Science in the Elementary Classroom:
The Fourth "R"

Reading, 'Riting, 'Rithmetic, and Science!

(Yes, we know that Science doesn't begin with "r",
but the Connecticut Science Supervisors Association
wishes to emphasize the important role of
Science in the Elementary classroom!)

About CSSA

The Connecticut Science Supervisors' Association (CSSA) serves as an advocate for science education in Connecticut and acts as a resource for state and local agencies on science issues. CSSA has consistently recognized the importance of the foundational science content and skills that are developed in the elementary years and supports efforts to strengthen the teaching and learning of science at all levels.

Other papers addressing science education issue published by CSSA are:
"Science Teachers for the Wonder Years"
"Science Safety in the Classroom" and
"Leading Science in the New Millennium - The Critical Role of the Science Supervisor"

To obtain copies of these position papers, or for more information about CSSA, please visit our website at www.cssaonline.net

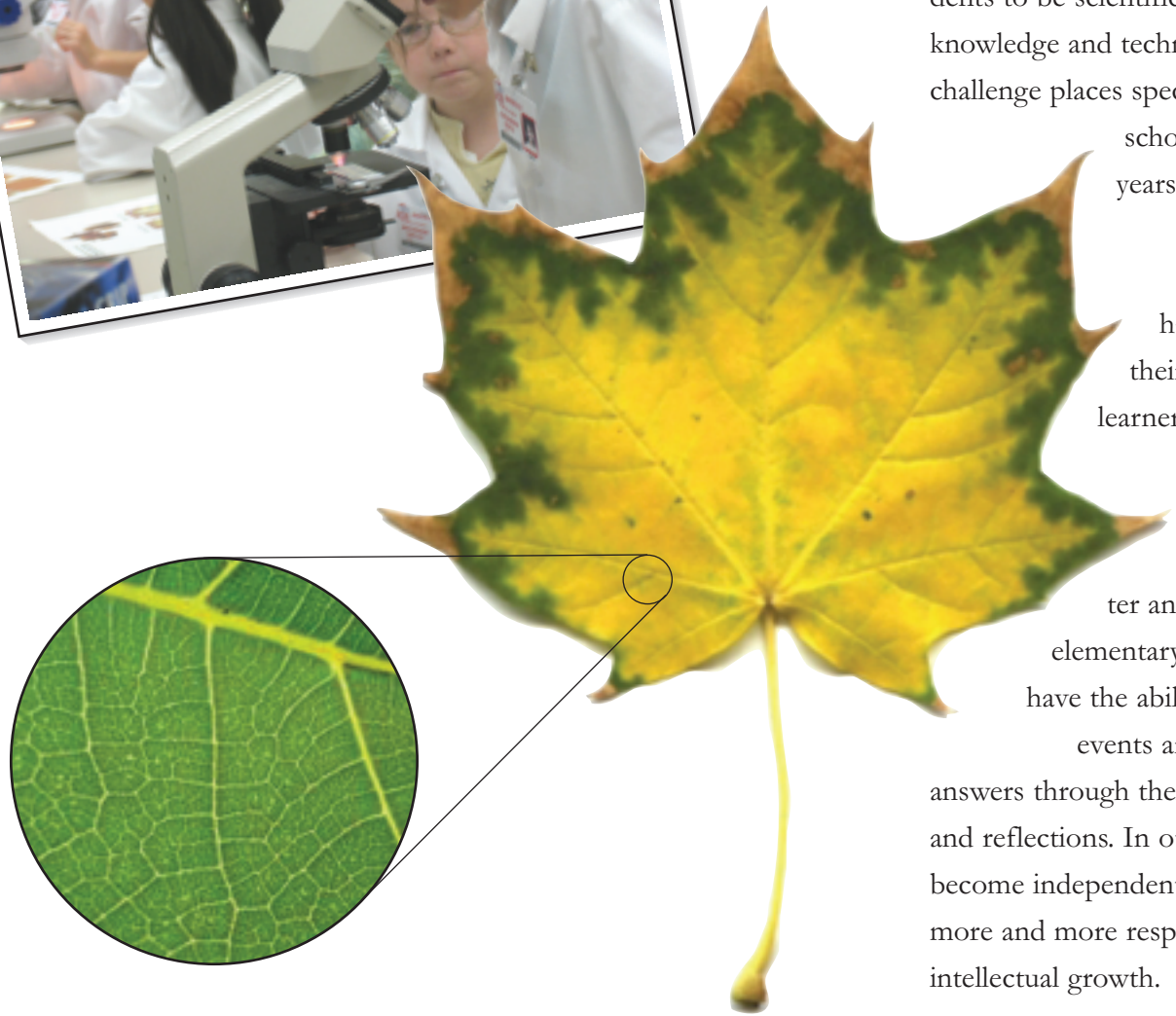
CSSA expresses sincere thanks to the Connecticut Academy for Education in Mathematics, Science & Technology, Inc. for its support, clear advice and true council.

