7 Miss Admin Code, Part 169

MISSISSIPPI DEPARTMENT OF EDUCATION
Ensuring a bright future for every child

2018 Mississippi College- and Career-Readiness Standards for Science

Effective Date: 2018-2019 School Year

2018 Mississippi College- and Career-Readiness Standards for Science

Carey M. Wright, Ed.D., State Superintendent of Education

Kim S. Benton, Ed.D., Chief Academic Officer

Jean Massey, Executive Director, Office of Secondary Education

Nathan Oakley, Ph.D., Executive Director, Office of Elementary Education and Reading

Wendy Clemons, Executive Director, Office of Professional Development

Tenette Smith, Ed.D., Bureau Director, Office of Elementary Education and Reading

Marla Davis, Ph.D., NBCT, Bureau Director, Office of Secondary Education

Jackie Sampsell, Ed.D., Science Specialist, Office of Secondary Education

Mississippi Department of Education
Post Office Box 771
Jackson, Mississippi
39205-0771

Office of Elementary Education and Reading
Office of Secondary Education
601-359-2586
www.mde.k12.ms.us/ESE

The Mississippi State Board of Education, the Mississippi Department of Education, the Mississippi School for the Arts, the Mississippi School for the Blind, the Mississippi School for the Deaf, and the Mississippi School for Mathematics and Science do not discriminate on the basis of race, sex, color, religion, national origin, age, or disability in the provision of educational programs and services or employment opportunities and benefits. The following office has been designated to handle inquiries and complaints regarding the nondiscrimination policies of the above mentioned entities:

Director, Office of Human Resources
Mississippi Department of Education

Table of Contents

Acknowledgements 6
Introduction 9
2018 Mississippi College- and Career-Readiness Standards for Science Overview 10
Research and Background Information 11
Core Elements in the Use and Design of the *MS CCRS for Science* 11
Content Strands and Disciplinary Core Ideas 13
Structure of the Standards Document 14
Safety in the Science Classroom 15
Support Documents and Resources 15
References 16
GRADES K-2 OVERVIEW 18
KINDERGARTEN 20
GRADE ONE 24
GRADE TWO 28
GRADES 3-5 OVERVIEW 32
GRADE THREE 34
GRADE FOUR 39
GRADE FIVE 43
GRADES 6-8 OVERVIEW 47
GRADE SIX 49
GRADE SEVEN 52
GRADE EIGHT 56
GRADES 9-12 OVERVIEW 61
BIOLOGY 63
BOTANY 69
CHEMISTRY 74
EARTH AND SPACE SCIENCE 81

ENVIRONMENTAL SCIENCE 85
FOUNDATIONS OF BIOLOGY 89
FOUNDATIONS OF SCIENCE LITERACY 94
GENETICS 98
HUMAN ANATOMY AND PHYSIOLOGY 102
MARINE AND AQUATIC SCIENCE I 110
MARINE AND AQUATIC SCIENCE II 110
PHYSICAL SCIENCE 116
PHYSICS 122
ZOOLOGY I (Invertebrate) 127
ZOOLOGY II (Vertebrate) 127

Acknowledgements

The Mississippi Department of Education gratefully acknowledges the hard work of the following individuals for their involvement in developing the *Mississippi College- and Career-Readiness Standards for Science* and the supporting documents.

SCIENCE WRITING TASK FORCE COMMITTEE MEMBERS (2015-2017)

Jennifer Bennett	Calhoun County School District
Tim Bermond	Clinton Public School District
Shani Bourn	Hancock County School District
Tammie Bright	Yazoo County School District
Kelly Cannan	Pascagoula-Gautier School District
Holly Carden	Desoto County School District
Peggy Carlisle	Jackson Public Schools
Tonya Carter	Sunflower County Consolidated School District
Renee Clary, Ph.D.	Mississippi State University Department of Geosciences
Gail Davis	Lafayette County Schools
Charronda Denis	Pascagoula-Gautier School District
Deborah Duncan	Neshoba County School District (Retired)
Tammie Franklin	Grenada School District
Kevin Gaylor	Jackson Public School District
Darcie Graham	University of Southern Mississippi Gulf Coast Research Lab
Tia Green	Tupelo Public School District
Brandi Herrington	Starkville Oktibbeha Consolidated School District
Jennifer Hood	Amory School District
Ann Huber	Mississippi Delta Community College/MSTA President
Whitney Jackson	University of Mississippi Center for Mathematics and Science Education
Deborah Jones	Lafayette County Schools/Northwest Community College
Tiffany Jones-Fisher	Mississippi Gulf Coast Community College
Myra Kinchen, Ed.D.	Clinton Public School District
Melissa Levy	Madison County School District
Jill Lipski	Long Beach School District
Sharman Lumpkin	Pearl River County School District
Heather Maness	Forest Municipal School District
Celeste Maugh	Tunica County School District
Angela McDaniel	Pearl Public School District
Crystina Moran	Biloxi Public School District
Jennifer Pannell	Union County School District
Maureen Pollitz	Picayune School District
Linda Posey	Meridian Public School District
Terry Rose	Stone County School District
Leslie Salter	Pascagoula-Gautier School District
Betsy Sullivan, Ph.D.	Madison County School District
Heather Sullivan	Mississippi Museum of Natural Science
Mary Swindell	Meridian Public School District
Kimberly Taylor-Gathings	Columbus Municipal School District

