SCIENCE

Louisiana

GRADE	SCORES		TOTAL SCORE
B	Content and Rigor	5/7	7/10
	Clarity and Specificity	2/3	

REPORT CARD

Content & Rigor	**4.7**
Scientific Inquiry & Methodology	2
Physical Science	5
Physics	4
Chemistry	6
Earth & Space Science	5
Life Science	6
Clarity & Specificity	**2.2**

Average numerical evaluations

Overview

The Louisiana science standards are reasonably challenging and comprehensive, but they suffer from a devastating flaw: Thanks to the state's 2008 Science Education Act, which promotes creationism instead of science, the standards (especially for biology and life science) are haunted by anti-science influences that threaten biology education in the state.

Organization of the Standards

Louisiana's K-8 science standards are divided first into four strands: science as inquiry, physical science, life science, and earth and space science. Each strand is then divided into a series of sub-strands and finally into grade-level expectations.

The high school standards are organized similarly, except that they are presented by course rather than by grade for each of the following: physical science, biology, chemistry, physics, earth science, and environmental science.

Building upon Louisiana's grade-level expectations are the state's comprehensive curriculum documents, available for each of the aforementioned grades and courses.

In addition to the state standards and optional curriculum resources, Louisiana's 2008 Science Education Act encourages cities, parishes, or local school boards to supplement state standards and curricula with materials that promote "critical thinking skills, logical analysis, and open and objective discussion of scientific theories including, but not limited to, evolution, the origins of life, global warming, and human cloning." The statute is a far-from-subtle encouragement to teach creationism instead of science, and to introduce nonexistent "scientific controversies" into the classroom under the false cloak of the genuine uncertainties that always exist at the frontiers of science and are the grist for scientific progress. It directs teachers to "teach the material presented in the standard textbook supplied by the school system" and to "use supplemental textbooks and other instructional materials to help students understand, analyze, critique, and review scientific theories in an objective manner..." While this act does not directly impact the Pelican State standards themselves, the impact of this Act is to undermine the teaching of critical scientific content.

Document(s) Reviewed

- *Louisiana Grade Level Expectations: Science*. 2004. Accessed from: http://www.doe.state.la.us/topics/gle.html
- *Louisiana Comprehensive Curriculum: Science*. 2008. Accessed from: http://www.louisianaschools.net/topics/comprehensive_curriculum.html

Content and Rigor

While the Louisiana standards are reasonably comprehensive, the rigor varies greatly across and within content areas and from grade to grade, making it difficult to believe that all students will be exposed to a sufficiently (or equally) rigorous and thorough K-12 science curriculum.

Scientific Inquiry and Methodology

At every grade level, "science as inquiry" is divided into two strands: "the abilities necessary to do scientific inquiry" and "understanding scientific inquiry." Both present cumulative lists of expectations but fail to articulate how these are related to the content areas. We are instead presented with a sterile list of "abilities." There are global statements such as "explain and give examples of how scientific discoveries have affected society." But, with nothing to guide the teacher as to grade-appropriate examples, these seem empty. Sadly, such nebulous standards are the rule, rather than the exception, in this domain.

Equally troubling, another global statement asks students to "explain how skepticism about accepted scientific explanations (i.e., hypotheses and theories) leads to new understanding." This cracks the door open to an invasion by creationists, particularly in light of the state's Science Education Act (discussed above).

The history of science—a useful pedagogical tool for the teaching of scientific process—receives no mention at all.

Physical Science

The physical science standards for Kindergarten through eighth grade are troubling for a number of reasons. For starters, too many grade-level expectations are repeated nearly verbatim across grade levels, making a progression or accumulation of content and rigor difficult to discern.

In addition, the rigor of the standards is inconsistent. The fourth-grade physical science standards, for example, are clear and appropriately rigorous. Many standards, however, are inappropriate for the grade. For instance, pre-Kindergartners and Kindergartners are to "express data in a variety of ways by constructing illustrations, graphs, charts, tables, concept maps, and oral and written explanations as appropriate," and to "express ideas about demonstrations or experiments (e.g., drawings, journals, reports, presentations, exhibitions, portfolios)." A tall order for such young students.

Finally, some important content is omitted entirely. For instance, a ninth-grade physical science course, which (as is typical) includes standards for both chemistry and physics, leaves out a substantial amount of critical content, including such key subjects as the laws of thermodynamics, the mole concept, the ideal gas law, kinetic theory, atomic structure, metallic and hydrogen bonding, and chemical equilibrium.

High School Physics

In the high school physics course (recommended for grades 11-12), the section titled "forces and motion" is a hodgepodge. It's no accident that high school physics content is presented in pretty much the same order in nearly all textbooks, but that strong hint has been ignored by Louisiana's standards writers. Their items cover the essential content, including such important topics as kinematics and curvilinear and oscillatory motion, with reference to gravitational, electrostatic, and strong nuclear forces. But the order of the items present is hopelessly scrambled, and neither Newton's laws nor analysis of one-dimensional motion appears.

