OVERVIEW OF THE ELEMENTARY AND MIDDLE SCHOOL CURRICULUM-EMBEDDED PERFORMANCE TASK MODEL

The Connecticut State Board of Education approved the Core Science Curriculum Framework in October 2004. The framework promotes a balanced approach to PK-12 science education that develops student understanding of science content and investigative processes.

WHAT IS A CURRICULUM-EMBEDDED PERFORMANCE TASK?

Curriculum-embedded performance tasks are modifiable instructional materials that engage students in developing abilities to do scientific inquiry as they explore standards-based science concepts. They are suggested models for instruction provided for districts' convenience rather than mandated exercises. Teachers are encouraged to embed the performance tasks within the course of the normal instructional day and within the appropriate instructional context. In this way, curriculum-embedded tasks are part of, not an addition to, the regular curriculum.

Curriculum-embedded performance tasks serve three main purposes: (1) they illustrate the expected performances for scientific inquiry, literacy and numeracy described in the Science Framework; (2) they are models for developing additional interdisciplinary inquiry investigations; and (3) they are contexts for questions on the Science CMT that assess understanding of scientific inquiry.

The embedded tasks are extended, open-ended investigations that allow students to explore in depth one aspect of an entire learning unit. Students learn to design simple scientific experiments to test ideas rather than to follow step-by-step directions to achieve a predetermined outcome. Each embedded task gives students opportunities to pose scientific questions, collect and organize data, identify patterns, formulate generalizations, communicate findings and raise questions for further study. The elementary performance tasks introduce students to understanding and conducting "fair tests." The middle school performance tasks focus on designing investigations that test cause/effect relationships by manipulating variables.

Teachers are encouraged to use the state-developed curriculum-embedded performance tasks in conjunction with numerous other learning activities that incorporate similar inquiry process skills to deepen understanding of science concepts. Students who regularly practice and receive feedback on problem-solving and critical thinking skills will steadily gain proficiency.

HOW WERE THESE PERFORMANCE TASKS DEVELOPED?

Developed in 2005 by Connecticut teachers working with the Connecticut State Department of Education, the curriculum-embedded performance tasks are examples of full inquiry investigations that engage students in using all the inquiry skills defined in the Science Framework. The embedded tasks for Grades 3-5, feature the following Expected Performances for Scientific Inquiry, Literacy and Numeracy:

- **B INQ.1** Make observations and ask questions about objects, organisms and the environment.
- **B INQ.2** Seek relevant information in books, magazines and electronic media.
- **B INQ.3** Design and conduct simple investigations.
- **B INQ.4** Employ simple equipment and measuring tools to gather data and extend the senses.

- **B INQ.5** Use data to construct reasonable explanations.
- **B INQ.6** Analyze, critique and communicate investigations using words, graphs and drawings.
- **B INQ.7** Read and write a variety of science-related fiction and nonfiction texts.
- **B INQ.8** Search the Web and locate relevant science information.
- **B INQ.9** Use measurement tools and standard units (e.g., centimeters, meters, grams, kilograms) to describe objects and materials.
- **B INQ.10** Use mathematics to analyze, interpret and present data.

The embedded tasks for Grades 6-8 feature the following Expected Performances for Scientific Inquiry, Literacy and Numeracy:

- **C INQ.1** Identify questions that can be answered through scientific investigation.
- **C INQ.2** Read, interpret and examine the credibility of scientific claims in different sources of information.
- **C INQ.3** Design and conduct appropriate types of scientific investigations to answer different questions.
- **C INQ.4** Identify independent and dependent variables, and those variables that are kept constant, when designing an experiment.
- **C INQ.5** Use appropriate tools and techniques to make observations and gather data.
- **C INQ.6** Use mathematical operations to analyze and interpret data.
- **C INQ.7** Identify and present relationships between variables in appropriate graphs.
- **C INQ.8** Draw conclusions and identify sources of error.
- **C INQ.9** Provide explanations to investigated problems or questions.
- **C INQ.10** Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

HOW ARE THE PERFORMANCE TASKS STRUCTURED?

