

Introduction to Indiana's Academic Standards for Science – 2010

Indiana's Academic Standards for Science were last revised in 2000. This new document, Indiana's Academic Standards for Science – 2010, reflects the ever-changing science content and the underlying premise that science education should be an inquiry-based, hands-on experience. These standards were adopted by the Indiana State Board of Education in April, 2010, and will be implemented in the 2011-12 school year.

Indiana's Academic Standards for Science – 2010 reflect a few significant changes that are worth noting. Primarily, there are fewer standards and each grade level focuses on the big ideas for each of these sub-disciplines: physical science; earth science; life science; and science, technology and engineering. The overarching organization of the standards has also changed; they are divided into two sections: Process Standards and Content Standards, which are described in greater detail below.

Process Standards

The Process Standards are the processes and skills that students are expected to learn and be able to do within the context of the science content. The separation of the Process Standards from the Content Standards is intentional; in doing so we want to make explicit the idea that what students are doing while they are learning science is extremely important. The Process Standards reflect the way in which students are learning and doing science and are designed to work in tandem with the science content, resulting in robust instructional practice.

The Process Standards are organized in the following grade bands: K-2, 3-5, 6-8. Within each grade band, the Process Standards address a particular topic or topics. Kindergarten introduces The Nature of Science, while grades 1 through 5, reflect two parts: The Nature of Science and The Design Process. In grades 6 through 8, Reading for Literacy in Science and Writing for Literacy in Science have been added to emphasize these processes in science. For high school, the Process Standards include Reading and Writing for Literacy in Science as well as The Nature of Science.

As noted in the previous paragraph, grades 6 through 8 and high school content courses will include Reading and Writing for Literacy in Science. It is important to note that these Process Standards emerged with the adoption of the Common Core State Standards in the area of Reading and Writing for Literacy in Science. The Literacy Standards establish that instruction in reading, writing, speaking, listening, and language is a shared responsibility. The Literacy Standards are predicated on teachers in the content areas using their unique disciplinary expertise to help students meet the particular challenges of reading, writing, speaking, listening, and language in their respective fields. It is important to note that the literacy standards are meant to complement rather than supplant content standards in the disciplines.

Part of the motivation behind the disciplinary approach to literacy promulgated by the Literacy Standards is extensive research establishing the need for college- and career-ready students

to be proficient in reading complex informational text independently in a variety of content areas. Most of the required reading in college and workforce training programs is informational in structure and challenging in content. Postsecondary education programs typically provide students with both a higher volume of such reading than is generally required in K-12 schools and comparatively little scaffolding.

The Literacy Standards make clear that significant reading of informational texts should also take place outside ELA classrooms in order for students to be ready for college and careers. Future assessments will apply the sum of all the reading students do in a grade, not just their reading in the ELA context. The Literacy Standards demand that a great deal of reading should occur in all disciplines.

The Literacy Standards also cultivate the development of three mutually reinforcing writing capacities: writing to persuade, to explain, and to convey real or imagined experience. College and career readiness requires that writing focus significantly on writing to argue and to inform or explain.

The Literacy Standards use grade level bands to present the standards. Teachers teaching at the beginning of the grade band may need to provide scaffolding for students to be successful, where teachers teaching at the end of the grade band should expect students to demonstrate the standards independently.

Content Standards

In grades 1 through 8, the Content Standards are organized in four distinct areas: 1) physical science; 2) earth science; 3) life science; and 4) science, technology and engineering. Kindergarten has only the first three areas: physical, earth and life science. In each of these areas there is at least one core standard, which serves as the big idea at that grade level for that content area. For the high school science courses, the content standards are organized around the core ideas in each particular course, which are represented by the core standard. The core standard is not meant to stand alone or be used as an individual standard, but instead is meant to help teachers organize their instruction around the “big ideas” in that content area and for grades K-8, at that particular grade level. Beneath each core standard are indicators which serve as the more detailed expectations within each of the content areas.

Finally, in the development of these revised science standards, careful attention was paid to how ideas are articulated across the grade levels so that content and skills that students will need to succeed in a particular sub-discipline are introduced in an appropriate manner in the early elementary grades and then progressed as students move towards high school.

Grade 8

Students in eighth grade study atoms, elements, compounds and molecules; and the relationship between atomic structure and chemical properties. They study the water cycle and the role of the sun's energy in driving this process. Students investigate how genetic information is transmitted from parents to offspring. Students study the physical properties of natural and engineered materials. Within this study students employ the key principles of the nature of science and the design process.

Process Standards

The Nature of Science

Students gain scientific knowledge by observing the natural and constructed world, performing and evaluating investigations, and communicating their findings. These principles should guide student work and be integrated into the curriculum along with the content standards on a daily basis.