Jessica Tegt, Ph.D.	Mississippi State University Dept. of Wildlife, Fisheries, and Aquaculture/Extension
David Teske	Louisville Public Schools (Retired)
Julie Viguerie	Lamar County School District
Tina Wagner	Mississippi School for Math and Science
Ryan Walker, Ph.D.	Mississippi State University Dept. of Curriculum, Instruction, and Special Education
Tiffany Webb	Gulfport School District
Kristy Wheat	Pass Christian School District
Veronica Wylie	Copiah County School District

FINAL REVIEW COMMITTEE (March 2017)

Cassie Barr	Marion County School District
Cindy Betancourt	Petal Public School District
Tammie Bright	Yazoo County School District
Brandon Cline	Rankin County School District
Deborah Duncan	Neshoba County School District (Retired)
Kasey Edwards	Neshoba County School District
Sharon Evans	Petal Public School District
Tia Green	Tupelo Public School District
Courtney Harris	Clinton Public School District
Jennifer Hite	Pearl Public School District
Myra Kinchen, Ed.D	Clinton Public School District
Bailey Kennedy	South Tippah School District
Elizabeth Knight	Rankin County School District
Jill Lipski	Long Beach School District
Heather Maness	Forest Municipal School District
Misti McDaniel	Neshoba County School District
Charlotte McNeese	Madison County School District
Angie Moore	Pearl Public School District
Ashley Pfalzgrat	Rankin County School District
April Pounders	South Tippah School District
Bobby Robinson	Madison County School District
Terry Rose	Stone County School District
Leslie Salter	Pascagoula-Gautier School District
Jessica Satcher	Lauderdale County School District
Andy Scoggin	Petal Public School District
Fonya Scott	Lauderdale County School District
Holly Sparks	Gulfport School District
Betsy Sullivan, Ph.D.	Madison County School District
Kelle Sumrall	Lafayette County School District
Jane Thompson	Gulfport School District
Jason Woodcock	Clinton Public School District
Kristy Wheat	Pass Christian School District

COORDINATION AND EDITING (2015 – 2017)

Gabrielle Barrientos	Research and Curriculum Unit, Mississippi State University
Marla Davis, Ph.D.	Mississippi Department of Education
Anne Hierholzer-Lang	Research and Curriculum Unit, Mississippi State University

Tanjanikia McKinney	University of Mississippi/Mississippi Department of Education
Cindy Ming	Research and Curriculum Unit, Mississippi State University
Holly Holladay	Research and Curriculum Unit, Mississippi State University
Kenny Langley	Research and Curriculum Unit, Mississippi State University
Jean Massey	Mississippi Department of Education
Roslyn Miller	Research and Curriculum Unit, Mississippi State University
Nathan Oakley, Ph.D.	Mississippi Department of Education
Myra Pannell	Research and Curriculum Unit, Mississippi State University
Jackie Sampsell, Ed.D.	Mississippi Department of Education
Denise Sibley	Research and Curriculum Unit, Mississippi State University
Jolanda Young	Research and Curriculum Unit, Mississippi State University

Introduction

Mission Statement

The Mississippi Department of Education is dedicated to student success, which includes improving student achievement in science, equipping citizens to solve complex problems, and establishing fluent communication skills within a technological environment. The Mississippi College- and Career-Readiness Standards provide a consistent, clear understanding of what students are expected to know and be able to do by the end of each grade level or course. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that students need for success in college and careers and allowing students to compete in the global economy.

Purpose

In an effort to closely align instruction for students who are progressing toward postsecondary study and the workforce, the *2018 Mississippi College- and Career-Readiness Standards for Science* includes grade- and course-specific standards for K-12 science.

This document is designed to provide K-12 science teachers with a basis for curriculum development. In order to prepare students for careers and college, it outlines what knowledge students should obtain, and the types of skills students must master upon successful completion of each grade level. The *2018 Mississippi College- and Career-Readiness Standards (MS CCRS) for Science* replaces the *2010 Mississippi Science Framework*. These new standards reflect national expectations while focusing on postsecondary success, but they are unique to Mississippi in addressing the needs of our students and teachers. The standards' content centers around three basic content strands of science: life science, physical science, and Earth and space science. Instruction in these areas is designed for a greater balance between content and process. Teachers are encouraged to transfer more ownership of the learning process to students, who can then direct their own learning and develop a deeper understanding of science and engineering practices, critical analysis, and knowledge. Doing so will produce students that will become more capable, independent, and scientifically literate adults.

