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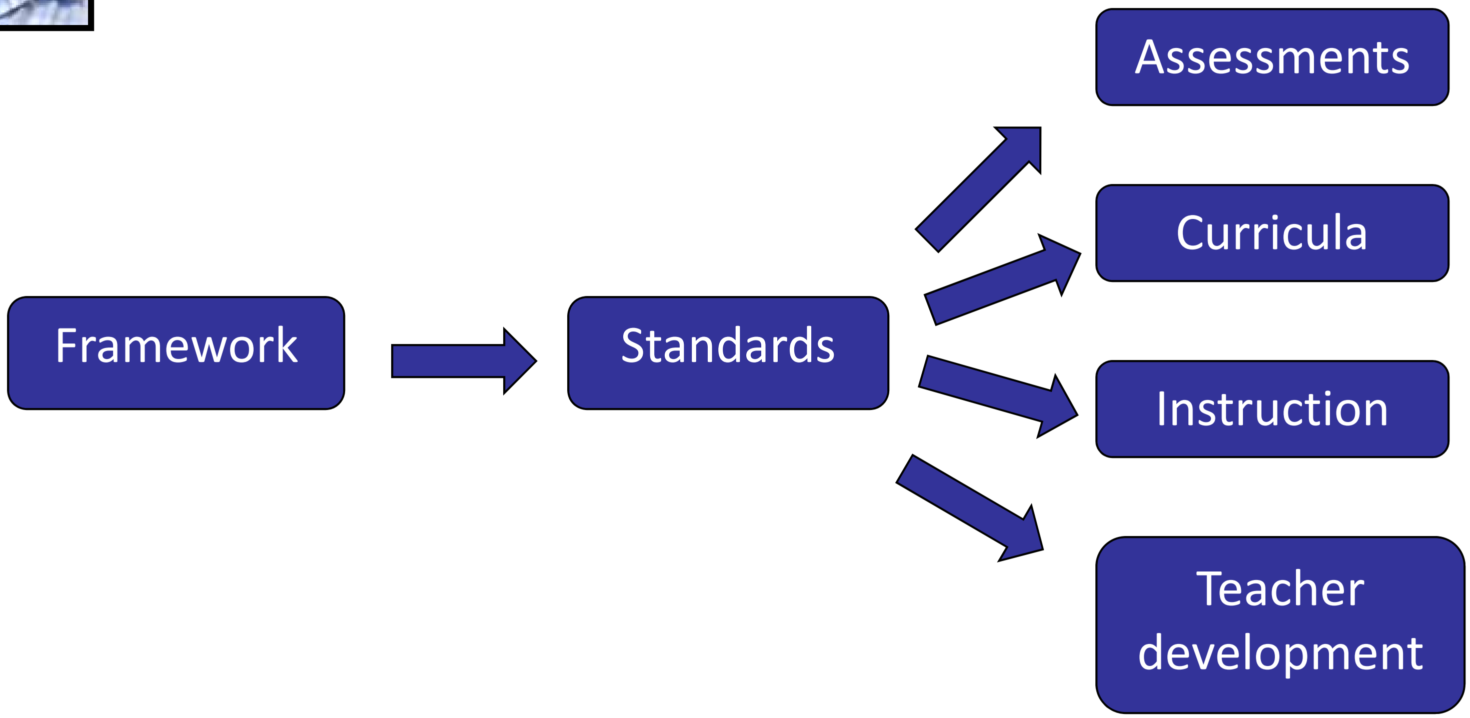
A Framework for K-12 Science Education: Practices, Crosscutting Concepts and Core Ideas

Presented by: Helen Quinn, Tom Keller and Brett Moulding

With NSTA Response from Dr. Francis Eberle

July 26, 2011



Framework
Standards
Assessments
Curricula
Instruction
Teacher development

Why now?

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

Who are we?

National Research Council
Board on Science Education

Committee Members

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Wyatt Anderson, University of Georgia (Biology)

Tanya Atwater, UC Santa Barbara (Earth Science)

Philip Bell, University of Washington (Learning Sciences)

Thomas Corcoran, Center for Policy Research in Education, Columbia Teachers College

Rodolfo Dirzo, Stanford University (Biology)

Phillip Griffiths, Institute for Advanced Study, Princeton (Mathematics)

Dudley Herschbach, Harvard University (Chemistry)

Linda Katehi, UC Davis (Engineering)

John Mather, NASA (Astrophysics)

Brett Moulding, Educator, Utah

Jonathan Osborne, Stanford University (Science Education)

James Pellegrino, University of Illinois at Chicago (Learning Sciences)

Stephen L. Pruitt, GA Department of Education (until June, 2010)

Brian Reiser, Northwestern University (Learning Sciences)

Rebecca Richards-Kortum, Rice University (Engineering)

Walter Secada, University of Miami (Mathematics Education)

Deborah Smith, Pennsylvania State University (Elementary Education)

Design Teams

Earth and Space Science

Michael Wysession (Lead), Department of Earth and Planetary Sciences, Washington University in Saint Louis