- Make predictions and develop testable questions based on research and prior knowledge.
- Plan and carry out investigation—often over a period of several class lessons—as a class, in small groups or independently.
- Collect quantitative data with appropriate tools or technologies and use appropriate units to label numerical data.
- Incorporate variables that can be changed, measured or controlled.
- Use the principles of accuracy and precision when making measurements.
- Test predictions with multiple trials
- Keep accurate records in a notebook during investigations.
- Analyze data, using appropriate mathematical manipulation as required, and use it to identify patterns. Make inferences based on these patterns.
- Evaluate possible causes for differing results (i.e., valid data).
- Compare the results of an experiment with the prediction.
- Communicate findings through oral and written reports by using graphs, charts maps and models.

The Design Process

As citizens of the constructed world, students will participate in the design process. Students will learn to use materials and tools safely and employ the basic principles of the engineering design process in order to find solutions to problems.

- Identify a need or problem to be solved.
- Brainstorm potential solutions.
- Throughout the entire design process, document the design with drawings (including labels) in a portfolio or notebook so that the process can be replicated.
- Select a solution to the need or problem.

- Select the most appropriate materials to develop a solution that will meet the need.
- Create the solution through a prototype.
- Test and evaluate how well the solution meets the goal.
- Evaluate and test the design.
- Present evidence using mathematical representations like graphs and data tables.
- Communicate the solution (including evidence) using mathematical representations (e.g., graphs, data tables), drawings or prototypes.
- Redesign to improve the solution based on how well the solution meets the need.

Reading and Writing Standards for Literacy in Science

The Reading and Writing Standards for Literacy in Science are presented in grade-level bands. Students at the beginning of a grade-band continuum will require a blend of scaffolding and direct, explicit instruction. By the end of the grade-band continuum, students should demonstrate proficiency of the literacy standards independently.

The grades 6-8 standards below define what students should understand and be able to do by end of 8th grade. These are to serve as a complement to the specific content demands of the science standards and be taught as skills that allow students to communicate and comprehend the science content.

Reading for Literacy in Science

Students need to develop the skills that allow them to read complex informational science texts with independence and confidence. Students need to build an appreciation of the norms and conventions of reading in science, an understanding of domain-specific words and phrases, an attention to precise details, the capacity to evaluate detailed arguments, synthesize complex information and follow detailed descriptions and procedures. Students need to be able to gain knowledge from challenging texts that make use of elaborate diagrams and data to convey information and illustrate concepts.

Key Ideas and Details

- 6-8.RS.1** Cite specific textual evidence to support analysis of science texts.
- 6-8.RS.2** Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
- 6-8.RS.3** Follow precisely a multistep procedure when carrying out experiments or taking measurements.

Craft and Structure

- 6-8.RS.4** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific context relevant to *grades 6-8 texts and topics*.

6-8.RS.5 Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.

6-8.RS.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

Integration of Knowledge and Ideas

6-8.RS.7 Integrate quantitative information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

6-8.RS.8 Distinguish among facts, reasoned judgment based on research findings and speculation in a text.

Writing for Literacy in Science

Students need to be able use writing as a key means to defend and assert claims, showing what they know about a subject and conveying what they have experienced, imagined, thought, and felt. They must be adept at gathering information, evaluating sources, and citing material accurately, reporting findings from their research and analysis of sources in clear manner.

Text Types and Purposes

6-8.WS.1 Write arguments to focus on discipline-specific content.

- a. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
- b. Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.
- c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
- d. Establish and maintain a formal style.
- e. Provide a concluding statement or section that follows from and supports the argument presented.

6-8.WS.2 Write informative/explanatory texts, including scientific procedures/experiments.

- a. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
- b. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.

- c. Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
- d. Use precise language and domain-specific vocabulary to inform about or explain the topic.
- e. Establish and maintain a formal style and objective tone.
- f. Provide a concluding statement or section that follows from and supports the explanation or information presented.

6-8.WS.3 Note: Students’ narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In science, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

6-8.WS.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

6-8.WS.5 With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.

6-8.WS.6 Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.

Research to Build and Present Knowledge

6-8.WS.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

6-8.WS.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

6-8.WS.9 Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

6-8.WS.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

6-8.RS.9 Compare and contrast the information gained from experiments, simulations, video or multimedia sources with that gained from reading a text on the same topic.

Range of Reading and Level of Text Complexity

6-8.RS.10 By the end of grade 8 read and comprehend science texts in the grades 6-8 text complexity band independently and proficiently.

Content Standards

Standard 1: Physical Science

Core Standard

Describe how atomic structures determine chemical properties and how atoms and molecules interact.

