SCIENCE

Mississippi

GRADE	SCORES		TOTAL SCORE
C	Content and Rigor	4/7	5/10
	Clarity and Specificity	1/3	

REPORT CARD

Content & Rigor	**3.8**
Scientific Inquiry & Methodology	2
Physical Science	2
Physics	6
Chemistry	5
Earth & Space Science	5
Life Science	3
Clarity & Specificity	**1.0**

Average numerical evaluations

Overview

The Mississippi science standards are a study in contrast. Some content areas are poorly written and disorganized, while others, notably earth and space science and high school physics and chemistry, are reasonably strong and thorough. An excessive reliance on shorthand—bullet points run rampant throughout the document—deprives the material of depth, making it difficult to imagine that a coherent, effective curriculum might emerge for students in the Magnolia State.

Organization of the Standards

The Mississippi K-8 *Science Framework* is divided first into four strands: inquiry, physical science, life science, and earth and space science. Each strand is then divided into a series of competencies, or standards. These competencies are then elaborated and clarified by means of objectives and sub-objectives. For example, a fifth-grade earth and space science competency asks students to "develop an understanding of the properties of Earth materials, objects in the sky, and changes in the Earth and sky." The related objectives and sub-objectives are as follows:

> **Summarize how weather changes.**
>
> - **Weather changes from day to day and over the seasons**
> - **Tools by which weather is observed, recorded, and predicted. (grade 5)**

Finally, the state assigns a "depth of knowledge" (DOK) level for each sub-objective. There are four DOK levels: recall, skill/concept, strategic thinking, and extended thinking. They are meant to "help administrators, teachers, and parents understand the objective in terms of the complexity of what students are expected to know and do." For example, DOK 1 (recall) states:

> **Level 1 (Recall) includes the recall of information such as a fact, definition, term, or a simple procedure, as well as performing a simple algorithm or applying a formula. Other key words that signify a Level 1 include "identify," "recall," "recognize," "use," and "measure." Verbs such as "describe" and "explain" could be classified at different levels depending on what is to be described and explained.**

The high school standards are organized similarly, except that competencies are presented by course, rather than by grade.

Document(s) Reviewed

▶ *Mississippi Science Framework*. 2010. Accessed from: http://www.mde.k12.ms.us/acad/id/curriculum/Science/Webpage%20links%207%2031%2008.htm

Mississippi offers an astonishingly large number of standards for high school courses. Along with ninth-grade physical science and physics and chemistry, the state articulates standards for Introduction to Biology, Biology I, Biology II, and seven other life science courses, as well as another seven sets of standards for courses ranging from Organic Chemistry to Aerospace Studies. And this does not include Advanced Placement courses.

Content and Rigor

The Mississippi standards have moments of strength, notably in physics and chemistry. But even for chemistry, the material often suffers from confusion, with some important content omitted entirely.

Scientific Inquiry and Methodology

The brevity of Mississippi's inquiry standards is both a blessing and a curse. In far too many states, process standards take up a disproportionate part of the whole; this is not the case in Mississippi. Unfortunately, the state often errs on the side of *too* brief—many of these standards are so compact that they fail to outline the specific content and skills that students need to learn. For example, Kindergarten students must "ask questions and find answers by scientific investigation," but the six bulleted tasks (e.g., "demonstrate an understanding of a simple investigation by asking questions" and "recognize that when a science investigation is done the way it was done before, very similar results are expected") offer little help as to how the stated competency can be realized in the classroom in the course of teaching content material. This vagueness stretches all the way through the grades; in first grade, one of the six objectives is to "predict the results of an investigation if it is repeated," certainly an objective that can be easily met. Fifth graders are asked to "evaluate results of different data (whether trivial or significant)." We cannot divine what this objective even *means*. Regrettably, similarly content-free standards can be found throughout.

Physical Science

The physical science standards are poorly presented. To begin, the state often throws several unrelated matters into a single confusingly written or scrambled sentence. It is frequently difficult to discern the connection between a single standard and the bulleted items that follow it. Take, for example, the following:

> **Describe physical properties of matter (e.g., mass, density, boiling point, freezing point) including mixtures and solutions.**
>
> - **Filtration, sifting, magnetism, evaporation, and flotation**
> - **Mass, density, boiling point, and freezing point of matter**
> - **Effects of temperature changes on the solubility of substances. (grade 5)**

This standard is a confused mess. In the first bullet, one assumes that students are meant to learn the five techniques that can be used to separate mixtures, though that expectation should be made far more clearly. The second bullet merely repeats information already in the standard itself. And what is expected of students in the third bullet is impossible to discern, especially since increasing the temperature raises the solubility of some substances, but decreases it for others.

Similarly, the following standard crams far too much into a single expectation:

> **Investigate and describe the effects of forces acting on objects.**
>
> - **Gravity, friction, magnetism, drag, lift, and thrust**
> - **Forces affecting the motion of objects. (grade 6)**

Gravity, friction, and magnetism are not forces, though gravitational forces, frictional forces, and magnetic forces are. And it is odd to jam them together with three forces of specific interest in aerodynamics and hydrodynamics. Finally, the second bullet is vague to the point of meaninglessness.

Similar standards can be found throughout.

High School Physics

The high school physics course is quite strong. Though excessively brief (the whole is covered in about three pages), the coverage is systematic, logical, and lucid, beginning with kinematics and dynamics, proceeding to work and energy, and then moving on to oscillations, sound and light, electromagnetism, and modern physics.

The coverage of kinetic and potential energy is also exemplary and is followed by strong and systematic coverage of both momentum and thermodynamics.

The rest of the physics material is quite similar in form and content. In all, these standards create a solid guide for curriculum and textbook developers.

