REPORT CARD

Content & Rigor	**3.0**
Scientific Inquiry & Methodology	7
Physical Science	2
Physics	0
Chemistry	0
Earth & Space Science	4
Life Science	5
Clarity & Specificity	**1.3**

Average numerical evaluations

Document(s) Reviewed[1]

- *Illinois Learning Standards: Goals 11, 12, 13*. 1997. Accessed from: http://www.isbe.state.il.us/ils/science/standards.htm
- *Illinois Classroom Assessments and Performance Descriptors*. 2002. Accessed from: http://www.isbe.state.il.us/ils/science/capd.htm
- *Illinois Assessment Frameworks*. 2004-2005. Accessed from: http://www.isbe.state.il.us/assessment/IAFIndex.htm

[1] Illinois's standards have not changed since Fordham's 2005 evaluation. However, the evaluation criteria used here have been updated and improved since 2005; also, in this report, we reviewed the assessment frameworks for the standards, something we did not do in 2005. (See Appendix A for document-selection methods and criteria used in this review.) These changes brought Illinois's final science grade from a B to a D. The complete 2005 review can be found here: http://www.edexcellence.net/publicationsissues/publications/sosscience05.html.

SCIENCE

Illinois

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

Overview

The Illinois science standards fail to provide the guidance necessary to ensure that students in the Land of Lincoln learn the critical K-12 science content they need to be college- and career-ready. Wild disorganization, poor writing, and illogical sequencing—compounded by critical content gaps and omissions—leave these standards significantly short of acceptable.

Organization of the Standards

Illinois's science standards are first articulated by three "goals": inquiry and design; concepts and principles; and science, technology, and society. For each goal, standards are provided for five vague grade bands: early elementary, late elementary, middle/junior high, early high school, and late high school.

The state also provides "expanded performance descriptors," which are meant to clarify the standards. Unfortunately, these descriptors are not explained by grade level, either. Instead, expectations of students must be fished out of a murky alphabet soup of "stages," A through J, which correspond loosely (but with much overlap) to grade levels. For example, stages A and B correspond to first grade; stages A, B, and C to second grade; stages B, C, and D to third grade; and so on. Stages I and J are both associated with grades eleven and twelve. For each of these expanded performance descriptors, both individual standards (different from those available through the goals documents) and "assessments" (which also read like standards) are available.

Finally, the *Illinois Science Assessment Framework* further organizes the goals and standards for the tested grades: four, seven, and eleven.

Content and Rigor

Illinois covers some content well—particularly in life science and earth and space science. But these highlights contrast sharply with the overwhelmingly inadequate treatment of the rest of the disciplines, which omit more essential content than they include.

Scientific Inquiry and Methodology

Illinois offers clear and well-articulated process standards that thoroughly outline what is expected of students and teachers. Process expectations are explicitly linked to content areas of the standards. Apart from the overuse of the term "brainstorming" as a desirable skill, there is nothing to find fault with here. Attention is paid to the historical and social aspects of science and technology; interestingly, students are asked to interview scientists about "how they address validity of scientific claims and theories and/or their understanding of scientific habits of mind (including sheer luck) and how they have been integral to their own research." All in all, an admirable job.

Physical Science/High School Physics/High School Chemistry

The treatment of physical science is a disaster from Kindergarten through twelfth grade. In the earlier grades, the biggest problems tend to involve a frustrating reliance on statements that are so broad as to be meaningless.

For instance, in the assessment framework we find this chain of expectations:

> **Understand that electrical energy can be converted to other types of energy such as heat, light, or mechanical energy. (grade 4)**
>
> **Understand that besides static electricity, there is also such a thing as current electricity. For example, given a battery, bulb, and wire, students will understand the proper configuration to make the bulb light. (grade 4)**

But this sequence is the reverse of the internal logic of the subject of electromagnetism. A bit later in the same document comes another jumble:

> **Understand that light travels at different speeds in different materials. Understand that this is why light refracts—or changes direction—namely because it goes from one material in which it moves at one speed into another material through which it moves at a different speed. (grade 7)**

Here the "explanation" in the second sentence is merely a reiteration of the first, and both are inadequate.

