SCIENCE

Iowa

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

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	**1.1**

Average numerical evaluations

Overview

Looking at the *Iowa Core Curriculum* for science is like trying to see through frosted glass. The paucity of detail, and the many moments of obscurity in the text, make it difficult and at times impossible to know precisely what is to be taught. What is clear, however, is that the standards do not contain the ingredients for a robust education in the sciences.

Organization of the Standards

The Iowa standards are divided into four content strands: science as inquiry, physical science, earth and space science, and life science. Within each strand, "essential concepts and/or skills" that students must master are presented in four bands: grades 9-12, grades 6-8, grades 3-5, and grades K-2 (presented in that order). Finally, the state provides an "illustration" of each essential concept and skill. These illustrations are drawn from the voguish *International Center for Leadership in Education (ICLE) Rigor and Relevance Framework* and its four pedagogical "Quadrants": Quadrant A–Assimilation, Quadrant B–Adaptation, Quadrant C–Acquisition, and Quadrant D–Application. The quadrants contain sample activities that teachers could use to teach the essential concept or skill, and the quadrants move from the least rigorous (Quadrant A) to the most rigorous (Quadrant D) (see Figure 1, from the high school earth and space science standards).

The state is careful to note that "the quadrants are samples, presented here to illustrate and clarify the expected level of rigor. They DO NOT constitute a curriculum nor will one set provide a sufficient opportunity for students to engage a big idea in science."

At the high school level, physical science is covered broadly; there is no separate coverage of physics or chemistry courses appropriate for these students. It is safe to assume, though, that the materials presented under the life science strand for grades 9-12 apply to a standard biology course.

Content and Rigor

Sloppy organization, vagueness, and lack of detail—this baleful trio characterizes the Iowa standards across all disciplines and grade levels.

Document(s) Reviewed

- *Iowa Core Curriculum: K-12 Science.* 2007. Accessed from: http://educateiowa.gov/index.php?option=com_content&view=article&id=2330&Itemid=4342

Figure 1: Illustration of *Understand and apply knowledge of Geochemical cycles* in the ICLE's Rigor and Relevance Framework	
Quadrant C **The carbon cycle is an important life supporting cycle. Some say the cycle has been shifted to an unbalanced system, one in which the shift has gone toward an overabundance of CO_2. Provide information to support or refute this belief.**	**Quadrant D** **You are a member of a business team charged with developing energy sources that will be used to decrease the emission of carbon dioxide. Respond to the following questions based on this scenario: What energy systems will you select as those to support for development? What are the pros and cons of each method? What are the short-term advantages and disadvantages of each? Long-term advantages/ disadvantages? The feasibility of their uses by developed and developing nations?**
Quadrant A **Students are asked to use a textbook and/or the Internet to compile a list of elements and compounds (ex. water, nitrogen) that may be associated with cycles in the earth-ocean-atmosphere system.** ***Evolution and Equilibrium**	**Quadrant B** **Students are asked to choose either the nitrogen or the carbon cycle, draw and label the cycle and explain it to other students using the drawing as a visual aid. Students should be sure to point out the role that humans play in the cycle.** ***Evidence, Models, and Explanation**

Scientific Inquiry and Methodology

The Iowa scientific inquiry and methodology standards constitute a single page ("Integrated Standards") that is functionally useless, providing no guidance or grade articulation. For example, the totality of the statement for "Science in Personal and Social Perspectives" reads, absurdly: "Make appropriate personal/lifestyle/technology choices, evaluate, observe, discuss/debate, recognize interactions and interdependencies at all levels, explain, describe environmental effects of public policy, choose appropriate course(s) of action." No further content, standards, or elaboration is provided.

Physical Science/High School Physics/High School Chemistry

The general disorganization of the Iowa standards is exacerbated by all-too-frequent errors that mar the document. This problem is particularly acute in the physical sciences.

Three examples, two concerning physics and one chemistry, will suffice. From physical science in high school: "The nuclear forces that hold the nucleus of an atom together, at nuclear distances, are usually stronger than the electric forces that would make it fly apart." A little thought reveals that the attractive nuclear forces must balance—not exceed—the repulsive electrostatic ones if the nucleus is to be stable.

