Bridging Research and Practice

A review of how advances on human cognition, development, and learning can be incorporated into educational practice of implementing effective science education programs

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National Science Resources Center

Established in 1985 as an organization of the National Academies and the Smithsonian Institution

National Science Resources Center

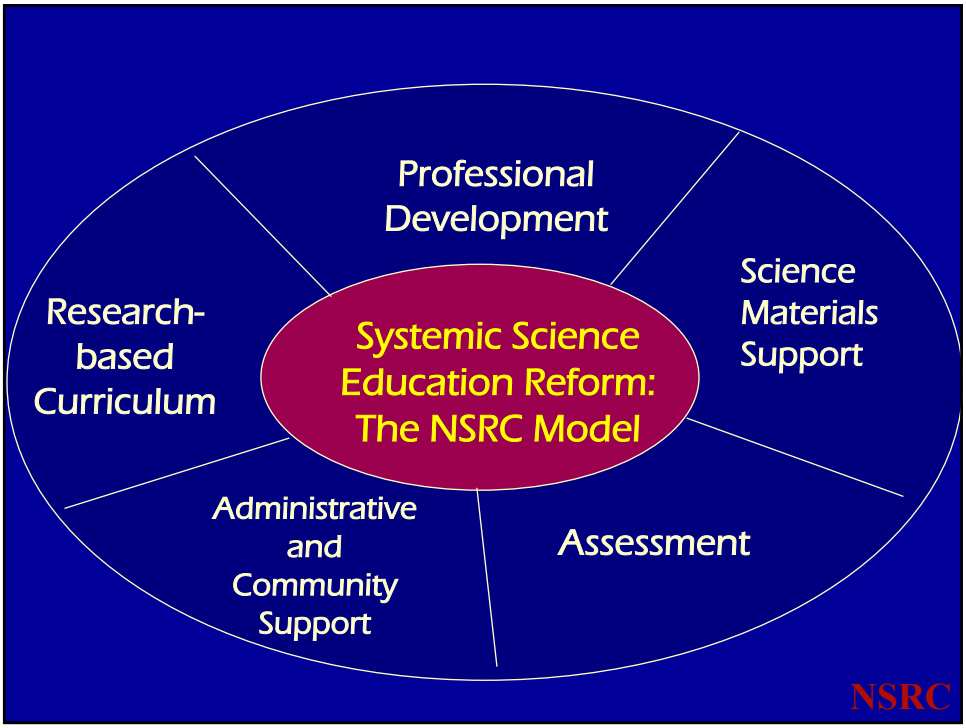
Mission

To improve the learning and teaching of science in the nation's 16,000 school districts

Core Principles

1. Science for all children
2. Products and services are informed by research and incorporate best practices
3. Reform strategies focus on systems thinking and leverage change through strategic partnerships

NSRC Science Education Reform Theory of Action


Professional Development
Science Materials Support
Research-based Curriculum
Systemic Science Education Reform: The NSRC Model
Administrative and Community Support
Assessment
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NSRC Centers of Excellence
Professional Development
Leadership and Assistance for Science Education Reform
Curriculum Development
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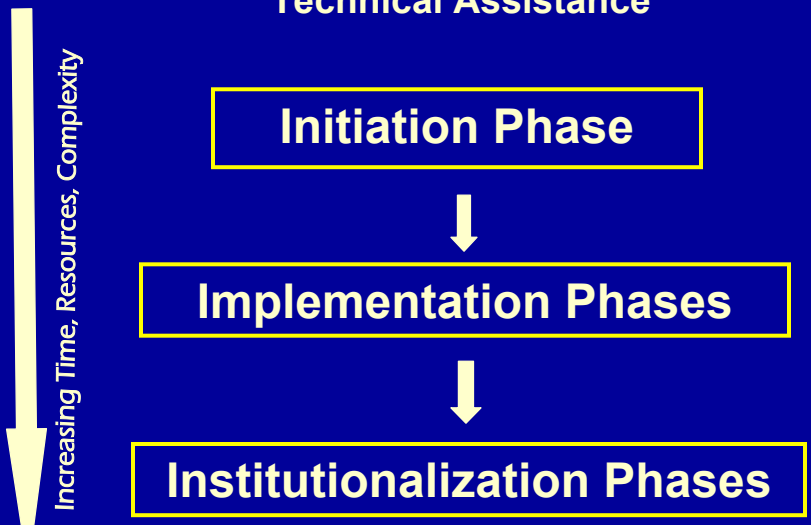
Stages of Work

School Districts Need Resources and Technical Assistance



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1. **What are the advances of human cognition, development and learning?**

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Sources

How People Learn *and*

Bridging Research and Practice

National Research Council
www.national-academies.org

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Learners and Learning

- Development and Learning Competencies
- Transfer of Learning
- Competent and Expert Performance

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Scientific understanding of learning includes understanding about

- **Learning processes**
- **Learning environments**
- **Teaching**
- **Sociocultural processes**

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Research Areas

- Role of prior knowledge in learning
- Plasticity and related issues of early experience upon brain development
- Learning as an active process

Research Areas

- Learning for understanding
- Adaptive expertise
- Learning as a time-consuming endeavor

Research

- **Importance of social and cultural contexts**
- **Transfer and the conditions for wide application of learning**
- **Subject matter uniqueness**
- **Assessment to support learning**
- **New educational technologies**

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Teachers and Teaching

- Teaching for In-Depth Learning
- Expert Teachers

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Learning Environments

- Tools of Technology
- Assessment to Support Learning
- Learning and Connections to Community

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2. What are the implications of this research for the design of curriculum, instruction, assessments, and learning environments?

