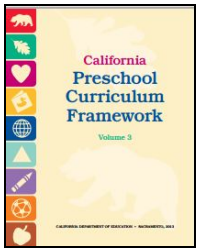
Science Domain



Guiding Principles

Guiding Principles	Page # (PCF, Vol. 3)	Notes/Ideas
The preschool environment supports children's curiosity and encourages inquiry and experimentation.	p. 138	
Content of inquiry is developmentally appropriate and builds on children's prior experiences.	p. 139	
Scientific inquiry experiences are interesting and engaging for children and teachers.	p. 139	
Children explore scientific concepts directly through active, hands-on, minds-on playful experiences.	p. 139	
Children explore scientific concepts in depth through multiple, related learning experiences over time.	p. 140	
Children construct knowledge through social interactions with peers and adults.	p. 140	
Children use language and other forms of communication to express their thoughts, describe observations, and document their work.	p. 140	
Teachers support children who are English learners in understanding and communicating scientific knowledge and skills.	p. 140	
Science is embedded in children's daily activities and play and provides a natural vehicle for integrating mathematics, literacy, and other content areas.	p. 141	
Individual differences are recognized, and all children are included and supported.	p. 141	
The preschool environment, home, and community are connected through science.	p. 141	

NSTA Position Statement:
The Next Generation Science Standards

I. Introduction

It is essential that *all* students have access to a high-quality science education that provides them with the skills and knowledge they need to be well-informed citizens, to be prepared for college and careers, and to understand and appreciate the scientific enterprise. The National Science Teachers Association (NSTA) recommends the adoption and implementation of the *Next Generation Science Standards* (*NGSS*; NGSS Lead States 2013) as an effective, research-based approach to accomplish these goals and transform science education.

From health care to environmental stewardship, a countless number of personal and societal issues require citizens to make informed decisions based on their understanding of science and technology. Today's modern workforce depends on individuals with scientific and technological skills (NRC 2010; NSB 2010). Research shows, however, that we are not preparing all students to achieve high levels of science performance (USDOE 2011); we are failing to graduate enough students with the skills needed to fill the growing number of jobs in science, technology, engineering, and mathematics (STEM) (NRC 2010); and many members of our society do not command the scientific literacy necessary to address important societal issues and concerns (NCES 2010).

Science education traditionally has focused on large volumes of content, primarily basic facts and vocabulary, while falling short on the deeper understanding of key scientific concepts and the application of these concepts to daily life. The *NGSS* calls for refocusing K–12 science to improve college preparation, STEM career readiness, and the ability of all members of society to make informed decisions.

II. Conceptual Shifts in the *NGSS*

The *NGSS* is based on *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (*Framework*; NRC 2012) and is intended to reflect a new vision for science education. The *NGSS* establishes seven conceptual shifts that demonstrate what is new and different about the *NGSS* compared with how science is being taught in many classrooms (See *NGSS* Appendix A). These shifts, as well as NSTA's interpretation of them, are listed below:

1. **K–12 science education should reflect the interconnected nature of science as it is practiced and experienced in the real world.**
   One of the most significant shifts of the *NGSS* is the recommendation that students engage in science learning at the nexus of three dimensions: science and engineering practices, crosscutting concepts, and disciplinary core ideas. Because many state and district standards address these dimensions separately, it will take a considerable effort to embrace this new vision in the implementation of the *NGSS*, including instruction, curriculum, assessment, and teacher preparation and professional development.

2. **The *NGSS* are student performance expectations, not curriculum.**
   The individual standards within the *NGSS* include performance expectations and the foundation boxes that include the science and engineering practices, disciplinary core ideas, and crosscutting concepts. The performance expectations are intended to aid the process of assessment by clarifying what students should be able to know and do at the end of the grade or grade band. They do not prescribe curriculum or lessons. The *NGSS* does not define what constitutes "the standard." According to the *NGSS (NGSS* Lead States 2013, p. xxiii) some states consider "the standard" to be the performance expectations alone, while others also include the content of the three foundation boxes and connections. NSTA recommends that "the standard" be defined as the combination of the performance expectations and the contents of the foundation boxes.

