# Introduction to the New York State P-12 Science Learning Standards

Department staff in collaboration with various stakeholders in science education across the state have engaged in a multi-tier process over several years (2010-2016) to develop New York State P-12 Science Learning Standards (NYSP-12SLS). The Statewide Leadership Team, Science Education Steering Committee, and Science Education Consortium have served in a formal advisory capacity to Department staff throughout the development process. The Department also gleaned important information from two public surveys; summer 2013 compared prior state science standards to the Next Generation Science Standards using a set of criteria, and a public survey (opened December 8, 2015-closed February 8, 2016) on the draft NYSP-12SLS based on the same criteria. In conjunction with the three committees, Department staff worked alongside members to analyze quantitative and qualitative survey data and feedback to determine the necessary changes included in the current revised NYSP-12SLS under consideration and posted on the Department's website.

The NYSP-12SLS are based on guiding documents grounded in the most current research in science and scientific learning; and reflect the importance of every student's engagement with natural scientific phenomenon at the nexus of three dimensions of learning; Science and Engineering Practices, Disciplinary Core Ideas, and Cross-cutting concepts; A Framework for K-12 Science Education[1] and the Next Generation Science Standards[2].

In the recent 2015 report, Revisiting the STEM Workforce by the National Science Board[3], it is stated that "the STEM workforce is extensive and critical to innovation and competitiveness" and careers in these fields will only grow in the next decade making it essential for accessibility to equitable learning opportunities for all students to benefit. Over the past several decades as well as recently, streams of research studies, reports, policies, and publications also document the under participation and often limited preparedness of many students across the United States in science, limiting inclusive opportunities to enter the Science, Technology, Engineering, and Mathematics (STEM) workforce and college pathways.

It is in this context that the proposed new state learning standards in science are well positioned to strengthen P-12 science education in our classrooms for all our students. As with any set of instructional standards, they need to be rigorous; they need to demand a balance of conceptual understanding and application and represent a significant level of achievement in science that will enable students to successfully transition to post-secondary education and the workforce.

## Context for Revision of the NYS P-12 Science Learning Standards

### Changing expectations for scientific achievement

Today's children are growing up in a world very different from the one even 15 years ago. Seismic changes in the labor market mean that we are living and working in a knowledge-based economy—one that demands advanced literacy and Science, Technology, Engineering and Mathematics (STEM) skills, whether for application in the private or public sector. Today, information moves through media at lightning speeds and is accessible in ways that are unprecedented; technology has eliminated many jobs while changing and creating others, especially those involving mathematical and conceptual reasoning skills. One characteristic of these fast-growing segment of jobs is that the employee needs to be able to solve unstructured problems while working with others in

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[1]National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press.
[2] National Research Council. (2013). *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.
[3] National Science Board. (2015). *Revisiting the STEM Workforce*. Arlington, VA: National Science Foundation.

teams. At the same time, migration and immigration rates around the world bring diversity to schools and neighborhoods. The exponential growth in interactions and information sharing from around the world means there is much to process, communicate, analyze and respond to in the everyday, across all settings. For a great number of jobs, conceptual reasoning and technical writing skills are integral parts to the daily routine.

To prepare students for the changes in the way we live and work, and to be sure that our education system keeps pace with what it means to be scientifically literate and what it means to collaboratively problem solve, we need a different approach to daily teaching and learning. We need content-rich standards that will serve as a platform for advancing children's 21st-century science skills —their abstract reasoning, their collaboration skills, their ability to learn from peers and through technology, and their flexibility as a learner in a dynamic learning environment. Students need to be engaged in dialogue and learning experiences that allow complex topics and ideas to be explored from many angles and perspectives. They also need to learn how to think and solve problems for which there is no one solution—and learn science skills along the way.

