SCIENTIFIC LITERACY: REFLECTIONS ON STANDARDS, STEM, AND STEWARDSHIP

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SCIENTIFIC LITERACY: REFLECTIONS ON STANDARDS, STEM, AND STEWARDSHIP

Introduction and Overview

Scientific Literacy

- *Reflections*

Next Generation Science Standards (NGSS)

- *Reflections*

STEM Education

- *Reflections*

Environmental Stewardship

- *Reflections*

Questions and Discussion

SCIENTIFIC LITERACY

SCIENTIFIC LITERACY

- Origin and History
- Vision I Knowledge of Science Subject Matter and Abilities of Inquiry
- Vision II The Application of Knowledge to Life Situations

SCIENTIFIC LITERACY

Definition of Scientific Literacy

In PISA 2006 scientific literacy referred to four interrelated features that involve an individual' s:

• Scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomenon, to draw evidence-based conclusions about science-related issues;

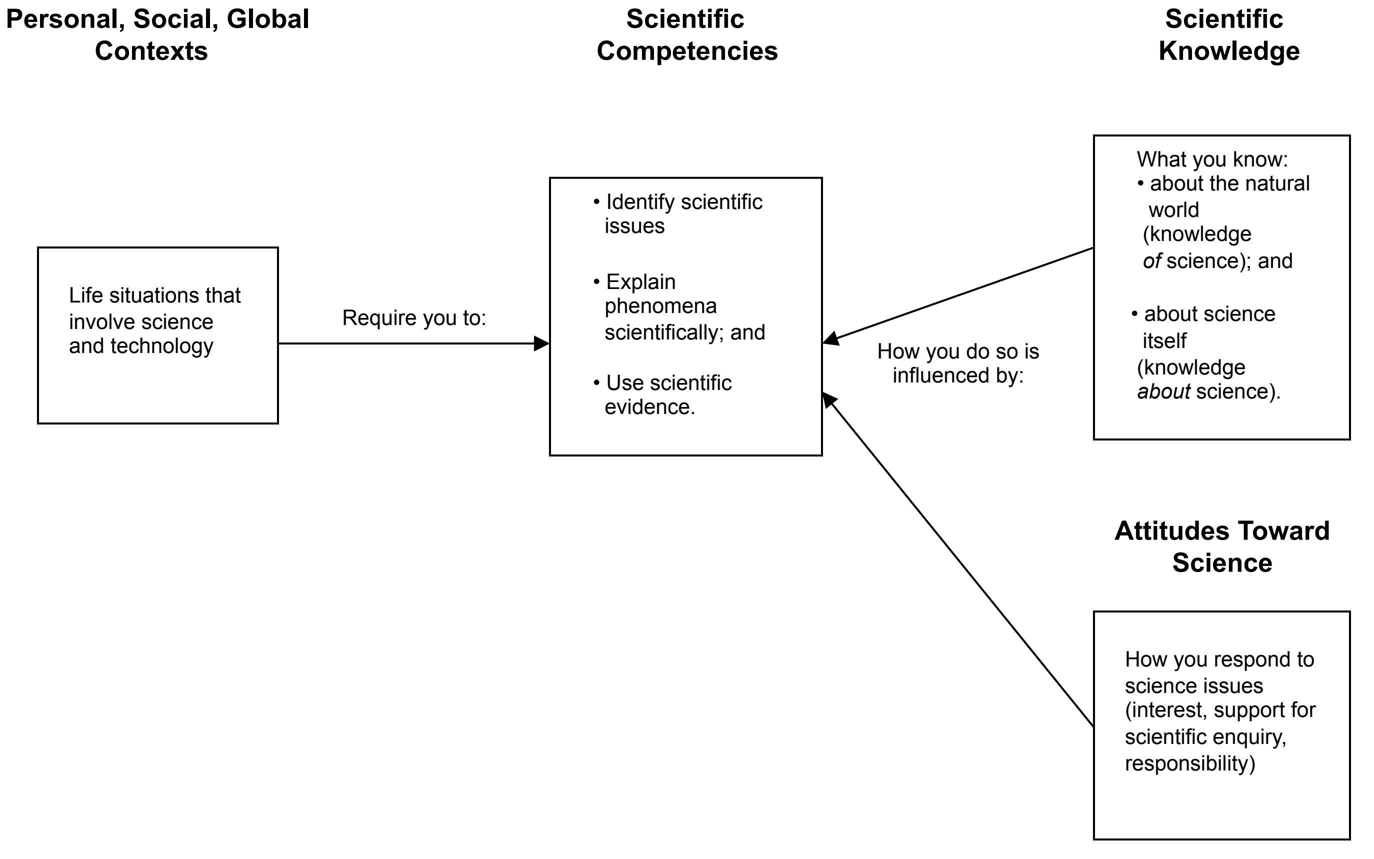
• Understanding of the characteristic features of science as a form of human knowledge and enquiry;