Implementation

The *2018 Mississippi College- and Career-Readiness Standards (MS CCRS) for Science* will be implemented during the 2018-2019 school year.

MISSISSIPPI
DEPARTMENT OF
EDUCATION
Ensuring a bright future for every child

2018 Mississippi College- and Career-Readiness Standards for Science Overview

Research and Background Information

In today's modern world and complex society, our students are required to possess sufficient knowledge of science and engineering to become vigilant consumers of scientific and technological information. To meet the growing challenges facing our future workforce, the National Research Council (NRC) published a research-based report on teaching and learning science in a 2012 document titled *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC, 2012). This document proposes a new approach to K-12 science education through the integration of science and engineering practices (SEPs), crosscutting concepts, disciplinary core ideas, and engineering design within the context of science instruction.

Core Elements in the Use and Design of the *MS CCRS for Science*

The *MS CCRS for Science* are goals that reflect what a student should know and be able to do. This document does not dictate a manner or methods of teaching. The standards in this document are not sequenced for instruction and do not prescribe classroom activities, materials, or instruction strategies. These standards are end-of year expectations for each grade or course. The standards are intended to drive relevant and rigorous instruction that emphasizes student mastery of both disciplinary core ideas (concepts) and application of science and engineering practices (skills) to support student readiness for citizenship, college, and careers.

The *MS CCRS for Science* document was built by adapting and extending information from *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC, 2012) and combining with Mississippi's previous science framework process strands (i.e., science as inquiry, unifying concepts and processes, science and technology, science in personal and social perspectives, and the history and nature of science). These concepts connect information across the science content strands (i.e., life science, physical science, and Earth and space science) with the disciplinary core ideas (e.g., ecology and interdependence, motions, forces, and energy, Earth systems and cycles) and are essential to both scientists and engineers because they identify common properties and processes found in practice.

The core elements are integrated across standards and performance objectives in each grade and course. A brief description of each core element is presented below.

1. Nature of Science: Science and Engineering Practices (SEPs) replaced the Inquiry Strand included in the *2010 Mississippi Science Framework*. Beyond integration within the standards, these practices must be mastered by students to produce a more scientifically literate citizenry and to develop students that are more excited about STEM (Science, Technology, Engineering, and Mathematics) topics and careers. Inquiry verbs, along with the SEPs, are woven throughout the standards, especially in the performance objectives. Each has a deliberate placement to indicate the depth of understanding expected of students.

   The practices describe the behaviors that scientists engage in as they investigate and build models and theories about the natural world. They also describe the key set of engineering practices that engineers use as they design and build models and systems. These practices work together (overlap and interconnect) and are not separated in the study and investigation of science concepts. For example, the practice of *mathematical and computational thinking* may include some aspects of *analyzing and interpreting data*. The data often come from *planning and carrying out an investigation*. The writing task force for the *MS CCRS for Science* incorporated this language into the performance objectives to emphasize the importance of a student-centered science classroom and not a teacher-centered classroom. A list of these eight practices is listed below.

a. **Ask Questions (science) and Define Problems (engineering)**
b. **Develop and Use Models**
c. **Plan and Conduct Investigations**
d. **Analyze and Interpret Data**
e. **Use Mathematical and Computational Thinking**
f. **Construct Explanations (science) and Design Solutions (engineering)**
g. **Engage in Scientific Argument from Evidence**
h. **Obtain, Evaluate, and Communicate Information**

2. Crosscutting concepts: These seven, binding concepts were adopted directly from the National Research Council's *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (2012) and should be woven into instruction for every grade and course. Crosscutting concepts are designed to help students see the unity of the sciences. Students often are confused when they study ecosystems for three weeks, then weather for two weeks, and finally motion and forces for several weeks. A concept is crosscutting if it communicates a scientific way of thinking about a subject and it applies to many different disciplines of science and engineering. Crosscutting concepts are sometimes called "the ties that bind." The seven concepts are listed below.

   a. **Patterns**
   b. **Cause and effect: Mechanism and explanation**
   c. **Scale, proportion, and quantity**
   d. **Systems and system models**
   e. **Energy and matter: Flows, cycles, and conservation**
   f. **Structure and function**
   g. **Stability and change**

3. Technology: If Mississippi students are to compete on a global stage and exit high school prepared for college, career, and life, technology should be used in the classroom in a way that suits 21st-century learners and reflects the modern workplace. Technology is essential in teaching and learning of science; it influences and enhances students' learning. Flexible access, customized delivery, and increased convenience for the user are core tenets. K-12 learners have fundamentally changed over the past few decades, and our classrooms should adapt to accommodate them. Dr. Ruben Puentedura's SAMR (Substitution, Augmentation, Modification, and Redefinition) model is a resource that can be considered by teachers, administrators, and technology staff as they integrate meaningful and appropriate digital learning experiences into the classroom. At the basic level, technology enhances instruction.

4. Science and society: This core element assures exploration of science's impacts on society and the feedback loop that must be cultivated and sustained to continue improvement of systems.

