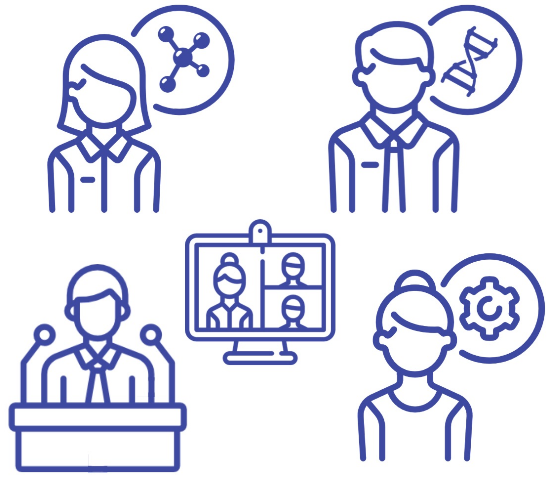
NGSS*
3-Dimensional

Planning Cards

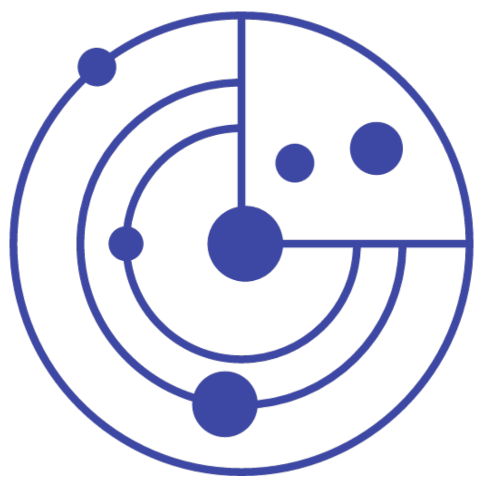
Science and Engineering

Practices



Asking

Questions



Developing and Using

Models

Science and Engineering Practices

Science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge.

- Asking Questions (for science)
- Defining Problems (for engineering)
- Developing and Using Models
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking
- Constructing Explanations (for science)
- Designing Solutions (for engineering)
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information

NGSS* 3-D Planning Cards

These cards were created by Paul Andersen to facilitate 3-dimensional learning and unit planning.

Learn More

thewonderofscience.com

Sources

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Achieve (2015). NGSS evidence statements. Washington, DC: Achieve

National Research Council (NRC). (2012). A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. Washington, DC: The National Academy Press

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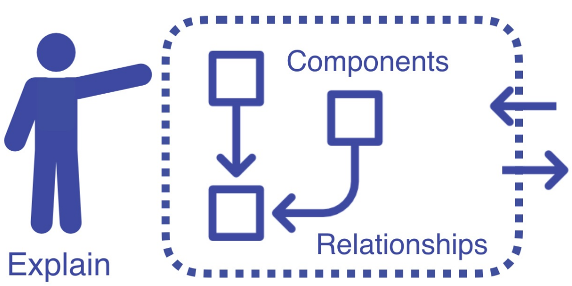
Developing and Using Models

Modeling can begin in the earliest grades, with students' models progressing from concrete "pictures" and/or physical scale models to more abstract representations of relevant relationships in later grades.

Student Performance

- Identify **components** of the model
- Identify **relationships** between components
- Use connections to describe, **explain**, and predict

What do I think?



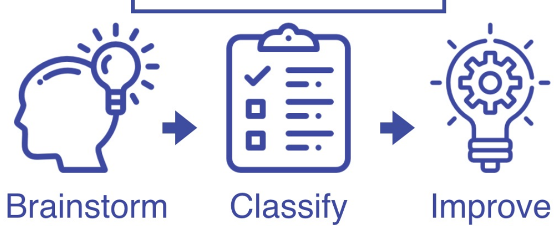
Asking Questions

Students at any grade level should be able to ask questions of each other about the texts they read, the features of the phenomena they observe, and the conclusions they draw from their models or scientific investigations.

Student Performance

- Formulate a question that addresses the **phenomenon**
- Identify the **nature** of the question
- Evaluate the empirical **testability** of the question

What do I wonder?



