LINCOLN CURRICULUM STANDARDS FOR

Science

Grade 6-8

The Role of Science Standards in Michigan

According to the dictionary, a standard is "something considered by an authority or by general consent as a basis of comparison." Today's world is replete with standards documents such as standards of care, standards of quality, and even standard operating procedures. These various sets of standards serve to outline agreed-upon expectations, rules, or actions, which guide practice and provide a platform for evaluating or comparing these practices.

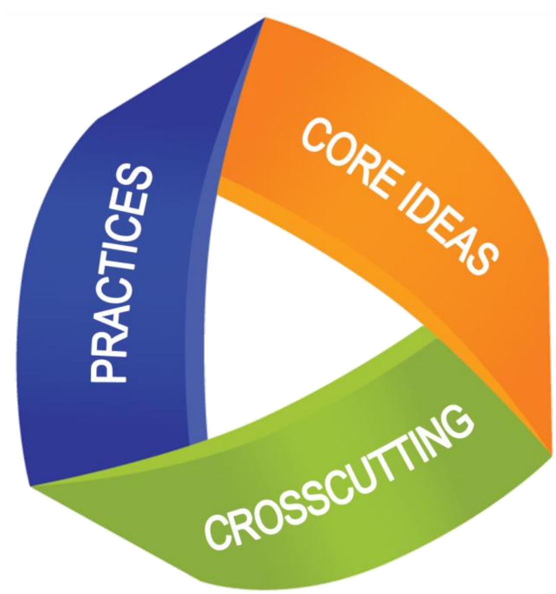
One such set of standards is the academic standards that a governing body may have for the expected outcomes of students. In Michigan, these standards, are used to outline learning expectations for Michigan's students, and are intended to guide local curriculum development and assessment of student progress. The Michigan Science Standards are performance expectations for students. They are not curriculum and they do not specify classroom instruction. Standards should be used by schools as a framework for curriculum development with the curriculum itself prescribing instructional resources, methods, progressions, and additional knowledge valued by the local community. Since Michigan is a "local control" state, local school districts and public school academies can use these standards in this manner to make decisions about curriculum, instruction, and assessment.

At the state level, these standards provide a platform for state assessments, which are used to measure how well schools are providing opportunities for all students to learn the content outlined by the standards. The standards also impact other statewide policies, such as considerations for teacher certification and credentials, school improvement, and accountability, to name a few.

The standards in this document identify the student performance outcomes for students in topics of science and engineering. These standards replace the Michigan Science Standards adopted in 2006, which were published as the Grade Level Content Expectations and High School Content Expectations for science.

Why These Standards?

There is no question that students need to be prepared to apply basic scientific knowledge to their lives and to their careers, regardless of whether they are planning STEM based careers or not. In 2011, the National Research Council released *A Framework for K-12 Science Education*,[1] which set forth guidance for science standards development based on the research on how students learn best. This extensive body of research suggests students need to be engaged in **doing science** by engaging the same practices used by scientists and engineers.



1 A New Conceptual Framework." *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press, 2012.

Furthermore, students should engage in science and engineering practices in the context of **core ideas** that become ever more sophisticated as students move through school. Students also need to see the connections of these disciplinary-based core ideas to the bigger **science concepts that cross disciplinary lines**. The proposed Michigan standards are built on this research-based framework. The framework was used in the development of the Next Generation Science Standards, for which Michigan was a lead partner. The Michigan Science Standards are derived from this effort, utilizing the student performance expectations and their relevant coding (for reference purposes). These standards are intended to guide local curricular design, leaving room for parents, teachers, and schools to surround the standards with local decisions about curriculum and instruction. Similarly, because these standards are performance expectations, they will be used to guide state assessment development.

Organization and Structure of the Performance Expectations

Michigan's science standards are organized by grade level K-5, and then by grade span in middle school and high school. The K-5 grade level organization reflects the developmental nature of learning for elementary students in a manner that attends to the important learning progressions toward basic foundational understandings. By the time students reach traditional middle school grades (6-8), they can begin to build on this foundation to develop more sophisticated understandings of science concepts within and across disciplines. This structure also allows schools to design local courses and pathways that make sense for their students and available instructional resources.