5. History of science: Because most modern-day scientific advancement derives from past discoveries, it is essential that students understand the breakthroughs that make today's work possible.

6. Engineering design process (EDP) is the method of devising a system, component, or process to meet desired needs. Engineering standards are represented in some performance objectives with grade-banded, specific wording that prompts educators to approach learning and exploration using the engineering process. These performance objectives are marked with an *. It is important to

note that the EDP is flexible. Most students will approach the process in various ways. The EDP is also a cycle—there is no official start or end point. Students can begin at any step, focus on just one step, move back and forth between steps, or repeat the cycle. Professional development and teacher resources will be developed for Mississippi teachers as EDP is incorporated into Mississippi standards.

Students should be provided a safe environment for failure without consequence, which is one of the most powerful drivers in learning. Providing many opportunities for students to fail, learn, and try again, with appropriate levels of support, fosters a deeper level of understanding and greater student interest and engagement.

Other Important Core Elements

Mathematics is integrated throughout the science standards document because it is essential to the scientific process, requiring students to quantify, analyze, and present results. Students must be familiar with data analysis, critical thinking, and recording their own data; students must organize and analyze it before presenting their findings. Analysis of scientific studies and publications from a quantitative perspective is also very important.

English/language arts skills are also integrated into the science standards. Students will be required to read informational text for understanding as well as process and critique information. Students must be able to articulate a critical point of view using proper terminology. In addition, the K-4 science curriculum should be increasingly tied to language arts to lay the foundation for students to have access to science before fifth grade.

Content Strands and Disciplinary Core Ideas

Science (and engineering) fields can be divided into three content-strand domains based on relative content presented in strands, extending from kindergarten to eighth grade. Grouping content in this way allows for vertical alignment of competencies and objectives to better organize content distribution. Content strands are not included in the Grades 9-12 course organization, which allows for a more logical, sequential placement and flow of content. Content strands are subdivided into 10 disciplinary core ideas in which standards and performance objectives for science content can be placed in grades K-8.

K-8 content strands with the 10 disciplinary core ideas include:

Life Science

1. Hierarchical Organization
2. Reproduction and Heredity
3. Ecology and Interdependence
4. Adaptations and Diversity

Physical Science

5. Organization of Matter and Chemical Interactions
6. Motions, Forces, and Energy

Earth and Space Science

7. Earth’s Structure and History
8. Earth and the Universe
9. Earth Systems and Cycles
10. Earth’s Resources

Structure of the Standards Document

The organization and structure of this standards document are as follows:

- Grade-band overview: An overview that describes the general content and themes for the grade-level band or the high school courses. Outputs and outcomes are provided along with examples of, and references to, science and engineering practices and connecting concepts.

- Grade-level or course overview: An overview that describes the specific content and themes for each grade level and/or high school course. The K-8 standards are presented with each grade focused on a grade-level theme. High school courses provide an overview of the major ideas and strategies to use when planning instruction for the course.

- Content strand: Domains into which science fields can be divided based on relative content extending from kindergarten to eighth grade. In grades K through 8, the content strands are organized into three distinct areas: (1) life science, (2) physical science, and (3) Earth and space science. For the Grade 9-12 courses, the content areas are organized around the core ideas of each course.

- Disciplinary core ideas: Subdivision of the main content strands providing recurring ideas from the three content strands. The core ideas are the key organizing principles for the development of learning units. The K-8 vertical alignment is designed in a spiral arrangement, which places emphasis on one of the three content strands in each grade level. All content strands will be found in each grade level, but all disciplinary core ideas will not be found in every grade level in K-8 due to the spiral arrangement of content.