Planning and Carrying Out Investigations

Analyzing and Interpreting Data

Mathematics

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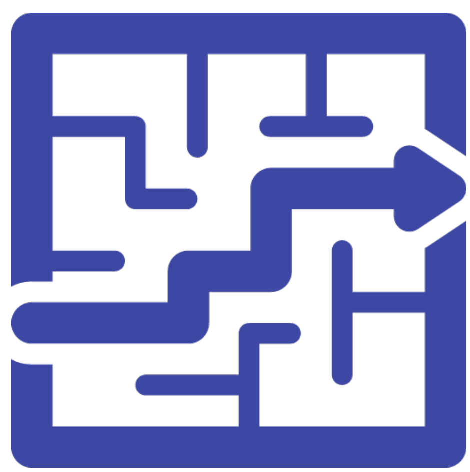
Computational Thinking



Constructing Explanations

Analyzing and Interpreting Data

Organize and interpret data through tabulating, graphing, or statistical analysis. Such analysis can bring out the meaning of data so that they may be used as evidence.

Student Performance

- **Organize** data
- Identify **relationships** within datasets
- Identify **relationships** between datasets
- **Interpret** data

What did I observe?

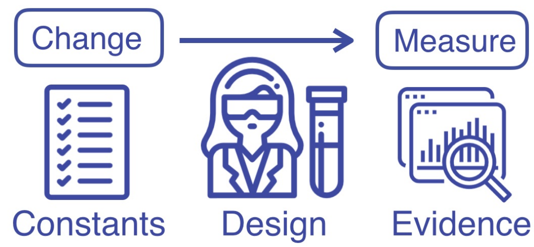
Planning and Carrying Out Investigations

Planning and carrying out investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Student Performance

- Identify the **evidence** and **purpose**
- Plan the **investigation**
- Collect the **data**
- **Refine** the design

How can I test it?



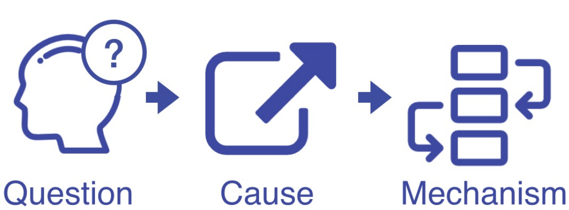
Constructing Explanations

Students are expected to construct their own explanations, as well as apply standard explanations they learn about from their teachers or reading.

Student Performance

- Formulate a **question**
- Identify a scientific **cause**
- Describe a causal **mechanism**

How does it work?



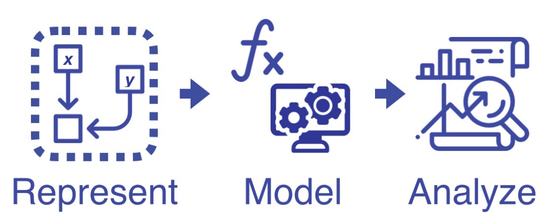
Using Mathematics and Computational Thinking

Using algebraic thinking and analysis for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Student Performance

- Identify **representations** in a system
- Use math and **mathematical modeling**
- Use **computational thinking**
- Analyze results

How can I model it?



Engaging in
Argument
from Evidence

Obtaining,
Evaluating, and
Communicating
Information

Defining
Problems

Designing
Solutions

Obtaining, Evaluating, and Communicating Information

Communicating information, evidence, and ideas in multiple ways: using tables, diagrams, graphs, models, interactive displays, and equations as well as orally, in writing, and through extended discussions.

Student Performance

- **Obtain** information
- **Evaluate** information
- **Communicate** information
- Select appropriate style and format

What did I learn?

Engaging in Argument From Evidence

Using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural world.

Student Performance

- Identify a given **claim**
- Identify provided **evidence**
- Evaluate and critique evidence
- Evaluate **reasoning** and synthesis

How do I know?

Designing Solutions

There is usually no single best solution but rather a range of solutions. Which one is the optimal choice depends on the criteria used for making evaluations.

Student Performance

- Generate the design **solution**
- Describe the **criteria** and **constraints**
- Evaluate potential **refinements**

How can I fix it?

Defining Problems

Students ask questions to define the engineering problem, determine criteria for a successful solution, and identify constraints.

