PART II

CAPT SECOND GENERATION

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CAPT OVERVIEW

It has been the policy of the Connecticut State Department of Education to review the major components of the statewide student assessment system approximately every five to seven years. These review periods are used to examine the direction of the assessment programs and to allow for changes that may have occurred in state curriculum frameworks, legislation, and shifts in priorities on the national, state and local levels.

The second generation of the CAPT will be administered beginning in the spring of 2001. During the past two years, staff members have been engaged in discussions with advisory committees of Connecticut educators, as well as the testing contractor, Harcourt Educational Measurement, to make the numerous decisions that will guide the development of the test. New test items for the CAPT were field tested in the spring 1999 and 2000.

The same standard for achieving the goal in science will be maintained from the first to the second generation of the CAPT. The following summarizes the major changes in the second generation CAPT.

CAPT AREA	CONTENT INCLUDED	SUMMARY OF CHANGES
Science	All science sections	Restrict content to most essential skills and knowledge
Reading Across the Disciplines	Response to literature	Reduce # of questions (4 instead of 6) Control length of story
	Reading for information	Add reading for information
Writing Across the Disciplines	Editing and revising	Revision of eding test
	Interdisciplinary writing	2 shorter tests replacing longer test
Mathematics	All mathematics sections	All content reviewed

THE SCIENCE ASSESSMENT

Content (Changes)

A major change between the first and second generations of the CAPT science assessment is that the science content that is measured will be better defined and more consistent from one year to the next. This change is in response to school district concerns that the content on the first generation CAPT has been a “moving target,” making it difficult to prepare students or to make meaningful comparisons from one year to the next. Science specialists at the Connecticut State Department of Education, with input from the Science Advisory Committee, have adapted knowledge and skills from the science curriculum frameworks, which are most critical and which can be reasonably measured through the CAPT. A detailed summary of the “eligible” content for the CAPT will be shared with school districts, and the test will more consistently cover the specified skills and knowledge.

The science test will assess conceptual understanding and applications of scientific knowledge and experimentation in three content domains: (1) life science; (2) physical science; and (3) earth science. Each of these domains encompasses the content in several of the content strands that are specified in Connecticut’s science curriculum frameworks.

The content in each of the domains is listed on pages 16-22. Each content strand (e.g., Ecosystems) within each of the domains will be assessed in every test form.

Test Format

The experimentation domain will center on the performance task that precedes the written test. School districts showed strong support for the hands-on task and expressed a desire that it should have even more prominence in the scoring of the test. In the written test, follow-up questions will include both open-ended and multiple-choice items. In the first generation science test, the open-ended items related directly to the performance task, but the multiple-choice items were generic questions about experimentation. In the second generation, all experimentation test items will be directly related to the performance task.

In each of the other domains (life science, physical science and earth science), the test will include both multiple-choice and open-ended items. Multiple-choice items will be organized in clusters that center on a common theme. To assist in making the test more consistent from year to year, each of the four content strands within a content domain (e.g., life science: ecosystems, genetics and evolution, cells, and human biology) will be assessed on every test.

The format of the second generation CAPT science assessment is similar to that of the first generation. For sample items and performance tasks, see the CAPT Released Item Packets (1994-1999).

Test Design

The CAPT science test will consist of the following numbers of items:

	Open-Ended	Multiple-Choice
Experimentation	4*	4*
Life Science	1	16
Physical Science	1	16
Earth Science	1	16
TOTAL	**7**	**52**

* Both open-ended and multiple-choice questions will be related to the science performance task.

Reporting of Results

The state goal in science will continue to be established on the total science score and will be the basis for certification of mastery. Additional standards are likely to be established below the state goals. Subscores will be reported in experimentation, life science, physical science and earth science.

Testing Time

In order to enable more detailed reporting, it is necessary to have a sufficient number of test items in each of the content domains. This requires the addition of 10 minutes to the test. The second generation science test will take 100 minutes (broken into two 50-minute sessions. The performance task will require 90 minutes.