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Implications for Learning

Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information that are taught, or they may learn them for the purposes of a test but revert to their preconceptions outside the classroom.

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Implications for Learning

To develop competence in an area of inquiry, students must:

1. Have a deep foundation of factual knowledge,
2. Understand facts and ideas in the context of a conceptual framework, and
3. Organize knowledge in ways that facilitate retrieval and application.

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Implications for Learning

- A metacognitive approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them.

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Implications for Teaching and Teacher Preparation

- Teachers must draw out and work with preexisting understandings that their students bring with them.

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Implications for Teaching and Teacher Preparation

- Teachers must move from superficial coverage of all topics in science with in-depth coverage of a few topics that allows key concepts in that discipline to be understood.

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Implications for Teaching and Teacher Preparation

- Teachers must come to teaching with the experience of in-depth study of science themselves.

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Implications for Teaching and Teacher Preparation

- The teaching of metacognitive skills should be integrated into the science instructional program.

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Implications for Assessment

- Formative assessments - ongoing assessments designed to make students' thinking visible to both teachers and students - are essential.

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Implications for Assessment

- Assessment for purposes of accountability must test deep understanding rather than surface knowledge.

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Implications for Learning Environment

- Schools and classrooms must be learner centered.

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Implications for Learning Environment

Learning is influenced in fundamental ways by the context in which it takes place. A community-centered approach requires the development of norms for the classroom and school, as well as connections to the outside world, that support core learning values.

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incorporated research into its science education programs?

Two examples:

1. Curriculum development
2. Design of professional development programs for teachers

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Development

of

Research-Based

Curriculum

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Goal: Development of Conceptual Understanding of Science

- Focus on concepts that are appropriate to students' level of cognitive development
- Stress concepts that relate to students' everyday experience
- Maintain a balance between life science, earth science, physical science, and technology

Research

- **Children's ideas about different science concepts**
- **How children learn and learn science at various developmental stages**
- **Important science concepts in life, earth, and physical sciences and their relationship to students' interest, relevance, and how they can be studies in a way that is developmentally appropriate for students at various ages**

Research

- Teachers' backgrounds and needs
- School district needs in terms of cost, equipment and supplies, education goals
- Standards: National and state

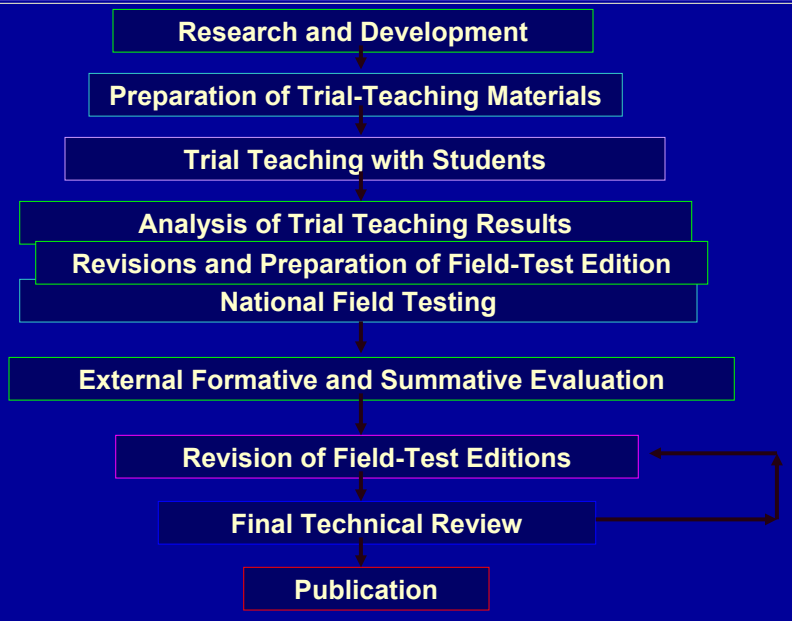
Goal: Development of Scientific Reasoning Skills

1	Observing, Measuring, and Identifying Properties
2–3	Seeking Evidence Recognizing Patterns and Cycles
4–5	Identifying Cause and Effect; Extending the Senses
6–8	Designing and Conducting Controlled Experiments

Goal: Development of Scientific Attitudes and Habits of Mind

- Curiosity
- Respect for evidence
- Critical reflection
- Flexibility
- Sensitivity to living things

