National Science Education Standards and Academy of Science for Kids

The Academy of Science for Kids (ASK) is under the creative direction of skilled, professional educators, who utilize the *National Science Standards* to develop insightful and innovative curriculum. The structure, organization, balance and presentation of the *National Science Education Standards* are unique to each Little Professor Science Kit. Each kit is designed to provide hands-on and minds-on activities that will cultivate the skills needed to learn, reason, think creatively, make decisions, and solve problems. ASK Science Kits have a proven track record of producing scientifically literate children—but perhaps more importantly, of producing children who love science.

Included with this overview is a chart showing the National Science Education Standards (NSES) as they correlate with each Little Professor Science Kit.

Feel free to contact Academy of Science for Kids at info@academyofscienceforkids.com if you have any questions.

National Science Education Standards: An Overview

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The *National Science Education Standards* are designed to guide our nation toward a scientifically literate society. Founded in exemplary practice and research, the *Standards* describe a vision of the scientifically literate person and present criteria for science education that will allow that vision to become reality.

Why is science literacy important? First, an understanding of science offers personal fulfillment and excitement—benefits that should be shared by everyone. Second, Americans are confronted increasingly with questions in their lives that require scientific information and scientific ways of thinking for informed decision making. And the collective judgment of our people will

determine how we manage shared resources—such as air, water, and national forests.

Science understanding and ability also will enhance the capability of all students to hold meaningful and productive jobs in the future. The business community needs entry-level workers with the ability to learn, reason, think creatively, make decisions, and solve problems. In addition, concerns regarding economic competitiveness stress the central importance of science and mathematics education that will allow us to keep pace with our global competitors.

In a world filled with the products of scientific inquiry, scientific literacy has become a necessity for everyone. Everyone needs to use scientific information to make choices that arise every day. Everyone needs to be able to engage intelligently in public discourse and debate about important issues that involve science and technology. And everyone deserves to share in the excitement and personal fulfillment that can come from understanding and learning about the natural world.

Scientific literacy also is of increasing importance in the workplace. More and more jobs demand advanced skills, requiring that people be able to learn, reason, think creatively, make decisions, and solve problems. An understanding of science and the processes of science contributes in an essential way to these skills. Other countries are investing heavily to create scientifically and technically literate work forces. To keep pace in global markets, the United States needs to have an equally capable citizenry.

The *National Science Education Standards* present a vision of a scientifically literate populace. They outline what students need to know, understand, and be able to do to be scientifically literate. They describe an educational system in which all students demonstrate high levels of performance, in which teachers are empowered to make the decisions essential for effective learning, in which interlocking communities of teachers and students are focused on learning science, and in which supportive educational programs and systems nurture achievement. The *Standards* point toward a future that is challenging but attainable—which is why they are written in the present tense.

The intent of the *Standards* can be expressed in a single phrase: Science standards for all students. The phrase embodies both excellence and equity. The *Standards* apply to all students, regardless of age, gender, cultural or ethnic background, disabilities, aspirations, or interest and motivation in science. Different students will achieve understanding in different ways, and different students will achieve different degrees of depth and breadth of understanding depending on interest, ability, and context. But all students can develop the knowledge and skills described in the *Standards*, even as some students go well beyond these levels.

By emphasizing both excellence and equity, the *Standards* also highlight the need to give students the opportunity to learn science. Students cannot achieve high levels of performance without access to skilled professional teachers, adequate classroom time, a rich array of learning materials, accommodating work spaces, and the resources of the communities surrounding their schools. Responsibility for providing this support falls on all those involved with the science education system.

Implementing the *Standards* will require major changes in much of this country's science education. The *Standards* rest on the premise that science is an active process. Learning science is something that students do, not something that is done to them. ''Hands-on" activities, while essential, are not enough. Students must have "minds-on" experiences as well.

The *Standards* call for more than "science as process," in which students learn such skills as observing, inferring, and experimenting. Inquiry is central to science learning. When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills.

The importance of inquiry does not imply that all teachers should pursue a single approach to teaching science. Just as inquiry has many different facets, so teachers need to use many different strategies to develop the understandings and abilities described in the *Standards.*

Nor should the *Standards* be seen as requiring a specific curriculum. A curriculum is the way content is organized and presented in the classroom. The content embodied in the *Standards* can be organized and presented with many different emphases and perspectives in many different curricula.