• Awareness of how science and technology shape our material, intellectual, and cultural environment; and

• Willingness to engage in science-related issues, and with the ideas of science, as a constructive, concerned, and reflective citizen (OECD, 2006).

SCIENTIFIC LITERACY

PISA Framework



STANDARDS

STANDARDS FOR SCIENCE EDUCATION

- Origin and History
- National Science Education Standards (NSES) (NRC, 1996)
- Next Generation Science Standards (NGSS) (Achieve, 2013)
- State Standards for Science Education

THE IDEA OF STANDARDS FOR SCIENCE EDUCATION

The Idea of Standards for Science Education Is Not New

- Harvard Laboratories
- Committee Reports and Yearbooks in 20th Century
- Benchmarks for Science Literacy (AAAS, 1993)
- National Standards for Science Education (NRC, 1996)

STANDARDS FOR SCIENCE EDUCATION

Vision

… create a vision for the scientifically literate person and standards for science education that, when established, would allow the vision to become reality. The standards, founded in exemplary practice and contemporary views of learning, science, society, and schooling, will serve to guide the science education system toward its goal of a scientifically literate citizenry in productive and socially responsible ways.

(NRC, 1996)

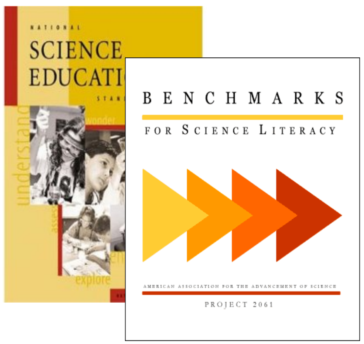
TRANSLATING STANDARDS FOR SCIENCE EDUCATION

- Nothing perfectly aligns with the NGSS except the NGSS
- Accommodating the language of NGSS for the language of curriculum and instruction
- Recognizing different dimensions of education—purpose, policy, program, and practice
- Understanding the limits and possibilities and accepting the trade-offs

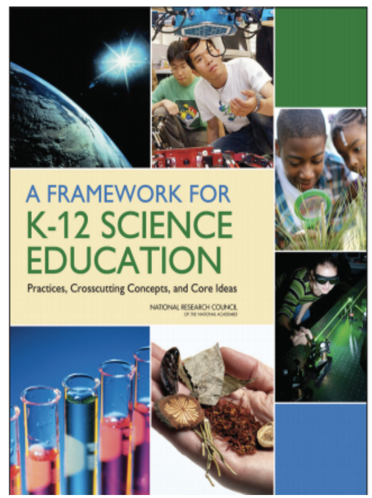
TRANSLATING STANDARDS FOR CLASSROOM INSTRUCTION