Michigan's prior standards for science were organized by grade level through 7th grade. Because these standards are not a revision, but were newly designed in their entirety, it was decided that the use of the grade level designations in the traditional middle grades (6-8) would be overly inhibiting to apply universally to all schools in Michigan. Such decisions do not specifically restrict local school districts from collaborating at a local or regional level to standardize instruction at these levels. Therefore, it is recommended that each school, district, or region utilize assessment oriented grade bands (K-2, 3-5, 6-8, 9-12) to organize curriculum and instruction around the standards. MDE will provide guidance on appropriate strategies or organization for such efforts to be applied locally in each school district or public school academy.

Within each grade level/span the performance expectations are organized around topics. While each topical cluster of performance expectations addresses the topic, the wording of each performance expectation reflects the three-dimensions of science learning outlined in *A Framework for K-12 Science Education*: cross-cutting concepts, disciplinary core ideas, and science and engineering practices.

Cross Cutting Concepts (CCC)

The seven Crosscutting Concepts outlined by the *Framework for K-12 Science Education* are the overarching and enduring understandings that provide an organizational framework under which students can connect the core ideas from the various disciplines into a "cumulative, coherent, and usable understanding of science and engineering" (*Framework,* pg. 83).

These crosscutting concepts are…

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

Disciplinary Core Ideas (DCI)

The crosscutting concepts cross disciplines. However within each discipline are core ideas that are developed across grade spans, increasing in sophistication and depth of understanding. Each performance expectation (PE) is coded to a DCI. A list of DCIs and their codes can be found on the MDE website and in the MDE Guidance Documents.

Science and Engineering Practices

In addition to the Crosscutting Concepts and Disciplinary Core Ideas, the National Research Council has outlined 8 practices for K-12 science classrooms that describe ways students should be engaged in the classroom as a reflection of the practices of actual scientists and engineers. When students "do" science, the learning of the content becomes more meaningful. Lessons should be carefully designed so that students have opportunities to not only learn the essential science content, but to practice being a scientist or engineer. These opportunities set the stage for students to transition to college or directly into STEM careers.

Coding Hierarchy

Based upon the Framework and development of the Next Generation Science Standards effort, each performance expectation of the Michigan Science Standards is identified with a reference code. Each performance expectation (PE) code starts out with the grade level, followed by the disciplinary core idea (DCI) code, and ending with the sequence number of the PE within the DCI. So for example, K-PS3-2 is a kindergarten PE, linked to the 3rd physical science DCI (i.e., Energy), and is the second in sequence of kindergarten PEs linked to the PS3. These codes are used in MSS and NGSS Science Resources to identify relevant connections for standards.

Listed below are the 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

Implementation

It is extremely important to remember that the research calls for instruction and assessments to blend the three dimensions (CCC, DCI, and Practices). It is this working together of the three dimensions that will allow all children to explain scientific phenomena, design solutions to problems, and build a foundation upon which they can continue to learn and be able to apply science knowledge and skills within and outside the K-12 education arena. While each PE incorporates these three dimensions into its wording, this alone does not drive student outcomes. Ultimately, student learning depends on how the standards are integrated in instructional practices in the classroom. There are several resources based on the National Research Council's *A Framework for K-12 Science Education* that were developed for educators to utilize in planning curriculum, instruction, and professional development. These include resources developed by Michigan K-12 and higher education educators, with plans to develop more guided by the needs of the field as implementation moves forward. This includes assessment guidance for the Michigan Department of Education, local districts, and educators.

Michigan Specific Contexts

Because the student performance expectations were developed to align to a general context for all learners, the Michigan Department of Education (MDE) works with a variety of stakeholders to identify Michigan-specific versions of the standards for student performance expectations that address issues directly relevant to our state such as its unique location in the Great Lakes Basin, Michigan-specific flora and fauna, and our state's rich history and expertise in scientific research and engineering. These versions of the performance expectations allow for local, regional, and state-specific contexts for learning and assessment. In addition to the specific performance expectations that frame more general concepts and phenomena in a manner that is directly relevant to our state, there are also a number of performance expectations which allow for local, regional, or state-specific problems to be investigated by students, or for students to demonstrate understandings through more localized contexts. Both of these types of performance expectations are identified in the following standards, as well as in the accompanying guidance document, which also identifies both clarification statements and assessment boundaries. The Michigan specific performance expectations should be used by educators to frame local assessment efforts. State level assessments will specifically address the performance expectations with Michigan-specific contexts.

