

UNIFYING CONCEPTS OF SCIENCE

Students are naturally curious about the world and their place in it. Sustaining this curiosity and giving it a scientific foundation must be a high priority in North Carolina schools. Students need to be actively involved in scientific investigations, develop a rational and objective framework for solving problems, and understand the concepts that unify the various fields of science. Science is not a mandate for rote memorization, nor a dormant collection of facts. Students should not simply be shown results or text or pictures about science. Instead they need to learn that science produces a dynamic, constantly expanding body of knowledge developed over time. Students should discover by their own experiences that science is a process of gathering and evaluating information, looking for patterns, and then devising and testing possible explanations based on actual evidence.

The science component of the North Carolina *Standard Course of Study* bases its goals and objectives on the unifying concepts of science as described in the *National Science Education Standards*. The use of unifying concepts is an effective way to create linkages within and among fields of science such as physics and biology. These key ideas underlie and integrate all scientific knowledge and connect with other disciplines such as mathematics and social studies. Consequently, the focus on unifying concepts helps students to construct a holistic understanding of science and its role in society. The application of these concepts provides students with productive and insightful ways of considering and integrating a range of basic ideas that help to explain the natural and designed world.

Unifying concepts help students organize their thinking about science. By understanding these concepts and using them as they explore science, students will learn to see the broad patterns that cut across all science fields. Unifying concepts should be emphasized continuously in the context of topics included in the goals and objectives from grades K-12. Constant references to, and active use of, these ideas will help students understand the unifying concepts. The unifying concepts then provide a lens through which students can focus their scientific thinking.

Unifying concepts, as identified by the *National Science Education Standards*, include the following:

- **Systems, order and organization-** An important part of understanding and interpreting the world is the ability to think about the whole in terms of its parts and, alternatively, about parts as they relate to one another and to the whole. Science shows that there is order and predictability in nature. Understanding the basic laws, theories, and models that explain the world can

be accomplished by connecting order and organization to systems. Students should study both natural and technological systems.

- **Evidence, models and explanation-** Students should have science experiences and a learning environment which encourage the quest for evidence. Evidence is defined by the *National Science Education Standards* as observations and data on which to base scientific explanations. Models are used to explain events which may or may not be directly observable. Models consist of physical objects or mathematical representations. Computer models are often constructed to simulate complex systems and to visualize data. Explaining in a scientifically literate manner consists of considering and evaluating new evidence in the light of existing knowledge. The national standards state that scientific explanations should be based on a scientific knowledge base and an understanding of the relationship among logic, evidence, and current knowledge.
- **Change, constancy and measurement-** The concepts of constancy and change underlie most understandings of the natural and technological world. Through observations, students learn that some characteristics of living things, materials, and systems remain constant over time, whereas others change. Through formal and informal studies, students develop an understanding of the processes and conditions in which change, constancy, and equilibrium take place. Change in systems can be quantified. Students should apply mathematical skills of accuracy, precision, scale, rate, and appropriate systems of measurement.
- **Evolution and equilibrium-** Evolution represents change in systems. Systems may be biological, physical, or technological. Geological systems include chemical, physical and biological processes. Change may be abrupt or occur over various lengths of time. As systems react to forces and change, a state of equilibrium may develop where forces and changes occur in opposite and off-setting directions.
- **Form and function-** As students analyze natural and technological systems, the form of sub-units of systems or entire systems should be explained in terms of function. Students should be able to explain form and function and how the two are interrelated.

Because the understanding and abilities associated with major conceptual and procedural schemes need to be developed over an entire educational experience, unifying concepts transcend disciplinary boundaries. The science standards are organized with the expectation that science-related activities occur at all grade levels--from initial explorations in kindergarten through increasingly organized and focused science investigations in higher grades--and that science is taught in conjunction with all other subject areas. Unifying concepts of science provide the basis for integration of the fields of science. The methods and thought processes of science have application well beyond the bounds of science and can support the broader goals of all subject areas.