## Increasingly Diverse Learner Populations

The need for a deeper, more innovative approach to mathematics teaching comes at a time when the system is already charged with building up language skills among the increasingly diverse population. Students who are English Language Learners (ELLs)/Multilingual Learners (MLLs) now comprise over 20% of the school-age population, which reflects significant growth in the past several decades. Between 1980 and 2009, this population increased from 4.7 to 11.2 million young people, or from 10 to 21% of the school-age population. This growth will likely continue in U.S. schools; by 2030, it is anticipated that 40% of the school-age population in the U.S. will speak a language other than English at home[4]. Today, in schools and districts across the U.S., many student's other than those classified as ELL are learning English as an additional language, even if not in the initial stages of language development—these children are often described as "language minority learners." Likewise, many students, large numbers of whom are growing up in poverty, speak a dialect of English that is different from the academic English found in school curriculum[5].

Each of these groups—ELLs/MLLs, language minority learners, and students acquiring academic English—often struggle to access the language, and therefore the knowledge that fills the pages of academic texts, despite their linguistic assets. Therefore, the context for this new set of Science Standards is that there is a pressing need to provide instruction that not only meets, but exceeds standards, as part of system-wide initiative to promote equal access to science skills for all learners while capitalizing on linguistic and cultural diversity.

All academic work does, to some degree, involve the academic language needed for success in school. For many students, including ELLs/MLLs, underdeveloped academic language affects their ability to comprehend and analyze texts, limits their ability to write and express their scientific reasoning effectively, and can hinder their acquisition of academic content in all academic areas in which learning is demonstrated and assessed through oral and written language. If there isn't sufficient attention paid to building academic language across all content areas, students, including ELLs/MLLs, will not reach their potential and we will continue to perpetuate

[4] Camarota, S. (2012). *Immigrants in the United States, 2010: A profile of America's foreign-born population*. Washington, D.C. Center for Immigration Studies.

[5] Aud, S., Hussar, W., Kena, G., Bianco, K., Frohlich, L., Kemp, J. et al. *The condition of education 2011* (NCES 2011-033). Lopez, M. & Velasco, G. *The Toll of the Great Recession: Childhood Poverty among Hispanics Sets Record*, *Leads Nation*, report prepared for the Pew Hispanic Center (Washington: Pew Hispanic Center, September 2011). Ryan, C. (2013). Language use in the United States: 2011. *American community survey reports*, *22*, 1-16.

achievement gaps. The challenge is to design instruction that acknowledges the role of language; because language and knowledge are so inextricable.
In summary, today's children live in a society where many of their peers are from diverse backgrounds and speak different languages; one where technology is ubiquitous and central to daily life. They will enter a workforce and economy that demands critical thinking skills, and strong communication and social skills for full participation in society. This new society and economy has implications for today's education system—especially our instruction to foster a deeper and different set of communication and critical thinking skills, with significant attention to STEM.

### Students with Disabilities and the Standards

Students with disabilities must have opportunities to benefit from high quality instruction and to reach the same learning standards as all students. Under federal and State law, it is a fundamental right of students with disabilities to not only be taught the same content (the general education curriculum) as other students, but also to be provided appropriate supports (including accommodations and scaffolding) and services based on their individual needs so that they can gain knowledge and skills and demonstrate what they have learned.

Each student's individualized education program (IEP) must be developed in consideration of the State learning standards and should provide information for teachers to effectively provide supports and services to address the individual learning needs of the student as they impact the student's ability to participate and progress in the general education curriculum.

In addition to supports and services, special education must include specially designed instruction, which means adapting, as appropriate to the needs of a student with a disability, the content, methodology or delivery of instruction to address the unique needs that result from the student's disability. By so doing, the teacher enables each student's access to the general education curriculum so that he or she can meet the learning standards that apply to all students. The *Blueprint for Improved Results for Students with Disabilities* focuses on seven core evidence-based principles for students with disabilities to ensure they have the opportunity to benefit from high quality instruction and to reach the same standards as all students. For additional information, please see http://www.p12.nysed.gov/specialed/publications/2015-memos/blueprint-for-improved-results-for-students-with-disabilities.html.