PURPOSE
Purpose statements include the aims, goals, and rationales. These statements tend to be universal, abstract, and apply to all components of the science education system (e.g., teacher education, curriculum, instruction, and assessment). Although it presents elements of both purpose and policy, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC 2012) has served as the purpose in this era of standards-based reform.
POLICY
Policies are more specific statements of standards, benchmarks, syllabi, and action plans based on the defined purposes. Policy statements are concrete translations of the purpose and apply to specific components such as teacher education, K-12 curriculum, and assessments. The *Next Generation Science Standards* is the policy statement most applicable to this discussion.
PROGRAM
Programs are the actual materials, books, and software used in states, schools, and classrooms. Programs are unique to disciplines, K-12 grades, and levels in the education system. Curriculum materials for K-12 science and state assessments are different examples of programs. Programs are a translation of policies to the unique requirements of programs.
PRACTICE
Practice refers to the specific actions of educators as they implement the program. Classroom teaching of science is an example of practices. Practice is the most unique and fundamental level of translation.

Developing the Standards

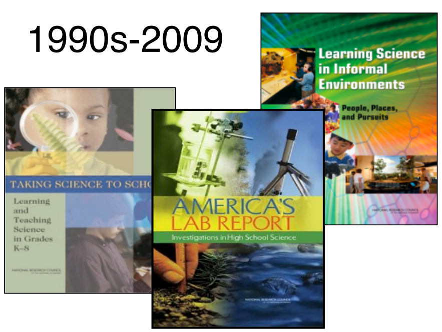


1990s



NEXT GENERATION SCIENCE STANDARDS
For States, By States

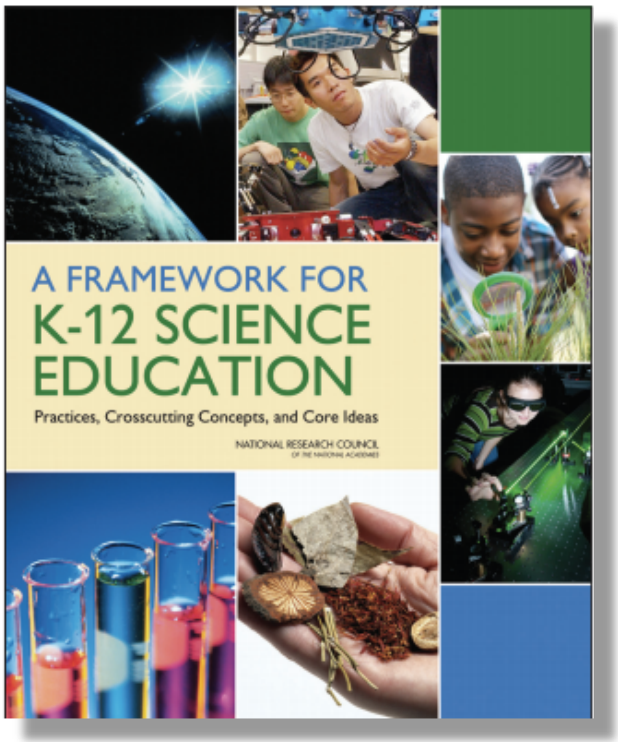
1990s-2009



National
Research
Council
1/2010 - 7/2011

Achieve
7/2010 – April 2013

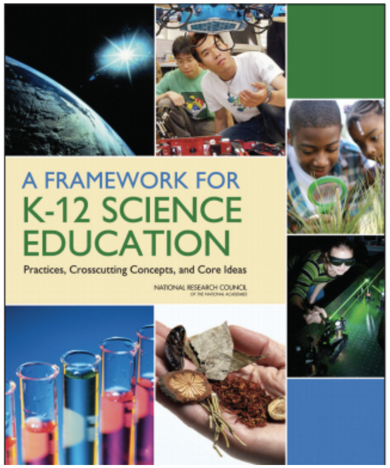
A Framework for K-12 Science Education



Three-Dimensions:

- **Scientific and Engineering Practices**
- **Crosscutting Concepts**
- **Disciplinary Core Ideas**