CSSA Description

CSSA is an organization of more than 140 science leaders in education who work together to achieve the following goals:

- To improve communications among science supervisors, teachers, administrators, and boards of education.
- To examine and evaluate curricula in science.
- To improve academic standards.
- To review, update and disseminate health and safety standards and procedures in science.
- To promote and conduct professional development activities for supervisors and teachers of science.
- To serve as a public advocate for science education in Connecticut.
- To represent the membership on state and national issues in science education.
- To act as a consultant and resource to state and local agencies on science issues.
- To promote research in science education.
- To cooperate with other professional organizations for the improvement of science education.

Science Is Everywhere



Today's children are growing up in a world increasingly influenced and shaped by science and technology. Indeed, the future of human civilization may well depend on how well we prepare this generation of students to be scientifically literate citizens capable of wisely using scientific knowledge and technological innovations for the benefit of all. This challenge places special emphasis and responsibility on the elementary school science program because it is during these early years that life-long attitudes and interests are developed.

Elementary school is a place where students can have hands-on/minds-on experiences that stimulate their curiosity and motivate them to become active learners. Teachers can nurture elementary students by providing them with learning opportunities that engage all their senses and that enable them to freely explore the properties and behaviors of matter and energy. One of the most important goals of any elementary science program is to help children learn that they have the ability to raise their own questions about objects or events and that they also have the ability to then seek answers through their own manipulations, experiments, observations, and reflections. In other words, science education can help children become independent learners with the ever increasing ability to assume more and more responsibility for their own personal development and intellectual growth.

Science Is Enriching and Empowering

Effective programs in elementary science education can contribute to a child's overall education in many important ways. The study of science in the elementary years can assist students in

- understanding the basic concepts and major theories of science;
- becoming more productive, thoughtful, and informed citizens;
- using the critical thinking skills of science explorations in all facets of their personal and civic lives;
- understanding that empirical evidence and rational thought are the basis for sound decisions;
- appreciating and enjoying the wonders and grandeur of the natural world;
- discovering opportunities for life-long interests, careers, and hobbies
- becoming more aware of the need to preserve and protect natural ecosystems and the plants and animals they contain;
- becoming more aware of the need to preserve natural resources;
- recognizing that science is a necessary component in many jobs and careers;
- developing their reading, writing, mathematical, and reasoning skills; and
- preparing for science courses in the middle and secondary school.

Science Really Counts

The addition of a science component to the Connecticut Mastery Tests, in the Spring of 2008, gives additional impetus to key district stakeholders to examine their elementary science programs for alignment with the goals and recommendations of state and national standards for science education.

Quo Vadis?

Good teaching is no accident. It requires careful planning and thoughtful organization of concepts, topics, learning activities, and teaching materials. Most important, it requires a clear sense of direction based on explicit goals and specific learning outcomes. Teachers must know what they are trying to accomplish well before any lesson or unit is begun. Indeed, teachers - and their students – must know where they are going in order to be able to know when and how well they have arrived. There are ample resources that curriculum writers can use when seeking guidance on what should be taught. National standards (e.g., Benchmarks for Science Literacy by the American Association for the Advancement of Science and National Science Education Standards by the National Research Council) and state standards (Connecticut's Core Science Curriculum Framework) can be extremely helpful to teachers and administrators when they seek to develop inquiry-oriented curricula based on the major concepts, principles, and theories of modern science.