3. **The science concepts in the *NGSS* build coherently from kindergarten through 12th grade.**
   The *Framework* states "to develop a thorough understanding of scientific explanations of the world, students need sustained opportunities to work with and develop the underlying ideas and to appreciate those ideas' interconnections over a period of years rather than weeks or months" (NRC 2012, p. 10). The *NGSS* supports this vision by providing learning goals that progress over the years and become more complex.

4. **The *NGSS* focus on deeper understanding of content as well as application of content.**
   The intent of the *NGSS* is to focus on a smaller, more teachable number of disciplinary core ideas that students should know by the time they graduate from 12th grade. It is important that the focus be put on the core ideas, rather than the countless number of facts and details associated with them. It is also important to recognize that the core ideas called for in the *NGSS* are more demanding than the content in many state science standards. In addition, NGSS calls for students to develop proficiency with the practices and use crosscutting concepts, which adds to the rigor.

5. **Science and engineering are integrated in the *NGSS*, from kindergarten through 12th grade.**
   Integrating engineering and technology into science standards is not a new concept, but these important subjects have failed to receive the attention they need and deserve. Investigations in technology and engineering "provide opportunities for students to deepen their understanding of science by applying their developing scientific knowledge to the solution of practical problems" (see *NGSS*, Appendix A). The *NGSS* elevates the importance of engineering and technology by integrating them into the standards.

6. **The *NGSS* is designed to prepare students for college, career, and citizenship.**
   The *NGSS* Appendix A states that "all students no matter what their future education and career path must have a solid K–12 science education in order to be prepared for college, careers, and citizenship." Other standards efforts have promoted standards for all students, but we have yet to achieve that goal. NSTA's mission echoes this imperative and we fully support standards that are for *all* students, not just those destined for careers in science and technology. The demanding and rigorous content in the NGSS can provide a solid foundation for students entering a variety of STEM fields. Many teachers and schools, however, may choose to provide additional and advanced expectations for students.

7. **The *NGSS* and *Common Core State Standards* (English language arts and mathematics) are aligned.**
   Science is a key component of a complete and rigorous curriculum for all students. The *NGSS* works in tandem with *Common Core State Standards* in mathematics and English language arts to facilitate integrated teaching and learning. Because of this essential connection that supports student learning, NSTA recommends the adoption of the *Common Core State Standards* by states and school districts.

A number of additional appendixes provide insight and guidance regarding key components of the *NGSS* and address a variety of important issues related to its successful implementation, such as equity, model courses, nature of science, and college and career readiness. NSTA recommends that all stakeholders have a working knowledge of these important and supportive appendixes. (see *NGSS* Appendixes B-M).

III. Implementation of the *NGSS*

Achieving the goals of the *NGSS* will take a long-term systemic effort that requires significant changes in instruction, curriculum, assessment, teacher preparation and professional development, accompanied by extensive financial, administrative, and public support. It will also depend on all stakeholders at the local, district, and state level assuming a shared and collaborative responsibility for helping realize the goals of the *NGSS*. The responsibility for implementation cannot and should not be vested solely in teachers and other school-based personnel. To achieve the goals of the *NGSS*, NSTA describes the desired state of the components of implementation and the recommended roles and responsibilities of the key stakeholders that are necessary to achieve successful implementation with fidelity of the *NGSS* in schools, districts, and states.

Adoption

Adoption is an important step in the implementation of the *NGSS*. Only with widespread state and local district adoption can the goal of common standards for all students in the nation be achieved.

Preparation for Implementation

For many school districts and teachers, both the number and degree of changes required to implement the *NGSS* will be significant. A considerable amount of preparation time is needed—before and after formal adoption—for science educators and school leaders to understand the changes or shifts, participate in the professional development or growth to support the changes, run trial or pilot work, and initiate the changes. Time is also needed to evaluate educators' growth and improvement and provide feedback as they work to become proficient in the new *NGSS*-based strategies, materials, and assessments. This dedicated time before full implementation is essential and will build awareness and understanding among stakeholders, while helping educators fully prepare for the *NGSS*.

