SCIENCE

New Hampshire

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

REPORT CARD

Content & Rigor	**2.7**
Scientific Inquiry & Methodology	2
Physical Science	4
Physics	0
Chemistry	0
Earth & Space Science	4
Life Science	6
Clarity & Specificity	**1.0**

Average numerical evaluations

Overview

The New Hampshire science standards are ambitious but undisciplined. The lower grades generally are good, but the quality declines as the grade level rises. Topics appear willy-nilly, leaving glancing blows but few direct hits, and the document makes unspecified but complicated requests of students. Bad writing, from imprecise science to poor grammar, does further damage.

Organization of the Standards

The New Hampshire standards are divided first into four strands: earth space science, life science, physical science, and science process skills. Each strand is then divided into sub-strands. Finally, for all strands except "science process skills," standards are presented for six grade spans: K-2, 3-4, 5-6, 7-8, 9-11-basic, and 11-12-advanced. (Standards addressing "science process skills" are presented for only three grade spans: K-4, 5-8, and 9-12.) These standards are also accessible through a series of individual grade-span documents as well as individual-strand documents.

The standards are introduced with a single page that describes important theories—a good idea that is poorly executed and adds little value to any of the content areas. The state also provides a series of "advanced" standards for grades 11-12. There is a grade-level overlap with the standards specified for grades 9-11, and the document never clarifies for whom the advanced-level standards are intended.

Content and Rigor

The New Hampshire standards suffer from a split personality. Some topics—life science, in particular—are covered thoughtfully, thoroughly, and with the appropriate level of rigor. Other topics, however, are missing critical content, and/or the level of rigor is inappropriate for the grade level.

Scientific Inquiry and Methodology

Troublingly, more than a quarter of the 125-page *Framework*—thirty-two pages—is devoted to science process skills, including inquiry and methodology. (By comparison, all of physical science is presented in only twenty-one pages.) Devoting so much space to this material inappropriately prioritizes process over content. Worse, the standards

Document(s) Reviewed

- *New Hampshire K-12 Science Literacy Curriculum Framework*. 2006. Accessed from: http://www.education.nh.gov/instruction/curriculum/science/documents/framework.pdf
- *New Hampshire Science Grade-Level Expectations, K-8*. 2006. Accessed from: http://www.education.nh.gov/instruction/assessment/necap/gle.htm#science
- *New Hampshire Science High School Grade-Span Expectations*. 2006. Accessed from: http://www.education.nh.gov/instruction/assessment/necap/gse.htm#science

themselves are generally vacuous statements that provide little guidance about what students should learn about scientific inquiry, methodology, or history. For example, a section comparing "ways of knowing" offers simplistic statements that confuse the relationship between science and "philosophic knowledge." Most modern philosophers would, for example, deny that "supernatural forces and viewpoints" are logical "philosophical explanations" (whatever that means).

In addition, the social and historical aspects of science receive scant attention.

Physical Sciences/High School Physics/High School Chemistry

The physical science concepts introduced in from Kindergarten through fourth grade are thoughtful, clearly and correctly expressed, and appropriately suited to their grade levels; they challenge students without expecting too much from them. Unfortunately, though the document remains functional, these laudable characteristics fade in the standards for the upper grades. Starting in fifth and sixth grades, the *Framework* falls victim to illogical ordering, inadequate development, and sloppy writing. Take, for instance, this nonsense:

> **Identify energy as a property of many substances. (grades 5-6)**

Other statements are simply inaccurate, such as:

> **Explain that sound vibrations move at different speeds. (grades 5-6)**

Of course, sound vibrations do *not* move at different speeds in the same medium!

There are also unrealistic expectations, such as this one:

> **Use data to determine or predict the overall (net) effect of multiple forces (e.g., friction, gravitational, magnetic) on the position, speed, and direction of motion of objects. (grades 7-8)**

On the chemistry side of physical science, hydrogen bonding, metallic bonding, Lewis dot structures, polarity, molarity, stoichiometry, and equilibrium are all missing. Further, oxidation gets short shrift; it is narrowly defined in eighth grade and never mentioned again.