Science Is Not A Spectator Sport

To emphasize the value of moving elementary students beyond the simple memorization of facts, and to stress that students should be doing science and not just reading about it, the Connecticut State Department of Education (CSDE) has developed inquiry-based laboratory investigations called "Curriculum Embedded Performance Tasks" (CEPT's), and strongly recommends their use in grades 3 - 10. These tasks are aligned with the conceptual themes and guiding questions found in the Core Science Curriculum Framework and follow a "5-E Model of Instruction" that consists of five general phases: Engagement, Exploration, Explanation, Elaboration, and Evaluation. The 5-E model is just one option among many models for conceptual development currently available. Using this model to plan and conduct science lessons does not automatically insure that the lessons will be inquiry oriented or properly aligned with national and state standards. However, the 5-E model will be used in the final portion of this paper as an illustrative model because it is the one employed by the CSDE in their CEPT's and because at least two of its phases - Exploration and Elaboration – emphasize and depend on an active-inquiry approach to teaching and learning.

Toward Excellence In Elementary Science

The intent of the first portion of this position paper was to emphasize the importance of science as a vital component of the elementary school curriculum and to suggest resources for determining what science should be taught. The remainder of this paper aims to illustrate to teachers and administrators one model for how science can be taught. Hopefully, then, the entire paper can serve as an aid to those seeking to develop and implement inquiry-oriented science curricula that are aligned with and build upon state and national standards.

Engagement

Exploration

Explanation

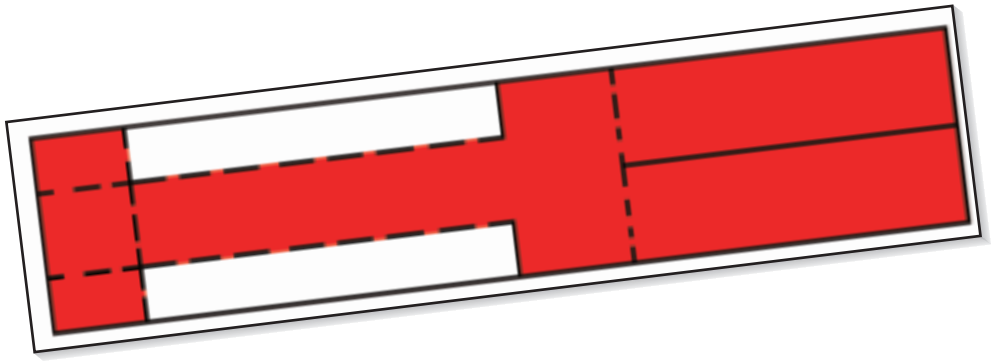
Elaboration

Evaluation

5-E: Phase I = Engagement

Young children are natural scientists. They are curious, energetic, eager to learn, open to new experiences, and they certainly enjoy being personally involved in the exploration of materials, objects, and ideas. In this stage of teaching and learning the teacher motivates and draws student attention to a new subject or idea by presenting a puzzling or unexpected "happening," by posing a question, or by asking students to solve a real-world problem.

For example, an effective activity that teachers have used at a variety of grade levels involves the construction and exploration of paper helicopters (http://www.paperairplanes.co.uk/heliplan.php). The teacher engages students by giving them a pattern that they can cut out, assemble, and then use for their initial explorations. This is an engaging activity because children have first-hand experiences that are both enjoyable and intellectually honest. They quickly begin to learn about the flight characteristics of their helicopters by flying them, modifying them, and comparing them. Such engagement quickly raises questions that lead students to new explorations and investigations.



5-E: Phase II = Exploration

The exploration phase builds upon the students' initial experiences with the topic and focuses on questions that students raise as a result of their initial engagement. For example, they may choose to see whose helicopter falls the slowest – and then try to find out "why". Other students might choose to color the wings with different colors and then watch the colors blend as the helicopters twirl. Other children might begin adding extra paper clips to learn what effect extra weight might have. The teacher can play an important role in the explorations by asking and modeling "What if . . ." questions. "What do you think will happen if the wings are shortened or lengthened? What might happen if the helicopter is made from heavier paper?"

