SCIENCE

New Jersey

GRADE	SCORES		TOTAL SCORE
D	Content and Rigor	2/7	3/10
	Clarity and Specificity	1/3	

REPORT CARD

Content & Rigor	**1.5**
Scientific Inquiry & Methodology	0
Physical Science	4
Physics	0
Chemistry	0
Earth & Space Science	4
Life Science	1
Clarity & Specificity	**1.0**

Average numerical evaluations

Overview

New Jersey's science standards are straightforward and complete at the lower grades. Unfortunately, they are tainted by a lack of appropriate follow-through. Instead of clarifying or augmenting the standards, the supplemental classroom material muddles them, and does more harm than good by introducing errors.

Organization of the Standards

New Jersey's science standards, collectively termed "learning progressions," are divided first into four strands: science practices, physical science, life science, and earth systems science. Each strand is then divided into sub-strands, and finally into "cumulative progress indicators" (CPIs), which indicate what students should be able to do by the end of pre-K and the end of grades 2, 4, 6, 8, and 12. (Note that the "science practices" strand lists expectations only for pre-K and the end of grades 4, 8, and 12.) Finally, the state provides a "content statement" that further explains each CPI.

To offer more instructional guidance to teachers, the Garden State provides a series of classroom application documents, which offer sample assessments and resources to accompany each standard. These denote what students should know and be able to do by the end of grades 4, 8, and 12 for the "science practices" strand, and by the end of grades 2, 4, 6, and 8 for the other three strands. These documents are organized in much the same way as the "learning progression" documents, though they also feature common student misconceptions, sample assessment items, a list of web-based resources, and more.

At the high school level, New Jersey further supplements standards with a series of core content clarification documents for high school biology, environmental science, and earth systems science. (No such supplemental material is offered for high school physical science, physics, or chemistry, though the state is currently writing material for each of these subjects.) These clarification documents contain the same types of information—sample assessment items and classroom activities—as the preK-8 classroom applications documents.

Document(s) Reviewed

- *New Jersey Science Standards Learning Progressions*. 2009. Accessed from: http://www.state.nj.us/education/aps/cccs/science/frameworks/2009progressions.pdf
- *New Jersey Science Classroom Applications Documents*. 2009. Accessed from: http://www.nj.gov/education/cccs/cad/5/
- *New Jersey High School Biology/Life Science, Earth Systems Science, and Environmental Science Core Course Content*. 2009-2011. Accessed from: http://www.nj.gov/education/aps/cccs/science/

Content and Rigor

New Jersey's science standards are, in a word, vapid. The bare-bones content that is covered is largely overshadowed by the supplemental materials, which introduce non sequiturs, misleading statements, and full-on errors into the standards. Worse yet, any glimmer of straightforward or rigorous curriculum at the K-8 level disappears by high school, where scant grade-appropriate content can be found.

Scientific Inquiry and Methodology

The scientific inquiry and methodology standards are virtually useless. The state presents four jumbled "science practices": understand scientific explanations; generate scientific evidence through active investigations; reflect on scientific knowledge; and participate productively in science. Worse, nowhere in the text does the word "hypothesis" (or any of its cognates) appear. Instead, students are asked to "pose theories"—a clear indication that the authors have confused theory with hypothesis.

The content and skills also fail to progress from grade to grade. By the end of fourth grade, students are asked to use evidence "to construct and defend arguments." By eighth grade, they are to collect evidence "carefully"; by the end of high school they are to collect "empirical evidence." The difference among these expectations is impossible to discern. And sadly, these are the norm, rather than the exception.

Physical Science/High School Physics/High School Chemistry

Physical science is the high-water mark for the New Jersey standards, but that's not saying much because the coverage of important content is severely uneven.

The standards do address some critical content clearly and with sufficient depth and rigor. A fairly serious treatment of mechanics begins in fourth grade. Thermodynamics is also well explained. Take, for example, the following:

> **Energy can be transferred from one place to another. Heat energy is transferred from warmer things to colder things. (grade 4)**

This is supplemented in the ancillary documents with:

> **Instructional Guidance**
> ***To assist in meeting this CPI, students may:***
>
> **Investigate and describe what happens when an object of higher temperature is placed in direct contact with an object of lower temperature. Record data and use the data to describe which way the heat energy is moving between objects. (grade 4)**

This is a nice, grade-appropriate introduction to the zeroth law of thermodynamics.

Other concepts are well stated through the classroom applications document, such as:

> **Christina has two identical cups that are filled to the same level with water. She also has two solid steel balls.**
>
> - **Christina puts ball 1 in cup 1 and ball 2 in cup 2. In which cup will the water level rise the most? Tell why you think so.**
> - **Christina has another ball that is the same size as ball 2, but this ball is made of wood and is hollow. If she put this hollow ball in one of the cups, do you think the water level would rise more or less than it would if ball 2 were put in the cup?**
> - **Tell why you think so. (grade 6)**

Such classroom examples are helpful; the experiment is clearly described and readily performed, and the questions will make sixth graders think.

