The Six Strands of Science Proficiency

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Science education should more deeply orient to the multiple dimensions of scientific work. The learning strands provide a relevant framework.

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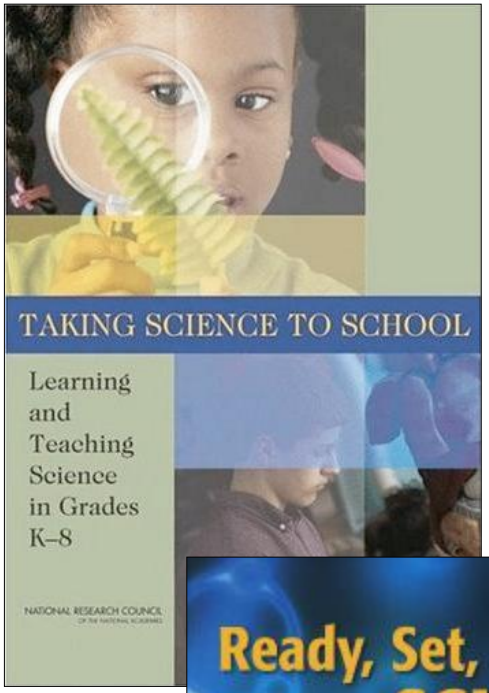

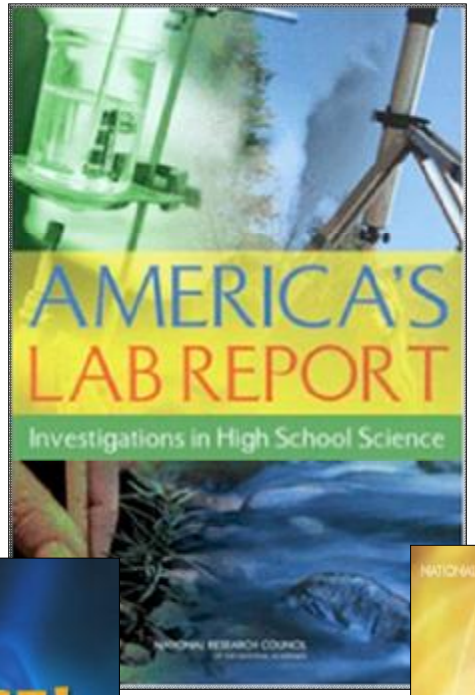