The New York State P-12 Science Learning Standards were developed in collaboration with various stakeholders in science education to ensure each student's access to science. To access resources and guidance on how the learning standards relate to curriculum, instruction and students with disabilities, see the NYSED Office of Special Education website at http://www.p12.nysed.gov/specialed/.

## Understanding the New York State P-12 Science Learning Standards

### The New York State P-12 Science Learning Performance Expectations

The New York State P-12 Science Learning Standards are a series of performance expectations that define what students should understand and be able to do as a result of their study of science. The New York State P-12 Science Learning Standards are based on the *Framework for K–12 Science Education* developed by the National Research Council[1] and the Next Generation Science Standards[2]. The framework outlines three dimensions that are needed to provide students a high-quality science education. The integration of these three dimensions provides students with a context for the content of science, how science knowledge is acquired and understood, and how the sciences are connected through concepts that have universal meaning across the disciplines.

Dimension 1: Science and Engineering Practices

Dimension 1, Science and Engineering Practices, describes (a) the major practices that scientists employ as they investigate and build models and theories about the world and (b) a key set of engineering practices that engineers use as they design and build systems. The term "practices" is used instead of a term such as "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice.

Similarly, because the term "inquiry," extensively referred to in previous standards documents, has been interpreted over time in many ways throughout the science education community, part of the intent in articulating the practices in Dimension 1 is to better specify what is meant by inquiry in science and the range of cognitive, social, and physical practices that it requires. As in all inquiry-based approaches to science teaching, the expectation is that students will themselves engage in the practices and not merely learn about them secondhand. Students cannot comprehend scientific practices, nor fully appreciate the nature of scientific knowledge itself, without directly experiencing those practices for themselves.

The eight science and engineering practices mirror the practices of professional scientists and engineers. Use of the practices in the performance expectations is not only intended to strengthen students' skills in these practices but also to develop students' understanding of the nature of science and engineering. Listed below are the eight science and engineering practices from the *Framework*:

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

The New York State P-12 Science Learning Standards use constructed grade-band endpoints for the science and engineering practices for grades P-5, middle school and high school that are based on progressions and twelfth-grade endpoints. The representations of the science and engineering practices appear in the New York State P-12 Science Learning Standards and supporting foundation boxes.

Dimension 2: Disciplinary Core Ideas

The continuing expansion of scientific knowledge makes it unrealistic to teach all the ideas related to a given discipline in exhaustive detail during the K-12 years. Given the cornucopia of information available today virtually at a touch—people live, after all, in an information age—an important role of science education is to prepare students with sufficient core knowledge so that they can acquire additional information on their own as they need it. An education focused on a limited set of ideas and practices in science and engineering should enable students to evaluate and select reliable sources of scientific information, and allow them to continue their development well beyond their K-12 school years as science learners, users of scientific knowledge, and perhaps also as producers of such knowledge.

The disciplinary core ideas are built on the notion of learning as a developmental progression. They are designed to help children continually build on and revise their knowledge and abilities, starting from their curiosity about what they see around them and their initial conceptions about how the world works. The goal is to guide their knowledge toward a more scientifically based and coherent view of the natural sciences and engineering, as well as of the ways in which they are pursued and their results can be used.

Dimension 3: Crosscutting Concepts

The crosscutting concepts have application across all domains of science. As such, they provide one way of linking across the domains in Dimension 3. These crosscutting concepts are not unique to The Framework. They echo many of the unifying concepts and processes in the National Science Education Standards, the common themes in the Benchmarks for Science Literacy, and the unifying concepts in the Science College Board Standards for College Success. They also reflect discussions related to the NSTA Science Anchors project, which emphasized the need to consider not only disciplinary content but also the ideas and practices that are within all of the science disciplines.