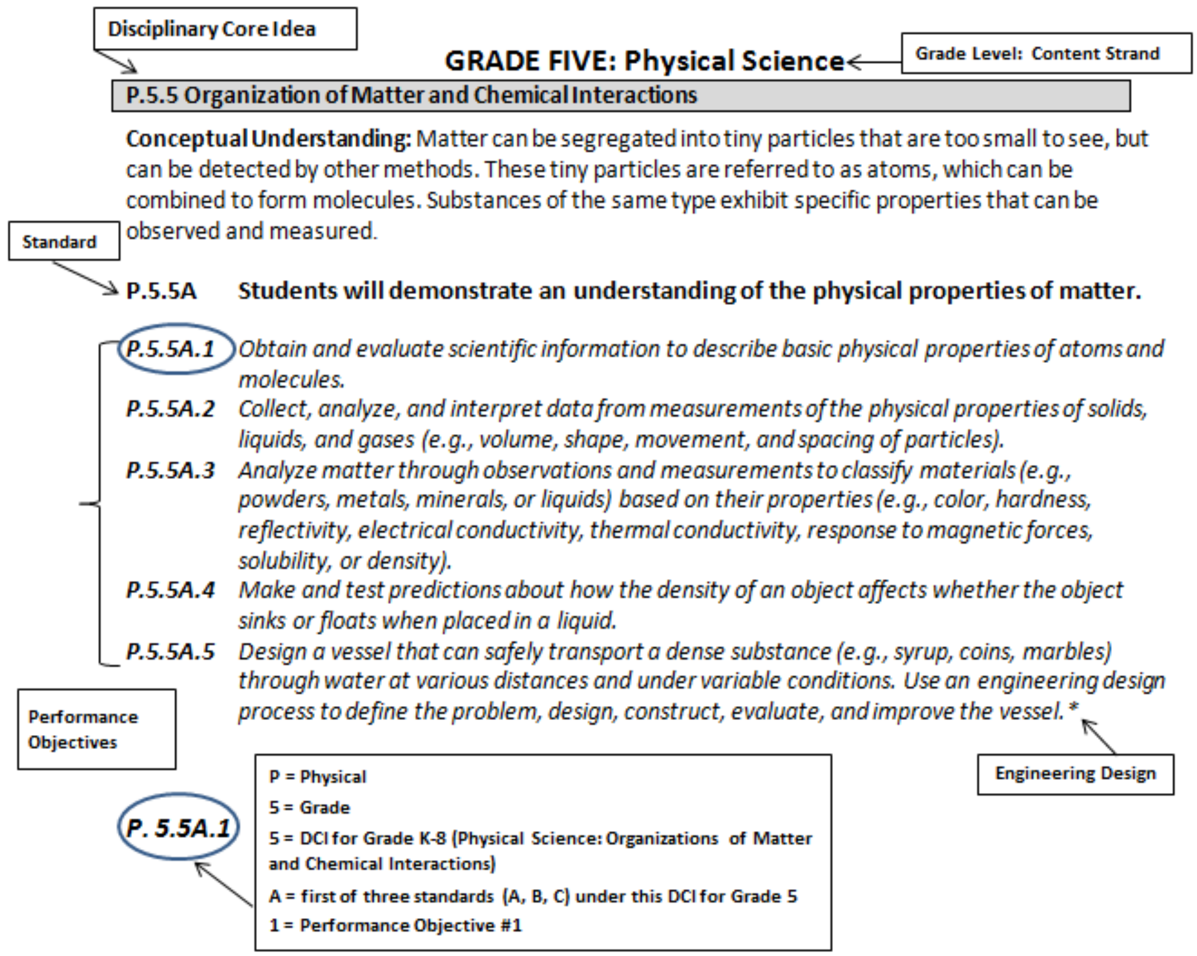
- Conceptual understanding: Statements of the core ideas for which student should demonstrate an understanding. Some grade level and/or course topics include more than one conceptual understanding with each guiding the intent of the standards.

- Content standards: Written below each disciplinary core ideas and conceptual understanding, the standards are a general statement of what students should know and be able to do because of instruction.

- Performance objectives: Detailed statements of content and skills to be mastered by the students. Performance objectives are specific statements of what students know and can do because of the science instruction at that level. These statements contain SEP and inquiry verb language.

Standards will appear in the following format:

Grade-Band Overview
Grade Level Theme (K-8)
Grade Level (K-8) or Course Overview (9-12)
Grade Level: Content Strand (K-8); Course Name (9-12)
    Disciplinary Core Idea (DCI)
    Conceptual Understanding
    Standard
    Performance Objectives



Disciplinary Core Idea

GRADE FIVE: Physical Science ← Grade Level: Content Strand

P.5.5 Organization of Matter and Chemical Interactions

Conceptual Understanding: Matter can be segregated into tiny particles that are too small to see, but can be detected by other methods. These tiny particles are referred to as atoms, which can be combined to form molecules. Substances of the same type exhibit specific properties that can be observed and measured.

Standard → **P.5.5A Students will demonstrate an understanding of the physical properties of matter.**

P.5.5A.1 Obtain and evaluate scientific information to describe basic physical properties of atoms and molecules.

P.5.5A.2 Collect, analyze, and interpret data from measurements of the physical properties of solids, liquids, and gases (e.g., volume, shape, movement, and spacing of particles).

P.5.5A.3 Analyze matter through observations and measurements to classify materials (e.g., powders, metals, minerals, or liquids) based on their properties (e.g., color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, solubility, or density).

P.5.5A.4 Make and test predictions about how the density of an object affects whether the object sinks or floats when placed in a liquid.

*P.5.5A.5 Design a vessel that can safely transport a dense substance (e.g., syrup, coins, marbles) through water at various distances and under variable conditions. Use an engineering design process to define the problem, design, construct, evaluate, and improve the vessel. **

Performance Objectives

Engineering Design

P. 5.5A.1

P = Physical
5 = Grade
5 = DCI for Grade K-8 (Physical Science: Organizations of Matter and Chemical Interactions)
A = first of three standards (A, B, C) under this DCI for Grade 5
1 = Performance Objective #1

Safety in the Science Classroom

The National Science Teachers Association (NSTA) encourages K–12 school leaders and teachers to promote and support the use of science activities in science instruction and work to avoid and reduce injury. NSTA provides the following guidelines for school leaders and teachers to develop safety programs that include the effective management of chemicals, implement safety training for teachers and others, and create school environments that are as safe as possible (NSTA 2013).