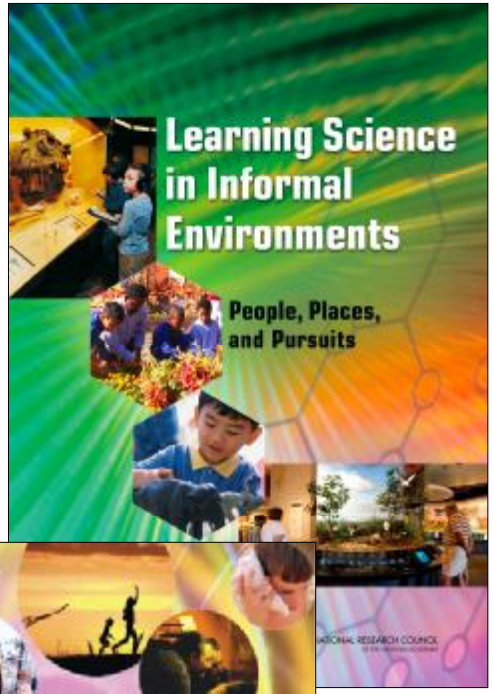

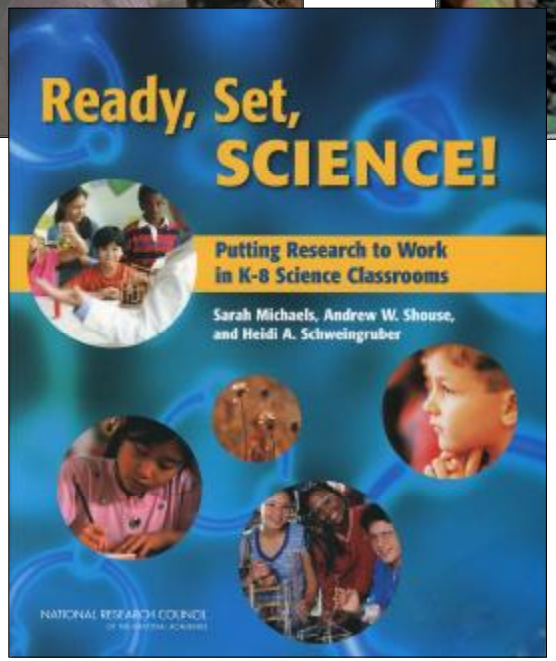

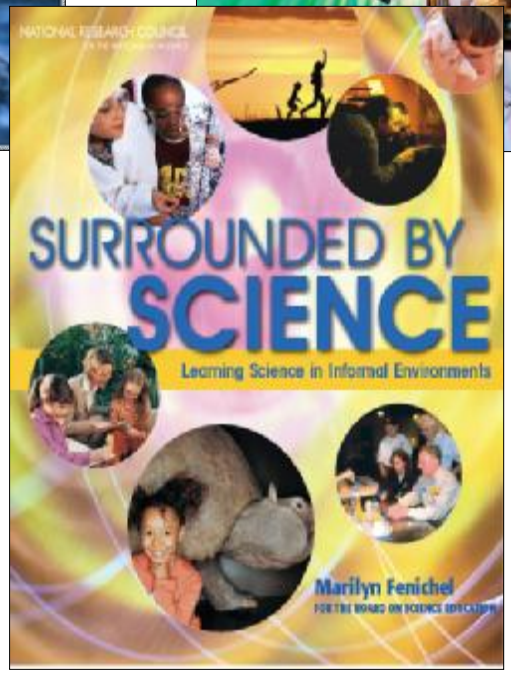

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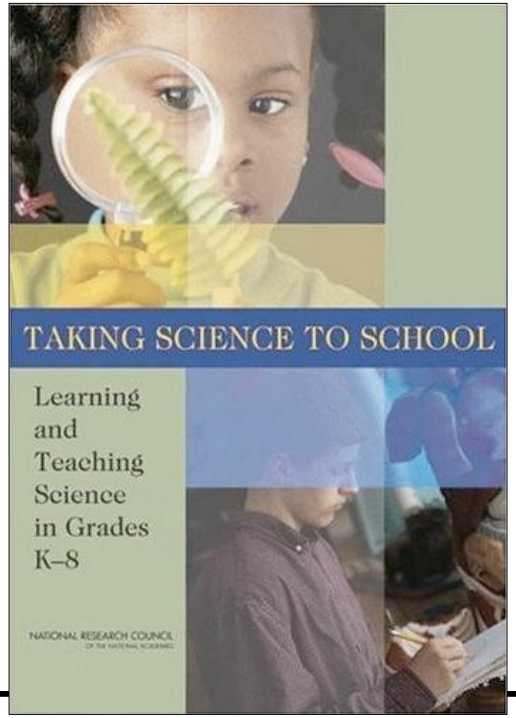
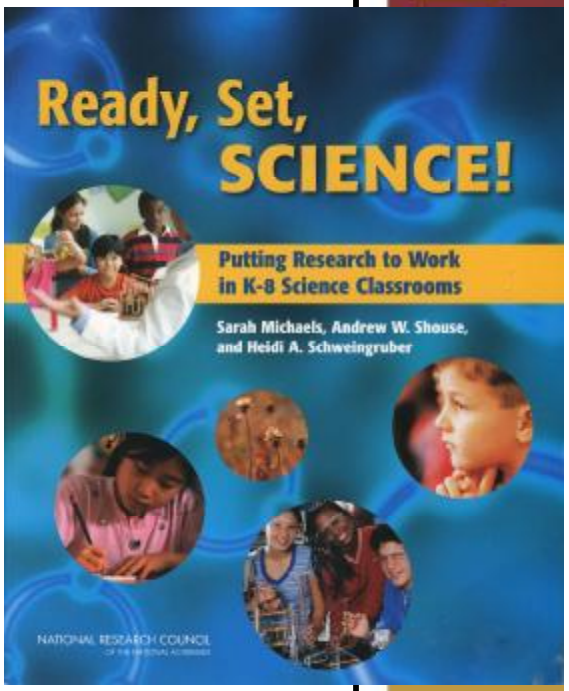
What is Science Learning? Consensus: Six Strands of Scientific Proficiency