Instead, the *Standards* provide criteria that people at the local, state, and national levels can use to judge whether particular actions will serve the vision of a scientifically literate society. They bring coordination, consistency, and coherence to the improvement of science education. If people take risks in the name of improving science education, they know they will be supported by policies and procedures throughout the system. By moving the practices of extraordinary teachers and administrators to the forefront of science education, the *Standards* take science education beyond the constraints of the present and toward a shared vision of the future.

Hundreds of people cooperated in developing the *Standards*, including teachers, school administrators, parents, curriculum developers, college faculty and administrators, scientists, engineers, and government officials. These individuals drew heavily upon earlier reform efforts, research into

teaching and learning, accounts of exemplary practice, and their own personal experience and insights. In turn, thousands of people reviewed various drafts of the standards. That open, iterative process produced a broad consensus about the elements of science education needed to permit all students to achieve excellence.

Continuing dialogues between those who set and implement standards at the national, state, and local levels will ensure that the *Standards* evolve to meet the needs of students, educators, and society at large. The *National Science Education Standards* should be seen as a dynamic understanding that is always open to review and revision.

The content standards outline what students should know, understand, and be able to do in natural science. The content standards are a complete set of outcomes for students; they do not prescribe a curriculum. Furthermore, implementation of the content standards cannot be successful if only a subset of the content standards is used (such as implementing only the subject matter standards for physical, life, and earth science). The understanding and abilities associated with major conceptual and procedural schemes need to be developed over an entire education, and the unifying concepts and processes transcend disciplinary boundaries. Students' understandings and abilities are grounded in the experience of inquiry, and inquiry is the foundation for the development of understandings and abilities of the other content standards.

Science as inquiry is basic to science education and a controlling principle in the ultimate organization and selection of students' activities. The standards on inquiry highlight the ability to conduct inquiry and develop understanding about scientific inquiry. Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments.

The eight categories of content standards are

1. Unifying concepts and processes in science. The understanding and abilities associated with major conceptual and procedural schemes need to be developed over an entire education. Conceptual and procedural schemes unify science disciplines and provide students with powerful ideas to help them understand the natural world. The objective is to bring together students' many experiences in science education across grades K-12. As an example, early grades should establish what it means to measure and how to use measurement tools, while the upper grades should establish the realization that measurement is important in all scientific endeavors.

2. Science as inquiry. Includes the "processes of science" and requires that students combine processes and scientific knowledge as they use scientific reasoning and critical thinking to develop their understanding of science. Table 6.1 shows the standards for inquiry.

TABLE 6.1. SCIENCE AS INQUIRY STANDARDS

LEVELS K-4	LEVELS 5-8	LEVELS 9-12
Abilities necessary to do scientific inquiry	Abilities necessary to do scientific inquiry	Abilities necessary to do scientific inquiry
Understanding about scientific inquiry	Understanding about scientific inquiry	Understanding about scientific inquiry

3. Physical science. Science subject matter focuses on the science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.

TABLE 6.2. PHYSICAL SCIENCE STANDARDS

LEVELS K-4	LEVELS 5-8	LEVELS 9-12
Properties of objects and materials	Properties and changes of properties in matter	Structure of atoms
Position and motion of objects	Motions and forces	Structure and properties of matter
Light, heat, electricity, and magnetism	Transfer of energy	Chemical reactions
		Motions and forces
		Conservation of energy and increase in disorder
		Interactions of energy and matter

4. Life science. Science subject matter focuses on the science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.

TABLE 6.3. LIFE SCIENCE STANDARDS

LEVELS K-4	LEVELS 5-8	LEVELS 9-12
Characteristics of organisms	Structure and function in living systems	The cell
Life cycles of organisms	Reproduction and heredity	Molecular basis of heredity
Organisms and environments	Regulation and behavior	Biological evolution
	Populations and ecosystems	Interdependence of organisms
	Diversity and adaptations of	Matter, energy, and organization in

	organisms	living systems Behavior of organisms

5. Earth and space science. Science subject matter focuses on the science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.