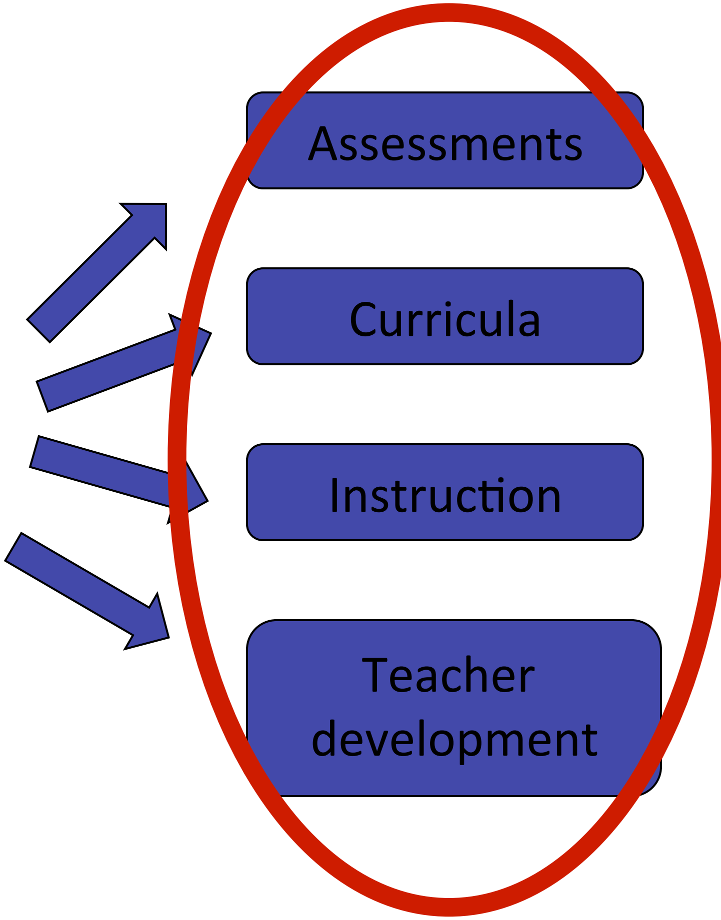
Framework and Standards: Planning for Implementation



NRC
July 2011

NEXT GENERATION SCIENCE STANDARDS

Achieve, Inc.
April 2013



Instructional Shifts

FROM →	TO
• Science	Science and CCSS (English Language Arts and Mathematics)
• Single Lessons and Activities	Integrated Instructional Sequences
• Science Concepts	Science and Engineering Practices Crosscutting Concepts Disciplinary Core Ideas
• Science Alone	Science and Engineering
• Grade-Level Content	Coherent Progression Across Grades of Concepts and Practices

FROM NGSS TO CLASSROOM INSTRUCTION

Contemporary Curriculum and Opportunities

- Assessments — "Will Assessments Change?"
- Curriculum — "Are There Curriculum Materials I Can Use?"
- Instruction — "Are There Effective Instructional Strategies I Can Use?"
- Common Core — "Are There Connections to the Common Core State Standards for English Language Arts and Mathematics?"
- Professional Education of Teachers — "What Knowledge and Skills Do Teachers Need to Implement NGSS?"

STEM EDUCATION

STEM EDUCATION

How can education help develop

- a STEM literate society;
- a deep technical workforce for the 21st century's knowledge economics; and
- an advanced research and development workforce focused on innovation?

STEM EDUCATION

A Definition of STEM Literacy

STEM literacy refers to an individual's

- knowledge, attitudes, and skills to identify questions and problems in life situations, to explain the natural and designed world, and to draw evidence-based conclusions about STEM-related issues;
- understanding of the characteristic features of STEM disciplines as forms of human knowledge, inquiry, and design;
- awareness of how STEM disciplines shape our material, intellectual, and cultural environments; and
- willingness to engage in STEM-related issues, and with the ideas of science, technology, engineering, and mathematics as a constructive, concerned, and reflective citizen.