1) Developing Interest in Science
2) Understanding and Using Scientific Explanations
3) Generating Scientific Evidence
4) Reflecting on the Scientific Enterprise
5) Engaging in Scientific Practices
6) Identifying with the

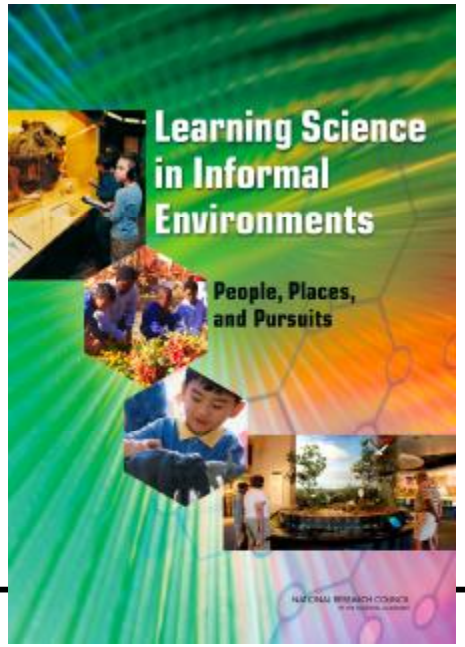
Note: Not separate goals—strands are intertwined in effective learning experiences

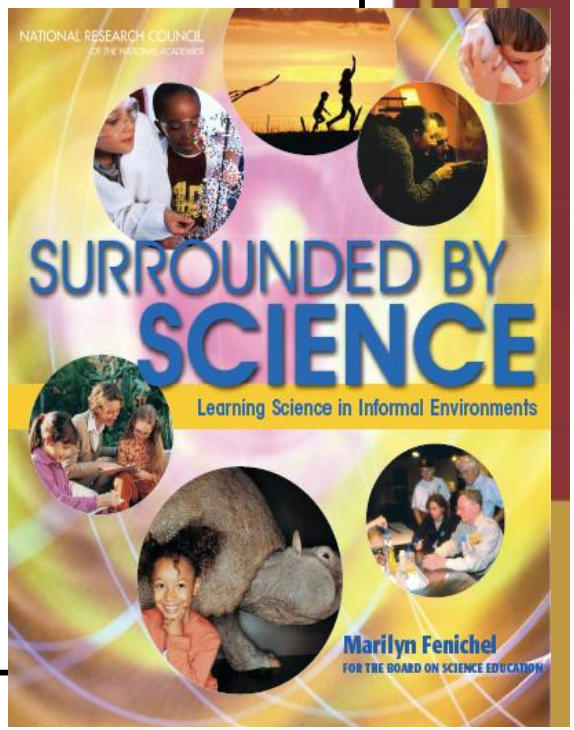
Taking Science to School	*Ready, Set, Science!*
§ **Formal research study** § **Reviews research and evidence on science learning, K-8** § **For academically inclined readers**	§ **Built on findings of TSTS** § **For a practitioner audiences** § **Uses case studies to provide rich illustrations** § **Provides in-depth description of instruction including action to implement changes**