The seven Crosscutting Concepts that are meant to give students an organizational structure to understand the world and help students make sense of and connect Core Ideas across disciplines and grade bands. They are not intended as additional content. Listed below are the Crosscutting Concepts from the Framework:

1. Patterns
2. Cause and Effect
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter in Systems
6. Structure and Function
7. Stability and Change of Systems

The New York State P-12 Science Learning Standards use constructed grade-band endpoints for the Crosscutting Concepts for grades P-5, middle school and high school that are based on progressions and twelfth-grade endpoints. The representations of the Crosscutting Concepts appear in the New York State P-12 Science Learning Standards and supporting foundation boxes.

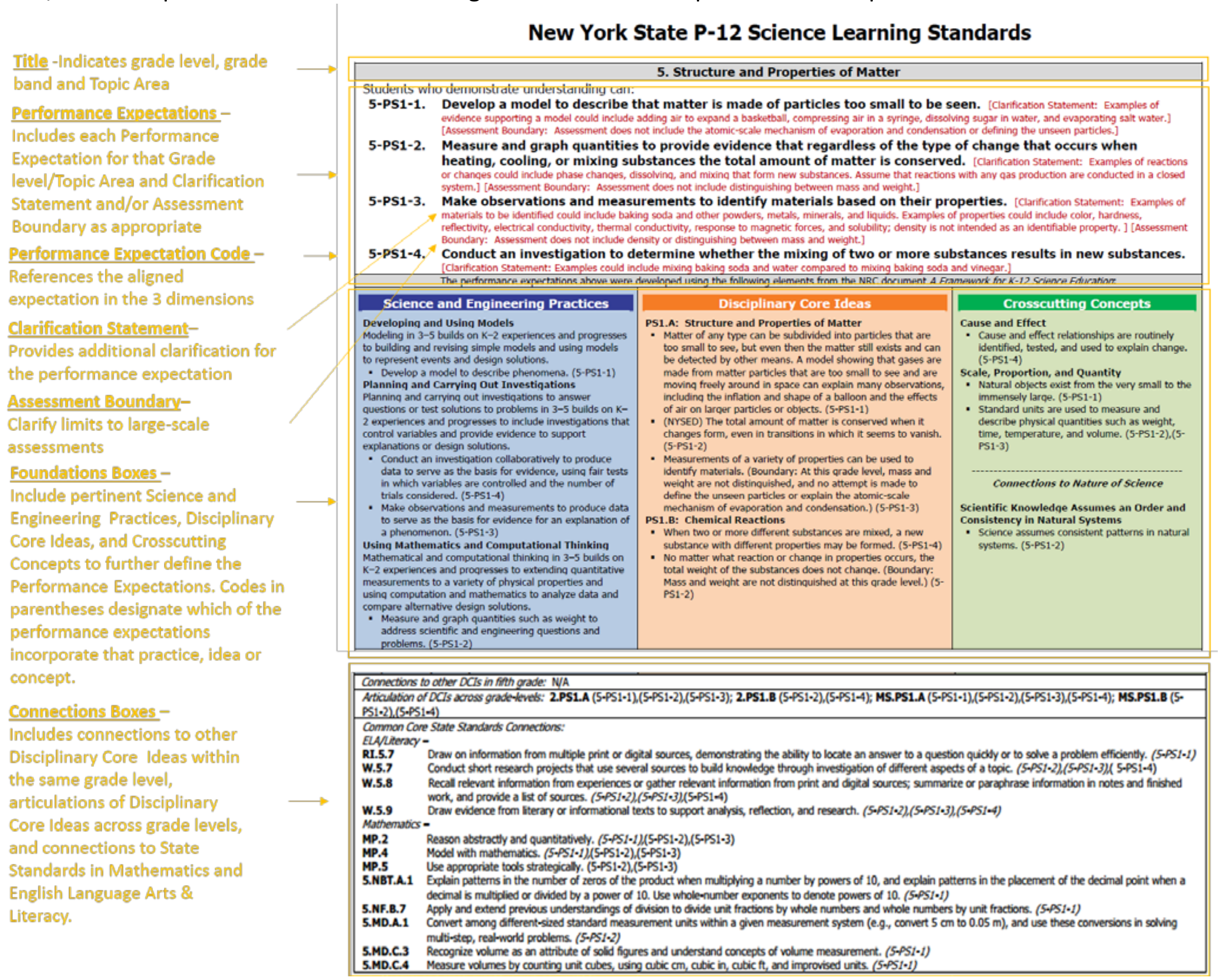
The Standards set student performance expectations among topics but do not define the intervention methods or materials necessary to support students who are well below or well above grade-level expectations. It is also beyond the scope of the Standards to define the full range of supports appropriate for English Language Learners (ELLs)/Multilingual Learners (MLLs) and for Students with Disabilities. However, the department ensured that teachers of English Language Learners (ELLs)/Multilingual Learners (MLLs) and Students with Disabilities participated in the development of the standards. The New York State Education Department (NYSED) has created two statewide frameworks, the *Blueprint for Improved Results for Students with Disabilities* and the *Blueprint for English Language Leaner Success,* aimed to clarify expectations and to provide guidance for administrators, policymakers, and practitioners to prepare ELLs/MLLs and Students with Disabilities for success. These principles therein the frameworks are intended to enhance programming and improve instruction that would allow for students within these populations to reach the same standards as all students and leave school prepared to successfully transition to post school learning, living and working.

