SCIENCE

Rhode Island

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

REPORT CARD

Content & Rigor	**1.8**
Scientific Inquiry & Methodology	0
Physical Science	3
Physics	0
Chemistry	0
Earth & Space Science	3
Life Science	5
Clarity & Specificity	**1.5**

Average numerical evaluations

Overview

Rhode Island's life science standards are the sole bright spot in an otherwise poorly developed set of K-12 science standards that is riddled with errors as well as serious gaps and omissions of important content.

Organization of the Standards

The Rhode Island science standards are divided into three domains: life science, earth and space science, and physical science. These domains are then subdivided into ten statements of enduring knowledge (EK), four in life science and three each in the other two domains. EK statements cut across grade levels and are "intended to identify the fundamental knowledge/concepts for each domain of science." For example, the first EK for life science states:

> **All living organisms have identifiable structures and characteristics that allow for survival (organisms, populations, and species).**

Within the EKs, the standards are further explained by "assessment targets." Finally, for life science and earth and space science, the state provides grade-span expectations for grades K-2, 3-4, 5-6, 7-8, and 9-11. No distinct provision exists for chemistry, physics, or biology classes. Some grade-span expectations are labeled "example extensions" and are meant to be more challenging than the typical standard.

Each assessment target is also linked to one or more "unifying themes," which are broad principles (including inquiry, form and function, nature of science, and patterns of change) that cut across disciplines. For instance, there are ten unifying themes for inquiry, including "collect data" and "design, conduct, & critique investigations."

Content and Rigor

In spite of the rather elaborate structure described above, Rhode Island's standards are skeletal in content. They offer little in the way of scientific content or substance, leaving much assumed and unsaid. And what they do emphasize is often misguided.

Document(s) Reviewed

► *Rhode Island Science Grade-Span Expectations, K-12*. 2007. Accessed from: http://www.ride.ri.gov/instruction/gle.aspx#science

Scientific Inquiry and Methodology

Scientific method and inquiry is covered in a single page, repeated in all three domain documents. These standards are represented through the state's six "unifying themes of science"—each with a series of bulleted sub-headings, notable only for their brevity. The nature of science section, for example, lists such categories as scientific theories, history of science, and science/tech/society, but no content is provided to indicate what, precisely, students should know and be able to do under each of these headings. "Scientific inquiry" exhorts students to "question and hypothesize," but the concepts of theory and hypothesis appear nowhere in the rest of the document.

In addition to these themes, which are specifically devoted to scientific inquiry and methodology, Rhode Island embeds process standards within its content expectations. While this effort is laudable, these process expectations are too vague to be helpful. For instance, one assessment target asks students to:

> **Sort/classify different living things using similar and different characteristics. Describe why organisms belong to each group or cite evidence about how they are alike or not alike. (grades K-4)**

While citing evidence is an important skill, in this context it adds little value. Students could just as easily be asked to list or describe similarities and differences.

Physical Science/High School Physics/High School Chemistry

Major concepts of physics are either omitted or glossed over. For example, the document goes into great detail about the study of energy without ever bothering to define it, even at the high school level. Electrostatics is not introduced until high school and electromagnetism is covered only briefly. Except for a passing mention in fifth and sixth grades, when students are asked to show "that electric currents and magnets can exert a force on each other," there is but one standard devoted it. The entire subject of mechanics is waved off with a single mention:

> **Students demonstrate an understanding of forces and motion by…using Newton's Laws of Motion and the Law of Conservation of Momentum to predict the effect on the motion of objects. (grades 9-11)**

Many important topics are subsumed under headings involving the term "energy." Although it is true that almost every physical process has something to do with energy, it makes little sense to use the term ubiquitously. These topics could readily be organized in a more useful manner.

Occasionally, something good appears—almost by accident. For instance, in third and fourth grades we read:

> **Students demonstrate an understanding of energy by…describing how heat moves from warm objects to cold objects until both objects are [*sic*] the same temperature. (grades 3-4)**

This standard is, in fact, a straightforward statement of the zeroth law of thermodynamics—something well worth knowing. (Though a student who understands this is not really "demonstrat[ing] an understanding of energy.")

In chemistry, the content is inadequate both in depth and progression through the grades. In Kindergarten through eighth grade, too much emphasis is placed on properties of substances and the conservation of matter/energy laws. Atoms are introduced in high school, yet elements and compounds occur earlier, in fifth through eighth grades. As noted above, separate physics and chemistry course content is not provided at the high school level.