In the later grades, logical structure falls apart, with equally troubling consequences. By eleventh grade, for example, students should be ready for the rigorous definition of energy, beginning with the work-energy theorem, proceeding to kinetic energy and then to potential energy as the energy of configuration. In Illinois, however, they get this instead:

> **Understand that energy, defined somewhat circularly, is 'the ability to change matter,' or 'the ability to do work.' Understand that energy is defined by the way it is measured or quantified. Understand the difference between potential and kinetic energy. (grade 11)**

This passage is nonsense—and backwards, as well.

Mixed in with the vapid and nonsensical standards are statements that are simply wrong. Take, for example, the following expectation:

> **Graphing the temperature variations associated with phase changes of simple substances. (grades 4, 5, and 6)**

But when a sample of a substance, being subjected to heating or cooling, is going through a phase change, the temperature does *not* change.

None of the documents appear to make room for a separate section on high school physics.

While still inadequate, the coverage of critical chemistry content is marginally better than that of physics. In eleventh grade, for example, the standards begin with clearly written conceptual statements that thoroughly address related ideas. The section on kinetic molecular theory and gas behavior explains gas pressure and diffusion by considering molecular motion. Gas law relationships include the ideal gas law and related problem solving. Also mentioned are the specific STP conditions and the necessary temperature conversions between Celsius and Kelvin scales.

There is also good material on such significant matters as balancing chemical equations, and the mole is defined nicely with a connection between mass and number of atoms.

Still, the standards are plagued by the omission of great swaths of critical content as well as expectations that are presented with no internal logic. For instance, the standards never get to important topics like shape and polarity of molecules, stoichiometry, carbon chemistry, rates of reaction, and equilibrium. Those items that do exist are plagued by a variety of shortcomings, such as in the following passage:

> **Apply scientific inquiries or technological designs to explain chemical bonding and reactions, balancing chemical reactions using formulas and equations to quantify reaction masses, volumes and ratios, examining factors that affect capacity to react or rates (concentrations, pH, catalysts, molarity, temperature, etc.), or referencing the bonding potential and strengths within and between atoms and molecules. (grades 11 and 12)**

Concentrations, pH, and molarity are cited as separate factors affecting reaction rates. But molarity *is* the unit of concentration while pH *is* a measure of concentration; specifically, that of the hydronium ions. And significantly missing from the list of rate factors is the surface area of solids. As for the rest of this statement, it is as if a glossary of science words had been tossed into the air. After landing, the resulting random word patterns were used to complete this performance descriptor.

Earth and Space Science

On the positive side, the treatment of cosmology in the learning standards and assessment framework is solid, as the following examples illustrate:

> **Explain theories, past and present, for changes observed in the universe. (early high school)**
>
> **Describe the size and age of the universe and evaluate the supporting evidence (e.g., red-shift, Hubble's constant). (late high school)**
>
> **Know the theory that over 10 billion years ago the universe began in a huge expansion called the Big Bang. Understand that in this event, all matter, energy, space, and time were created as the universe expanded from a single point. Understand that one piece of evidence for this theory is the 3K background radiation. (grade 11)**

These standards are clear, accurate, and sufficiently rigorous. And the material covering Earth history is equally strong, as demonstrated by the following:

> **Understand that geologic layers and radioactive dating of rocks and meteorites provide evidence that the earth is about 4.6 billion years old, and that life has existed on Earth for over 3 billion years. Understand how to use a geologic time table. (grade 7)**
>
> **Understand that life on Earth has been changed by major catastrophes (e.g., the impacts of asteroids, volcanic eruptions). (grade 7)**
>
> **Understand that most scientists believe that the sun, the earth, and the rest of the solar system formed from a nebular cloud of dust and gas 4.6 billion years ago. (grade 11)**

"Most scientists believe" is a sop to creationists, but the statements are otherwise clear.