Things go similarly awry when high school students receive the popular "rowdy raisins" demonstration—a bit tardily, as this typically comes around fifth grade. For this project, "students explain what they observe when a few raisins are dropped into a container full of a clear carbonated beverage and relate this phenomena to scuba diving. Why is rule number one in scuba diving that divers are NOT to hold their breath? What are the bends? What do the gas laws have to do with diving?"

These are excellent questions whose answers involve no little insight into the solubility of gases as a function of pressure as well as the physiological basis of the bends. But the behavior of the raisins has nothing to do with scuba diving. Their up-and-down motion is due entirely to the breaking off at the surface of bubbles nucleated on the fruit in the carbonated liquid.

Ionic, covalent, and polar covalent molecules crop up in both Quadrants B and D of the high school physical science standards. Here students are asked to use these terms to explain how the body absorbs vitamins and the ability of detergents to remove stains. Yet they have not yet learned about ions or polarity, among other key topics.

Earth and Space Science

There are a few rare bright spots in Iowa's coverage of earth and space science. The role of water as a solvent in geology is well presented in third through fifth grades, and the properties of soils are considered in a consistent manner.

But the flashes of light are eclipsed by numerous examples of topics that are mentioned but not described or explained in satisfactory detail. The history of the universe is raised but the body of evidence supporting this model is woefully insufficient. Relative and absolute dating are mentioned but there is no description of the processes. The layers of the

earth get a dusting of attention—"the solid earth consists of layers including a lithosphere; a hot, convecting mantle and a dense metallic core" (grades 6-8)—but that's it.

Life Science

The content for life science in Kindergarten through fifth grade is very vague, and the content for sixth through eighth grades is not much better. That's not surprising, given how little ink the standards devote to the subject: two pages for Kindergarten through second grade, two pages for grades three through five, and three pages for grades six through eight. In contrast, the material we presume is intended for high school biology (though it is not so labeled) receives twenty pages. Up to the level of high school biology, the word evolution is nonexistent; there is just some gauzy stuff about biological adaptation.

Then comes the highly detailed high school biology course, where the content is generally sound, including excellent evolution material and even some human evolution. But here again, many of the items in the quadrants are obscure or difficult to perform. For example, measuring O_2 and CO_2 production requires elaborate equipment. Students and teachers receive little guidance for how to perform these activities.

The overall score for content and rigor is a sub-par two out of seven (see Appendix A: Methods, Criteria, and Grading Metric)—a mark that, given the occasional flashes of excellence, is even more disappointing for what might have been.

Clarity and Specificity

It's hard to decide if the *Iowa Core Curriculum: K-12 Science* is "not half bad" or just "half bad." On the plus side, the use of English is good and the document even contains the occasional "wow" moment. The discussion of water as a solvent in third through fifth grades is a nifty addition.

But the "essential concepts and/or skills" are often far too broad. The principles underlying them are sometimes "included but are not limited to"—an unhelpful construction, to say the least. Although the sample quadrants sometimes contain useful ideas and processes, these appear to be chosen more or less at random; they are not particularly useful for guiding the construction of a curriculum. For example, why should topics like electronic structure, electronegativity, and first ionization energy suddenly appear in a quadrant activity when they weren't even hinted at in the "essential concept and/or skill" statement? By the same token, one has to wonder what other important and required topics were left out because there are only four quadrants.

Confusingly, the standards are presented in reverse chronological order, so that the high school standards appear first. This idiosyncratic top-down ordering of materials (from high school down to Kindergarten) makes it difficult to trace the building of a concept from elementary beginnings to a sophisticated level.

Too often, students are to be asked unanswerable questions or given wildly challenging tasks. An example from life sciences: "If a characteristic is found in bacteria, fungi, pine trees, snakes, and humans, when did it most likely evolve?" The obvious answer is "when the last common ancestor of these organisms lived," but that is little better than a tautology.

Poor organization, vagueness, and lack of detail underlie the Iowa science standards, leaving them with a score of one out of three for clarity and specificity. (See Appendix A: Methods, Criteria, and Grading Metric.)