Unfortunately, many of the classroom examples are poorly written. For example, a fourth-grade chemistry standard asks students to "identify objects that are composed of a single substance and those that are composed of more than one substance using simple tools found in the classroom." In an illustrative experiment in the ancillary document, students are asked to conduct an experiment in which a graduated cylinder containing 60ml of salt water is left undisturbed for two days, after which the water is all gone and the cylinder contains a layer of salt. Of course, if the standards writers had actually conducted this experiment themselves, they would realize that, unless the cylinder is "left undisturbed" on a hot plate, most of the liquid will still be present.

New Jersey has no standards for high school physics or chemistry. Instead, the learning-progressions document includes a column labeled "by the end of grade 12" which, over the course of twelve pages, evenly covers chemical and physical subject matter. But the order is chaotic and the level mostly too low to furnish a basis for traditional high school chemistry or physics courses. Further, there is often poor progression between the document's content statements and CPIs—or no connection at all. For example, one content statement reads:

> **The conservation of atoms in chemical reactions leads to the ability to calculate the mass of products and reactants using the mole concept. (grade 12)**

While the corresponding CPI says only:

> **Balance chemical equations by applying the law of conservation of mass. (grade 12)**

Notice that both the term "mole concept" and any reference to stoichiometry found in the content statement are missing from the CPI. In fact the word "mole" only appears once in the whole document, in the example above. Overall, the high school material would be better suited for an eighth-grade physical science course.

Earth and Space Science

From Kindergarten on, the New Jersey earth and space science standards cover a good deal of critical content. For example, several topics from high school astronomy and cosmology are well explained, including theories about the origin of the universe and the solar system and stellar evolution, illustrated by the Hertzsprung-Russell diagram.

The structure and evolution of the Earth are also presented, with dating techniques and plate tectonics mentioned, though not always in enough detail. For example, by the end of eighth grade, students are asked to supply evidence for plate tectonic theory, but the standards give no indication of what that evidence is.

The rock cycle is covered reasonably well with the following sixth-grade standard:

> **The rock cycle is a model of creation and transformation of rocks from one form (sedimentary, igneous, or metamorphic) to another. Rock families are determined by the origin and transformations of the rock.**
>
> - **Distinguish physical properties of sedimentary, igneous, or metamorphic rocks and explain how one kind of rock could eventually become a different kind of rock. (grade 6)**

Unfortunately, as is the case in other disciplines, coverage of important content is sometimes superficial. In high school, for example, students are asked to:

> **Analyze the vertical structure of Earth's atmosphere, and account for the global, regional, and local variations of these characteristics and their impact on life. (grade 12)**

Not only is this demand excessively broad, the verb "analyze" is grandiose in this context.

The classroom applications documents often offer useful information to supplement the standards; however, they include a large number of links to external websites, which are relevant for a time but may quickly become outdated and unhelpful.

Life Science

The New Jersey life science standards sacrifice content for process. As a consequence, general concepts are presented with good logical flow but few details. And, even when details are given, concerns arise. For example, at the end of eighth grade, students are asked to:

> **Describe the environmental conditions or factors that may lead to a change in a cell's genetic information or to an organism's development, and how these changes are passed on. (grade 8)**

In fact, at this point there is no indication that students know how a cell's genetic information is encoded, and hence there is no way they can know how it changes. Moreover, changes in an organism's development, if not the consequence of genetic changes, are not "passed on."

Furthermore, the classroom examples that are added to clarify the standards range from hokey and inane to irrelevant and unrealistic. As an example of "hokey," one second-grade example shows a picture of four fish, one with long whiskers, and states, "Catfish have whisker-like parts around their mouths..." It then asks, "Which of these is a catfish?"

And one of "irrelevant and unrealistic":

> **You are the leader (mayor, principal, manager, etc.) of a human-created system (a city, a school, a restaurant, etc.). Compare, using an original metaphor, the functions and interdependence of cell organelles to the elements of your human-created system. Create a commercial to advertise your city, school, restaurant, etc. using the details of the organelles' functions to draw people in, highlighting how efficiently the elements work together, just like within a cell. (grade 6)**

What does this teach about organelles—or anything else for that matter?

The one saving grace in the life sciences is the high school treatment of evolution, which is quite comprehensive.

Given their serious shortcomings—magnified by the issues in the classroom-applications document—New Jersey's standards earn a woeful two out of seven for content and rigor. (See Appendix A: Methods, Criteria, and Grading Metric.)

Clarity and Specificity

While the standards are clearly organized and presented, the expectations are often empty or jargon-filled. For instance, by the end of fourth grade, students are expected to:

> **Demonstrate understanding of the interrelationships among fundamental concepts in the physical, life, and Earth systems sciences. (grade 4)**
>
> **Use outcomes of investigations to build and refine questions, models, and explanations. (grade 4)**

These standards contain virtually no content; it's impossible to determine what students should know or be able to do.

Furthermore, standards are frequently repeated from grade to grade, offering no clear progression of content or rigor. Take, for example, the following:

> **Use mathematical, physical, and computational tools to build conceptual-based models and to pose theories. (grade 8)**
>
> **Develop and use mathematical, physical, and computational tools to build evidence-based models and to pose theories. (grade 12)**

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