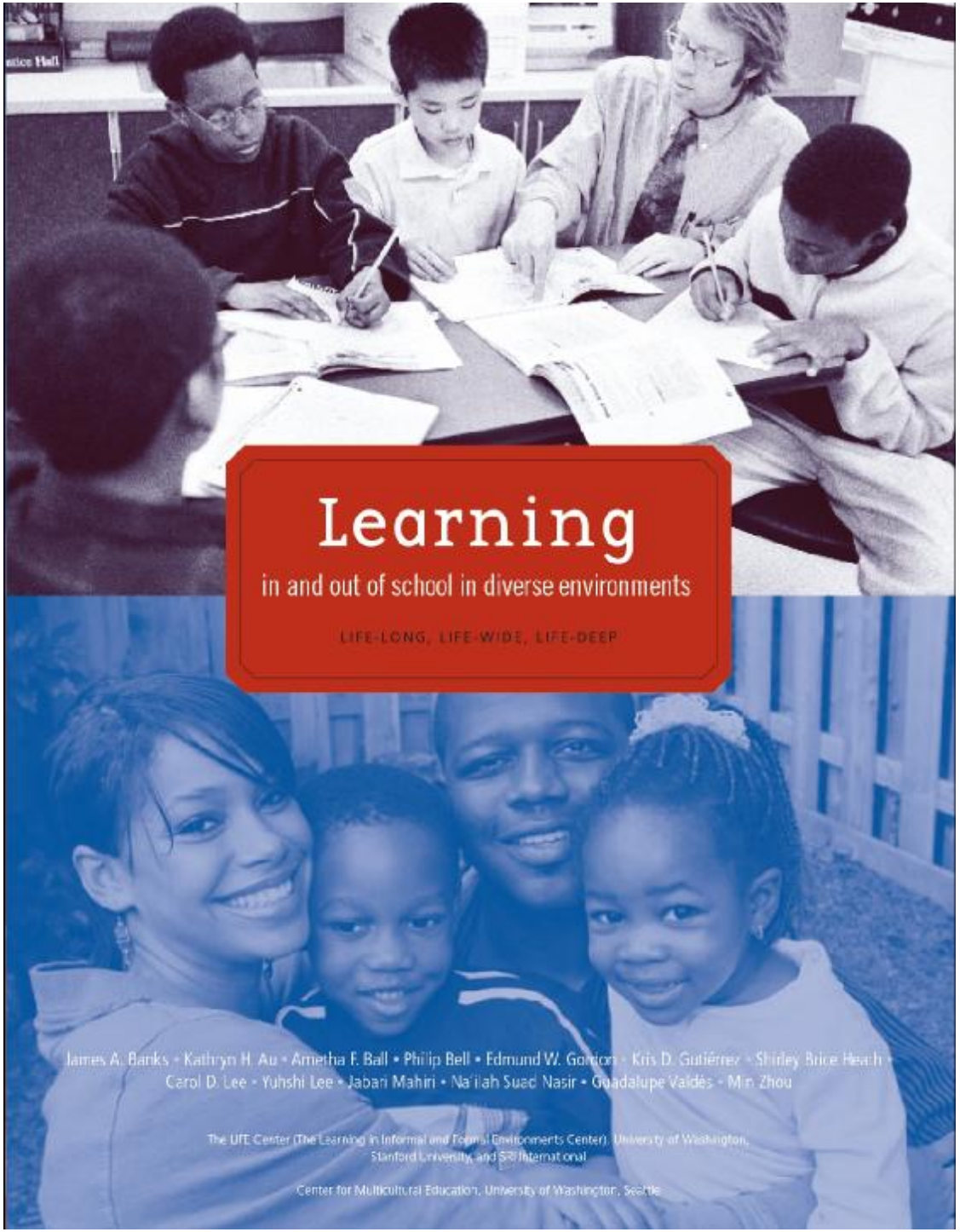




Learning Science in Informal Environments	*Surrounded by Science*
§ Formal research study § Reviews evidence on science learning in wide range of informal environments § For academically inclined readers	§ Built on findings of LSIE § For a practitioner audience § Uses case studies to provide rich illustrations § Provides in-depth description of learning with ways to implement changes