This trend continues in high school. Consider the treatment of heat energy:

> **Describe the relationship between heat and temperature, explaining that heat energy consists of the random motion and vibrations of atoms, molecules, and ions; and that the higher the temperature, the greater the atomic or molecular motion. (grades 9-11)**
>
> **Explain the concept of entropy. (grades 11-12)**

The first of these two statements is all that the "basic" standards for grades nine through eleven have to say about thermodynamics. This is utterly inadequate. It adds insult to injury to append the second "advanced" statement, which is surely incomprehensible without a prior discussion of the laws of thermodynamics (especially the second law). Its only possible function is to put the reader in awe of writers who know the magical word "entropy."

There is no coverage of high school physics or chemistry.

Earth and Space Science

Earth and space science receives uneven attention. Much is good; the treatments of soils, the evolution of the atmosphere, geologic time measurement, and stellar evolution are sound. But missing entirely are such fundamentals as the solar system as part of a galaxy, volcanism, the greenhouse effect, air pressure (though a "tools" section mentions using a barometer, a string search turns up only one mention of pressure, after the word "blood"), and the distinction between climate and weather.

Fossils are presented as a recurrent theme in earth sciences. Likewise, the related life science theme "Humans are similar to other species in many ways, and yet are unique among Earth's life forms" is well developed and includes good consideration of disease mechanisms—a subject strangely absent from most state standards.

Life Science

The life science standards are well conceived and progress appropriately through the grades. As mentioned above, disease mechanisms are laudably introduced in fifth and sixth grades, beginning with:

> **Explain that the human body has ways to defend itself against disease-causing organisms and describe how defenders, including tears, saliva, the skin, some blood cells and stomach secretions support the defense process. (grades 5-6)**

The content builds nicely on this foundation, both within this grade band and also in the later grades.

New Hampshire also clearly prioritizes evolution in its standards, beginning with the introduction of the *Framework*. To preempt any distortion of the validity of

evolution as being "just a theory," the document offers a straightforward list, with brief descriptions, of several other major scientific theories, from gravity to the Big Bang. Further, evolution is introduced early:

> **Recognize that some plants and animals, which are alive today, are similar to living things which have become extinct, such as elephants and mammoths. (grades K-2)**

In seventh and eighth grades, genes and chromosomes are introduced, as are embryological concepts. Some human embryology is included—which is both atypical and laudable. Even more impressively, humans are put into the evolutionary context.

Still, even in a state that handles evolution well, the rare creationist ploy sneaks in. Two Granite State standards ask students to support *or refute* the Big Bang theory (in earth space science) and the genetic relationships among groups of organisms (in life science).

Further, some of the benchmarks are too broad to be useful. For example:

> **Describe the interaction of living organisms with non-living things. (grades 3-4)**

The high school standards are well conceived, with clear, broad, and challenging development of content. There is one unfortunate exception: Mitosis and meiosis are segregated out into the "advanced" eleventh- and twelfth-grade standards, while Mendelian genetics and Punnett squares are explained in the "basic" ninth- through eleventh-grade standards. Teaching Mendelian genetics without an understanding of meiosis would be impossible.

Overall, the major oversights noted above earn New Hampshire an average score of three out of seven for content and rigor. (See Appendix A: Methods, Criteria, and Grading Metric.)

Clarity and Specificity

New Hampshire prides itself on straight talk—it's hard to beat "live free or die" for pithiness. But that directness is often missing from the state's science standards, where vague expectations make it difficult to divine what the document intends to convey. For example:

> **Explain the complete mole concept and identify ways in which it can be used, such as to differentiate between actual and relative mass. (grades 11-12)**

Similarly, students are asked to "understand how the Nebular Hypothesis, fusion, and the process of differentiation contributes [*sic*] to the structure and organization of the universe" (grades 11-12). We are at a loss to understand how a hypothesis might contribute to a structure.

This muddiness also pervades the material on scientific inquiry and methodology, where the standards merely present a series of goals with little guidance as to how to articulate them in the classroom.

The one exception is in the area of life science, where the standards are clear and the content progresses well from grade to grade. New Hampshire's strong treatment of the life sciences buoys the state's clarity and specificity score, leaving the Granite State with a one out of three in this realm. (See Appendix A: Methods, Criteria, and Grading Metric.)