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

Board on Science Education

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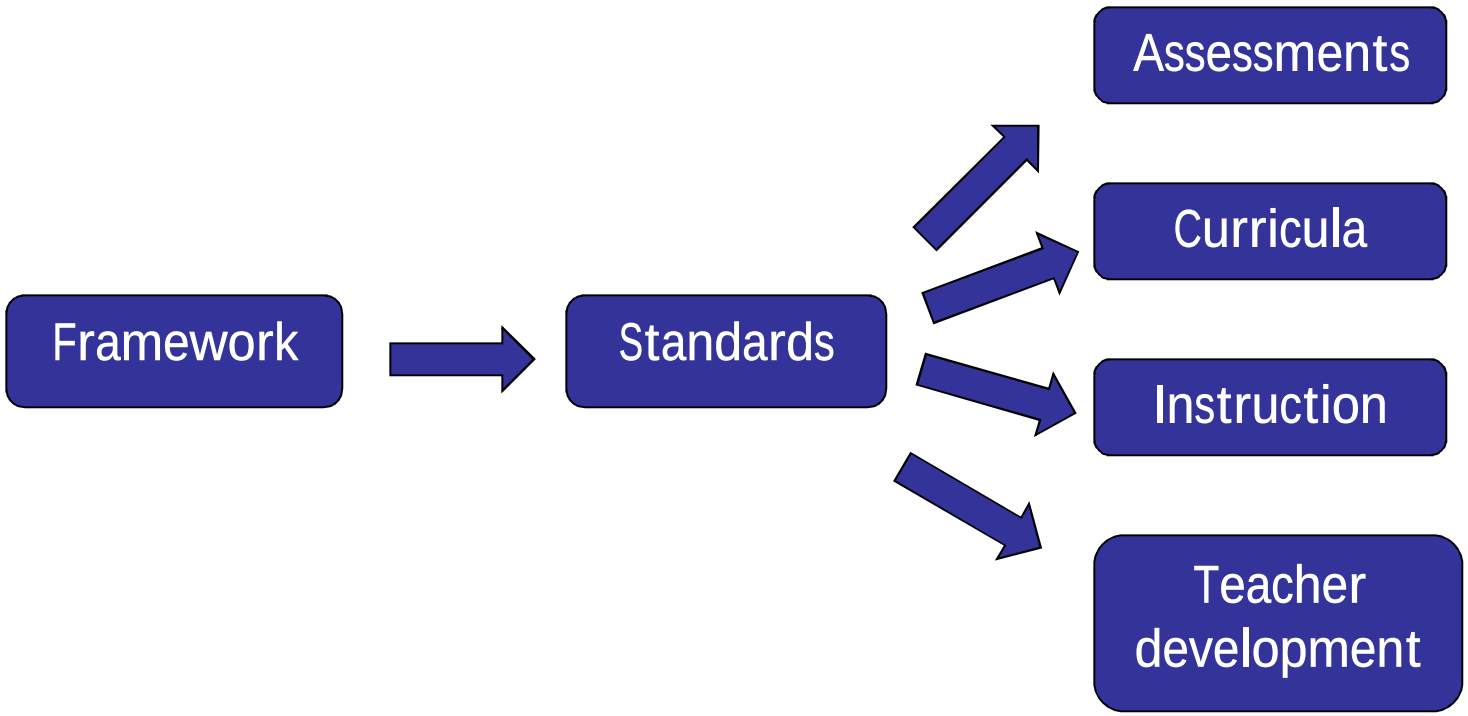
Science for All Students

- Science, engineering and technology are cultural achievements and a shared good of humankind
- Science, engineering and technology permeate modern life
- Understanding of science and engineering is critical to participation in public policy and good decision-making
- National need

Why is a K-12 science framework needed?

- Improved knowledge about learning and teaching science
- Opportunities to improve current teaching practice
- Advances in scientific knowledge


Framework
Standards
Assessments
Curricula
Instruction
Teacher development

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

Statement of Task

- Identify small set of core and crosscutting ideas in life, physical, earth and space, and engineering
- Articulate how these intersect for at least 3 grade levels
- Create examples of performance expectations
- Develop guidance on implementation
- Develop an R&D agenda

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Study Process

- Held stakeholder meetings for informed input (Summer/Fall, 2009)
- Developed draft report over four meetings
- Draft of conceptual framework released to public (July 2010)
- Committee reviewed all public feedback and revised report
- Report revised in response to NRC internal expert review process
- Report released July 2011

Structure of the Report

- Part I: A Vision for K-12 Science Education
- Part II: Dimensions of the Framework
- Part III: Realizing the Vision

Three Dimensions

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

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 information and computer technology
6. Developing explanations and designing solutions
7. Engaging in argument
8. Obtaining, evaluating, and communicating information

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

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
Chapter 9

- 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.

Key Components in the System that Need to be Aligned

Chapter 10

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

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Diversity and Equity
Chapter 11

- Equalizing opportunities to learn
- Inclusive science instruction
- Making diversity visible
- Value multiple modes of expression

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Guidance for Standards Developers
Chapter 12

- Set rigorous learning goals for all students
- Emphasize all 3 dimensions
- Include performance expectations
- Be organized as progressions that support learning over multiple grades
- Attend to issues of diversity and equity

Key Areas of Research
Chapter 13

- Learning progressions
- Scientific and engineering practices
- Curricular and instructional materials
- Assessment
- Supporting teachers' learning
- Evaluation of the impact of standards

Major changes from July draft

- Re-organized chapters
- Added chapters on implementation, diversity and equity, and guidance for standards developers
- Expanded discussion of integrating the three dimensions
- Replaced “prototype learning progressions” with “grade-band endpoints”

Next Steps

- Outreach and dissemination of the framework by the NRC
- State-led development of Next Generation Science Standards, coordinated by Achieve
- Progress on critical steps toward implementation

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- The Committee
- Strategic partners (NSTA, AAAS, Achieve)
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- NRC Staff
- Expert reviewers

Free PDF version of *A Framework for K-12 Science Education* is available as of Wednesday, July 20 at:
nap.edu

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