THE CAPT SCIENCE FRAMEWORK

PROCESSES AND CONTENT FOR THE SECOND GENERATION SCIENCE TEST

I. Conceptual Understanding and Application of Scientific Knowledge

- Describe natural phenomena with appropriate scientific terms.
- Explain natural phenomena with scientific concepts.
- Predict future events based on scientific knowledge.
- Apply scientific reasoning and knowledge.
- Interpret and communicate scientific information using words, equations, graphs and charts.

II. Experimentation

- Recognize and define problems for scientific investigations.
- Design appropriate procedures to solve the problem.
- Predict the results based on knowledge of problem-related content.
- Conduct investigations, collect data and record observations.
- Interpret data, draw conclusions and assess their validity.

(All of the above in the following content areas:)

Life Science

- ecosystems
- genetics and evolution
- cells
- human biology

Physical Science

- structure of matter
- reactions and interactions
- forces and motion
- energy sources and transformations

Earth Science

- astronomy
- earth’s natural resources
- meteorology
- earth history and dynamics

LIFE SCIENCE

Ecosystems

As a result of studying various ecosystems:

Students understand that, while matter is recycled in an ecosystem, there is a one-way flow of energy in ecosystems.

- Describe the oxygen, carbon and nitrogen cycles and explain their significance.
- Explain how carbon dioxide and water are converted into energy-rich foods through an energy-capturing mechanism (photosynthesis).
- Describe the transfer of energy from the sun to the environment and back to space, through food webs consisting of producers, consumers and decomposers.

Students understand how the number and variety of organisms and populations are dependent on the resources and physical factors of their environments.

- Explain how changes in resources, predation and climate can affect the growth of different populations.
- Explain how organisms are adapted to environmental conditions in different biomes.
- Explain how human activity can impact the stability of various ecosystems.

Genetics And Evolution

As a result of studying patterns of heredity and historical changes in life forms:

Students understand how each organism carries a set of instructions (genes composed of DNA) for specifying the components and functions of the organism.

- Describe how genetic materials are organized in genes and chromosomes in the cells of living organisms.
- Explain how the genetic information from both parents is mixed in the fertilized egg to produce an individual with new combinations of genes and traits.
- Explain how genes are related to inherited traits and how genes can be manipulated by modern technologies.

Students understand that the basic idea of biological evolution is that the Earth's present-day species developed from earlier species.

- Explain how environmental changes can lead to the extinction and evolution of species.
- Describe how fossils and anatomical evidence provide support for the theory of evolution.

Cells

As a result of observing and studying cells in single and multiple-celled organisms:

Students understand the basic cell structures and functions of living cells.

- Describe the basic similarities and differences found in the structures of plant, animal and bacterial cells.
- Describe the structure and explain the main functions of skin, nerve, muscle and blood cells.
- Explain how the cell membrane helps the cell to maintain its unique internal composition.

Students understand that cells divide for growth of the organism, repair and reproduction.

- Describe the process of mitotic cell division and explain how this process is important in growth of the organism and repair of tissues.
- Describe the process producing reproductive cells (meiosis) in females (egg cells) and males (sperm cells).

Human Biology

As a result of studying the structure and function of the human body:

Students understand the healthy functioning of the human body and how environmental conditions, nutrition, physical activity and pathogens affect its functioning.

- Describe the structure and function of the major human organ systems (e.g., circulatory, respiratory, digestive, reproductive and nervous systems).
- Explain the role of nutrients and physical activity in the functioning of the human body.
- Explain the human body’s defense system against infectious diseases and the role of antibiotics and vaccinations.

PHYSICAL SCIENCE

Structure of Matter

As a result of working with different materials and learning theories about the structure of matter:

Students understand the basic structure of atoms and the properties of elements.

- Describe the basic structure of atoms (including protons, neutrons and electrons) and how the atoms of one element are alike and different from each other.
- Describe the organization of the elements in the periodic table, including the properties and electronic arrangements of elements in the first three periods.

Students understand the use of physical and chemical properties to classify and describe matter.