High School Chemistry

The Mississippi science standards touch on most of the essential high school chemistry content students should

learn. Unfortunately, that content is often presented in a haphazard and disorganized way. For example, Le Châtelier's principle is introduced before students have been asked to learn about equilibrium. Found only in ninth-grade physical science, electron transitions and atomic spectra belong in chemistry class because they helped explain modern atomic theory. Hydrogen bonding, appropriately, is found in Biology I. But it is not included in Chemistry I, where it also belongs, as an important type of intermolecular force.

Adding confusion, some chemistry standards merely hint at what students should know. Take, for example, the following:

> **Develop a three-dimensional model of molecular structure.**
>
> - **Lewis dot structures for simple molecules and ionic compounds**
> - **Valence shell electron pair repulsion theory (VSEPR). (high school chemistry)**

Missing are the names for the molecular shapes predicted for Lewis dot structures, the connection of these shapes to molecular polarity, and what VSEPR theory is and how it is used. Those who need to use the Mississippi chemistry standards will cry out for more guidance.

Earth and Space Science

The earth and space science content from Kindergarten through eighth grade varies—it is richly ambitious in places and sketchy in others. The standards include much important content, but the presentation is often confusing.

As an example of laudably ambitious material, eighth grade includes some cosmology—a topic normally presented in high school (often ninth-grade) courses:

> **Describe the hierarchical structure (stars, clusters, galaxies, galactic clusters) of the universe and examine the expanding universe to include its age and history, and the modern techniques (e.g., radio, infrared, ultraviolet, and X-ray astronomy) used to measure objects and distances in the universe. (grade 8)**

Unfortunately, the quality is not consistent. For example, the sixth-grade treatment of weather gives only the vague direction that students should:

> **Analyze climate data to draw conclusions and make predictions. (grade 6)**

What, precisely, students should know or be able to do is unclear. Yet in other grades, similar material is spelled out in rich detail.

Plate tectonics includes some important content, but the material is disorganized and sometimes a bit garbled. Minerals get little more than mention in Kindergarten through eighth grade, and though the subject does show up in the high school earth and space science course, it is oddly presented. Further, the rock cycle is not developed.

Life Science

To their credit, the Mississippi standards do not shy away from the term "evolution," which appears extensively throughout the document. Unfortunately, the progression of the subject is not easy to follow at the high school level, as it is scattered through approximately ten life science courses. And perhaps most troubling, students are only required to take one course for high school graduation, leaving little confidence that students will graduate with a firm understanding of this important topic.

Worse, problems of sequence and rigor persist across topics and grade levels, and students are often asked to learn content that is simply inappropriate for their grades. For example, in fourth grade, students are asked to:

> **Compare characteristics of organisms, including growth and development, reproduction, acquisition and use of energy, and response to the environment.**
>
> - **Life cycles of various animals to include complete and incomplete metamorphosis**
> - **Plant or animal structures that serve different functions in growth, adaptation, and survival**
> - **Photosynthesis. (grade 4)**

That material is too advanced for fourth graders.

Then, in sixth grade, students are asked to:

> **Compare and contrast structure and function in living things to include cells and whole organisms.**
>
> - **Hierarchy of cells, tissues, organs, and organ systems to their functions in an organism**
> - **Function of plant and animal cell parts (vacuoles, nucleus, cytoplasm, cell membrane, cell wall, chloroplast)**
> - **Vascular and nonvascular plants, flowering and non-flowering plants, deciduous and coniferous trees. (grade 6)**

Such material is normally addressed at the high school level.

With mixed quality ranging from the very good treatment of physics to the poor treatment of physical science, Mississippi ends up with an average score of four out of seven for content

and rigor. (See Appendix A: Methods, Criteria, and Grading Metric.)

Clarity and Specificity

The Mississippi science standards are disorganized, making it difficult to track the progression of content and rigor from grade to grade. The state provides objectives and sub-objectives, which are meant to clarify what students should know and be able to do, yet the document notes that "*objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time*" (original emphasis). That's a good thing, because the order of the objectives is often a jumble where some assume knowledge that the standards have not previously explained. Further complicating matters, the assigned depth of knowledge (DOK) indicators often make little sense, making it seem like the standards writers weren't sure what the objectives actually entailed.

In several places, expectations boil down to jarring episodes of boosterism of local agencies and businesses. For example, students are asked to:

> **Develop a logical argument to explain how the forces which affect the motion of objects has [*sic*] real-world applications including (but not limited to) examples of Mississippi's contributions as follows:**
>
> - **Automotive industry (Nissan's new production plant is located in Canton, MS. Toyota's new facility is in Tupelo, MS.)**
> - **Aerospace industry (The Raspet Flight Research Laboratory, housed at Mississippi State University, is one of the premier university flight research facilities in the country.)**
> - **Shipbuilding industry (Ingall's [*sic*] Shipbuilding, of Pascagoula, MS, is a leading supplier of marine vessels to the United States Navy.) (grade 6)**

This poorly written standard gives the illusion that a study of Mississippi businesses will somehow convey an understanding of Newton's second law of motion (the effect of force on motion). It won't.

Unfortunately, confused and confusing writing is commonplace. For example, one standard asks students to compare "seismic wave velocities of earthquakes and volcanoes to lithospheric plate boundaries using seismic data" (grade 8). Whatever was intended here, seismic wave velocities, like those of all mechanical waves, depend only on the medium through which they are passing, and not the source or any boundaries through which they may pass.

Taken together, these drawbacks earn Mississippi a one out of three for clarity and specificity. (See Appendix A: Methods, Criteria, and Grading Metric.)