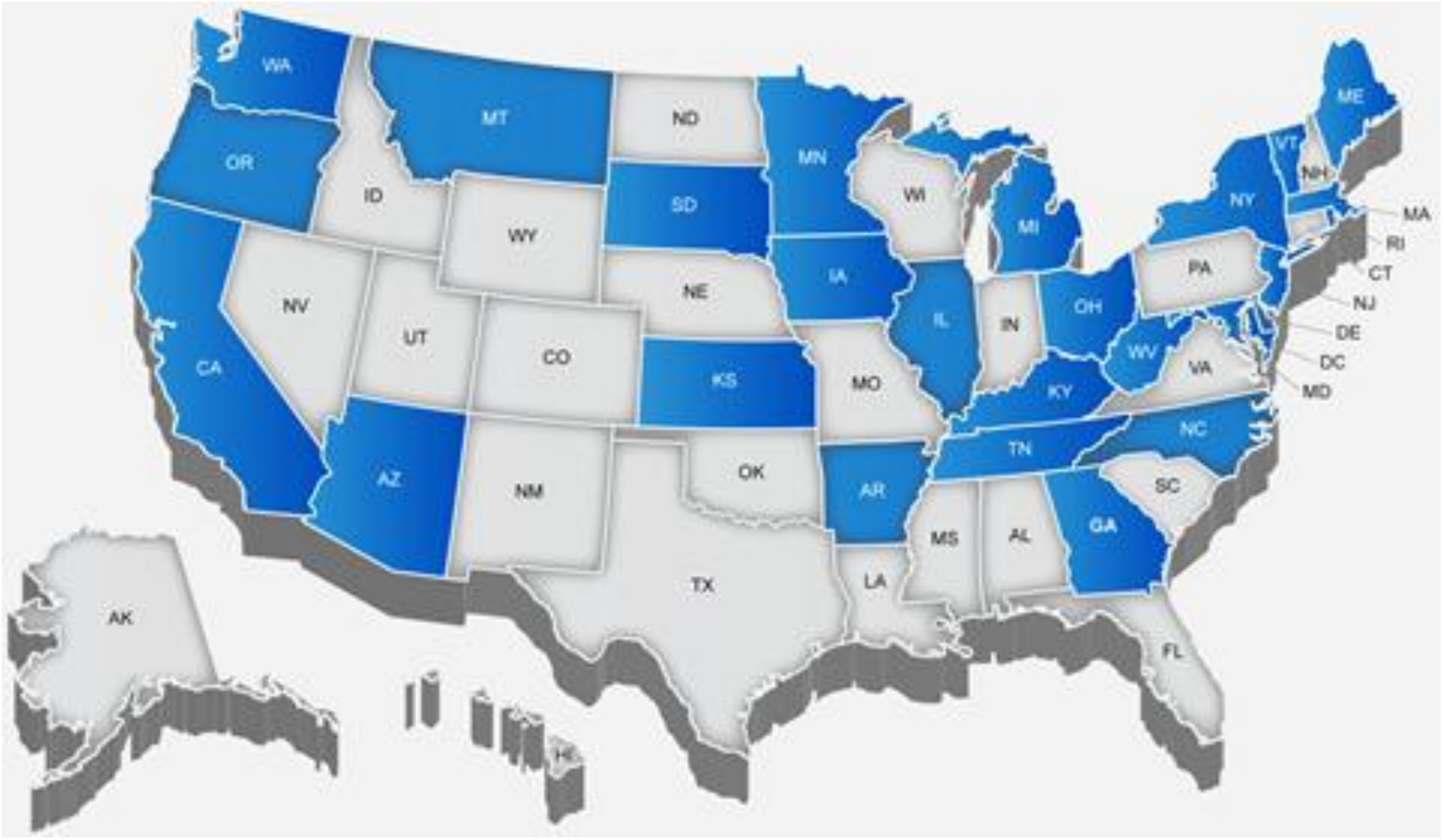
All individuals, with a small number of notable exceptions, can engage in and learn complex subject matter . . . when supportive conditions and feedback mechanisms are in place and the learner makes a sustained effort.

Framework Page 280

Messages from the Framework

- The message in the Framework is for a coherent vision for science teaching and learning.
- Understanding this message is powerful and meaningful to change science education.
- Building this message is an important step in the process of implementing new standards.
- The messages for science education must be consistent with the Framework to move the endeavor forward in a coherent and meaningful way.

A Collaborative Effort



Discussion

- Why is it important to understand the Framework vision and not just the standards?
- What are some of the questions you have about the Framework?
- What is the process we will use in our state to enhance our vision for science teaching and learning to the vision of the Framework?
- What will likely change?
- Other questions for discussion?

Thank you