Earth and Space Science

To their detriment, the earth and space science standards prefer broad statements to finer detail, and even the combination of "unifying themes" and linked "statements of enduring knowledge" offer little in the way of content. Worse, the content that is present is not particularly thorough or well-thought-out. Take, for example, the presentation of the rock cycle. In fifth through eighth grades, an assessment target asks students to do the following:

> **Using data about a rock's physical characteristics make and support an inference about the rock's history and connection to rock cycle. (grades 5-8)**

While some detail is included in this standard, the actual rock types are not even mentioned. In high school, the rock cycle gets another brief mention:

> **Students demonstrate an understanding of processes and change over time within earth systems by… explaining how heat (produced by friction, radioactive decay and pressure) affects the Rock Cycle [*sic*]. (grades 9-11)**

But the word "sedimentary" occurs in the standards only in the context of plate tectonic evidence, and "igneous" and "metamorphic" are not present.

Other important topics are missing as well. Weather and climate show up in the same sentence, but the relationship is not explained. Fossils are mentioned as "fossil evidence" but their formation is not addressed.

Still, there are a few bright spots: Space science—specifically astronomy and cosmology—fare somewhat better, with good mention of such subjects as stellar evolution, Doppler measurements of universal expansion, and the structure and function of the solar system.

The movement of the earth's plates is well handled in seventh and eighth grades, appropriately building off the standards that ask fifth- and sixth-grade students to understand the location of plate boundaries. But this line of standards regresses in high school: Discussion of mountain ranges is the only thing added, while "faults" have been watered down to "existing patterns."

Life Science

The life sciences are the sole bright spot in the Rhode Island standards. Even with the shortness of the standards document—life science runs a mere nineteen pages—the grade-span expectations generally cover important content with sufficient depth and rigor. Life requirements, respiration and photosynthesis, and cells and tissues are adequately handled. The greatest defect involves the treatment of reproduction, particularly meiosis. (In high school, this term is listed in the "example extensions" column but not in the main material, even though it is essential in explaining sexual inheritance patterns.) Human evolution receives good coverage from Kindergarten through eighth grade, but it is also mentioned only in the "example extensions" column—though one of the four life science EK statements is, "Humans are similar to other species in many ways, and yet are unique among Earth's life forms." In general, however, one comes away with the sense that some sound biology and evolution will be taught.

The strong coverage of important life science content helps Rhode Island eke out a pitiful average score of two out of seven for content and rigor. (See Appendix A: Methods, Criteria, and Grading Metric.)

Clarity and Specificity

The Rhode Island standards are as vague as they are devoid of content. Too many fail to include the detail necessary to guide rigorous curricula and instruction. Take, for example, the following standard:

> **Students demonstrate an understanding of earth materials by…describing, comparing, and sorting rocks, soils, and minerals by similar or different physical properties (e.g., size, shape, color, texture, smell, weight, temperature, hardness, composition). (grades 3-4)**

It's not clear what students would look for in classifying minerals. Size and shape are arbitrary, color can vary and is not always important, and temperature will be whatever the room temperature happens to be. Texture and hardness make sense if they are properly defined in a way that third and fourth graders can manage, but it is not clear how students at this level would deal with composition.

In middle school, students are asked to:

> **Demonstrate an understanding of processes and change over time within earth systems by…explaining cause and effect relationships between global climate and energy transfer. (grades 7-8)**

A grandiose goal with no specifics, except for the tautological "hint" that energy transfer has something to do with climate (as it does with every other process).

In other cases, the standards are so general that they ask the impossible. Take, for example, the following high school standard, which distorts the meaning of thermodynamic efficiency:

> **Students demonstrate an understanding of energy by…explaining the Law of Conservation of Energy as it relates to the efficiency (loss of heat) of a system. (grades 9-11)**

Or this elementary school standard, which asks students to make an impossible connection between studying shadows and understanding energy:

> **Students demonstrate an understanding of energy by…demonstrating when a shadow will be created using sunny versus cloudy days. (grades K-2)**

Overall, these drawbacks earn Rhode Island an average score of two out of three for clarity and specificity. (See Appendix A: Methods, Criteria, and Grading Metric.)