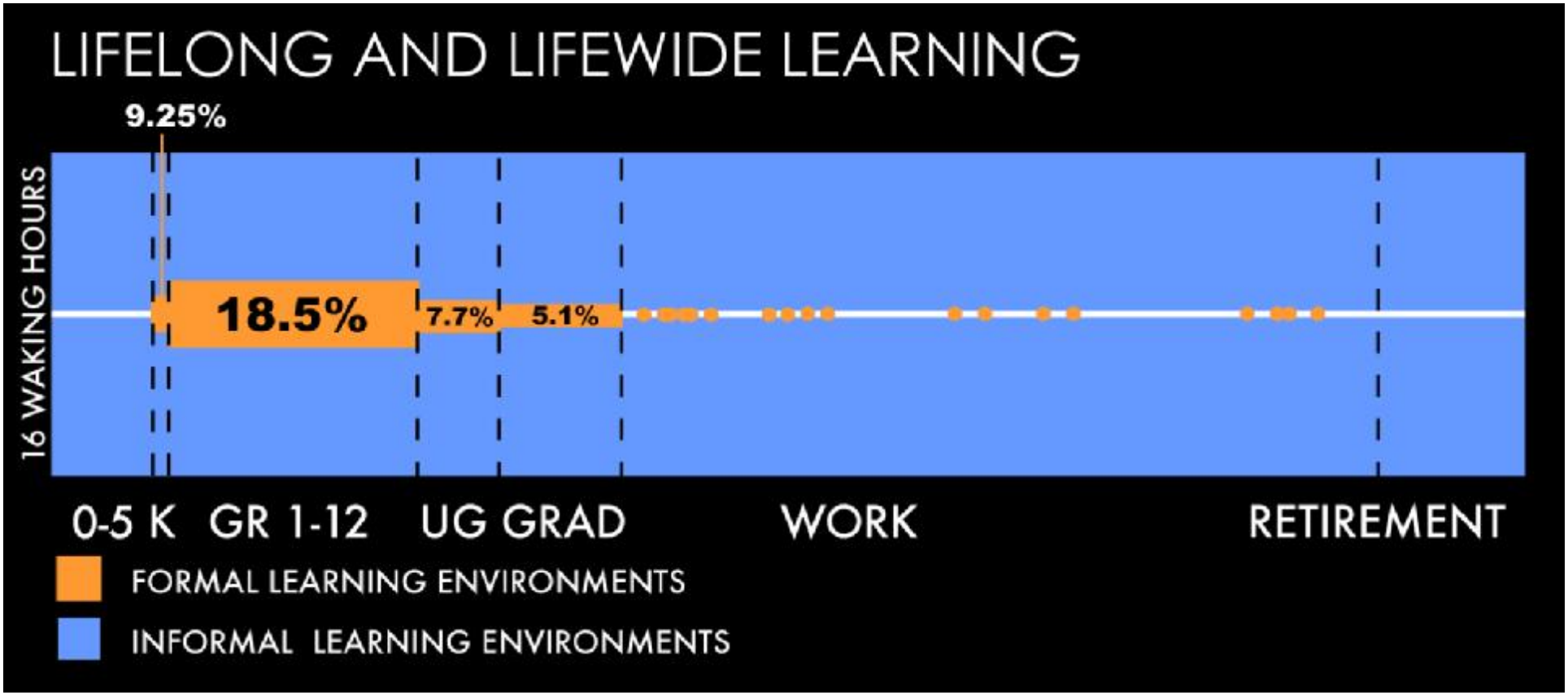


Research Synthesis of Learning In and Out of School in Diverse Communities

- Report synthesizes research on the relation between school and out-of-school learning of diverse students
- Focus on maximizing strengths and building on the educational capital of diverse students, rather than a focus on performance gaps
- Develops 3 concepts, 4 learning principles & policy implications

http://life-slc.org/panel

Life-long, Life-wide & Life-deep Learning



Life-Deep Learning embraces social, religious, moral, and ethical values that guide what people believe, how they act, and how they judge themselves and others. Learning, development, and education are deeply grounded in value systems operating in society—frequently in implicit ways.

Source: Stevens, R. & Bransford, J. in Banks, et al., *Learning In and Out of School in Diverse Environments,* 2007.