On the other hand, the standards themselves are too broad to offer much guidance. They rarely support the material in the assessment framework and leave teachers with minimal concrete guidance as to what students should know and be able to do. Consider, for example, the following learning standards, which ask that students:

> **Identify and explain natural cycles of the Earth's land, water, and atmospheric systems (e.g., rock cycle, water cycle, weather patterns). (late elementary)**
>
> **Analyze and explain large-scale dynamic forces, events, and processes that affect the Earth's land, water, and atmospheric systems (e.g., jetstream, hurricanes, plate tectonics). (middle/junior high school)**
>
> **Describe and explain short-term and long-term interactions of the Earth's components (e.g., earthquakes, types of erosion). (late elementary)**
>
> **Describe interactions between solid earth, oceans, atmosphere, and organisms that have resulted in ongoing changes of Earth (e.g., erosion, El Nino [*sic*]). (middle/junior high school)**

If not for the laudable content presented in the assessment framework, the Illinois earth and space science standards would be almost unsalvageable. Further, the convoluted organization of the standards among three disparate documents has a direct and strongly negative impact on the standards' overall rigor.

Life Science

Life science is the (relatively) high watermark for the Illinois standards. While by no means perfect—there is a curious absence of anything, at any grade level, on organ systems or physiology (muscles, nerves, digestion, etc.)—some of the material is laudably rigorous.

The assessment framework for grades four, seven, and eleven provides an excellent sequence pertaining to biochemistry, (molecular) genetics, and (molecular) cell biology that other states would do well to emulate. For example, in seventh grade, students are asked to understand mitosis and meiosis in considerable detail, as well as the concept that cells differentiate as they multiply in a zygote. In high school they learn that specialization of cells in multicellular organisms is usually due to different patterns of gene expression.

Surprisingly, although Illinois provides good coverage of evolution in grade seven and in high school, Illinois is one of the few states that still eschews the use of the word "evolution," misusing the euphemism "change over time" as a substitute:

> **Understand natural selection or *survival of the fittest*, and understand that *this is thought to be one of the explanations* how animals and plants *change over time***

> **and that it was the explanation given by *Charles Darwin*. (emphasis added) (grade 7)**

In spite of a glimmer of quality in life science, the overall rating can be no more than a three out of seven for content and rigor. (See Appendix A: Methods, Criteria, and Grading Metric.)

Clarity and Specificity

Between the many overly broad statements and frequent head-scratching rambles, the Illinois standards rate poorly on clarity and specificity. However, scrutiny of a wide selection of individual items shows that the quality of the standards on these criteria varies significantly. Some are clear and specific, while others are so vague they are virtually meaningless.

The physical science material is perhaps the worst offender, rife with garbled, confusing, and plainly illogical writing. A few examples suffice to illustrate the problem:

> **Describe the effects of electromagnetic and nuclear forces including atomic and molecular bonding, capacitance, and nuclear reactions. (early high school)**

What a wild combination of unconnected ideas! It is as though one wrote: "Describe the effects of turkey and plumbing supply sales including supermarkets and convenience stores, banks, and the tax structure."

> **Identify the number of different kinds of elements in a chemical formula. (grade 7)**

What is a "kind of element" and how does one do this?

> **Identify the basic properties of acids and bases. Know the relationship between acids, bases, and indicators (e.g., blue litmus paper changes to red when placed in an acid). (grade 7)**

That's a tortured way of saying, "know that indicators turn different colors when exposed to acids and bases." Relationships are for psychologists, not hydrogen ions.

> **Know the laws of the conservation of matter and energy. (grade 7)**

Quite a bit for a single indicator—and that's only part of it.

> **Understand that density is mass per volume, and that what is denser than something else at the same volume will have more mass, but at the same mass it will have less volume. Understand that less dense bodies have greater buoyant force in water. (grade 7)**

Let's hope the same authors didn't write the English language arts standards.

The damage is not total, however. The content statements in the assessment framework are coherent, clear, literate, scholarly, specific, elegant, and sometimes superb. But these aren't enough to raise the average score for clarity and specificity above a lowly one out of three. (See Appendix A: Methods, Criteria, and Grading Metric.)