1) National Science Teacher Association's *Safety in the Science Classroom*, accessible at http://www.nsta.org/docs/SafetyInTheScienceClassroom.pdf.
2) An extensive list of safety resources is available at http://www.nsta.org/safety/.

Support Documents and Resources

The MDE will develop support documents after these standards have been approved by the State Board of Education. Local districts, schools, and teachers may use these documents to construct standards-based science curriculum, allowing them to customize content to fit their students' needs and match available instructional materials. The support documents will include suggested resources, instructional strategies, essential knowledge, and detailed information about the core elements (e.g., SEPs, crosscutting concepts).

Professional development efforts will be aligned with the standards and delivered in accord with teacher resources to help expand expertise in delivering student-centered lessons (e.g., inquiry-based learning, 5-E instructional models, or other best practices in STEM teaching). The most successful national models and programs will be referenced for a capacity-building effort that can develop a more effective culture of science education in Mississippi.

Investigate, Apply, and Understand

It is important that the pedagogical paradigm of Mississippi's science classroom reflects the nature of the content being learned. The essence of science is natural to children and includes discovery, observation, questioning, design, testing, failure, iteration, and hands-on application. Research-based approaches such as inquiry-based (IB), project-based, and discovery learning are all pedagogical pathways that make sense, especially in the science classroom. Mississippi's science teachers are encouraged to embrace the growth mindset and constantly seek to upgrade classroom approaches by experimenting and adopting methods that excite students to learn and become functional, autonomous learners and contributors. Students should be provided increased maneuverability in the classroom to formulate their own ideas to investigate and understand the scientific and engineering design processes.

References

ACT. (2014). *ACT college and career readiness standards—Science. (2014).* Retrieved from http://www.act.org/content/dam/act/unsecured/documents/CCRS-ScienceStandards.pdf

Alabama State Department of Education. (2015). *Alabama course of study: Science.* Montgomery, AL: Author.

Indiana Department of Education. (2016). *Indiana's Academic Standards for Science – 2016*. Retrieved from http://www.doe.in.gov/standards/science-computer-science

Massachusetts Department of Elementary and Secondary Education. (2016). *2016 Massachusetts science and technology/engineering curriculum framework*. Malden, MA: Author.

Mississippi Department of Education. (2008). *2010 Mississippi science framework*. Jackson, MS: Author.

Mullis, I. V. S., & Martin, M. O. (Eds.). (2013). *TIMSS 2015 assessment frameworks.* Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

National Assessment Governing Board. (2014). *Science framework for the 2015 National Assessment of Educational Progress* (Contract No. ED-04-CO-0148). Washington, DC: U.S. Government Printing Office.

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: The National Academies Press.

National Science Teachers Association. (2013). *Safety in the science classroom, laboratory, or field sites.* Retrieved from http://www.nsta.org/docs/SafetyInTheScienceClassroomLabAndField.pdf

Next Generation Science Standards Lead States. (2013). *Next Generation Science Standards: For states, by states.* Washington, DC: The National Academies Press.

Schrock, K. (2013, Nov. 9). Resources to support the SAMR model [Blog post]. Retrieved from http://www.schrockguide.net/samr.html

South Carolina Department of Education. (2014). *South Carolina academic standards and performance indicators for science.* Columbia, SC: Author.

Virginia Department of Education. (2010). *Science standards of learning for Virginia public schools.* Richmond, VA: Author.

GRADES 6-8 OVERVIEW

Critical to middle school students is the foundation needed to be successful in high school science. In Grades 6-8, students use an integrated science curriculum to develop and plan controlled investigations and create more explicit and detailed models and explanations. Students must have opportunities to develop the skills necessary to engage in scientific and technical reasoning that are necessary for success in college, careers, and citizenship.

Because of using an integrated science model, the development of themes for each grade became necessary to assure continuity of thought processes.

- Grade 6 – Structure and Function
- Grade 7 – Systems and Cycles
- Grade 8 – Cause and Effect

In Grade 6, students need more tangible concepts, but by Grade 8, the complexity of the content increases to abstract cause and effect relationships. Explaining patterns and making predictions based on an understanding of cause and effect allows students to conceptualize and describe the relationships among natural phenomena. By building complexity into the standards, student skill sets are further strengthened as they prepare for high school courses.

The core science content utilizes hands-on classroom instruction to reinforce the seven crosscutting concepts (i.e., patterns; cause and effect; scale, portion, and quantity; systems and system models; energy and matter; structure and function; and stability and change).

SEPs are in life science, physical science, and Earth and space science. The SEPs are designed so that students may develop skills and apply knowledge to solve real-life problems. While presented as distinct skill sets, the eight practices intentionally overlap and interconnect as students explore the science concepts. Some examples of specific skills students should develop in Grades 6-8 are listed below.

