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

Board on Science Education

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Final now available

NATIONAL RESEARCH COUNCIL
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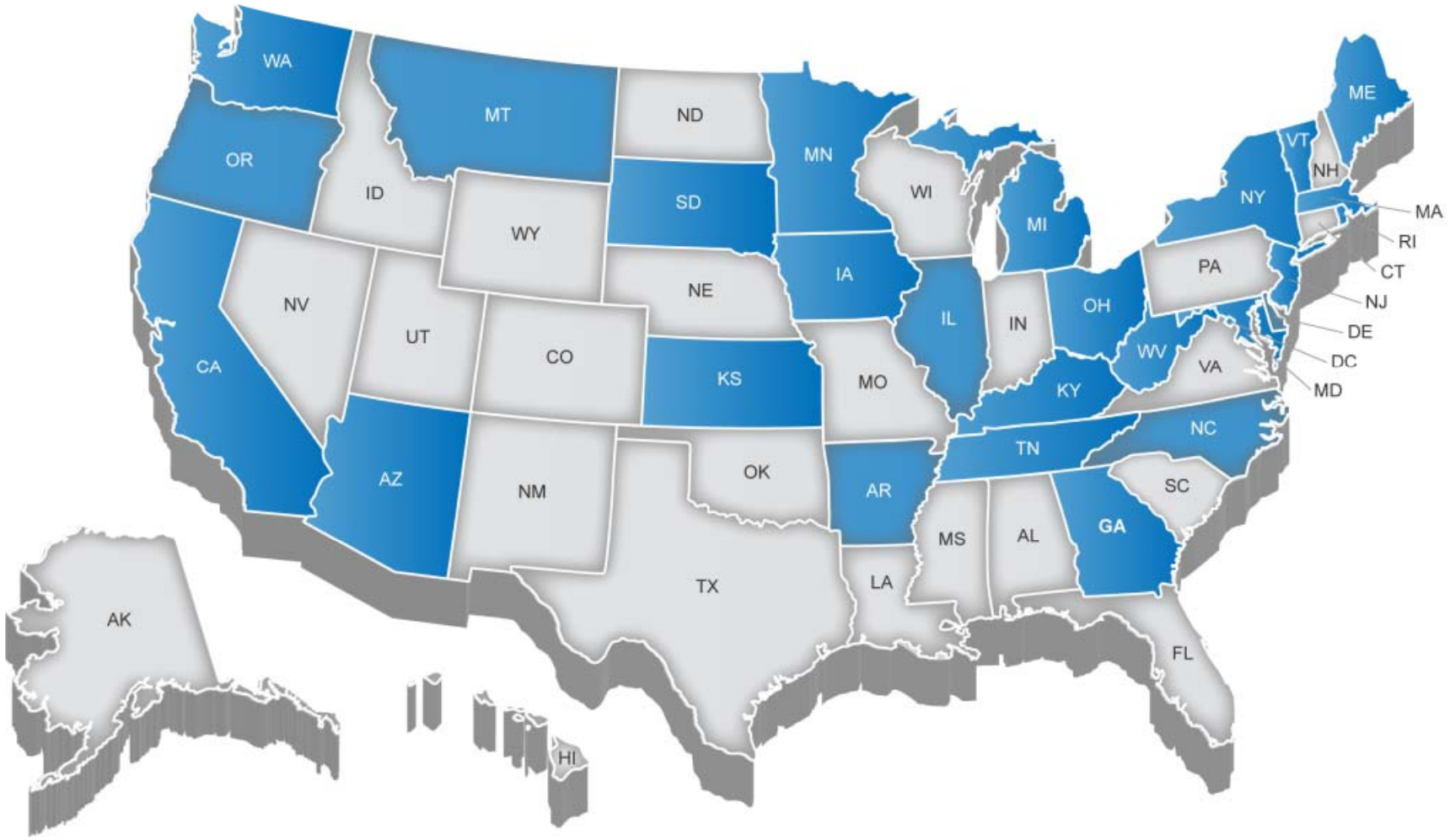
Context