No set of grade-specific standards can fully reflect the variation in learning profiles, rates, and needs, linguistic backgrounds, and achievement levels of students in any given classroom. When designing and delivering science instruction, educators must consider the cultural context and prior academic experiences of all students while bridging prior knowledge to new knowledge and ensuring that content is meaningful and comprehensible. In addition, as discussed above, educators must consider the relationship of language and content, and the vital role that language plays in obtaining and expressing mathematics content knowledge. The Standards should be read as allowing for the widest possible range of students to participate fully from the outset, along with appropriate adaptations to ensure equitable access and maximum participation of all students.

## Organization of the New York State P-12 Science Learning Standards

The New York State P-12 Science Learning Standards have been written as performance expectations that depict what the student must do to show proficiency in science. Science and Engineering Practices were coupled with components of the Disciplinary Core Ideas and Crosscutting Concepts to make up the performance expectations. Science concepts build coherently across K-12. The emphasis of the New York State P-12 Science Learning Standards is a focused and coherent progression of knowledge from grade band to grade band, allowing for a dynamic process of building knowledge throughout a student's entire P-12 science education.

The performance expectations are organized by grade level from Prekindergarten through 5th grade and by topic at the middle and high school level. The highlighted performance expectations are expectations that are different from the Next Generation Science Standards. The order in which the performance expectations are presented is not necessarily the order in which the performance expectations need to be taught. Performance expectations from various domains are connected, and educators will need to determine the best overall design and approach, as well as the instructional strategies needed to support their learners to attain grade-level/course expectations and the knowledge articulated in the performance expectations.




It is important to note; the New York State P-12 Science Learning Performance expectations reflect what a student should know and be able to do—they do not dictate the manner or methods by which the performance expectations are taught. The performance expectations are written in a way that expresses the concept and skills to be performed but still leaves curricular and instructional decisions to districts, school and teachers. The performance expectations do not dictate curriculum; rather, they are coherently developed to allow flexibility in the instruction of the performance expectations. Learning opportunities and pathways will continue to vary across schools and school systems, and educators should make every effort to meet the needs of individual students, based on their pedagogical and professional impressions and information.

## Connecting to the Performance Expectations

The real innovation in the New York State P-12 Science Learning Standards is the requirement that students are required to operate at the intersection of practice, content, and connection. Performance expectations are the way to integrate the three dimensions. It provides specificity for educators, but it also sets the tone for how science instruction should look in classrooms. When implemented, the New York State P-12 Science Standards will result in coherent, rigorous instruction with students being able to acquire and apply scientific knowledge to unique situations as well as having the ability to think and reason scientifically.