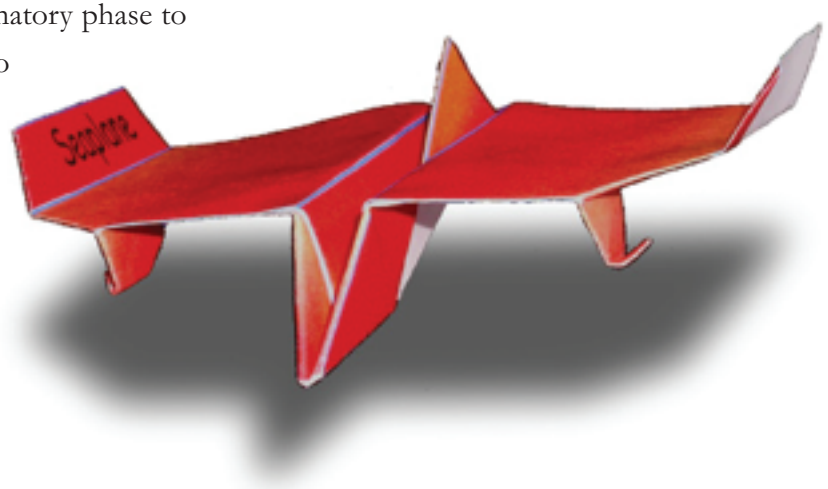
Once students have had sufficient time for exploration – a time that might extend over several class sessions – the teacher can help the children to organize their findings and to move on to explanations of their observations. Teachers can help by teaching students that observations and initial findings should be recorded and organized as a basis for understanding and for additional experimentation. Any number of graphic organizers such as Venn diagrams or KWL charts can be used at this stage to help students organize and examine the results of their explorations.

5-E: Phase III = Explanation

The explanation phase is a time when teachers encourage and help students to "make sense" of their observations by sharing and analyzing data, by comparing and contrasting results, and by proposing tentative explanations for the phenomena they have observed. This is the time for teachers to ask students to support their ideas with evidence and then use their evidence to link new learning to past experiences.

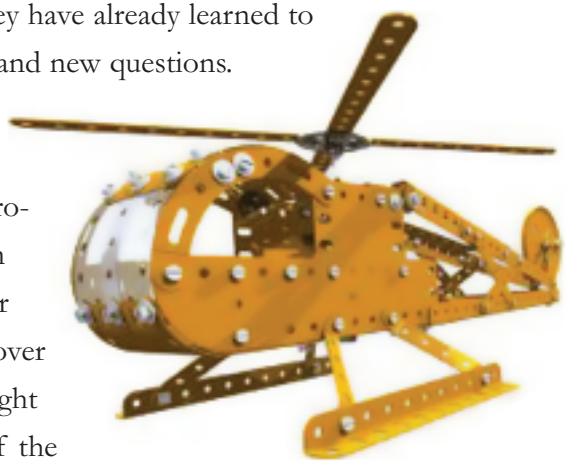
The teacher's role is to facilitate discussion and reflection, and to help students see how their questions and explorations have helped them grow in knowledge and skill. This is also an opportunity for teachers to introduce new terms, provide formal definitions for the phenomena that have been investigated, and to encourage students to engage in additional research.

It is important to use this explanatory phase to help students feel the need to go beyond the tentative explanations that have been formulated, and to learn even more about the topic, by posing new questions and thinking about additional experiments that might be done.

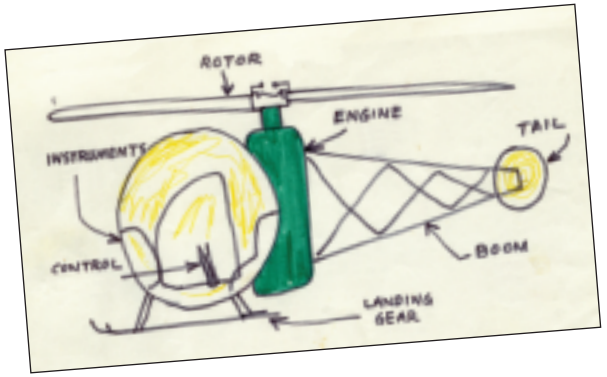


5-E: Phase IV = Elaboration

In the elaboration phase students deepen their knowledge and extend their skills by applying what they have already learned to new problems, new situations, and new questions.