An important starting point in understanding the goals, structure, and use of the *NGSS* is the *Framework*. **NSTA recommends that the *Framework* be considered an essential companion document to the *NGSS* and be fully understood and used as the foundation of the standards.**

Components to Achieve Full Implementation

NSTA considers full implementation of the *NGSS* to include the complete scope of changes or modifications necessary in all components of the K–12 science education system to support student accomplishment of the *NGSS* expectations. These components include instruction, curriculum, assessment, teacher preparation, and professional development, accompanied by extensive financial, administrative, and public support.

The components that follow are interdependent and should be aligned in a coherent manner. For the purposes of this statement, however, they are presented separately.

Instruction

Teaching and learning are at the heart of quality science education. All students can develop science proficiency if the instruction provides them with opportunities for a range of scientific investigations and thinking, including—but not limited to—inquiry and investigation, collection and analysis of evidence, logical reasoning, and communication and application of information. The vision of the *Framework* and the *NGSS* is to engage students in the core ideas through the integration of science and engineering practices while making connections to the crosscutting concepts. Instruction, although varied in nature, should provide student proficiency in the following four strands (NRC 2007) and their related dimensions in the *Framework* and the *NGSS*:

- Knowing, using, and interpreting scientific explanations of the natural world (disciplinary core ideas and crosscutting concepts)
- Generating and evaluating scientific evidence and explanations (practices)
- Participating productively in scientific practices and discourse (practices)
- Understanding the nature and development of scientific knowledge (practices and crosscutting concepts)

Curriculum

A major goal of the *NGSS* and an expectation for its successful implementation is for students to build and apply ideas in a coherent manner or progression within each year or course, and over the 13 years of their K–12 educational experience. It is important for all stakeholders to understand that the *NGSS* is a set of standards and *do not* dictate a particular curriculum nor advocate for the use of specific instructional materials. It is the task of states and/or districts to establish a curriculum and to develop and/or select instructional materials aligned with the *NGSS*. Aligned materials integrate the three dimensions of scientific and engineering practices, disciplinary core ideas, and crosscutting concepts. A curriculum that is aligned provides a sequence of topics within each grade and grade band from kindergarten to grade 12 that is consistent with the progression of core ideas from the *NGSS*. This, most likely, will require a significant change in the structure of courses and the total K–12 curriculum sequence that currently exists. Appendix K of the *NGSS* provides extensive guidance in this process.

Assessment

The *NGSS* performance expectations describe what students should know and be able to do within each grade level or grade band for the purposes of assessment. A significant effort is needed to use these performance expectations to modify and guide the development of classroom/formative and high-stakes summative assessments at all levels of an assessment system (classroom, school, district, state, and national). It is important to use assessments to ensure that students achieve the vision of the *Framework* as expressed in the *NGSS* at each grade level or grade band. The use of performance expectations that integrate practices, disciplinary core ideas, and crosscutting concepts in developing assessment tasks will be new and unique to most educators.

Teacher Preparation and Professional Development

The continuum of teacher development from initial preparation through ongoing professional development is a critical factor in delivering the quality of instruction called for in the *Framework* and the *NGSS*. Teachers need a thorough understanding of the disciplinary core ideas and practices they are expected to teach, how students learn them, and the range of instructional strategies that can support student learning.

