SCIENCE

New Mexico

GRADE	SCORES		TOTAL SCORE
C	Content and Rigor	4/7	6/10
	Clarity and Specificity	2/3	

REPORT CARD

Content & Rigor	**3.5**
Scientific Inquiry & Methodology	5
Physical Science	4
Physics	0
Chemistry	0
Earth & Space Science	5
Life Science	7
Clarity & Specificity	**1.5**

Average numerical evaluations

Overview

The New Mexico science standards start on the right track, but falter along the way. The standards are clear but lack adequate specificity. While the content that is presented is strong, the Land of Enchantment omits much necessary content. New Mexico's biggest flaw is a regrettable avoidance of quantitative methods.

Organization of the Standards

The K-12 New Mexico science standards are divided into three strands: scientific thinking and practice, content of science, and science and society. Each strand is then divided into a series of sub-strands, called standards. For instance, the three "standards" for the "content of science" strand are physical science, life science, and space science. Next, the state provides benchmarks for each of three grade bands (K-4, 5-8, and 9-12). Finally, grade-specific performance standards articulate how students will demonstrate mastery of each benchmark at each grade, K-8, and for the 9-12 grade band.

Content and Rigor

The operative words that describe the New Mexico science standards are "as far as they go" (which is somewhat ironic given the state's motto, *Crescit eundo*, or "it grows as it goes"). Overall, the standards are strong enough—as far as they go. And when they go far, as in life science, they are outstanding, covering all the necessary content with adequate depth and rigor. Alas, too often they fall short of that benchmark, particularly in upper level physical science, leaving their development in varying stages of completion. The result is an average performance that, with a little more effort, could have been excellent.

Scientific Inquiry and Methodology

While New Mexico's grade-specific performance standards for scientific inquiry and methodology are generally thorough, clear, and grade appropriate, the grade-band benchmarks add little value. Many are vague; for instance, from Kindergarten through fourth grade, students are asked to "use scientific methods to observe, collect, record, analyze, predict, interpret, and determine reasonableness of data." What makes data "reasonable" is anyone's guess.

Document(s) Reviewed[1]

- *New Mexico Science Standards*. 2003, reformatted 2008. Accessed from: http://www.ped.state.nm.us/mathscience/scienceStandards.html

[1] Fordham's 2005 evaluation also reviewed New Mexico's 2003 content-standards document. In 2008, the content standards were reformatted, changing the document some. In addition, the evaluation criteria used to judge the standards have been updated and improved since 2005. (See Appendix A for a complete explanation of criteria used in this review.) Through this new lens, and with this reformatted standards document, New Mexico's science grade dropped from an A to a C. The complete 2005 review can be found here: http://www.edexcellence.net/publications-issues/publications/sosscience05.html.

In addition, the benchmarks rarely make meaningful distinctions in content or rigor across grade bands. In fifth through eighth grades, one benchmark simply asks students to "use scientific methods to develop questions, design and conduct experiments using appropriate technologies, analyze and evaluate results, make predictions, and communicate findings." By high school, students are asked to "use *accepted* scientific methods to develop questions, design and conduct experiments using appropriate technologies, analyze and evaluate results, make predictions, and communicate findings" (emphasis added). As if using unacceptable methods were sufficient before high school.

In addition, the standards make no mention of the historical and social aspects of science.

Physical Science/High School Physics/High School Chemistry

Overall, New Mexico presents rigorous material for the elementary grades. Forms and states of matter are presented early—including the gas state, which is usually not covered until later:

> **Observe that the three states of matter (i.e., solids, liquids, and gases) have different properties (e.g., water can be liquid, ice, or steam).**
>
> **Describe simple properties of matter (e.g., hardness, flexibility, transparency). (grade 1)**

Other topics, including light, gravity, and forms of energy (kinetic, potential, and chemical) are equally well handled. Even better, atoms are first presented in fourth grade, with protons, neutrons, and electrons entering the standards in eighth grade.

Unfortunately, the New Mexico standards do stumble in their physical science expectations. While the necessary content is often present, some standards suffer from a lack of depth and completeness. Worse still, some standards are simply wrong, as in the following eighth-grade example:

> **Explain that elements are organized in the periodic table according to their properties. (grade 8)**

The state of the high school physical science standards is far worse. New Mexico fails to outline high school courses for either physics or chemistry, and important topics normally found in these courses are glossed over or missing entirely in the high school physical science standards. Indeed, all of high school physical science is shoehorned into about three-and-a-half pages. To be fair, what is present therein is generally well organized and well written, but at a level that cannot serve well as the basis for college-prep courses.

A particular concern is the virtual absence of mathematical relationships (including metric measurements). In spite of the piety of the high school benchmark asking students to "use mathematical concepts, principles, and expressions to analyze data, develop models, understand patterns and relationships, evaluate findings, and draw conclusions" (grades 9-12), $F = ma$ is about the only equation in the entire document. Newton's law of gravitation—the dependence of the gravitational force on the mass of two objects and the distance between them—is stated only qualitatively. No quantitative expression appears for the electrostatic force between two charges, either.