For example, students might "outgrow" the initial pattern provided by the teacher and design new and innovative patterns for their helicopter models to discover how changes in shape affect flight characteristics. What happens if the wings are rounded? Squared off? What happens if the wings are not of equal length? What happens if the size of a helicopter is changed? How small can a paper helicopter be and still fly? How large can a paper helicopter be and still fly? How will the speed of a helicopter be affected as the size of the helicopter is decreased? Students might choose to use a photocopy machine to produce helicopters that are one-half, one-third, one-fourth, and one-fifth the size of an original pattern and then fly them to learn how size influences flight behavior.



5-E: Phase V = Evaluation

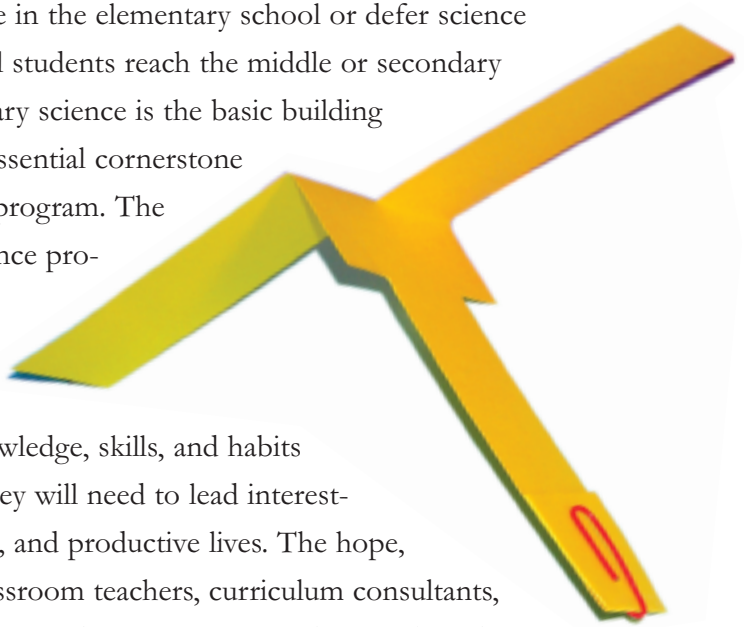
Evaluation is an essential part of teaching and learning because it provides feedback on how much and how well the students have learned, and it provides a firm basis for deciding what needs to be done next. Thoughtful evaluation requires data from a variety of sources including classroom observations, anecdotal records, student reports and projects, portfolios, student self-evaluations, teacher and student-designed rubrics, and results from tests and quizzes.

The sample helicopter activity that has been used for illustrative purposes in this paper contains many opportunities for formal and informal evaluation. The questions, experiments, and explanations provided by the students provide a rich source of evaluative data that can be used to determine how well objectives are being met and can serve as a rational basis for planning new cycles of instruction.

Toward A Shared Vision

Future citizens of the Twenty-first Century deserve and, indeed, require a thorough and comprehensive education in science. Toward this end, every school system should have a carefully planned K – 12 science curriculum sequence. By using the methods of science, students increase their understanding of science concepts and develop skills of observation, prediction, analysis, and communication.

It is eminently clear that school systems should not ignore the importance of science in the elementary school or defer science instruction until students reach the middle or secondary levels. Elementary science is the basic building block and the essential cornerstone of any science program. The elementary science program must be designed to help students acquire the knowledge, skills, and habits of mind that they will need to lead interesting, responsible, and productive lives. The hope, then, is that classroom teachers, curriculum consultants, science supervisors, administrators, members of boards of education, and community leaders will recognize the pivotal importance of science education in the elementary school and make every effort to support, nurture, and strengthen it.



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