Implementing the *NGSS* requires that experienced teachers make a significant shift in the content and manner in which they have been teaching and that beginning teachers make a shift from how they were taught at the university level. For many teachers a modification in the content knowledge and competencies will need to be made. To support the implementation of the *NGSS*, teachers are required to demonstrate the ability to

- master the science and engineering content in the *NGSS* at the grade level/band they teach;
- integrate the three dimensions of science and engineering practices, disciplinary core ideas, and crosscutting concepts in instruction and classroom assessment, instead of teaching them separately;
- organize, maintain, and use instructional materials in student investigations in a safe and effective manner;
- facilitate appropriate and effective discourse and argumentation with and among students;
- integrate engineering design concepts into science instruction;

- collaborate with mathematics and English language arts teachers to capitalize on the recommendations in the *NGSS* connection to *Common Core State Standards*;
- assess and monitor student movement along the progressions within a year or course and over the entire K–12 experience; and
- provide support and remediation for those students falling behind in their achievement of the expected progression and additional challenges for students who are ready to move ahead in the progression.

In addition to the unique challenges of implementing new science standards, all teachers will continue to face the daily educational requirements to

- participate in the evaluation of instructional materials aligned with the content of the *NGSS*;
- differentiate instruction so that all students, including those who are struggling and those who are exceling, are properly supported and challenged;
- maintain a classroom atmosphere that stimulates the affective dimension of learning; and
- use technology to enhance student learning.

IV. Declarations

NSTA supports the vision described in the *Framework* and recommends the adoption and implementation of the *NGSS*. All stakeholders carry a significant responsibility for the successful implementation of the *NGSS*. NSTA recommends that these stakeholders assume the following roles and responsibilities.

State and District Policy Makers

It is essential for state and district policy makers (state legislatures; state and local boards of education; and in many cases, the governing bodies of cities) to

- establish policies and regulations that ensure a coherent system of curriculum and assessment;
- allow ample time for teachers, educators, and administrators to carefully, deliberately, and reflectively participate in and carry out a process for planning and implementing the *NGSS*;
- support the adoption of the *NGSS* with fidelity to the original document and commit the resources and support necessary to fully implement them;
- develop district and state policies and regulations for both formal and informal education that are consistent with and supportive of the expectations in the *NGSS* and the vision of the *Framework*;
- allocate the necessary funds so that science programs can be executed as designed and completed in the agreed-upon time period; and
- provide technical and financial support at the state and local levels to create assessments consistent with the NGSS.

Administrators

At the state, district, and school level it is essential for administrators (science coordinators, department chairs, principals, assistant superintendents, and superintendents) to

- monitor student progress within grade levels or courses from year to year;
- provide remedial support for students who fall behind the expected progression of achievement, while also ensuring that all students are challenged;
- provide coaching, professional development, and instructional materials that are coherent with the *NGSS*;
- allocate the necessary funds so that science programs can be executed as designed and completed in the agreed-upon time period;
- ensure that the quality of facilities, equipment, and technology needed for implementation of the *NGSS* are provided;
- ensure that funds are allocated and the procedures for obtaining needed science supplies are clear and well defined;
- advocate for the value of and support for the *NGSS* in the school, district, and community;
- give science educators the instructional time and resources they need to meet the expectations of implementing the instruction and curriculum described in the *Framework* and the *NGSS*; and
- provide technical and financial support at the state and local levels to create assessments consistent with the *NGSS*.

Science Educators

K–12 science educators, including teachers in both formal and informal settings, are central to the successful implementation of the *NGSS*. It is imperative for them to

- embrace the vision of the *Framework* to improve science education—independent of state or district decisions regarding adoption—by incorporating the best practices established by the *NGSS* through the enhancement of instruction, curriculum, professional development, and the selection or development of instructional materials;
- provide opportunities for students to be actively involved in a variety of scientific investigations that integrate the three dimensions resulting in an increased student understanding of science and engineering concepts;
- engage all students through the use of scientific and engineering practices to strengthen connections to the core concepts;
- be aware of the conceptions that students bring to class and the instruction needed to build on and/or modify them;
- maintain a classroom atmosphere that supports and reinforces the attitude of reflection, respect for logical thinking, and consideration of scientifically based alternate explanations;
- provide remedial support for students who fall behind the expected progression of achievement, while also ensuring that all students are challenged;
- participate in the selection and/or design of instructional materials aligned with the *NGSS*; and
- participate in professional development opportunities designed to support the implementation of the *NGSS*.