Science Materials Research and Development Process



NSRC Curriculum Development Center

NSRC K-8 Science Education Curriculum Programs

GRADE LEVEL	LIFE AND EARTH SCIENCES		PHYSICAL SCIENCES AND TECHNOLOGY	
1	Organisms	Weather	Soils and Liquids	Comparing and Measuring
2	The Life Cycle of Butterflies	Soils	Changes	Balancing and Weighing
3	Plant Growth and Development	Rocks and Minerals	Chemical Tests	Sound
4	Animal Studies	Land and Water	Electric Circuits	Motion and Design
5	Microworlds	Ecosystems	Food Chemistry	Floating and Sinking
6	Experiments with Plants	Measuring Time	Magnets and Motors	The Technology of Paper
7/8	Human Body Systems	Catastropic Events	Properties of Matter	Energy, Machines, and Motion
7/8	Investigating	Earth	Light	Electric Circuits

STC Curriculum

STC / MS Curriculum

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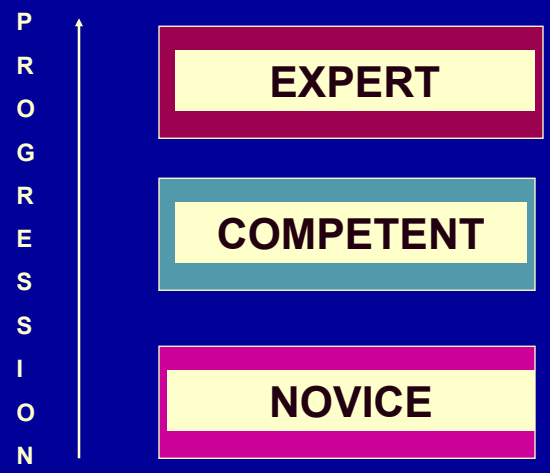
Professional Development

Programs that prepare educators to teach inquiry-centered science and that consider professional growth as a long-term process.

Assessment of Expertise



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Stages of Expertise

Novice

Has acquired some knowledge of factual information about a science discipline, inquiry, and assessment

- Lacks knowledge and experience required to understand the relationship of factual information to science concepts
- Uses instructional strategies that lack an understanding of how students develop conceptual understanding of science concepts

Stages of Expertise

Novice

- Lacks familiarity with practiced routines.
- Performs tasks that are context-free.
- Behaves rationally with little flexibility.

Stages of Expertise

Competent

- Has acquired proficient knowledge of factual information about a science discipline and inquiry
- Understands the relationship of factual information to science concepts
- Lacks the additional knowledge required to have a thorough understanding of the relationship of factual information to science concepts

Stages of Expertise

Competent

- Uses instructional strategies that begin to help students develop conceptual understanding of science concepts while developing critical-thinking and problem-solving skills
- Makes conscious choices about what to teach.
- Sets priorities, goals, and plans.
- Delivers reasonable instruction.

Stages of Expertise

Expert

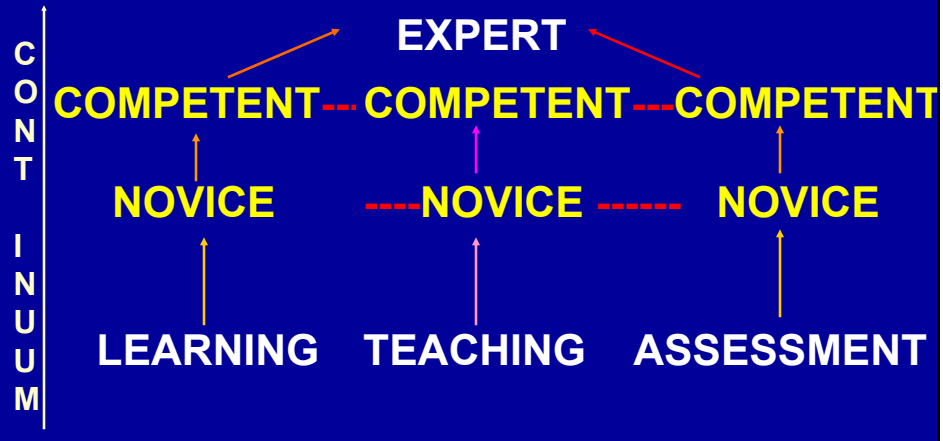
- Has comprehensive knowledge of factual information about a science discipline and inquiry
- Understands the relationship of factual information to science concepts
- Can efficiently use and acquire new information to about important science concepts

Stages of Expertise

Expert

- Consistently uses instructional strategies that are designed to help students develop and assess their understanding of science concepts
- Uses both analytical thought and intuition.
- Shows fluid performance.
- Knows what to do and when to do it.

Development of Expertise



4. What research agenda is needed is needed to bridge the gap of research and educational practice in the implementation of effective science education program

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www.national-academies.org

www.nsrconline.org

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