Science Competencies That Go Unassessed

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High-stakes tests, such as many statewide educational assessments, measure only a subset of competencies associated with curriculum standards. In large part, this is a result of constraints associated with multiple-choice and the other item formats typically used with these assessments. Although these item formats can present fairly sophisticated tasks, many cognitively complex competencies require alternative formats such as performance assessments.

The present paper lists important science competencies that go unassessed by statewide tests. Our context is Florida's present curriculum standards, referred to as the Next Generation Sunshine State Standards. The Florida Comprehensive Achievement Test (FCAT) is used to assess the standards.

Florida's standards are presented as benchmarks. The focus of our work is on Grade 7 science benchmarks, which are grouped within the following "big ideas" across four Body of Knowledge areas:

Body of Knowledge	Big Idea
Nature of Science	1: The Practice of Science 2: The Characteristics of Scientific Knowledge 3: The Role of Theories, Laws, Hypotheses, and Models
Earth and Space Science	6: Earth Structures
Physical Science	10: Forms of Energy 11: Energy Transfer and Transformations
Life Science	15: Diversity and Evolution of Living Organisms 16: Heredity and Reproduction 17: Interdependence

Within this paper, a **competency** refers to a description of a particular mental ability or skill students are expected to learn. Sometimes a benchmark explicitly states the ability or skill, although typically it is implied. In either case, competencies represent the set of mental abilities and skills that students must acquire to meet the curriculum standards set within a particular domain at a particular grade level.

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Because competencies refer to students' mental abilities and skills—their thought processes—competencies cannot be directly observed. Whereas competencies exist within the mind of the student, directly observable **evidence** related to the degree to which a student possesses a particular competency must be established to infer competence. This evidence is derived from students' performances on an assessment task. Thus, the directly observable evidence, derived from a specific task, provides the basis for making an inference about the degree to which students possess a particular competency.

A **task** is then the specific test item or performance assessment through which evidence pertaining to student competencies can be derived. A task encompasses the specifics of an assessment, such as the materials and stimuli presented to students, the questions or problems posed to students, and the responses or work products that students must produce in the context of the assessment.

From the following list of competencies, our next step is to identify examples of evidence that indicate the degree to which students possess particular competencies, and describe specific tasks for students to perform to establish this evidence. This evidence and related tasks will be developed for only selected competencies listed here. The others are presently assessable with FCAT-like tests.

Again, the assessment of those competencies listed below is beyond the reach of tests similar to the FCAT. Although the competencies reference Grade 7 science benchmarks within Florida's Next Generation Sunshine State Standards, similar competencies are likely implicit in the middle-school science standards that are used by other states. As with the FCAT, it is anticipated similar competencies are beyond what can be measured by the various tests presently used in statewide assessments of science standards. To the degree that these competencies are essential, their exclusion from statewide assessments is detrimental.

Nature of Science

Big Idea 1: The Practice of Science

A. Scientific inquiry is a multifaceted activity. The processes of science include the formulation of scientifically investigable questions, construction of investigations into those questions, the collection of appropriate data, the evaluation of the meaning of those data, and the communication of this evaluation.

B. The processes of science frequently do not correspond to the traditional portrayal of "the scientific method."

C. Scientific argumentation is a necessary part of scientific inquiry and plays an important role in the generation and validation of scientific knowledge.

D. Scientific knowledge is based on observation and inference; it is important to recognize that these are very different things. Not only does science require creativity in its methods and processes, but also in its questions and explanations.

Benchmark	Competencies That Go Unassessed

SC.7.N.1.1: Define a problem from the seventh grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.	• Student can conduct a scientific investigation consisting of the following subcompetencies:
	  • *Student can formulate a scientifically testable question(s) that relates to the context or data provided.*
	  • *Student can create a plan for carrying out a scientific investigation, including what, when, and how to measure variables.*
	  • *Student can carry out a plan for scientific investigations of various types.*
	  • *Student can organize data by creating a table, chart, or other representation to facilitate interpretation.*
	  • *Student can make inferences and predictions and use the data to defend or refute conclusion.*

Benchmark	Competencies That Go Unassessed
SC.7.N.1.2: Differentiate replication (by others) from repetition (multiple trials).	*Assessable with FCAT-like tests*
SC.7.N.1.3: Distinguish between an experiment (which must involve the identification and control of variables) and other forms of scientific investigation and explain that not all scientific knowledge is derived from experimentation.	*Assessable with FCAT-like tests*
SC.7.N.1.4: Identify test variables (independent variables) and outcome variables (dependent variables) in an experiment.	*Assessable with FCAT-like tests*
SC.7.N.1.5: Describe the methods used in the pursuit of a scientific explanation as seen in different fields of science such as biology, geology, and physics.	• Student can explain that different methods are used to investigate scientific questions in various fields of science. • Student can give examples of and describe methods used in each of the fields of biology, geology, and physics.
SC.7.N.1.6: Explain that empirical evidence is the cumulative body of observations of a natural phenomenon on which scientific explanations are based.	• Student can explain that data obtained through a scientific investigation are empirical. • Student can explain that empirical data are used to scientifically explain the natural world.
SC.7.N.1.7: Explain that scientific knowledge is the result of a great deal of debate and confirmation within the science community.	• Student can develop an explanation of the process by which scientists confirm and debate each other's methods, data, and conclusions, which can include replication, alternative methods for investigating the same question, and reanalysis of existing data sets.

