Arizona Science Standards Science and Engineering Practices for 3-5 | For use with Arizona Science Standards

Asking Questions and Defining Problems

A science practice is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

- Identify scientific (testable) and non-scientific (non-testable) questions.
- Ask questions based on careful observations of phenomena and information.
- Ask questions to clarify ideas or request evidence.
- Ask questions that relate one variable to another variable.
- Ask questions to clarify the constraints of solutions to a problem.
- Use prior knowledge to describe problems that can be solved.
- Define a simple design problem that can be solved through the development of an object, tool or process and includes several criteria for success and constraints on materials, time, or cost.
- Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations.

- Develop and revise models collaboratively to measure and explain frequent and regular events.
- Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.
- Use simple models to describe or support explanations for phenomena and test cause and effect relationships or interactions concerning the functioning of a natural or designed system.
- Identify limitations of models.
- Develop a diagram or simple physical prototype to convey a proposed object, tool or process.
- Use a simple model to test cause and effect relationships concerning the functioning of a proposed object, tool or process.

Planning and Carrying Out Investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually.

- Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered.
- Evaluate appropriate methods and tools for collecting data.
- Make observations and/or measurements, collect appropriate data, and identify patterns that provide evidence for an explanation of a phenomenon or test a design solution.
- Make measurements of two different models of the same proposed object, tool or process to determine which better meets criteria for success.

Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Engineering investigations include analysis of data collected in the tests of designs.

- Display data in tables and graphs, using digital tools when feasible, to reveal patterns that indicate relationships.
- Use data to evaluate claims about cause and effect.
- Compare data collected by different groups in order to discuss similarities and differences in their findings.
- Use data to evaluate and refine design solutions.
- Interpret data to make sense of and explain phenomena, using logical reasoning, mathematics, and/or computation.
- Analyze data to refine a problem statement or the design of a proposed object, tool or process.

Using Mathematics and Computational Thinking

Mathematics and computation are fundamental tools for representing physical variables and their relationships in both science and engineering,

- Use mathematical thinking and/or computational outcomes to compare alternative solutions to an engineering problem.
- Organize simple data sets to reveal patterns that suggest relationships.
- Describe, measure, estimate, and graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.
- Decide if qualitative or quantitative data is best to determine whether a proposed object or tool meets criteria for success.

Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate.

- Compare and/or combine across complex texts and/or other reliable media to acquire appropriate scientific and/or technical information.
- Determine the main idea of a scientific text and explain how it is supported by key details; summarize the text.
- Combine information in written text with that contained in corresponding tables, diagrams, and/or charts.
- Use multiple sources to generate and communicate scientific and/or technical information orally and/or in written formats, including various forms of media and may include tables, diagrams, and charts.
- Use models to share findings or solutions in oral and/or written presentations, and/or extended discussions.
- Obtain and combine information from books and/or other reliable media about potential solutions to a specific design problem.

Constructing Explanations and Designing Solutions

The goal of science is the construction of theories that provide explanatory accounts of the world. The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world.

- Construct explanations of observed quantitative relationships (e.g., the distribution of plants in the backyard).
- Use evidence (e.g., measurements, observations, patterns) to construct a scientific explanation or design a solution to a problem.
- Identify the evidence that supports particular points in an explanation.
- Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.
- Apply scientific knowledge to solve design problems.
- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the problem.

The elements are not to be used as a check-off list, but rather a useful tool to help educators identify the specific pieces of knowledge and skill that make up the practice, crosscutting concept, or core idea at that grade-band.

ARIZONA Department of Education

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Engaging in Argument from Evidence

Reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem in science and engineering.

- Construct and/or support scientific arguments with evidence, data, and/or a model.
- Compare and refine arguments based on the strengths and weaknesses of the evidence presented.
- Respectfully provide and receive critiques on scientific arguments with peers by citing relevant evidence and posing specific questions.
- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.

Arizona Science Standards Crosscutting Concept for 3-5 | For use with Arizona Science Standards

Patterns

Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

- Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products.
- Patterns of change can be used to make predictions.
- Patterns can be used as evidence to support an explanation.
  - What do you observe?
  - Is there a pattern?
  - What pattern do you notice?
  - Can you describe the pattern?
  - How would you classify this pattern?
  - What predictions are possible based on the pattern?
  - What is the same? What is different?
  - How often does this happen?
  - The pattern I notice is _____.
  - From the pattern _____ I predict that _____ because _____.

Stability and Change

For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

- Change is measured in terms of differences over time and may occur at different rates.
- Some systems appear stable, but over long periods of time will eventually change.
  - What is changing or staying the same?
  - Describe if this happens slow or fast.
  - How does this change over a long period of time?
  - How often does this change?
  - Does this have a repeating cycle or pattern?
  - What could you change to make this better?
  - I claim ___ is changing/staying the same, because our evidence shows ____.
  - Over a long period of time, _____ stays the same/changes, because _____.

Structure and Function

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

- Different materials have different substructures, which can sometimes be observed.
- Substructures have shapes and parts that serve functions.
  - How does the shape (or structure) of ... make it work better?
  - What material is best to ...? Why?
  - What is the function of ...?
  - How can this structure be improved?
  - What shape is best to ...?
  - How does this work?
  - What is the purpose of ...?
  - How is the structure related to the function?
  - The important structures of _____ are _____ , _____ , _____.
  - The _____ (structure) of a _____ is for _____ function).

Energy and Matter

Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

- Matter is made of particles.
- Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.
- Energy can be transferred in various ways and between objects.
  - What are the properties of ...?
  - Do the properties stay the same? Are they different?
  - Can you break this up into smaller pieces?
  - Can you put it back together again? How?
  - What is the weight before and after?
  - What happened to the energy? Where did it go?
  - How was the energy transferred?
  - How is the energy moving in/out/within/between an object(s)?
  - I claim that _____ (matter) changed because _____.
  - I noticed evidence of energy when _____ happened.

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.

- A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
- A system can be described in terms of its components and their interactions.
  - What are the parts that make this up?
  - What does each part do?
  - How do the parts work together?
  - Can you draw a picture (or diagram) of the system?
  - What is the system?
  - How do the parts of the system interact?
  - What process is occurring? Can you describe it?
  - The parts of the system are _____ , _____ , _____.
  - In this system _____ interacts with _____ to cause _____.

Cause and Effect

Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

- Cause and effect relationships are routinely identified, tested, and used to explain change.
- Events that occur together with regularity might or might not be a cause and effect relationship.
  - How/Why did that happen?
  - What is causing this to happen?
  - When will it happen again? Can you make it happen again?
  - What is the effect from the change?
  - How can you show that this caused?
  - Can you identify the cause and the effect?
  - What do you predict will happen if...?
  - How do you know that the cause and effect are connected?
  - One cause of _____ (effect) might be _____.
  - From the cause effect relationship, I would claim that _____.

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 when considering phenomena,

- Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.
- Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.
  - Which is bigger/smaller? How much larger/smaller?
  - Which is hotter/cooler? What is the difference in temperature?
  - Which happens faster/slower? What is the difference in time?
  - How long does that take?
  - Is that a long time or a short time?
  - How can you measure that? What tool and units will you use?
  - What measurement could you take?
  - When comparing _____ to _____ , I noticed _____.
  - I used _____ units to measure because _____.

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