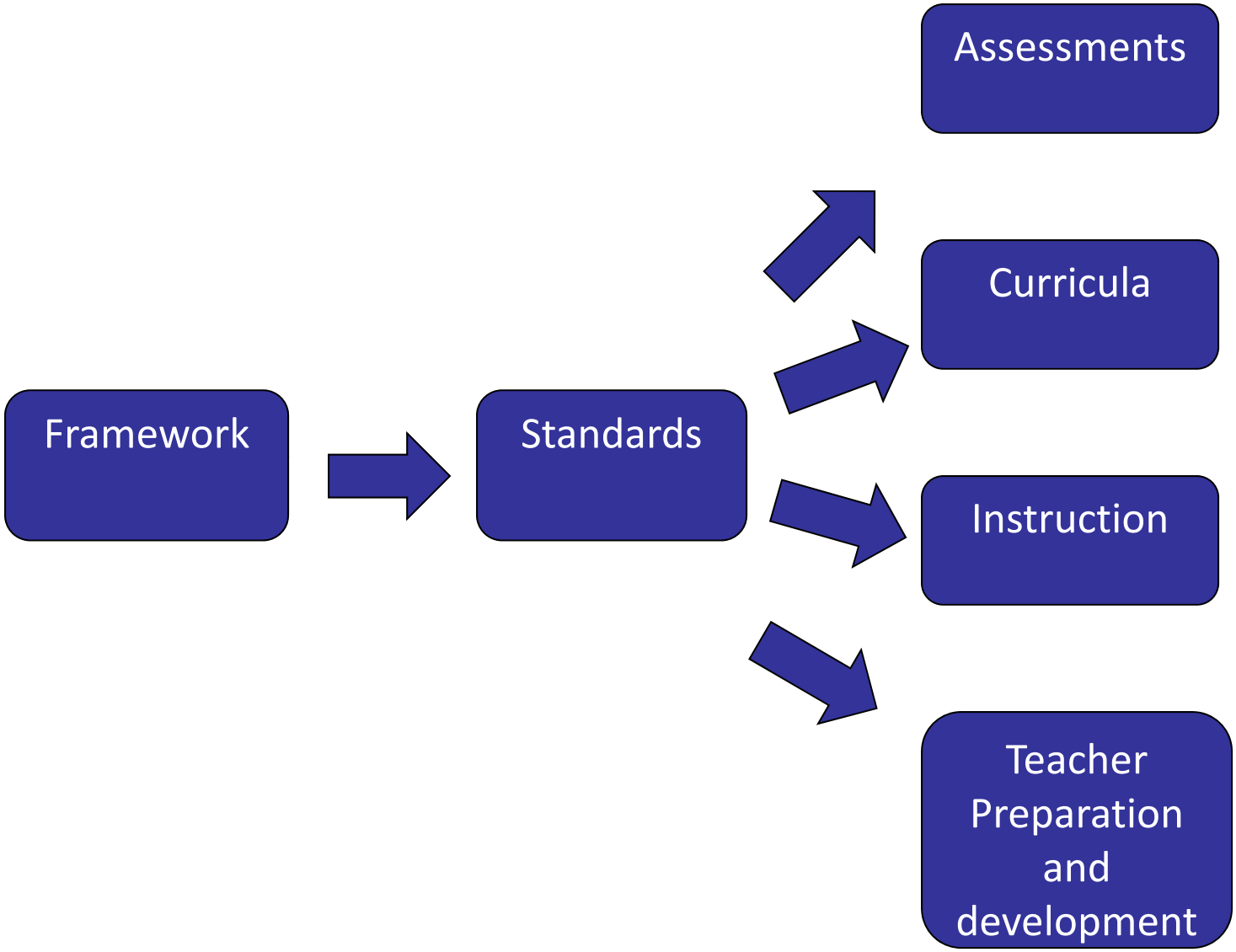
- Education is US is a controlled at the state and local level.
- Common Core Math and Language Arts -- 47+ states choosing common standards

Next Generation Science Standards

- Stage 1 NRC Framework –July 2011
- Stage 2 Achieve Standards –under development, first public release soon

Lead State Partners




Framework
Standards
Assessments
Curricula
Instruction
Teacher Preparation and development

Three Dimensions

- Scientific and engineering practices
- Crosscutting concepts
- Disciplinary core ideas

Some teacher preparation challenges

- Elementary

Where do they meet the practices?

How do they interpret the cross-cutting ideas?

- High School

Connections across disciplines?

Flexibility for new course sequences?

Goals of the Framework

- Coherent investigation of core ideas across multiple years of school
- More seamless blending of practices with core ideas and crosscutting concepts

Scientific and Engineering Practices

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Developing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Crosscutting Concepts

1. Patterns
2. Cause and effect: mechanism and explanation
3. Scale, proportion and quantity
4. Systems and system models
5. Energy and matter: flows, cycles and conservation
6. Structure and function
7. Stability and change

Example: energy

- How do we ensure a common language across disciplines?

- How do teachers in one course build on knowledge gained in a different course?

Physics teachers need to know how chemists, earth scientists and biologists talk about energy, as well as how physicists do, and use inter-disciplinary examples where appropriate.

Teachers in all disciplines need to adjust their language around energy toward a more common conception.

What college science courses help make these connections?

A core idea for K-12 science instruction is a scientific idea that:

- Has broad importance across multiple science or engineering disciplines or is a key organizing concept of a single discipline
- Provides a key tool for understanding or investigating more complex ideas and solving problems
- Relates to the interests and life experiences of students or can be connected to societal or personal concerns that require scientific or technical knowledge
- Is teachable and learnable over multiple grades at increasing levels of depth and sophistication

Disciplinary Core Ideas: Physical Sciences

- PS1 Matter and its interactions
- PS2 Motion and stability: Forces and interactions
- PS3 Energy
- PS4 Waves and their applications in technologies for information transfer

Disciplinary Core Ideas: Life Sciences

- LS1 From molecules to organisms: Structures and processes
- LS2 Ecosystems: Interactions, energy, and dynamics
- LS3 Heredity: Inheritance and variation of traits
- LS4 Biological evolution: Unity and diversity

Disciplinary Core Ideas: Earth and Space Sciences

- ESS1 Earth's place in the universe
- ESS2 Earth's systems
- ESS3 Earth and human activity

Disciplinary Core Ideas: Engineering, Technology and Applications of Science

- ETS1 Engineering design
- ETS2 Links among engineering, technology, science and society

Integrating the Dimensions

- To facilitate students' learning the dimensions must be woven together in standards, assessments, curriculum and instruction.

- Students should explore a core idea by engaging in the practices and making connections to crosscutting concepts.

Where do teachers learn to do this?

Key Components in the System that Need to be Aligned

- Standards
- Curriculum and instructional materials
- Assessment
- Pre-service preparation of teachers
- Professional development for in-service teachers

Example: Teacher Preparation needs

See recent PCAST reports

- Revised Science Courses,

especially at intro level for elementary teachers

experience of the practices

If teachers have never experienced data analysis, or argument from evidence, how can they teach it?

- Revised "Science Teaching Methods" courses

Free PDF version of *A Framework for K-12 Science Education* is available as of

www.nap.edu

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