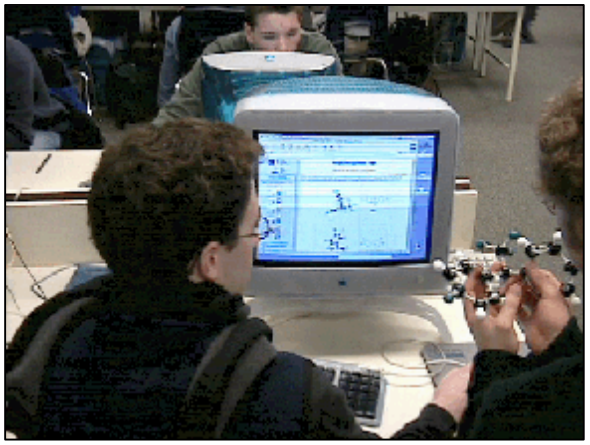
Multiple Venues for Science Learning

Designed Informal Settings

(e.g., Allen & Gutwill, 2004; Callanan & Jipson, 2001; Rennie & McLafferty, 2002)

Everyday Settings & Family Activities

(e.g., Callanan & Oakes, 1992; Crowley & Galco, 2001; Goodwin, 2007; Bell et al., 2006)



Classroom Instruction

(e.g., Barton, et al., 2003; Linn, 2006; Newton, Driver & Osborne, 1999; Reiser et al., 2001; Lehrer & Schauble, 2000)

Programs for Young & Old

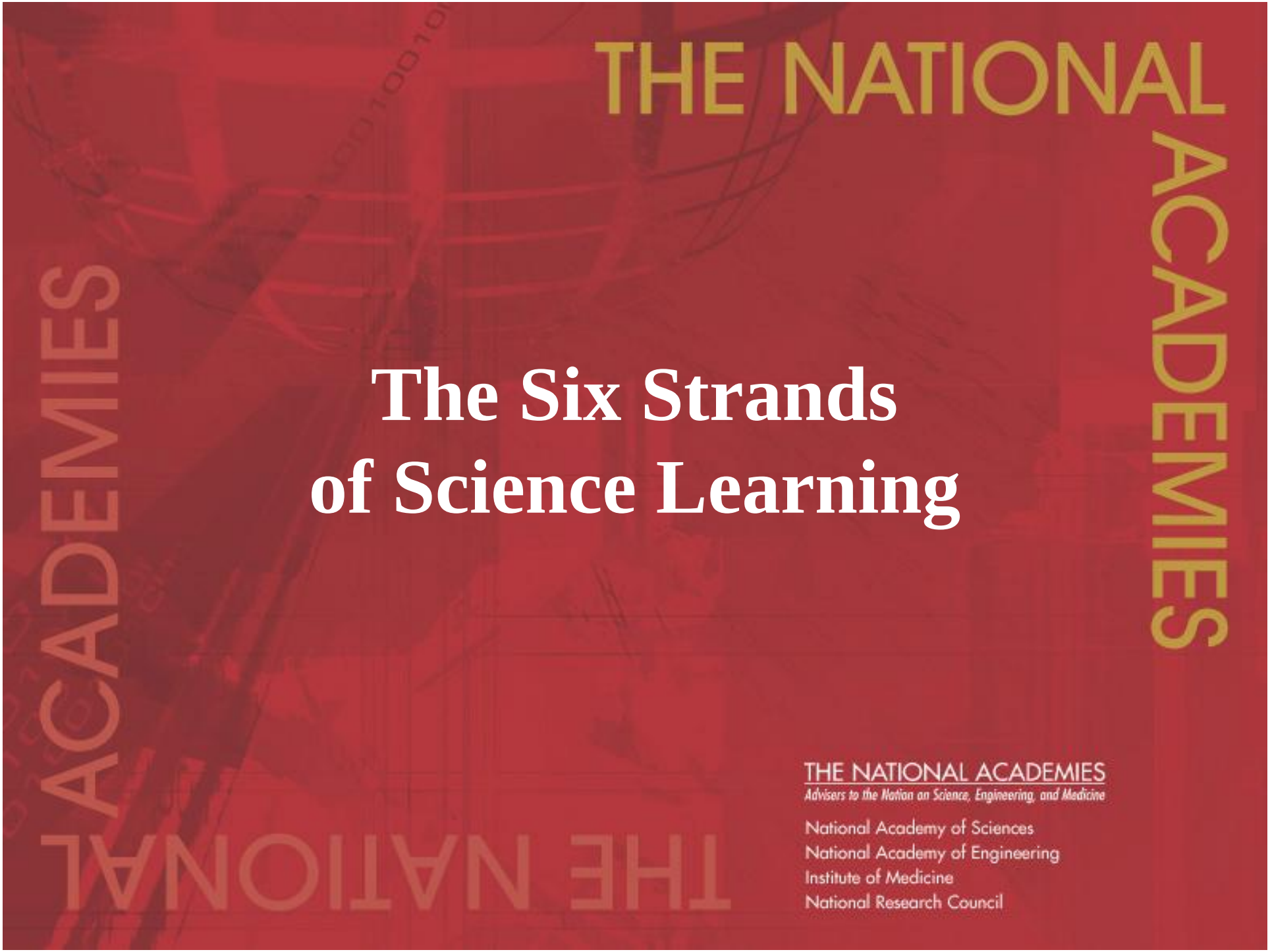
(e.g., Halpern, 2002; Noam, et al., 2003; Gibson & Chase, 2002)