- Describe the different physical properties that are used to classify matter, including density, melting point and boiling point.
- Explain that new substances are formed when atoms combine by transferring or sharing electrons (i.e., ionic and covalent bonding).
- Explain the differences among atoms, elements, molecules, compounds and mixtures and give examples of each using common materials.

Reactions and Interactions

As a result of studying changes in matter and how they occur:

Students understand the differences between physical and chemical changes of matter.

- Describe the physical states of matter (solids, liquids and gases) in terms of the arrangement and motion of particles and explain how heat is related to changes in the physical state of matter.
- Describe the differences between chemical and physical changes of matter and explain how chemical changes involve the rearrangement of molecules, atoms or ions to form new substances.

Students understand that materials interact with each other in various forms.

- Explain that total mass and energy are conserved in synthesis and decomposition reactions.
- Describe combustion and corrosion reactions of materials with oxygen (i.e., burning, respiration and rusting).
- Describe the chemical structures and properties of acids and bases and relate them to the properties of common household products.

Forces and Motion

As a result of studying the motion of different objects:

Students understand that energy and matter interact through forces that result in changes in the motions of objects.

- Explain the relationships among distance, time and speed, interpret graphs of motion, and perform calculations using the equation *Distance = Speed x Time.*
- Describe Newton's three laws of motion, apply them to everyday phenomena, and perform calculations using the equation *Force = Mass x Acceleration.*
- Describe the effects of gravitation on the motion and weight of objects.

Students understand the nature of electricity and magnetism.

- Describe the factors that affect the electrical forces between charges and explain how electric currents and magnets exert a force on each other.
- Describe the effects of voltage and resistance on the flow of electric charges in a series circuit.

Energy Sources and Transformations

As a result of studying various forms of energy:

Students understand the nature of various forms of energy.

- Describe various forms of energy, including light, heat, chemical, electrical and mechanical energy, and identify them in various physical settings.
- Describe kinetic and potential energy transformations in biological, chemical, mechanical and electrical systems.
- Describe simple machines, including ramps, levers and pulleys, and explain their use in terms of work and forces.

Students understand the properties of sound and light.

- Describe different classifications within the electromagnetic spectrum in terms of their wavelengths, energies, effects on living organisms and uses in modern technologies.
- Describe the wave properties of sound, including volume and pitch.
- Explain the behavior of light, including reflection, refraction, absorption and the phenomenon of color.

EARTH SCIENCE

Astronomy

As a result of learning about the solar system and the universe:

Students understand the structure, motion and composition of stars, planets and other bodies with an emphasis on our solar system.

- Describe the orientation, direction and duration of the movement of the Earth around its axis and around the sun and relate these to day/night cycles and the seasons.
- Explain how the changes in the relative position of the sun, moon and Earth affect the phases of the moon and eclipses, and describe ocean tidal variations.
- Describe our solar system, including the estimated size, composition and surface features of the sun, planets and lesser members.
- Explain how astronomers collect and interpret information to determine the motion, structure and composition of stars.

Earth's Natural Resources

As a result of studying Earth's natural resources:

Students understand that the Earth has various natural resources important to all living organisms.

- Describe how essential natural resources (i.e., air, water, soil and minerals) vary in their abundance, and explain the importance of conservation and recycling of natural resources.
- Describe sources of fresh water and the importance of water to life.

Students understand the use of the Earth's natural resources by humans.

- Describe renewable and nonrenewable sources of energy and the advantages and disadvantages of their use.
- Use maps to identify geological features and determine locations, scales and directions.

METEOROLOGY

As a result of studying the Earth’s weather and climate patterns:

Students understand that our atmosphere is dynamic and has patterns of weather systems.

- Explain how winds originate and are affected by the unequal heating of the Earth’s surface, the rotation of the Earth, and the distribution of land and water surfaces.
- Explain the water cycle and the energy that drives it.
- Explain how meteorologists collect and interpret meteorological data from various sources.

Students understand the reasons for the distribution of climates around the world.