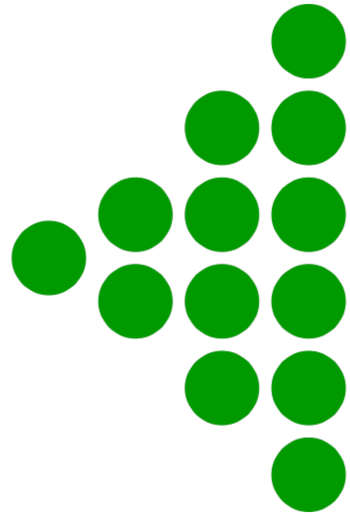
Student Performance

- Identify the **problem** to be solved
- Define the **criteria**
- Define the **constraints**

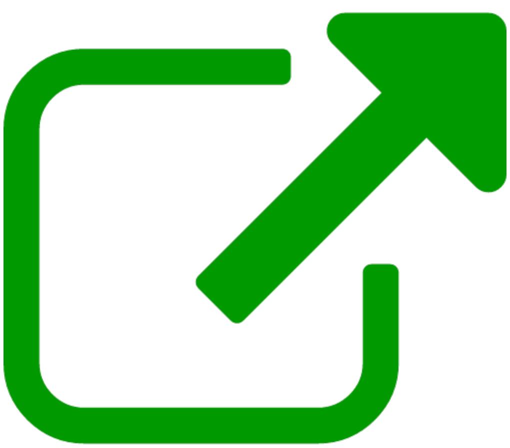
What is the problem?

Crosscutting

Concepts



Patterns



Cause Effect

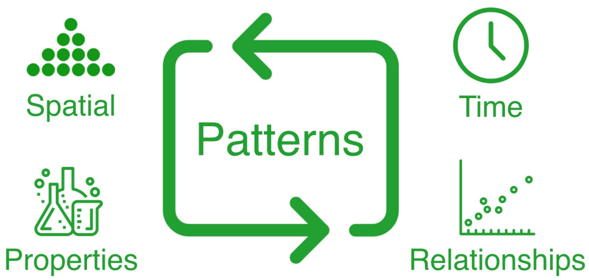
Scale Proportion Quantity

Patterns

Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Framing Questions

- What structures or shapes are found in the phenomenon or system after careful observation?
- What cycles or events repeat over time?
- How could these patterns be represented?
- How could patterns be used to classify or organize objects and events?
- What causal relationships are found in the data?



Crosscutting Concepts

These concepts help provide students with an organizational framework for connecting knowledge from the various disciplines into a coherent and scientifically based view of the world.

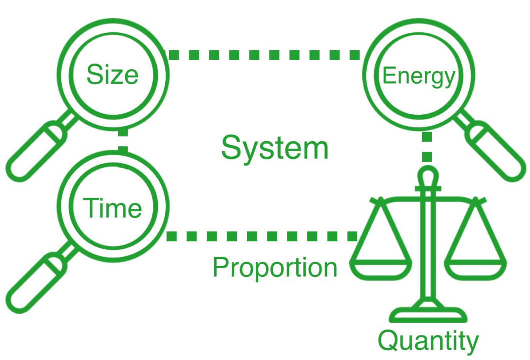
- Patterns
- Cause and Effect: Mechanism and Explanation
- Scale, Proportion, and Quantity
- Systems and System Models
- Energy and Matter: Flows, Cycles, and Conservation
- Structure and Function
- Stability and Change

Scale, Proportion, and Quantity

It is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

Framing Questions

- What aspects of the system may be relevant at different time, size, and energy scales?
- How do different quantities vary at different scales?
- What measurements could be made to describe the system more precisely?
- What proportional relationships can be observed?

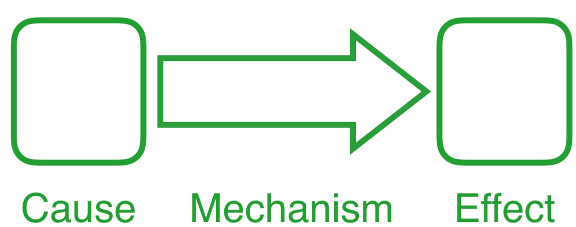


Cause and Effect

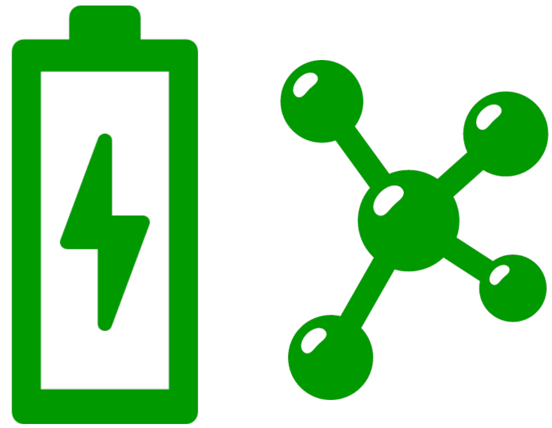
Events have causes, sometimes simple, sometimes multifaceted. Correlation does not imply causation.

