Science Process Skills in Action

Based on the Exploratorium Institute for Inquiry *(www.exploratorium.edu)*

The following list provides examples of what you might actually do when you are using these process skills.
It can be challenging to tease out separate skills because to a certain extent the boundaries are artificial. Being able to distinguish individual skills helps us support our students more effectively.

OBSERVING Using the senses and appropriate tools to gather information about an object, event, or phenomenon.	When ***observing***, you might be:	• collecting evidence • identifying differences and similarities • using tools or instruments as necessary to extend the range of the senses • measuring • out of many observations, distinguishing those which are relevant to the problem at hand	An example of ***observing***: Listing the similarities and differences of a cube of ice and a ball of ice.
QUESTIONING Raising questions about an object, event, or phenomenon.	When ***questioning***, you might be:	• readily asking a variety of questions about phenomena • recognizing differences between questions that can and cannot be answered by investigation • turning a non-investigable question into a question that can be acted upon	An example of ***questioning***: Asking "Will ice melt faster with or without salt sprinkled on it?"
HYPOTHESIZING Giving a tentative explanation, based on experience, of a phenomenon, event, or the nature of an object. A hypothesis is testable.	When ***hypothesizing***, you might be:	• attempting to give explanations which are consistent with evidence or with ideas from prior experiences • showing that you are aware that there may be more than one explanation that fits the evidence • inferring • constructing models to help clarify ideas • NOTE: A hypothesis is NOT the same thing as a prediction	An example of ***hypothesizing***: Increased surface area causes faster melting. This explains why crushed ice will melt faster than a block of ice of the same mass.
PREDICTING Forecasting the outcome of a specific future event based on a pattern of evidence or a hypothesis.	When ***predicting***, you might be:	• forecasting the outcome of a specific event, making use of evidence from experience or a possible explanation (hypothesis) • using patterns in information or observations in forecasting outcomes of specific events that go beyond the data (extrapolations) • NOTE: A prediction is NOT a wild guess.	An example of ***predicting***: Water flowing from a height of 8 inches will wash away more sand than water flowing from a height of 6 inches. This prediction is based on the pattern that water flowing from 6 inches washed away more sand than water flowing from 4 inches, and water flowing from 4 inches washed away more sand than water flowing from 2 inches.
PLANNING & INVESTIGATING Designing an investigation that includes procedures to collect reliable data.	When ***planning & investigating***, you might be:	• devising a way to test a hypothesis • identifying and controlling variables: for a fair test, identifying the variable that has to be changed, the things that should be kept the same • identifying what to look for or measure to obtain a result in an investigation • using measuring instruments • comparing what you actually did with what you planned • NOTE: Planning is NOT always formal.	An example of ***planning and investigating***: Deciding to put a teaspoon of salt on one ice cube and a teaspoon of sugar on another identical ice cube; setting them side by side, and observing their relative melting rates in order to determine if one melts faster than the other.
INTERPRETING Answering the question,"What do your findings tell you?"	When ***interpreting***, you might be:	• considering evidence • discussing what you find in relation to your initial questions • finding a pattern or other meaning in a collection of data • drawing a conclusion by assessing the data	An example of ***interpreting***: After observing the melting rates of an ice cube sprinkled with salt and one without salt, concluding that salt reduces the freezing point of water.
COMMUNICATING Representing observations, ideas, theoretical models, or conclusions by talking, writing, drawing, making physical models, and so forth.	When ***communicating***, you might be:	• talking, writing, drawing, making physical models, etc. to present your observations, ideas, theoretical models, or conclusions • creating data tables, graphs, and charts to record and organize results • choosing forms for recording or presenting results that are appropriate for the type of information collected and presented, and appropriate for the audience	An example of ***communicating***: Describing the relationship between the melting time for an ice cube and amount of salt sprinkled on the cube by writing about it or by constructing a graph.

See the overlap between the Exploratorium's *Science Processes*, and the Next Generation Science Standards' *Science and Engineering Practices* (written later). As the Exploratorium notes, there are many ways of breaking down skills and processes and practices, and the list can become exhaustive.

NGSS Science and Engineering Practices (https://ngss.nsta.org/practicesfull.aspx)

Asking Questions and Defining Problems	A practice of science 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.
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. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.
Planning and Carrying Out Investigations	Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.
Analyzing and Interpreting Data	Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.
Using Mathematics and Computational Thinking	In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.
Constructing Explanations and Designing Solutions	The products of science are explanations and the products of engineering are solutions.
Engaging in Argument from Evidence	Argumentation is the process by which explanations and solutions are reached.
Obtaining, Evaluating, and Communicating Information	Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

Consider these *Instructional Shifts* from the *College and Career Readiness Standards for Adult Education* (CCRSAE):

- **ELA: output** (writing & speaking) **should use evidence from input** (what is read or listened to)
- **Math: apply** conceptual understanding and procedural skill and fluency—where better to apply than in science!