Each performance task includes two investigations: one that provides some structure and guidance for students, and a second that allows students more opportunity to operate independently. The goal is to gradually increase students' independent questioning, planning and data analysis skills.

Written and oral communication is an indispensable component of doing science. Not all science knowledge can be derived by completing a hands-on task. Therefore, each curriculum-embedded task gives students opportunities to expand their understanding of concepts through reading, writing, speaking and listening components. These elements foster scientific literacy, student collaboration, classroom discourse, and the establishment of a science learning community.

Mathematics is essential for quantifying scientific observations, displaying data and analyzing findings. Each curriculum-embedded performance task offers opportunities for students to apply mathematics processes such as measuring, weighing, averaging or graphing, to answer scientific questions.

The performance tasks use the "5-E" Learning Cycle, a format used in many inquiry-based learning units or lessons. A key feature of this model is that students are engaged in exploratory experiences that allow them to observe, question and make tentative explanations before formal instruction and terminology is introduced. The five stages in a 5-E learning cycle are:

- **Engagement:** stimulate students' interest, curiosity and preconceptions;
- **Exploration**: first-hand experiences with concepts without direct instruction;
- **Explanation:** students' explanations followed by introduction of formal terms and clarifications;
- **Elaboration:** applying learning in a new context. Students frequently develop their own questions and complete follow-up investigations;
- **Evaluation:** students and teachers reflect on change in conceptual understanding and identify ideas still "under development" and in need of further investigation.

HOW ARE PERFORMANCE TASKS USED WITH YOUR CLASS?

Curriculum-embedded performance tasks are designed as instructional materials that allow students to practice scientific inquiry (as described in Connecticut's inquiry standards) at the same time as they build understanding of critical science content in state standards. Hence, the performance tasks should be *"embedded"* within a learning unit related to a Framework Content Standard. For example, while teaching a unit about human body systems (Content Standard 7.2,) the teacher decides the appropriate time to incorporate the "Feel The Beat" performance task to investigate factors affecting pulse rate.
In short, curriculum-embedded performance tasks are NOT intended to be administered as summative tests or unrelated to what students are learning at the time.

Teachers play an important role in providing instruction and feedback as students progress toward greater levels of proficiency and independence in carrying out scientific inquiry. Performance tasks provide many opportunities for "teachable moments" during which teachers can provide "as needed" instruction in specific components of scientific inquiry, such as making objective observations, posing and refining scientific questions, designing fair tests or controlled experiments, organizing and graphing data, making evidence-based conclusions and communicating findings.

There is no single "correct" method or outcome for any of the performance tasks. In fact, variations in students' observations, procedures, data and conclusions provide opportunities for fruitful class discussions and teachable moments. Students' conclusions, however, should be logical interpretations of data collected in a systematic, or reliable, way. In the scientific community, scientists present their methods, findings and conclusions to their peers for critical review. Similarly, in the science classroom, students' critical thinking skills are developed when they participate in a learning community in which students critique their own work and the work of their peers.

ASSESSING STUDENT WORK ON CURRICULUM-EMBEDDED PERFORMANCE TASKS

Learning progress depends on teachers and students having a common understanding of the attributes of high quality scientific inquiry work. To support formative assessment for learning, the State Department of Education has developed formative feedback rubrics aligned with standards for scientific inquiry for elementary and middle grades ("INQs"). Instead of assigning a point score or a letter grade to student work, the rubric describes *qualities* of novice, intermediate and skillful work for each of four key components of scientific inquiry. By selecting the performance descriptor that most closely describes a student's work for each inquiry component, the rubric can be used by teachers and students to:

a) develop a profile of a student's inquiry abilities at a given point in time;

b) identify strengths and areas for improvement;

c) clearly describe criteria for progressing to the next higher level of competence; and

d) track student growth each year, and across grades.