STEM EDUCATION

Contexts for STEM Education

GLOBAL, NATIONAL, AND LOCAL ISSUES	HEALTH MAINTENANCE/DISEASE PREVENTION ENERGY EFFICIENCY ENVIRONMENTAL QUALITY NATURAL HAZARDS NATURAL RESOURCE USE UNDERSTANDING OF STEM DISCIPLINES
EDUCATIONAL THEME	A STEM-LITERATE SOCIETY
ADVANCING THE GOALS OF STEM EDUCATION	ADDRESS 21^{ST} CENTURY GRAND CHALLENGES IN APPROPRIATE PROGRAMS, COURSES, AND CLASSES PROVIDE OPPORTUNITIES FOR THE APPLICATIONS OF KNOWLEDGE AND SKILLS TO STEM-RELATED ISSUES INCLUDE SCIENTIFIC, ENGINEERING, DESIGN, AND MATHEMATICAL PRACTICES

STEM EDUCATION

STEM Education and 21st Century Skills

NATIONAL ISSUE	KNOWLEDGE ECONOMY
EDUCATION THEME	A DEEP TECHNICAL WORKFORCE
ADVANCING THE GOALS OF STEM EDUCATION	DEVELOP STUDENTS' 21ST CENTURY SKILLS & ABILITIES • Adaptability • Complex Communication • Non-routine Problem Solving • Self Management/Self Development • Systems Thinking

STEM EDUCATION

Innovation and STEM Careers

NATIONAL ISSUE	INNOVATION
EDUCATION THEME	AN ADVANCED RESEARCH AND DEVELOPMENT WORKFORCE
ADVANCING THE GOALS OF STEM EDUCATION	FOCUS ON STEM CAREERS IN ORDER TO: • Increase the number and diversity of students in STEM professions • Recruit top students to STEM professions • Keep individuals in STEM careers