1. Ask questions to explain how density of matter (observable in various objects) is affected by a change in heat and/or pressure.
2. Develop and use models to show relationships among the increasing complexity of multicellular organisms (cells, tissues, organs, organ systems, organisms) and how they serve the needs of the organism.
3. Conduct simple investigations about the performance of waves to describe their behavior (e.g., refraction, reflection, transmission, and absorption) as they interact with various materials (e.g., lenses, mirrors, and prisms).
4. Analyze and interpret data to explain how the processes of photosynthesis, and cellular respiration (aerobic and anaerobic) work together to meet the needs of plants and animals.
5. Use mathematical computation and diagrams to calculate the sum of forces acting on various objects.
6. Construct an explanation for how climate is determined in an area using global and surface features (e.g. latitude, elevation, shape of the land, distance from water, global winds, and ocean currents).
7. Engage in scientific argument based on current evidence to determine whether climate change happens naturally or is being accelerated through the influence of man.
8. Obtain and evaluate scientific information to explain the relationship between seeing color and the transmission, absorption, or reflection of light waves by various materials.

Curricula and instructions that integrate science and engineering practices should reflect the skills outlined above.

The Engineering Design Process (EDP) is a step-by-step method of devising a system, component, or process to meet desired needs. This is similar to the “scientific method” which is taught to young scientists. However, the EDP is a flexible process. Students can begin at any step, focus on just one step, move back and forth between steps, or repeat the cycle. Engineering standards are represented in some performance objectives with grade-banded, specific wording that will prompt students to approach learning and exploration using the engineering process. **These performance objectives are marked with an * at the end of the statement.** Professional development and teacher resources will be developed for teachers as EDP is incorporated into Mississippi standards.

The use of science and engineering practices and crosscutting concepts will actively engage students in science, building on their natural curiosity and encouraging further study in science and engineering fields. As science also requires the ability to think and reason, students will therefore also develop the skills necessary to be successful in college, career, and society.

GRADE SIX

Theme: Structure and Function

Grade 6 students need concrete opportunities to engage with natural phenomena. The integration of Earth and space, life, and physical sciences gives students many opportunities to explore the relationship of structure and function in the world around them. By analyzing the macro- and microscopic world, the role of cells in life functions, the interdependence in ecosystems, the diversity of life on Earth, the relationship between force and motion, and the organization and interactions of objects in the universe, Grade 6 students can make claims and provide evidence about structure-function relationships in different scientific domains.

GRADE SIX: Life Science

L.6.1 Hierarchical Organization

Conceptual Understanding: Living things are distinguished from nonliving things by several characteristics. All living things are comprised of one (unicellular) or more (multicellular) cells, which are the smallest units of life. Cells carry out life functions and undergo cell division using specialized structures that allow them to acquire energy and water, grow, reproduce, dispose of waste, and survive. Multicellular organisms are organized in a hierarchy of increasing complexity with related, specialized structures and functions.

L.6.1 Students will demonstrate an understanding that living things range from simple to complex organisms, are organized hierarchically, and function as whole living systems.

L.6.1.1 *Use argument supported by evidence in order to distinguish between living and non-living things, including viruses and bacteria.*

L.6.1.2 *Obtain and communicate evidence to support the cell theory.*

L.6.1.3 *Develop and use models to explain how specific cellular components (cell wall, cell membrane, nucleus, chloroplast, vacuole, and mitochondria) function together to support the life of prokaryotic and eukaryotic organisms to include plants, animals, fungi, protists, and bacteria (not to include biochemical function of cells or cell part).*

L.6.1.4 *Compare and contrast different cells in order to classify them as a protist, fungus, plant, or animal.*

L.6.1.5 *Provide evidence that organisms are unicellular or multicellular.*

L.6.1.6 *Develop and use models to show relationships among the increasing complexity of multicellular organisms (cells, tissues, organs, organ systems, organisms) and how they serve the needs of the organism.*

GRADE SIX: Life Science

L.6.3 Ecology and Interdependence

Conceptual Understanding: All organisms depend on biotic and abiotic factors for survival. When any environmental factor changes, a corresponding change in diversity and population of organisms will also occur. The environment and the organism in which it lives are therefore interdependent.

L.6.3 Students will demonstrate an understanding of the relationships among survival, environmental changes, and diversity as they relate to the interactions of organisms, populations, and the environment.