Framing Questions

- What relationships between events or patterns can be observed in the phenomenon or system?
- How can these relationships be explained?
- Are any of these relationships cause and effect?
- What evidence supports a cause and effect relationship?
- What further investigations would help determine if these relationships are cause and effect?

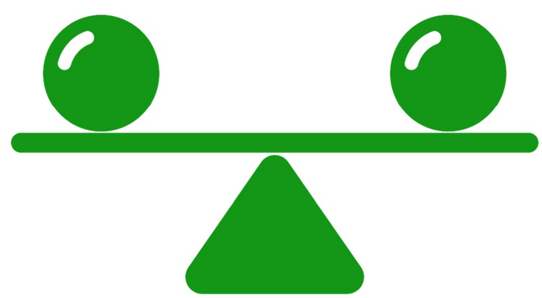


Systems
System Models



Energy
Matter

Structure
Function



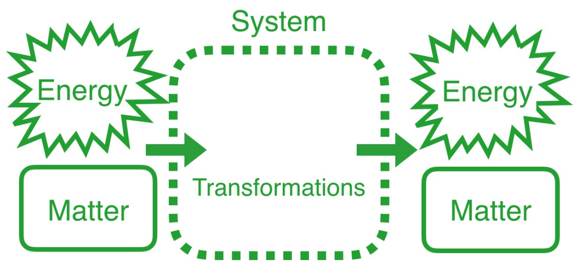
Stability
Change

Energy and Matter

Tracking energy and matter flows, into, out of, and within systems.

Framing Questions

- What matter flows into, out of, and within the system?
- What physical and chemical changes occur in the system?
- What transformations of energy are important in the system?
- How does the flow of energy drive the movement of matter in the system?
- How are energy and matter conserved in the system?

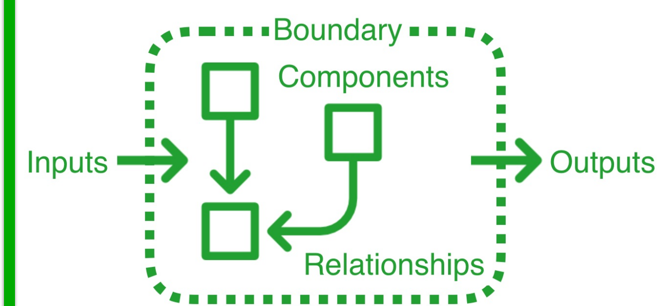


Systems and System Models

A system is an organized group of related objects or components. Models can be used for understanding and predicting the behavior of systems.

Framing Questions

- What is included in the system? What is external?
- What are the components of the system and how are they related?
- What are the inputs and outputs of the system?
- What predictions can be made from a system model?
- What are the limits of the system model?

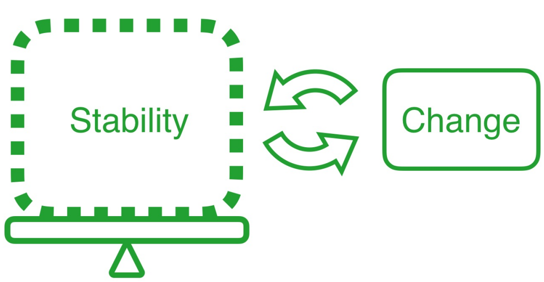


Stability and Change

Conditions that affect stability and factors that control rates of change are critical elements to consider and understand in natural systems.

Framing Questions

- Under what range of conditions does the system operate effectively?
- What changes in conditions cause changes in its stable operation?
- What changes in conditions could cause the system to become unstable or fail?
- What feedback loops in the operation of the system enhance its range of stable operations?



Structure and Function

The way an object is shaped or structured determines many of its properties and functions.

Framing Questions

- What shapes or structures are observed in the system at this scale?
- What roles do these structures play in the functioning of the system?
- How do the structures support the functions?
- How does the environment affect the fitness of organisms with specific structures?