Big Idea 2: The Characteristics of Scientific Knowledge

A. Scientific knowledge is based on empirical evidence, and is appropriate for understanding the natural world, but it provides only a limited understanding of the supernatural, aesthetic, or other ways of knowing, such as art, philosophy, or religion.

B. Scientific knowledge is durable and robust, but open to change.

C. Because science is based on empirical evidence it strives for objectivity, but as it is a human endeavor the processes, methods, and knowledge of science include subjectivity, as well as creativity and discovery.

Benchmark	Competencies That Go Unassessed
SC.7.N.2.1: Identify an instance from the history of science in which scientific knowledge has changed when new evidence or new interpretations are encountered.	*Assessable with FCAT-like tests, assuming that students are being asked to distinguish between instances/noninstances of new knowledge that changed a scientific paradigm*

Big Idea 3: The Role of Theories, Laws, Hypotheses, and Models

A. The terms that describe examples of scientific knowledge, for example; "theory," "law," "hypothesis," and "model" have very specific meanings and functions within science.

Benchmark	Competencies That Go Unassessed
SC.7.N.3.1: Recognize and explain the difference between theories and laws and give several examples of scientific theories and the evidence that supports them.	• Student can explain the difference between theories and laws. • Student can provide examples of scientific theories. • Student can explain why an example constitutes a scientific theory. • Student can provide examples of evidence that support a scientific theory.
SC.7.N.3.2: Identify the benefits and limitations of the use of scientific models.	*Assessable with FCAT-like tests*

Earth and Space Science

Big Idea 6: Earth Structures

A. Over geologic time, internal and external sources of energy have continuously altered the features of Earth by means of both constructive and destructive forces. All life, including human civilization, is dependent on Earth's internal and external energy and material resources.

Benchmark	Competencies That Go Unassessed
SC.7.E.6.1: Describe the layers of the solid Earth, including the lithosphere, the hot convecting mantle, and the dense metallic liquid and solid cores.	*Assessable with FCAT-like tests*
SC.7.E.6.2: Identify the patterns within the rock cycle and relate them to surface events (weathering and erosion) and subsurface events (plate tectonics and mountain building).	*Assessable with FCAT-like tests*
SC.7.E.6.3: Identify current methods for measuring the age of Earth and its parts, including the law of superposition and radioactive dating.	*Assessable with FCAT-like tests*
SC.7.E.6.4: Explain and give examples of how physical evidence supports scientific theories that Earth has evolved over geologic time due to natural processes.	• Student can provide examples of physical evidence and related natural processes that support the scientific theories that Earth has evolved over geologic time. • Student can explain *why* a specific piece of evidence supports our understanding of the scientific theories that Earth has evolved over geologic time.

Benchmark	Competencies That Go Unassessed
SC.7.E.6.5: Explore the scientific theory of plate tectonics by describing how the movement of Earth's crustal plates causes both slow and rapid changes in Earth's surface, including volcanic eruptions, earthquakes, and mountain building.	*Assessable with FCAT-like tests*
SC.7.E.6.6: Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water quality, changing the flow of water.	*Assessable with FCAT-like tests*
SC.7.E.6.7: Recognize that heat flow and movement of material within Earth causes earthquakes and volcanic eruptions, and creates mountains and ocean basins.	*Assessable with FCAT-like tests*

Physical Science

Big Idea 10: Forms of Energy

A. Energy is involved in all physical processes and is a unifying concept in many areas of science.

B. Energy exists in many forms and has the ability to do work or cause a change.

Benchmark	Competencies That Go Unassessed
SC.7.P.10.1: Illustrate that the sun's energy arrives as radiation with a wide range of wavelengths, including infrared, visible, and ultraviolet, and that white light is made up of a spectrum of many different colors.	• Student can illustrate a standing wave of varying energy, and therefore wavelengths. • Student can demonstrate (e.g., by using a prism) and explain that light is composed of various energies (or wavelengths) that can be separated into a rainbow of colors.
SC.7.P.10.2: Observe and explain that light can be reflected, refracted, and/or absorbed.	• Student can identify and explain when light is reflected off a surface, refracted going through a medium (including a prism), and absorbed (as when meeting something black).
SC.7.P.10.3: Recognize that light waves, sound waves, and other waves move at different speeds in different materials.	*Assessable with FCAT-like tests*

Big Idea 11: Energy Transfer and Transformations

A. Waves involve a transfer of energy without a transfer of matter.

B. Water and sound waves transfer energy through a material.

C. Light waves can travel through a vacuum and through matter.

D. The Law of Conservation of Energy: Energy is conserved as it transfers from one object to another and from one form to another.