Big Ideas from the K-8 Volume

1. Children starting school are surprising competent. They can think in sophisticated, abstract ways.
2. Prior knowledge and experience are critical; learning is not the result of a straight-forward maturational process.
3. Students learn science by actively engaging in the practices of science.
4. Sustained exploration of a core set of scientific ideas is a promising approach—i.e., learning progressions

Big Ideas from Informal Volume

1. STEM learning is accomplished across a variety of informal and formal venues. It is a *life-long*, *life-wide* and *life-deep* endeavor that includes young and old as well as school and non-school settings.
2. Informal environments can help support STEM workforce development. Importantly, people also develop *STEM literacies* relevant to everyday life through their activities in informal environments.
3. *Cultural diversity* can play a powerful, constructive role in science learning in these (and all) settings. Educators should deeply attend the cultural and personal dimensions of learning and cognition.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Important Ideas in the Strands

- The strands are interwoven in learning. Advances in one strand support advances in the others.
- The strands emphasize the idea of "knowledge in use" – that is students' knowledge is not static and proficiency involves deploying knowledge and skills across all strands.
- Students are more likely to advance in their understanding of science when environments provide learning opportunities that attend to all strands.

6 Strands of Science Learning

Learners who understand science. . .

1: Experience excitement, interest, and motivation to learn about phenomena in the natural and physical world.

2: Come to generate, understand, remember, and use concepts, explanations, arguments, models and facts related to science.

3: Manipulate, test, explore, predict, question, observe, and make sense of the natural and physical world

4: Reflect on science as a way of knowing; on processes, concepts, and institutions of science, and on their own process of learning about phenomena.

5: Participate in scientific activities and learning practices with others, using scientific language and tools.

6: Think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science.

Weaving Together the Six Strands

Ready, Set, Science! includes a set of case vignettes to highlight how research findings relate to classroom practice.

Biodiversity in a City Schoolyard (pp. 22-27)

- 5th Grade predominately low-income urban school, northwestern Mass.
- The class decides to investigate the plants and animals around their school.

Strand 1: Generate Excitement, Develop Interest, and Motivation to Learn about the Natural World

- Through family and school activities, children are brought into repeated, meaningful experiences with the natural world—whether it is around their home or in remote wilderness areas. Many joyfully engage with natural phenomena and experiences that capture their interest and motivate them to learn more about the environment.

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Strand 2: Developing and Using Scientific Explanations, Models and Concepts

- Children begin studying their school yard and neighborhood by identifying the trees, shrubs and flowers. Over time and through investigations and discussion they realize that certain plants are found in certain areas. They begin to develop a conceptual understanding of *habitat*.