L.6.3.1 *Use scientific reasoning to explain differences between biotic and abiotic factors that demonstrate what living organisms need to survive.*

L.6.3.2 *Develop and use models to describe the levels of organization within ecosystems (species, populations, communities, ecosystems, and biomes).*

L.6.3.3 *Analyze cause and effect relationships to explore how changes in the physical environment (limiting factors, natural disasters) can lead to population changes within an ecosystem.*

L.6.3.4 *Investigate organism interactions in a competitive or mutually beneficial relationship (predation, competition, cooperation, or symbiotic relationships).*

L.6.3.5 *Develop and use food chains, webs, and pyramids to analyze how energy is transferred through an ecosystem from producers (autotrophs) to consumers (heterotrophs, including humans) to decomposers.*

GRADE SIX: Life Science

L.6.4 Adaptation and Diversity

Conceptual Understanding: Because living organisms are so diverse, scientists have created a system by which living things are organized into groups according to their characteristics (physical and/or genomic) for identification and research purposes. The kingdoms are very diverse but also have quite a bit in common. Organisms exhibit structural and behavioral characteristics such as adaptations, patterns of growth and development, and life cycles that increase their chances of reproduction and survival in a changing environment.

L.6.4 **Students will demonstrate an understanding of classification tools and models such as dichotomous keys to classify representative organisms based on the characteristics of the kingdoms: Archaebacteria, Eubacteria, Protists, Fungi, Plants, and Animals.**

L.6.4.1 *Compare and contrast modern classification techniques (e.g., analyzing genetic material) to the historical practices used by scientists such as Aristotle and Carolus Linnaeus.*

L.6.4.2 *Use classification methods to explore the diversity of organisms in kingdoms (animals, plants, fungi, protists, bacteria). Support claims that organisms have shared structural and behavioral characteristics.*

L.6.4.3 *Analyze and interpret data from observations to describe how fungi obtain energy and respond to stimuli (e.g., bread mold, rotting plant material).*

L.6.4.4 *Conduct investigations using a microscope or multimedia source to compare the characteristics of protists (euglena, paramecium, amoeba) and the methods they use to obtain energy and move through their environment (e.g., pond water).*

L.6.4.5 *Engage in scientific arguments to support claims that bacteria (Archaebacteria and Eubacteria) and viruses can be both helpful and harmful to other organisms and the environment.*

GRADE SIX: Physical Science

P.6.6 Motions, Forces, and Energy

Conceptual Understanding: Newton's Laws describe forces and motion affecting substances in various environments and situations. Motion is determined by the amount of force applied. Focusing on magnetic, frictional, and gravitational forces will provide an understanding of the relationship between distance and contact forces.

P.6.6 Students will demonstrate an understanding of Newton's laws of motion using real world models and examples.

P.6.6.1 *Use an engineering design process to create or improve safety devices (e.g., seat belts, car seats, helmets) by applying Newton's Laws of motion. Use an engineering design process to define the problem, design, construct, evaluate, and improve the safety device.**

P.6.6.2 *Use mathematical computation and diagrams to calculate the sum of forces acting on various objects.*

P.6.6.3 *Investigate and communicate ways to manipulate applied/frictional forces to improve movement of objects on various surfaces (e.g., athletic shoes, wheels on cars).*

P.6.6.4 *Compare and contrast magnetic, electric, frictional, and gravitational forces.*

P.6.6.5 *Conduct investigations to predict and explain the motion of an object according to its position, direction, speed, and acceleration.*

P.6.6.6 *Investigate forces (gravity, friction, drag, lift, thrust) acting on objects (e.g., airplane, bicycle helmets). Use data to explain the differences between the forces in various environments.*

P.6.6.7 *Determine the relationships between the concepts of potential, kinetic, and thermal energy.*

GRADE SIX: Earth and Space Science

E.6.8 Earth and the Universe

Conceptual Understanding: The hierarchical organization of the universe is the result of complex structure and function. Current theories suggest that time began with a period of extremely rapid expansion. Presently, Earth's solar system consists of the Sun and other objects that are held in orbit by the Sun's gravitational force. The interactions of the Earth, the Moon, and the Sun have effects that can be observed on Earth. Various technologies have aided in our understanding of Earth's place in the universe.

E.6.8 Students will demonstrate an understanding of Earth's place in the universe and the interactions of the solar system (sun, planets, their moons, comets, and asteroids) using evidence from multiple scientific resources to explain how these objects are held in orbit around the Sun because of its gravitational pull.

E.6.8.1 *Obtain, evaluate, and summarize past and present theories and evidence to explain the formation and composition of the universe.*

E.6.8.2 *Use graphical displays or models to explain the hierarchical structure (stars, galaxies, galactic clusters) of the universe.*

E.6.8.3 *Evaluate modern techniques used to explore our solar system's position in the universe.*

E.6.8.4 *Obtain and evaluate information to model and compare the characteristics and movements of objects in the solar system (including planets, moons, asteroids, comets, and meteors).*

E.6.8.5 *Construct explanations for how gravity affects the motion of objects in the solar system and tides on Earth.*

E.6.8.6 *Design models representing motions within the Sun-Earth-Moon system to explain phenomena observed from the Earth's surface (positions of celestial bodies, day and year, moon phases, solar and lunar eclipses, and tides).*

E.6.8.7 *Analyze and interpret data from the surface features of the Sun (e.g., photosphere, corona, sunspots, prominences, and solar flares) to predict how these features may affect Earth.*