STEWARDSHIP

NATIONAL AND GLOBAL CHALLENGES

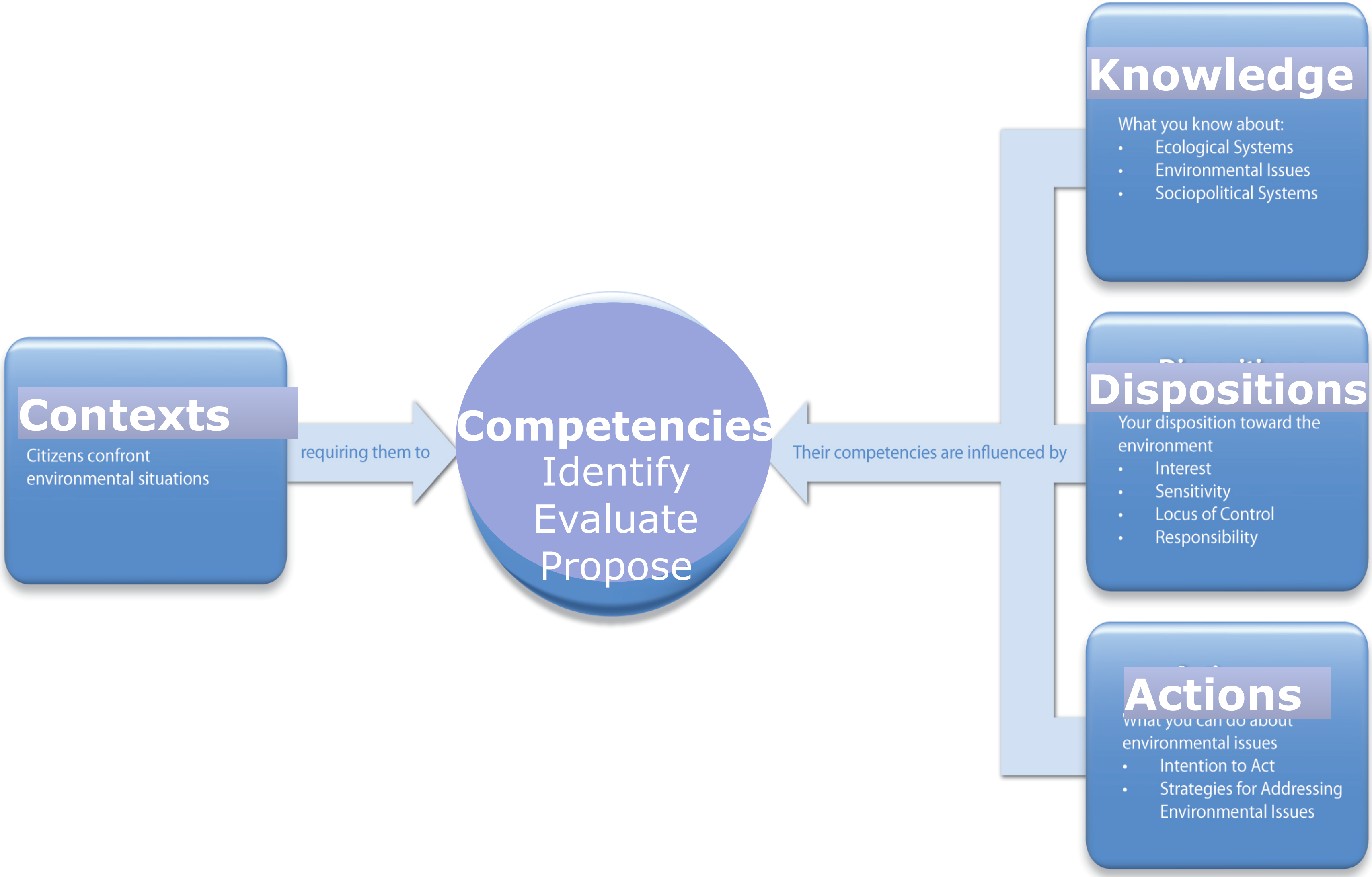
- Economic stability and the development of a 21st century workforce
- Energy efficiency and adequate responses for a carbon-constrained world
- Environmental quality and the need for evidence-based responses to global climate change
- Resource use and the need to address continuing conflicts over limited natural resources
- Mitigation of natural hazards by preparing for severe weather, earthquakes, and fires
- Health maintenance and the need to reduce the spread of preventable diseases
- Public understanding of the role of scientific advances and technological innovations in health and human welfare

ENVIRONMENTAL LITERACY

Definition of Environmental Literacy

Environmental literacy is the knowledge necessary to understand the environment as an ecological system, the insight in the impact of human behavior on the natural world, and the disposition and motivation to apply one's knowledge, skills, and insight in order to make environmentally beneficial decisions about one's own behavior and to evaluate environmentally critical developments as a rational citizen.

Environmental Literacy Framework



CURRICULUM FRAMEWORK FOR STEM EDUCATION

	Personal	Local/National	Global
Biodiversity	Floral and fauna	Endangered species, habitat loss, exotic invasive species	Ecological sustainability, sustainable use of species
Population Growth	Growth, birth/death, emigration, immigration	Maintenance of human population, population distribution, over population	Population growth and its social, economic and environmental consequences
Natural Resources	Personal consumption of materials	Production and distributions of food, water, energy	Sustainable use of renewable and non-renewable resources
Environment Quality and Health	Impact of use and disposal of materials on air and water quality	Disposal of sewage and solid waste, environmental impact	Sustainability of ecosystem services
Natural Hazards and Extreme Weather	Decisions about housing in areas vulnerable to flooding, tidal and wind damage	Rapid changes (e.g., earthquakes), slow changes (e.g., coastal erosions), risks and benefits	Climate change, extreme weather events
Land Use	Conservation of agricultural lands and natural areas	Impact of development and diversion of water, watersheds and flood plains	Production and loss of topsoil, loss of arable land