Scott Linneman, Geology Department, Western Washington University

Eric Pyle, Department of Geology & Environmental Science, James Madison University

Dennis Schatz, Pacific Science Center

Don Duggan-Haas, Paleontological Research Institution and its Museum of the Earth

Life Science

Rodger Bybee (Lead), BSCS

Bruce Fuchs, National Institutes of Health

Kathy Comfort, WestEd

Danine Ezell, San Diego County Office of Education

Physical Science

Joseph Krajcik *(Lead)*, School of Education, University of Michigan

Shawn Stevens, School of Education, University of Michigan

Sophia Gershman, Watchung Hills Regional High School

Arthur Eisenkraft, Graduate College of Education, University of Massachusetts

Angelica Stacy, Department of Chemistry, University of California, Berkeley

Engineering, Technology and Applications of Science

Cary Sneider *(Lead)*, Center for Education, Portland State University

Rodney L. Custer, Department of Technology, Illinois State University

Jacob Foster, Mass. Department of Elementary and Secondary Education

Yvonne Spicer, Nat'l Center for Technological Literacy, Museum of Science, Boston

Maurice Frazier, Chesapeake Public School System

Let's pause for questions from the audience

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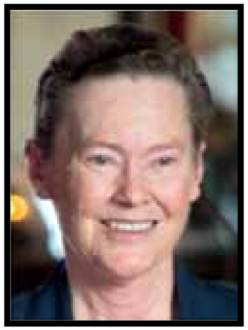
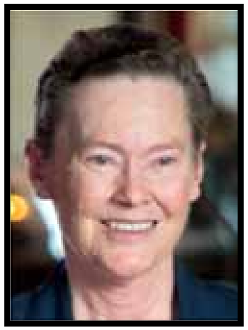


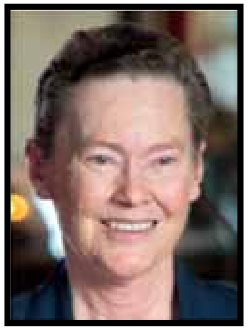
Vision: Science for All Students

- 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



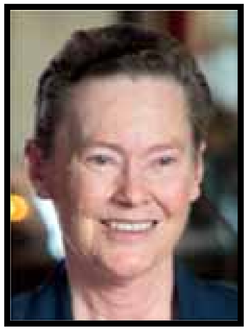
Vision: Coherent learning

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



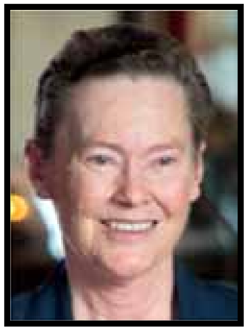
Structure of the Report

- 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

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Do your students use modeling for understanding?

A. Habitually, in science

B. When prompted, often

C. When prompted, sometimes

D. Rarely

E. Never

Do your students distinguish a claim and supporting evidence?

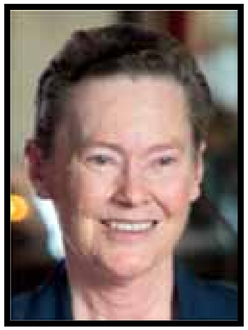
A. Readily

B. When prompted, often

C. When prompted, sometimes

D. Rarely

E. Never



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

Do your students use the language of systems?

A. Readily

B. When prompted, often

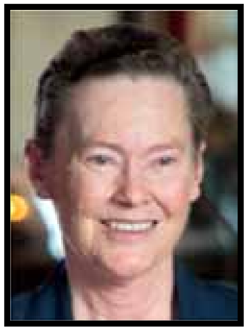
C. When prompted, sometimes

D. Rarely

E. Never

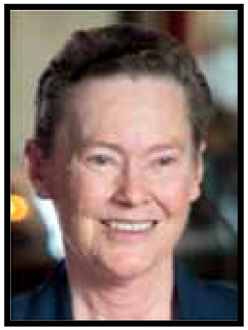
A core idea for K-12 science instruction is a scientific idea that:

- 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



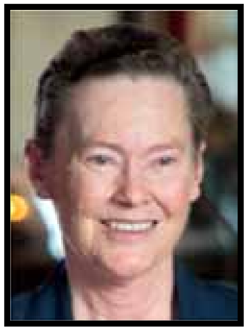
Disciplinary Core Ideas: Physical Sciences

- 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

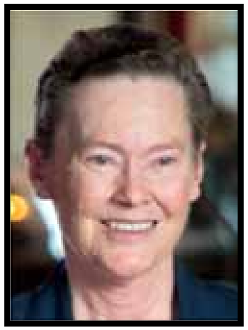


Disciplinary Core Ideas: Earth and Space Sciences

- 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



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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.

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Key Components in the System that Need to be Aligned for Implementation

Chapter 10

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

Diversity and Equity

Chapter 11

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

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

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

http://www.nap.edu/catalog.php?record_id=13165

Response from NSTA

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