MDE is collaborating with multiple statewide partners to generate a list of support materials for the state standards that focuses on resources and potential strategies for introducing or exploring DCIs through a local, regional, or statewide lens to make the learning more engaging and authentic. These contextual connections are not included in the specific performance expectations, as educators should merely use these as recommendations for investigation with students, and assessment developers have the opportunity to use these to develop specific examples or scenarios from which students would demonstrate their general understanding. This approach provides the opportunity for educators to draw upon Michigan's natural environment and rich history and resources in engineering design and scientific research to support student learning.

Michigan Educator Guidance

The Michigan Science Standards within this document are the performance expectations for students in grades K-12 for science and engineering practices, cross cutting concepts, and disciplinary core ideas of science and engineering. In order to be able to develop and guide instruction to address the standards for all students, Michigan educators will need access to a range of guidance and resources that provide additional support for the teaching and learning of science. This guidance will be developed and shared with Michigan educators following the adoption of the proposed standards. The MDE provides additional guidance based upon educator needs and requests, and utilizes support from practicing Michigan educators and educational leaders to develop such guidance or tools to aid in the implementation of the standards.

Accompanying this standards document will be a range of resources provided to educators and assessment developers to help frame the learning context and instructional considerations of the performance expectations. Such guidance will include appropriate connections and references to the Science and Engineering Practices, the Disciplinary Core Ideas (DCI), and Cross Cutting Concepts (CCC) that frame each performance expectation. External partners, including the Michigan Mathematics and Science Center Network, Michigan Science Teachers Association, and National Science Teachers Association, and professional development providers in Michigan, will utilize the coding references of the standards to provide additional resources to Michigan educators.

The MDE will provide ongoing support to educators through guidance and professional learning resources, which will be updated regularly. Additional information and references can be found at http://michigan.gov/science.

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Structure and Properties of Matter

MS-PS1-1	Develop models to describe the atomic composition of simple molecules and extended structures.
MS-PS1-3	Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
MS-PS1-4	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Chemical Reactions

MS-PS1-2	Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
MS-PS1-5	Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
MS-PS1-6	Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*

Forces and Interactions

MS-PS2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*
MS-PS2-2	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
MS-PS2-3	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
MS-PS2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
MS-PS2-5	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

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Energy

MS-PS3-1	Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
MS-PS3-2	Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
MS-PS3-3	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. *
MS-PS3-4	Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.
MS-PS3-5	Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Waves and Electromagnetic Radiation

MS-PS4-1	Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
MS-PS4-2	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
MS-PS4-3	Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.

* - Integrates traditional science content with engineering. - Includes a Michigan specific performance expectation.

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Structure, Function, and Information Processing

MS-LS1-1	Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
MS-LS1-2	Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
MS-LS1-3	Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
MS-LS1-8	Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

Matter and Energy in Organisms and Ecosystems

MS-LS1-6	Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
MS-LS1-7	Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. **
MS-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. **
MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Interdependent Relationships in Ecosystems

MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. **
MS-LS2-5	Evaluate competing design solutions for maintaining biodiversity and ecosystem services. * **

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** - Allow for local, regional, or Michigan specific contexts or examples in teaching and assessment.

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Growth, Development, and Reproduction of Organisms

MS-LS1-4	Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
MS-LS1-5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. **
MS-LS3-1	Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
MS-LS3-2	Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
MS-LS4-5	Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

Natural Selection and Adaptations

MS-LS4-1	Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. **
MS-LS4-2	Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.
MS-LS4-3	Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.
MS-LS4-4	Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.
MS-LS4-6	Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

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Space Systems

MS-ESS1-1	Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
MS-ESS1-2	Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
MS-ESS1-3	Analyze and interpret data to determine scale properties of objects in the solar system.

History of Earth

MS-ESS1-4	Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.
MS-ESS2-2	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
MS-ESS2-3	Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

Earth's Systems

MS-ESS2-1	Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. **
MS-ESS2-4	Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. **
MS-ESS3-1	Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. **

**- Allow for local, regional, or Michigan specific contexts or examples in teaching and assessment.

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Weather and Climate

MS-ESS2-5	Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. MS-ESS2-5 MI *Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions in Michigan due to the Great Lakes and regional geography.*
MS-ESS2-6	Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
MS-ESS3-5	Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Human Impacts

MS-ESS3-2	Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. * **
MS-ESS3-4	Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Engineering Design

MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

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