TABLE 6.4. EARTH AND SPACE SCIENCE STANDARDS

LEVELS K-4	LEVELS 5-8	LEVELS 9-12
Properties of earth materials	Structure of the earth system	Energy in the earth system
Objects in the sky	Earth's history	Geochemical cycles
Changes in earth and sky	Earth in the solar system	Origin and evolution of the earth system
		Origin and evolution of the universe

6. Science and technology. Establish connections between the natural and designed worlds and provide students with opportunities to develop decision-making abilities. They are not standards for technology education; rather, these standards emphasize abilities associated with the process of design and fundamental understandings about the enterprise of science and its various linkages with technology.

TABLE 6.5. SCIENCE AND TECHNOLOGY STANDARDS

LEVELS K-4	LEVELS 5-8	LEVELS 9-12
Abilities to distinguish between natural objects and objects made by humans	Abilities of technological design	Abilities of technological design
Abilities of technological design	Understanding about science and technology	Understanding about science and technology
Understanding about science and technology		

7. Science in personal and social perspectives. An important purpose of science education is to give students a means to understand and act on personal and social issues. The science in personal and social perspectives

TABLE 6.6. SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

LEVELS K-4	LEVELS 5-8	LEVELS 9-12
Personal health	Personal health	Personal and community health
Characteristics and changes in populations	Populations, resources, and environments	Population growth
Types of resources	Natural hazards	Natural resources
Changes in environments	Risks and benefits	Environmental quality
Science and technology in local challenges	Science and technology in society	Natural and human-induced hazards
		Science and technology in local, national, and global challenges

8. History and nature of science. In learning science, students need to understand that science reflects its history and is an ongoing, changing enterprise.

TABLE 6.7. HISTORY AND NATURE OF SCIENCE STANDARDS

LEVELS K-4	LEVELS 5-8	LEVELS 9-12
Science as a human endeavor	Science as a human endeavor	Science as a human endeavor
	Nature of science	Nature of scientific knowledge
	History of science	Historical perspectives

Reviewers are reminded that the content described is not a science curriculum. Content is what students should learn. Curriculum is the way content is organized and emphasized; it includes structure, organization, balance, and presentation of the content in the classroom. Although the structure for the content standards organizes the understanding and abilities to be acquired by all students K-12, that structure does not imply any particular organization for science curricula. As science advances, the content standards might change, but the conceptual organization will continue to provide students with knowledge, understanding, and abilities that will improve their scientific literacy.

The *National Science Education Standards* envision change throughout the system. The science content standards encompass the following changes in emphases:

LESS EMPHASIS ON	MORE EMPHASIS ON
Knowing scientific facts and information	Understanding scientific concepts and developing abilities of inquiry
Studying subject matter disciplines (physical, life, earth sciences) for their own sake	Learning subject matter disciplines in the context of inquiry, technology, science in personal and social perspectives, and history and nature of science
Separating science knowledge and science process	Integrating all aspects of science content

Covering many science topics	Studying a few fundamental science concepts
Implementing inquiry as a set of processes	Implementing inquiry as instructional strategies, abilities, and ideas to be learned
CHANGING EMPHASES TO PROMOTE INQUIRY	
LESS EMPHASIS ON	MORE EMPHASIS ON
Activities that demonstrate and verify science content	Activities that investigate and analyze science questions
Investigations confined to one class period	Investigations over extended periods of time
Process skills out of context	Process skills in context
Emphasis on individual process skills such as observation or inference	Using multiple process skills—manipulation, cognitive, procedural
Getting an answer	Using evidence and strategies for developing or revising an explanation
Science as exploration and experiment	Science as argument and explanation
Providing answers to questions about science content	Communicating science explanations
Individuals and groups of students analyzing and synthesizing data without defending a conclusion	Groups of students often analyzing and synthesizing data after defending conclusions
Doing few investigations in order to leave time to cover large amounts of content	Doing more investigations in order to develop understanding, ability, values of inquiry and knowledge of science content
Concluding inquiries with the result of the experiment	Applying the results of experiments to scientific arguments and explanations
Management of materials and equipment	Management of ideas and information
Private communication of student ideas and conclusions to teacher	Public communication of student ideas and work to classmates