Benchmark	Competencies That Go Unassessed
SC.7.P.11.1: Recognize that adding heat to or removing heat from a system may result in a temperature change and possibly a change of state.	*Assessable with FCAT-like tests*
SC.7.P.11.2: Investigate and describe the transformation of energy from one form to another.	• Student can perform an experiment that demonstrates the events as energy is transformed from one form to another and can describe these events.
SC.7.P.11.3: Cite evidence to explain that energy cannot be created nor [or] destroyed, only changed from one form to another.	• Student can cite and explain evidence of transformations between potential and kinetic energy. • Student can cite and explain evidence of energy transformation from one form to another. • Student can cite and explain evidence that energy can neither be created nor destroyed.
SC.7.P.11.4: Observe and describe that heat flows in predictable ways, moving from warmer objects to cooler ones until they reach the same temperature.	*Assessable with FCAT-like tests*

Life Science

Big Idea 15: Diversity and Evolution of Living Organisms

A. The scientific theory of evolution is the organizing principle of life science.

B. The scientific theory of evolution is supported by multiple forms of evidence.

C. Natural Selection is a primary mechanism leading to change over time in organisms.

Benchmark	Competencies That Go Unassessed
SC.7.L.15.1: Recognize that fossil evidence is consistent with the scientific theory of evolution that living things evolved from earlier species.	*Assessable with FCAT-like tests*
SC.7.L.15.2: Explore the scientific theory of evolution by recognizing and explaining ways in which genetic variation and environmental factors contribute to evolution by natural selection and diversity of organisms.	• Student can explain the ways in which mechanisms of change (e.g., selection, mutation, genetic drift, migration) in populations operate on and contribute to variation in populations over generations. • Student can explain ways in which genetic variation and environmental factors intersect to influence survival, reproduction, and diversity.
SC.7.L.15.3: Explore the scientific theory of evolution by relating how the inability of a species to adapt within a changing environment may contribute to the extinction of that species.	• Student can explain that adaptations occur through natural selection acting upon genetic variation. • Student can explain why a species must continue to adapt when its environment changes in order for that species to continue to have an advantage. • Student can explain that the rate of change in the environment and the population together influence whether a species survives.

Big Idea 16: Heredity and Reproduction

A. Reproduction is characteristic of living things and is essential for the survival of species.

B. Genetic information is passed from generation to generation by DNA; DNA controls the traits of an organism.

C. Changes in the DNA of an organism can cause changes in traits, and manipulation of DNA in organisms has led to genetically modified organisms.

Benchmark	Competencies That Go Unassessed
SC.7.L.16.1: Understand and explain that every organism requires a set of instructions that specifies its traits, that this hereditary information (DNA) contains genes located in the chromosomes of each cell, and that heredity is the passage of these instructions from one generation to another.	*Assessable with FCAT-like tests*
SC.7.L.16.2: Determine the probabilities for genotype and phenotype combinations using Punnett Squares and pedigrees.	*Assessable with FCAT-like tests*
SC.7.L.16.3: Compare and contrast the general processes of sexual reproduction requiring meiosis and asexual reproduction requiring mitosis.	*Assessable with FCAT-like tests*

Benchmark	Competencies That Go Unassessed
SC.7.L.16.4: Recognize and explore the impact of biotechnology (cloning, genetic engineering, artificial selection) on the individual, society and the environment.	• Student can provide examples of common biotechnologies, such as cloning, genetic engineering, and artificial selection. • Student can explain uses and limitations of common biotechnologies. • Student can explain short- and long-term impacts (positive and negative) of specific biotechnologies on individuals, society, and the environment.

Big Idea 17: Interdependence

A. Plants and animals, including humans, interact with and depend upon each other and their environment to satisfy their basic needs.

B. Both human activities and natural events can have major impacts on the environment.

C. Energy flows from the sun through producers to consumers.

Benchmark	Competencies That Go Unassessed
SC.7.L.17.1: Explain and illustrate the roles of and relationships among producers, consumers, and decomposers in the process of energy transfer in a food web.	• Student can create a diagram (i.e., food web) that illustrates the flow of energy among producers, consumers, and decomposers within an ecosystem (e.g., student can create an illustration of the flow of energy beginning with solar energy, which is first used by the producers, then the consumers feed on the producers, and ultimately, the decomposers feed on both the producers and consumers). • Student can explain complex interrelationships among the various types of organisms in a food web.
SC.7.L.17.2: Compare and contrast the relationships among organisms such as mutualism, predation, parasitism, competition, and commensalism.	*Assessable with FCAT-like tests*
SC.7.L.17.3: Describe and investigate various limiting factors in the local ecosystem and their impact on native populations, including food, shelter, water, space, disease, parasitism, predation, and nesting sites.	• Student can observe and describe a local ecosystem. • Student can determine potential limiting factors for specified populations in a local ecosystem. • Student can explain complex relationships between biotic and abiotic factors in an ecosystem. • Student can investigate multiple factors that impact native populations in the ecosystem.