The essential components of scientific inquiry are drawn from *Inquiry and the National Science Education Standards* (National Academy of Sciences, 2000):

Component 1. Making scientific observations and posing testable questions

Component 2. Designing investigations to answer scientific questions

Component 3. Displaying and working with data

Component 4. Communicating evidence-based conclusions

DIFFERENTATING PERFORMANCE TASKS

The State Department of Education does not mandate that the embedded tasks be used as published. In fact, the tasks are offered in a Microsoft Word format that allows for easy modification by the classroom teacher to meet the needs of his or her students. Teachers may modify all parts of the task or create differentiated student materials for skills groups within the class.

An important goal of science education is to give all students opportunities to become curious, pose questions, collect and analyze data, and communicate conclusions. For different learners, these same actions will require different levels of "scaffolding" as they move toward greater levels of independence. For example, if students have had experiences creating their own data tables, the teacher may decide to delete all or part of the data table provided in the performance task. Other possible modifications include (but are not limited to):

- text readability;
- giving students responsibility to create all or parts of the observation table, data table or a graph;
- giving students responsibility to develop the experimental question;
- giving students responsibility to develop the experimental procedure and controlling the variables;
- giving students responsibility for the choosing the method for communication of results and conclusions; or
- giving students responsibility for generating their own follow-up questions and investigations.

Many science investigations used in schools provide inquiry learning opportunities similar to those illustrated in the performance tasks. Students need a variety of classroom experiences to deepen their understanding of a science concept and to become proficient in using scientific processes, analysis and communication. **Teachers are encouraged to use the state-developed curriculum-embedded performance tasks in conjunction with numerous other learning activities that incorporate similar inquiry processes and critical thinking skills.**

HOW ARE THE PERFORMANCE TASKS RELATED TO THE CMT?

The curriculum-embedded performance tasks will provide a context for some CMT questions that assess students' understanding of scientific inquiry. The CMT questions do not assess student recall of the embedded task itself; rather, the questions assess the understanding of scientific inquiry that students acquire as a result of participating in many scientific inquiries.

Students are not expected to recall the SPECIFIC DETAILS OR A SINGLE "RIGHT" ANSWER to any performance task. The questions, similar to the examples shown below, will assess students' general understandings about scientific observations, testable questions, designing experiments, analyzing data, making evidence-based conclusions, evaluating experimental quality and making improvements.

Below is an example of the type of multiple-choice question that might appear on the Elementary Science CMT. The question is related to the "Soggy Paper" performance task:

Some students did an experiment to find out which type of paper holds the most water. They followed these steps:

1. Fill a container with 25 milliliters of water.
2. Dip pieces of paper towel into the water until all the water is absorbed.
3. Count how many pieces of paper towel were used to absorb all the water.
4. Repeat with tissues and napkins.

If another group of students wanted to repeat this experiment, which information would be most important for them to know?

a. The size of the water container
b. The size of the paper pieces *
c. When the experiment was done
d. How many students were in the group

Below is an example of the type of constructed-response question that might appear on the Middle School Science CMT. The question is related to the "Feel The Beat" performance task:

> Imagine that you want to do a pulse rate experiment to enter in the school science fair. You've decided to investigate whether listening to different kinds of music affects people's pulse rate.
>
> Write a step-by-step procedure you could use to collect reliable data related to your question. Include enough detail so that someone else could conduct the same experiment and get similar results.

NOTE THAT THE CMT QUESTIONS DO NOT ASSESS A CORRECT "OUTCOME" OF A PERFORMANCE TASK OR STUDENTS' RECOLLECTION OF THE DETAILS OF THE PERFORMANCE TASK. Students who have had numerous opportunities to make observations, design experiments, collect data and form evidence-based conclusions are likely to be able to answer the task-related CMT questions correctly, even if they have not done the state-developed performance tasks. However, familiarity with the context referred to in the test question may make it easier for students to answer the question correctly.