- 8.1.1 Explain that all matter is composed of particular arrangements of atoms and that there are approximately one hundred types of atoms (i.e., elements).
- 8.1.2 Understand that elements are organized on the periodic table based on atomic number.
- 8.1.3 Explain how the arrangement of atoms and molecules determines chemical properties of substances.
- 8.1.4 Describe the structure of atoms and relate the arrangement of electrons to how atoms interact with other atoms.
- 8.1.5 Explain that atoms join together to form molecules and compounds and illustrate with diagrams the relationship between atoms and compounds and between atoms and molecules.
- 8.1.6 Explain that elements and compounds have characteristic properties such as density, boiling points and melting points that remain unchanged regardless of sample size.
- 8.1.7 Explain that chemical changes occur when substances react and form one or more different products, whose physical and chemical properties are different from those of the reactants.
- 8.1.8 Demonstrate that in a chemical change the total numbers of each kind of atom in the product are the same as in the reactants and that the total mass of the reacting system is conserved.

Standard 2: Earth and Space Systems

Core Standard

Explain how the sun's energy heats the air, land and water and drives the processes that result in wind, ocean currents and the water cycle. (8.2.1, 8.2.2, 8.2.3, 8.2.4, 8.2.5)

Core Standard

Describe how human activities have changed the land, water, and atmosphere. (8.2.6, 8.2.7)

- 8.2.1 Recognize and demonstrate how the sun's energy drives convection in the atmosphere and in bodies of water, which results in ocean currents and weather patterns.
- 8.2.2 Describe and model how water moves through the earth's crust, atmosphere and oceans in a cyclic way as a liquid vapor and solid.
- 8.2.3 Describe the characteristics of ocean currents and identify their effects on weather patterns.
- 8.2.4 Describe the physical and chemical composition of the atmosphere at different elevations.
- 8.2.5 Describe the conditions that cause Indiana weather and weather-related events such as tornadoes, lake effect snow, blizzards, thunderstorms and flooding.
- 8.2.6 Identify, explain and discuss some effects human activities (e.g., air, soil, light, noise and water pollution) have on the biosphere.
- 8.2.7 Recognize that some of Earth's resources are finite and describe how recycling, reducing consumption and the development of alternatives can reduce the rate of their depletion.
- 8.2.8 Explain that human activities, beginning with the earliest herding and agricultural activities, have drastically changed the environment and have affected the capacity of the environment to support native species. Explain current efforts to reduce and eliminate these impacts and encourage sustainability.

Standard 3: Life Science

Core Standard

Understand the predictability of characteristics being passed from parents to offspring. (8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.3.5, 8.3.6, 8.3.7)

Core Standard

Explain how a particular environment selects for traits that increase the likelihood of survival and reproduction by individuals bearing those traits. (8.3.8, 8.3.9, 8.3.10)

- 8.3.1 Explain that reproduction is essential for the continuation of every species and is the mechanism by which all organisms transmit genetic information.
- 8.3.2 Compare and contrast the transmission of genetic information in sexual and asexual reproduction.
- 8.3.3 Explain that genetic information is transmitted from parents to offspring mostly by chromosomes.
- 8.3.4 Understand the relationship between deoxyribonucleic acid (DNA), genes and chromosomes.
- 8.3.5 Identify and describe the difference between inherited traits and the physical and behavioral traits that are acquired or learned.
- 8.3.6 Observe anatomical structures of a variety of organisms and describe their similarities and differences. Use the data collected to organize the organisms into groups and predict their relatedness.
- 8.3.7 Recognize and explain that small genetic differences between parents and offspring can accumulate in successive generations so that descendants may be different from their ancestors.
- 8.3.8 Examine traits of individuals within a population of organisms that may give them an advantage in survival and reproduction in given environments or when the environments change.
- 8.3.9 Describe the effect of environmental changes on populations of organisms when their adaptive characteristics put them at a disadvantage for survival. Describe how extinction of a species can ultimately result from a disadvantage.
- 8.3.10 Recognize and describe how new varieties of organisms have come about from selective breeding.

Standard 4
Science, Technology and Engineering

Core Standard

Identify the appropriate materials to be used to solve a problem based on their specific properties and characteristics.

- 8.4.1 Understand how the strength of attractive forces among particles in a material helps to explain many physical properties of the material, such as why different materials exist as gases, liquids or solids at a given temperature.
- 8.4.2 Rank the strength of attractions among the particles of room-temperature materials.
- 8.4.3 Investigate the properties (i.e., mechanical, chemical, electrical, thermal, magnetic and optical) of natural and engineered materials.