- Explain how regional climates are determined by energy transfer from the sun and are influenced by cloud cover, the Earth’s rotation, oceans and mountains.
- Explain the possible causes and effects of global phenomena including El Nino, global warming and ozone depletion.

Earth History and Dynamics

As a result of studying the composition of the Earth and the changes it undergoes:

Students understand interactions among the Earth’s lithosphere, hydrosphere, atmosphere and biosphere.

- Describe how plate tectonics is related to the interior composition of the Earth, including its core, mantle and crust, and relate it to major geological events, including earthquakes, volcanic eruptions and mountain building.
- Explain how the formation, weathering, sedimentation and reformation of rock constitute a continuing rock cycle.
- Describe how waves, wind, water and ice shape the Earth’s land surface.
- Describe how geological history and major time periods can be determined using evidence from fossils and rock sequences.

CURRICULUM ALIGNMENT ISSUES

Inquiry-based science is not something to be memorized, but rather a knowledge base that must evolve through explorations and experiences. A science program should identify the content and skills for each grade level in order to provide a developmental foundation of the nature of science. Most school districts have a science curriculum, but process skills and applications of science may not be as well defined as the content. Process skills include collecting, recording and analyzing data; making comparisons; formulating conclusions; designing experiments; making predictions or estimating results; organizing data from observations into tables or charts; sequencing objects or events; comparing or contrasting objects based upon physical properties; explaining cause and effect relationships in an observation; and much more. Does the science curriculum identify the skills students are expected to accomplish at each grade level? Does the science curriculum identify the appropriate applications of scientific principles? Does the science curriculum reflect the true nature of science as described in *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993) and the *National Science Standards* (National Research Council, 1996)?

Scope and Sequence

Determining the scope and sequence of the science program is of critical importance to curriculum developers and teachers. Defining curriculum expectations is not enough to ensure that students have opportunities to become scientifically literate and well-prepared for the CAPT. Without ongoing articulation between elementary, middle and high school science teachers, programs tend to become isolated islands, with each level never knowing the curriculum expectations and goals at other levels. Teachers need opportunities to talk and share with teachers at other levels. Setting up a process where teachers at different levels can share what they are doing can improve the efficiency of the educational system and help to eliminate redundancies that often occur.

Teachers at all grade levels need time to discuss the science curriculum to ensure that the scope and sequence is appropriate and avoids redundancies. While many curricular models exist, students should have opportunities to study life, earth and physical science during their K-12 experience. The sciences may be integrated, as many national reports and science educators recommend, or studied separately. Since the content portion of the CAPT is equally divided among the life, earth and physical sciences, the instructional program should be balanced among these fields.

The fundamental goal of life science instruction is to help students understand and explain the nature and function of living things. During the 20th century, the focus of biological research changed from descriptive natural history to investigation, especially at cellular and sub-cellular levels, with evolution as the central, unifying theory.

Physical science relates to basic knowledge and understanding concerning the nature of the universe, as well as physical principles that operate within it. As with other fields, instruction in physical science should take into account how students learn. Students should encounter concepts, principles and laws of physical science at successively higher levels of abstraction over several years.

Earth science instruction helps students understand how earth scientists depict data through maps and other means to interpret objects, their features and structures, and the events and processes that caused them. Instruction should center around the structure of the Earth (lithosphere), water (hydrosphere), air (atmosphere) and the Earth in space.

Content is what students should learn. Curriculum is the way content is organized and emphasized; it includes structure, organization, balance and presentation of the content in the classroom. Scientific knowledge should be organized in a structure that connects discrete pieces of information in meaningful ways. Curriculum that reduces the sheer amount of material covered and that eliminates subject-matter boundaries, allows for greater connections among science, mathematics and technology.