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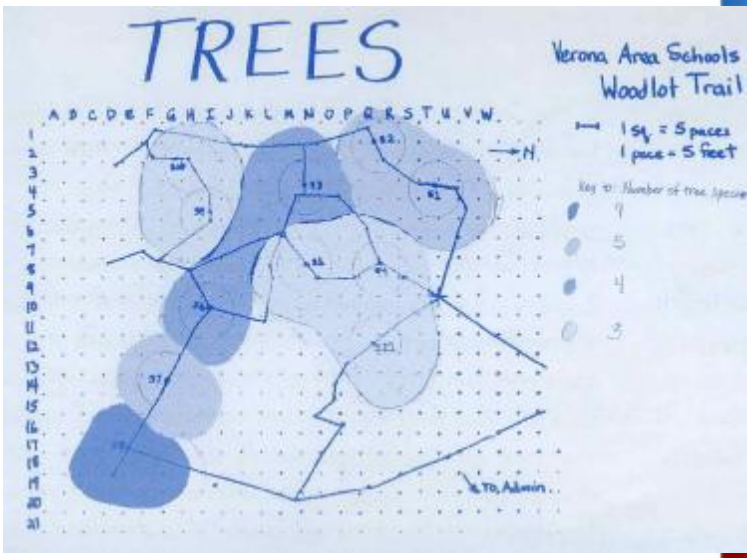
Strand 3: Generating Scientific Evidence, Explanations, and Arguments

- Children begin by mapping the plants they identify. They later divide into groups and carry out investigations of particular plants and animals (trees, weeds, squirrels, etc.).



They encounter problems in how to study the plants or animals and develop strategies for measuring and recording observations and summarizing results. They decide they need to map observations more carefully and begin to develop methods of sampling.

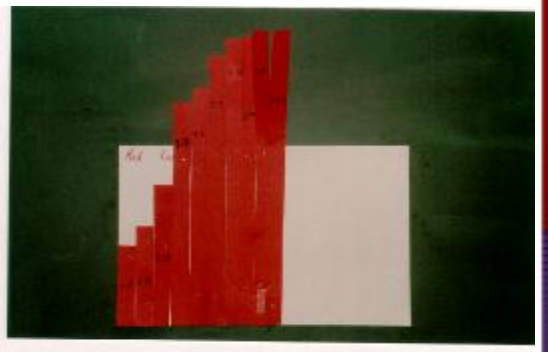
Strand 4: Reflecting on the Scientific Enterprise and Its Role in Society

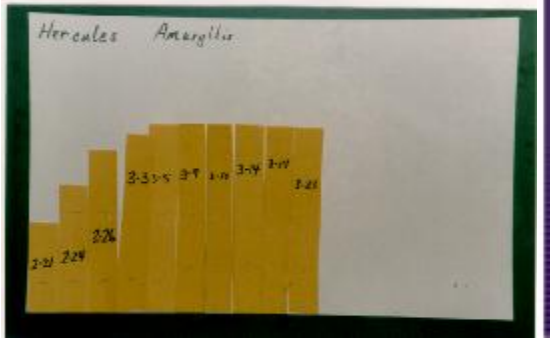
The students notice that the trees on one side of the school yard are taller than on the other. They hypothesize that trees on one side may be older, but they realize that the evidence they gathered about the age of the trees is limited. This leads them to reflect on the quality and limitations of other evidence they have gathered and to question their interpretation of the evidence. They realize that all scientific work might involve these issues.

Strand 5: Participating productively in science practices

- The children refine their data collection protocols and participate in monthly "biodiversity" conferences where they share the results of their ongoing investigations.

They learn how to summarize and present their data, how to develop and present an argument based on empirical evidence, and how to ask appropriate questions, e.g., about interpretations or limitations of the evidence.





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Strand 6: Develop an identity as someone who knows about, uses, and contributes to science

- The children come to identify with the work and knowledge of environmental science as something they understand and can use. Some children start to develop reputations for being knowledgeable about particular aspects of science. Their reputations lead to subsequent learning experiences and ways of being more deeply involved in science.

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Important Ideas in the Strands

- Science learning is multi-faceted (i.e., more than just "content" or facts)
- Broad learning → Broad assessments
- There is overlap in learning goals between informal and formal environments
- There are unique affordances of informal and formal environments & complementarities

Strands are Increasingly Influencing…

- Teacher Education (preservice, inservice)
- Curriculum Development
- Research & Evaluation
- Assessment Design
- Policy Discussions

Building on the strands raises a range of issues…

- Standards should focus on the intertwining of these strands
- Instruction needs to integrate the strands in meaningful, sustained investigations (and not separately treat content & process)
- Assessments should focus on how multiple strands get coordinated during knowledge construction and use

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