High School Chemistry

Louisiana's standards offer an ambitious scope of study, dealing with most chemistry content well: oxidation reactions, carbon chemistry, and stoichiometry are all thoroughly covered. Some examples:

> **Predict the kind of bond that will form between two elements based on electronic structure and electronegativity of the elements (e.g., ionic, polar, nonpolar). (high school chemistry)**
>
> **Calculate pH of acids, bases, and salt solutions based on the concentration of hydronium and hydroxide ions. (high school chemistry)**
>
> **Compute percent composition, empirical formulas, and molecular formulas of selected compounds in chemical reactions. (high school chemistry)**

Though minor, the most significant shortcoming of the Louisiana chemistry standards is that some critical prerequisite content is missing. For example, high school chemistry students are asked to:

> **Predict the direction of a shift in equilibrium in a system as a result of stress by using LeChatalier's [*sic*] principle. (high school chemistry)**

Unfortunately, students have not yet been asked to understand reaction rates. This knowledge is essential for comprehending equilibrium, equilibrium constants, and equilibrium expressions. Students need to understand thoroughly the concept of equilibrium in order to comprehend stresses to the system.

Another expectation asks students to "draw accurate valence electron configurations and Lewis dot structures for selected molecules, ionic and covalent compounds, and chemical equations" (high school chemistry). There are two problems with this standard: Lewis dot structures are not used for chemical equations, and valence electron configurations are used only for atoms or their ions—not for molecules, compounds, or chemical equations.

By addressing these concerns and adding material on kinetic molecular theory, the ideal gas law equation, and molecular shapes, the Louisiana chemistry standards could get closer to perfect.

Earth and Space Science

The Louisiana earth and space science standards contain a good deal of key content, some of it with impressive depth and rigor, particularly in Kindergarten through eighth grade. For instance, the subject of plate tectonics is well covered, as are the rock and water cycles, mineral properties, and the solar system. The eighth-grade standards even include a strong reference to the Hertzsprung-Russell diagram.

Unfortunately, the high school standards are insufficiently rigorous and are missing some important material. Astronomical units are not mentioned. Neither are the mechanics and measurement of earthquakes, volcanism, the greenhouse effect, or the solar cycle. Climate and weather are poorly developed.

The quality of the activities provided in the optional *Comprehensive Curriculum* is mixed. Even when a topic is well covered by the standards, the suggested curriculum sometimes fails to develop the topic sufficiently. For instance, an activity on Bowen's reaction series provides little explanation for the observed phenomena. In addition, the curriculum often includes silly activities, such as pressing modeling clay, supposedly to mimic metamorphism and give some sort of information about foliated versus monomineralic textures. It doesn't.

Life Science

The life science standards for Kindergarten through eighth grade are generally quite strong and include much important information, some of it covered with impressive depth. For example, in fourth grade, students are asked to "explain the primary role of carbohydrates, fats, and proteins in the body." Many states don't even include this content in high school, but here, the state not only expects students to know it, but also provides supplemental material that helps define these terms in grade-appropriate ways.

The seventh-grade biology standards are also excellent, as are the high school standards, and both cover nearly all of the essential content well.

The most significant drawback to the standards covering Kindergarten through eighth grade is the omission of evolution. Indeed, the term evolution doesn't appear at all. Instead, eighth graders are asked only to:

> **Compare fossils from different geologic eras and areas of Earth to show that life changes over time. (grade 8)**

Asking students to understand that life changes over time is not the same thing as asking them to learn the building blocks of evolutionary theory.

Fortunately, the high school coverage of evolution is reasonably strong. Tenth graders, for example, are asked to:

> **Analyze evidence on biological evolution, utilizing descriptions of existing investigations, computer models, and fossil records. (high school biology)**

In addition, the comprehensive curriculum provides useful and rigorous supplemental material that further clarifies what the state expects students to know about evolution.

Taken together, these strengths and drawbacks earn Louisiana a solid average score of five out of seven for content and rigor. (See Appendix A: Methods, Criteria, and Grading Metric.)

Clarity and Specificity

In general, the Louisiana standards are clearly written, using verbs we all understand. The state appropriately asks students to "use scientific notation," "write and name formulas," and "calculate."

At times, however, the standards are poorly organized, and there are several standards that are too vague to inform curriculum and instruction. In high school physical science, for example, students are expected to "measure and calculate the relationships among energy, work, and power." Such an exercise would be useful indeed—but without a bit of guidance it's destined to fail.

The writing at times is equally ambiguous, with equally unfortunate implications. In high school, for example, students are asked to "draw accurate valence electron configurations and Lewis dot structures for selected molecules, ionic and covalent compounds, and chemical equations." That's a bit sloppy. One can draw an electron configuration for an atom or ion. Lewis dot structures can be made for atoms and their ions, but they are used primarily for covalently bonded molecules and polyatomic ions. But chemical equations?

Still, flaws like these appear so infrequently that the general impression of the curriculum is positive, as is reflected in the score of two out of three for clarity and specificity. (See Appendix A: Methods, Criteria, and Grading Metric.)