Alabama Science

Grades 9-12: Overview

Science and Engineering Practices (SEPs)

1. **Asking Questions and Defining Problems: Formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.** 9-12.SEP.1

2. **Developing and Using Models: Using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).** 9-12.SEP.2

3. **Planning and Carrying Out Investigations: Designing and conducting investigations that test and provide evidence for conceptual, mathematical, physical, and empirical models.** 9-12.SEP.3

4. **Analyzing and Interpreting Data: Introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of graphs and models to generate and analyze data.** 9-12.SEP.4

5. **Using Mathematics and Computational Thinking: Using algebraic thinking and analysis, a range of linear and nonlinear functions (including trigonometric functions, exponentials and logarithms), and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.** 9-12.SEP.5

6. **Constructing Explanations and Designing Solutions: Constructing explanations and designs that are supported by multiple, independent, student-generated sources of evidence consistent with scientific ideas, principles, and theories.** 9-12.SEP.6

7. **Engaging in Argument from Evidence: Using appropriate, sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.** 9-12.SEP.7

8. **Obtaining, Evaluating, and Communicating Information: Evaluating the validity and reliability of claims, methods, and designs.** 9-12.SEP.8

Crosscutting Concepts (CCCs)

1. **Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced, thus requiring improved investigations and experiments. Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system. Mathematical representations are needed to identify some patterns. Empirical evidence is needed to identify patterns.** `9-12.CCC.1`

2. **Cause and Effect: Mechanism and Prediction: Empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller-scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects.** `9-12.CCC.2`

3. **Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. Some systems can be studied only indirectly as they are too small, too large, too fast, or too slow for direct observation. Patterns observable at one scale may not be observable or exist at other scales. Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).** `9-12.CCC.3`

4. **Systems and System Models: Systems can be designed to do specific tasks. When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions (including energy, matter, and information flows) within and between systems at different scales. Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.** `9-12.CCC.4`

5. **Energy and Matter: Flows, Cycles, and Conservation: The total amount of energy and matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of the flow of energy and matter into, out of, and within that system. Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.** `9-12.CCC.5`

6 **Structure and Function: Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal the structure's function and/or solve a problem. The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of their various materials.** 9-12.CCC.6

7 **Stability and Change: Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability.** 9-12.CCC.7