Worse still, some of the content included in the high school physical science standards is not rigorous enough even for a ninth-grade physical science course. For instance, there is no reason that students cannot be given an initial introduction to heat transfer mechanisms before high school. Yet, the first such introduction comes with the following high school standard:

> **Understand how heat can be transferred by conduction, convection, and radiation, and how heat conduction differs in conductors and insulators. (grades 9-12)**

On the chemistry side, a paucity of content likewise prevails. For instance, there are no standards about atomic models nor any mention of metallic or hydrogen bonding. The mole concept is not addressed, nor is molar volume (because ideal gases are not considered) or molarity (because the standards offer nothing on solutions). Spectra and electron transitions are only hinted at in the cryptic phrases "wavelengths of electromagnetic radiation" and "gain or lose energy only in discrete amounts."

In sum, while the physical science standards start off strong in the early grades, they degenerate dramatically in the later ones, leaving the deeper requirements of college-prep chemistry and physics courses unmet.

Earth and Space Science

The earth and space science standards for Kindergarten through eighth grade cover much essential content at an appropriate level of depth and with few errors. The coverage of space science is a little stronger than is that for solid earth material such as rocks and minerals, plate tectonics, and earthquakes.

For instance, there is an excellent sixth-grade standard that addresses the solar system:

> **Locate the solar system in the Milky Way galaxy.**

Identify the components of the solar system, and describe their defining characteristics and motions in space, including:

- **sun as a medium sized star**
- **sun's composition (i.e., hydrogen, helium) and energy production**
- **nine planets, their moons, asteroids. (grade 6)**[1]

On the earth science side, coverage is reasonable, but not outstanding. Often the trouble is that topics are merely mentioned, without explanatory details:

Know that Earth is composed of layers that include a crust, mantle, and core. (grade 6)

Here, the layers are named but not described. What should students know about, for instance, the mantle? Then in high school:

Explain plate tectonic theory and understand the evidence that supports it. (grades 9-12)

There is no way to judge the breadth or depth of such a standard.

Even with this occasional lack of detail, the New Mexico earth and space science standards are clear and businesslike, and cover most of the necessary territory with few obvious errors. They even present the occasional "wow" moment, as in this standard, beautifully accurate for Kindergarten: Observe that the sun warms the land and water and they warm the air. (Kindergarten)

Likewise, the treatment of geologic time in high school is complete and rigorous:

Understand the changes in Earth's past and the investigative methods used to determine geologic time, including:

- **rock sequences, relative dating, fossil correlation, and radiometric dating**
- **geologic time scales, historic changes in life forms, and the evidence for absolute ages (e.g., radiometric methods, tree rings, paleomagnetism). (grades 9-12)**

Life Science

The life science standards are generally clear, rigorous, and thorough. Students in second grade learn about the circulatory, digestive, and respiratory systems. Cells are introduced in fourth grade, and a seventh-grade unit on evolution is as good as or better than what is commonly seen in high school.

[1] Note: This standard was written in 2003, before Pluto was demoted.

At the high school level, again there is excellent content on diversity, deep time, and common ancestry—with many fantastic standards covering important content at the appropriate depth. For instance, high school students are asked to:

Explain how cells differentiate and specialize during the growth of an organism, including:

- **differentiation, regulated through the selected expression of different genes**
- **specialized cells, response to stimuli (e.g., nerve cells, sense organs). (grades 9-12)**

Biochemistry and cell biology are also well covered in high school. And, while there is little physiology at this level, the solid coverage of physiology in the standards for Kindergarten through eighth grade provides some consolation.

Further, the standards are pointedly accurate—not falling victim to the inaccuracies common in other states. For instance, eighth graders are commendably asked to "understand that all living organisms are composed of cells from one to many trillions." This is the right order of magnitude for such a statement; too many states inappropriately cap the number of cells at "millions."

There are, unfortunately, some statements that promulgate misconception. For instance, second-grade students are told to "know that bacteria and viruses are germs," when it would be better to "know that what are called 'germs' include bacteria and viruses."

Overall, New Mexico earns an average score of four out of seven for content and rigor. (See Appendix A: Methods, Criteria, and Grading Metric.)

Clarity and Specificity

The New Mexico science standards are straightforward and well written. However, the document reads a bit too much like an executive summary than a useful outline of an educational initiative, with lists of important terms included in a patchwork of examples alongside the performance standards.

A result is that critical details get lost in the compression. In physical science, for example, all of kinetic theory is contained in the single statement: "Explain how thermal energy (heat) consists of the random motion and vibrations of atoms and molecules and is measured by temperature" (grades 9-12).

Similarly, for earth and space science, much content has been so condensed that it appears as a mere list of topics, without any indicator of depth or complexity:

> **Know that the regular and predictable motions of the Earth-moon-sun system explain phenomena on Earth, including:**
>
> - **Earth's motion in relation to a year, a day, the seasons, the phases of the moon, eclipses, tides, and shadows. (grade 6)**

And in chemistry, the words acidic, basic, neutral, pH, neutralization, and redox appear as terms in lists, but there is no real explanation or application made of them.

Of the two components to this category, New Mexico aces clarity but does not go nearly far enough in providing an adequate level of specificity. As such, the Land of Enchantment scores a two out of three for clarity and specificity. (See Appendix A: Methods, Criteria, and Grading Metric.)