INSTRUCTIONAL STRATEGIES

Traditional instruction has a well-established order. "Information comes first, followed by questioning to determine student understanding, and ending with some sort of problem-solving activity. While this approach is very systematic and easy for teachers to manage, it does not reflect the kind of learning which takes place in the real world." (*Problem-Based Learning*, Shelagh Gallagher, Center for Gifted Education, College of William and Mary, 1995.) Inquiry-based instruction is much more than merely presenting a hands-on lesson. Some questions that teachers may want to consider include: Does your activity promote or confine thinking? Did you review the last science activity you incorporated into your lesson? Does this activity define every step and procedure? Does it include a data table or chart and questions that direct the student to the correct conclusion? Does this lesson give the students an opportunity to think for themselves? Can you try a different approach? Present the problem without the specific steps and have your students explain the steps they would follow to find the solution. Do not include a data table but have the students design and explain the resolution to the question or problem based upon their own experiment and data.

Opportunities to work in groups encourage students to share responsibility for learning. Students develop approaches and explanations, exchange information, talk and listen, argue and persuade. They learn to order their thoughts and compare their own thinking processes with those of their peers. Students also become involved in tutoring and encouraging each other. When students work in groups, they all have a chance to be successful and everyone's effort contributes to the group's results.

Assessment

Student assessment should allow students opportunities to demonstrate higher-order thinking skills. To do this, teachers may:

- implement activities that require students to generate hypotheses and design experiments to support their hypotheses;
- develop performance-based activities to assess what students are learning; and
- incorporate opportunities for students to write out their responses to questions.

Addressing student progress is an important part of science education. Assessment encompasses more than testing. It includes techniques such as systematic teacher observation and assessment, in which the tasks assessed more closely parallel the learning activities and outcomes that are desired in the science classroom. In systematic teacher observation, the teacher carefully observes students to ensure that they are using scientific processes and procedures appropriately. In an effective science classroom, a teacher might use assessment to fulfill any or all of the following purposes:

- find out what students know before instruction begins;
- determine how students are progressing toward learning goals;

- identify which strategies and thinking processes students use in their answers or conclusions;
- establish what students have learned after a specific period of instruction;
- signal to students the areas in which they need to improve; and
- communicate teacher expectations about what is important.

Skills beyond recognition and recall can be assessed through a number of means: individual performance-based activities, multiple performance-based activities gathered into a portfolio, and appropriately constructed multiple-choice tests. Students should be offered many different options for communicating what they know and understand, and for raising new questions about a subject. Opportunities to demonstrate ideas, quantify results and make written, oral or visual presentations of findings and hypotheses are essential.

Working individually or in groups with equipment and materials, students might be asked to do a laboratory experiment or solve a real-life problem. Through a series of systematic observations and questions, teachers can evaluate both processes the students use and their understanding of the major concept involved.

As a starting point, students can be given the procedures for the activity while being required to decide what kind of data table or chart they will use to record the information. Ultimately, students can be given the problem without the specific procedures and determine the procedures and tables prior to doing the activity.

Helping Students

Teachers are the best judges of the type and level of assistance students need. The Connecticut Mastery Test (CMT) and Connecticut Academic Performance Test (CAPT) provide useful information to support those judgments. Optimum learning occurs if data is used wisely when teachers create learning environments in which:

- there is respect for all students;
- there are expectations that all students can be highly successful;
- challenging content is taught;
- opportunities to reason and solve problems together are integral parts of the daily learning experience for all students;
- learning is made active, exciting and applicable to real-life experiences; and
- both teachers and students are actively engaged in exploring thought-provoking ideas.

To help your students learn science better, teachers can:

- ensure that students have opportunities to learn and explore life, earth and physical sciences each year of their K-12 school experience; and
- regularly incorporate laboratory experiences which require them both to use scientific equipment and think critically about scientific concepts.

Generally, to help students learn better, teachers are encouraged to enlist:

- parents to regularly monitor and discuss their youngsters' school work; and
- colleagues to develop significant interdisciplinary experiences in which students both engage themselves and write about.

There is no "quick fix" for helping students meet the CAPT goal standard in science. Students will do best the first time they take the test as sophomores, as well as any retest, when their science experiences from kindergarten through high school incorporate the science processes and content areas in the CAPT science framework.