CONCLUSION

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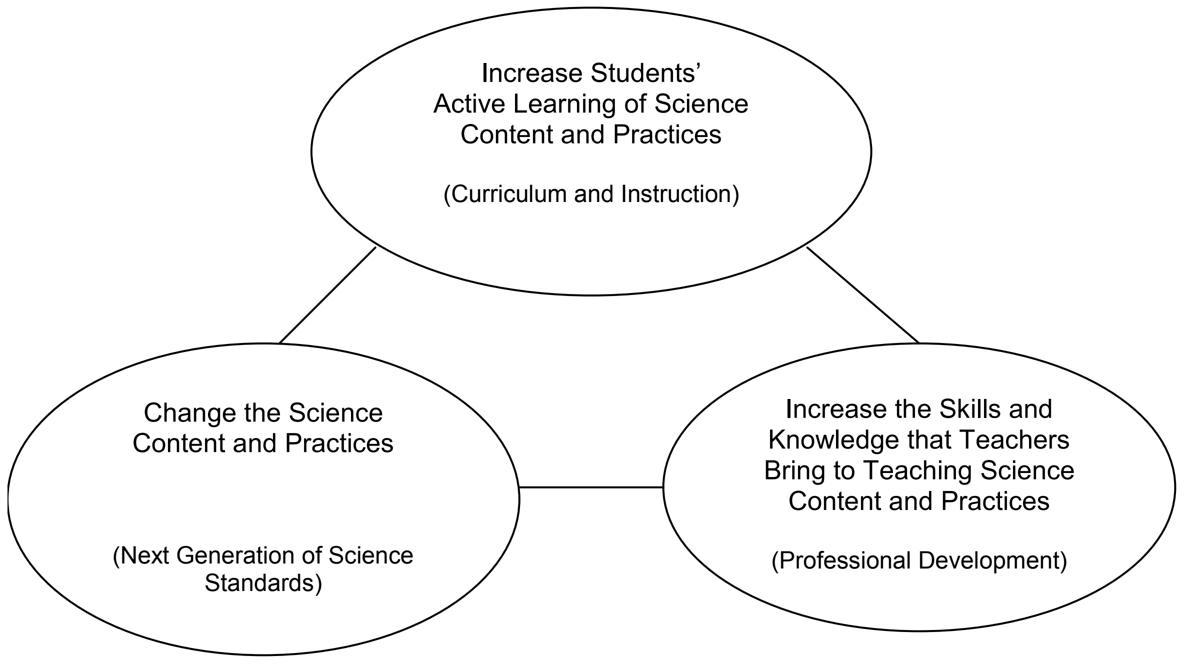
INSTRUCTIONAL CORE



Adapted from: Richard Elmore. "Improving the Instructional Core." In City, E., Elmore, R., Fiarman, S., & Teite, L. (2009). *Instructional Rounds in Education: A Network Approach to Improving Teaching and Learning.* Cambridge, MA: Harvard Education Press.

CONCLUSION

How, then do we achieve an appropriate balance between the demands of individuality and the demands of community? I have a very simple starting point to which I think there is no alternative. We converse—informally in small groups and more formally through organizations via systematic political processes. The proper education of the public and indeed the proper creation of "publics" will not go forward in our society until we undertake anew a great public dialogue about education are among the most important questions that can be raised in our society, particularly at this juncture in its history.

(Cremin, 1976, p. 74)

CONCLUSION

THE SISYPHEAN QUESTION IN SCIENCE EDUCATION:

WHAT SHOULD THE SCIENTIFICALLY AND TECHNOLOGICALLY LITERATE PERSON KNOW, VALUE, AND BE ABLE TO DO—AS A CITIZEN?

(Bybee, 1985)