The vision for science education in the 21st century is that all practices are expected to be utilized by educators. Educators and curriculum developers must bear this in mind as they design instruction. For the New York State P-12 Science Standards development, a key issue in developing the performance expectations was the actual choice of the Practices with the DCI and the Crosscutting Concepts, the transition words between the Practice and the DCI language, and the ability of a student to perform the expectation. Due to the nature of some of the Practices, they could not usually be used as a standalone practice. Often, the “Asking Questions” Practice leads to an investigation that produces data that can be used as evidence to develop explanations or arguments. Similarly, mathematics is implicit in all science. Models, arguments, and explanations are all based on evidence. That evidence can be mathematics. There are specific places the standards require mathematics, but the places where mathematics is not explicitly required should not be interpreted as precluding students from using mathematical relationships to support other practices. Practices such as models, arguments, and explanations are often more prominent throughout the standards to ensure rigorous content receives its due focus. Ultimately, the New York State P-12 Science Standards balance the practices within the performance expectations.

In this respect, the science standards set an expectation of student understanding across the years. The points of intersection between the three dimensions of teaching and learning are intended to be weighted toward central and generative concepts in the school science curriculum. These concepts merit the time, resources, innovative energies, and focus necessary to qualitatively improve the curriculum, instruction, assessment, professional development, and student achievement in science.

## Glossary of Terms:

**Assessment Boundary Statements**
Grade level endpoints, based on available research, that provide guidance or specify the scope of a performance expectation for a grade level.

**Code for Topic Name**
An abbreviated, unique identifier that is associated with each Performance Expectation.

**Cross-Cutting Concepts**
Ideas or themes that provide an organizational framework for connecting knowledge from various disciplines into a coherent and scientifically-based view of the world.

**Clarification Statements**
Descriptions found in the NGSS System Architecture that supply examples or shed additional light on the performance expectations.

**Connection Boxes**
Part of the NGSS System Architecture. Identifies science topics that share corresponding DCIs across disciplines at the same grade level, articulation of DCIs across grade levels, and links to ELA and Mathematics Common Core Standards.

**Domain**
The equivalent of a major content area. Includes Earth & Space Science, Life Science, Physical Science, and Engineering, Technology, and Applications of Science.

**Disciplinary Core Ideas**
The sum of concepts, that when understood, enable a person to make sense of the natural and designed world.

**Dimensions**
Three major elements of science and engineering that when properly integrated provide students with a context for the content of science, how science knowledge is acquired and understood, and how concepts that have meaning across the disciplines connect the sciences. Engineering Design A set of systematic practices applied to derive solutions to human problems.

**Foundation Boxes**
Part of the New York State P-12 Science Standards Architecture. Provide information that expands and explains the performance expectations in terms of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

**Framework for Science Education[1]**
Precursor document that offered a vision the key science and engineering ideas and practices that all students should learn by the end of high school. Provided the conceptual foundation for developing the NYSP-12SLS.

**Learning Progressions**
Descriptions of how students' knowledge and skills develop over multiple years at increasing levels of depth and sophistication. Idea of learning as a developmental progression is the basis for organizing the student performance expectations.

**Nature of Science**
The shared values, practices, and perspectives that characterize the scientific approach to understanding the natural world. Among these are a demand for explanations supported by empirical evidence that are testable.

**Practices**
Behaviors and understandings that scientists employ to investigate and build models and theories about the world and routines that engineers use to design and build systems.

**Student Performance Expectation**
Form in which the New York State P-12 Science Standards are written. Each statement incorporates a Science and Engineering Practice, Crosscutting Concept, and Disciplinary Core Idea.

**21st Century Knowledge and Skills**
Proficiencies needed by all high school graduates to meet the rigors of college, careers, and citizenship.