Community Members

At the local level it is essential for community members (parents, business leaders, and other members of the community) to

- support science teachers and administrators in making the changes called for in instruction, curriculum, and assessment;
- support the use of new instructional materials that support the use of new course content and curriculum design that are aligned with the *NGSS*;
- provide significant administrative and community support to promote the understanding and acceptance of new course content and course placements;
- work in partnership with schools and/or districts to give teachers opportunities to learn about the cultural fabric of the community; and
- help secure resources to support the successful implementation of the *NGSS.*

Higher Education Professors and Administrators

The administration and faculty of higher education—in both schools of education and schools of arts and sciences—are responsible for the initial preparation of science teachers and they share the responsibility with local school districts to provide ongoing professional development. Therefore, it is essential for professors and administrators at institutions of higher education to

- fully understand the *NGSS* and its implication for the institution's requirements for courses, majors, certification, and graduation;
- be familiar with the performance expectations, and the learning progressions that underlie them, so that college instruction builds on the knowledge and skills that students gain through NGSS;
- coordinate with local schools to ensure science educators have the abilities and skills to succeed in the schools;
- work with local school personnel to provide additional support for new teachers of science;
- design and deliver science content courses using methods that model effective uses of the science and engineering practices; and
- use instructional strategies in arts and sciences content courses and methods courses that are necessary for students to achieve an understanding of the *NGSS* content.

V. Historical Background and the Development Process for the *NGSS*

Writers of *Science for All Americans* (AAAS 1989) were the first to clearly define the "understandings and ways of thinking [that] are essential for all citizens in a world shaped by science and technology." Standards efforts responding to this initiative included *Benchmarks for Science Literacy* (AAAS 1993) and the *National Science Education Standards* (NRC 1996).

Since then, major advances have been made in both the world of science and in our understanding of how students learn science effectively (NRC 1999; NRC 2012, pp. 80–82). Among this research is strong evidence that "…learning about science and engineering involves integration of the knowledge of scientific explanations (i.e., content knowledge) and the

practices needed to engage in scientific inquiry and engineering design." It also concludes "knowledge and practice must be intertwined in designing learning experiences in K–12 science education" (NRC 2012, p. 11). To achieve the goals of science literacy, new science standards are needed to reflect this expanded body of knowledge, including the premise that students can only fully understand the disciplinary core ideas by engaging in the practices.

The National Research Council, Achieve, the National Science Teachers Association, and the American Association for the Advancement of Science became lead partners in the two-part process to develop next generation science standards with funding from the Carnegie Corporation of New York. The work involved numerous science teachers, among many other stakeholders, and was informed by NSTA's early work on a science standards effort called Science Anchors.

A National Research Council (NRC) expert committee was charged during the first part of the process to establish the foundation for new standards. In 2012 the NRC published *A Framework for K–12 Science Education* (NRC 2012) based on research on teaching and learning science, as well as on the latest efforts to establish "foundational knowledge and skills for K–12 science and engineering." The *Framework* recommends that new science standards reflect this knowledge and be built around three major dimensions: practices used by scientists and engineers to engage in scientific inquiry and engineering design, content that includes a limited number of core ideas in four disciplinary areas, and crosscutting concepts that provide overarching connections among all sciences. The *Framework* elevates the role of scientific and engineering practices as the means to foster a deep, rich understanding of science and technology.

The second part of the process was the development of new standards that reflect the vision of the *Framework*. In a process facilitated by Achieve, Inc., 26 states led this effort and worked collaboratively with a 41-member writing team—many of them teachers—and with stakeholders in science, science education, higher education, industry, and others. All stakeholders were invited to review and comment on two public drafts. NSTA supported the effort by recommending science teachers for the writing team, submitting extensive reviews by teams of science educators from across the country, and providing additional insight and guidance along the way. The *Next Generation Science Standards* were released in April 2013. The new K–12 standards are presented by grade levels in kindergarten through fifth grade and by grade bands for middle and high school.

—Adopted by the NSTA Board of Directors
November 2013

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