Kimberly G. Massey

Introducing the…

Science and Engineering Practices

K-5 Science in RHSD At-A-Glance

K-5 Science Units of Study and Corresponding Kits **Aug. 2018**

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Kindergarten	Unit: Observing the World Through Senses Kit: Senses (Insights)	Unit: Objects & Materials Kit: Wood & Paper (FOSS)	Unit: Weather No Kit: Suggested Activities (RHSD)	Unit: Exploring Organisms & the Environment Kit: Animals 2x2 (FOSS) Living things (Insights)
1st Grade	Unit: Exploring Light & Shadows Kit: Light & Shadows (RHSD Kit)	Unit: Exploring Sun & Moon Kit: Suggested Activities (RHSD)	Unit: Earth's Natural Resources Kit: Pebbles, Sand, Silt (FOSS)	Unit: Plants & Their Environments Kit: New Plants (FOSS)
2nd Grade	Unit: Solids & Liquids (Magnets) Kit: Solids & Liquids (STC)	Unit: Exploring Pushes and Pulls Kit: Push, Pull & Go (Carolina)	Unit: Weather Kit: Weather (STC)	Unit: Animal & their Environments Kit: Insects (FOSS)
3rd Grade	Unit: Properties & Changes in Matter Kit: Changes (STC)	Unit: Earth's Materials & Resources Kit: Rock & Minerals (STC)	Unit: Energy Transfer Electricity & Magnetism Kit: Energy & Electromagnetism (FOSS)	Unit: Environments & Habitats Kits: Structures of Life (FOSS)
4th Grade	Unit: Characteristics & Growth of Organisms Kit: Animals Studies (STC)	Unit: Weather & Climate Kit: Weather instruments (DSM)	Unit: Stars & Solar System Kit: Sun, Earth, Moon (Insights)	Unit: Forms of Energy—Light & Sound Kit: Light & Sound Waves (Carolina) Physics of Sound (FOSS) (old)
5th Grade	Unit: Matter & Mixtures Kit: Mixtures & Solutions (FOSS)	Unit: Changes in Landforms & Oceans Kit: Landforms (FOSS)	Unit: Relationships in Ecosystems Kit: Ecosystems (STC)	Unit: Forces & Motion Kit: Motion & Design (STC)

Language of 2014 Standards

- The 2005 SC Science standards were written according to Bloom's Taxonomy.
- The 2014 SC Science Standards are written according to the language of the SEP's.

GRADE THREE
PHYSICAL SCIENCE: PROPERTIES AND CHANGES IN MATTER

Standard 3.P.2: The student will demonstrate an understanding of the properties used to classify matter and how heat energy can change matter from one state to another.

3.P.2A. Conceptual Understanding: Matter exists in several different states and is classified based on observable and measurable properties. Matter can be changed from one state to another when heat (thermal energy) is added or removed.

Performance Indicators: Students who demonstrate this understanding can:

3.P.2A.1 Analyze and interpret data from observations and measurements to describe and compare the physical properties of matter (including length, mass, temperature, and volume of liquids).

3.P.2A.2 Construct explanations using observations and measurements to describe how matter can be classified as a solid, liquid or gas.

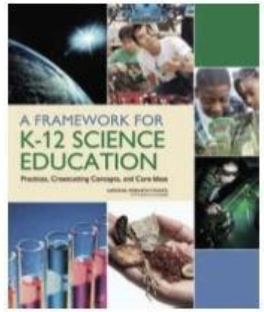
3.P.2A.3 Plan and conduct scientific investigations to determine how changes in heat (increase or decrease) change matter from one state to another (including melting, freezing, condensing, boiling, and evaporating).

3.P.2A.4 Obtain and communicate information to compare how different processes (including burning, friction, and electricity) serve as sources of heat energy.

3.P.2A.5 Define problems related to heat transfer and design devices or solutions that facilitate (conductor) or inhibit (insulator) the transfer of heat.

Scientific and Engineering Practices in K–12 Classrooms

Understanding *A Framework for K–12 Science Education*



by Rodger W. Bybee

This morning I watched *Sesame Street*. During the show, characters "acted like engineers" and designed a boat so a rock could float. In another segment, children asked questions and made predictions about the best design for a simple car. They then built a model car and completed an investigation to determine which design worked best when the cars went down inclined planes. Children also learned that a wider base provided stability for a tower. And, among other segments, the children counted from 1 to 12 and explored the different combinations of numbers that equaled 12. Bert and Ernie had to move a rock and ended up "inventing" a wheel. These segments exemplify the science, technology, engineering, and mathematics (STEM) theme that *Sesame Street* is introducing in the show's 42nd season.

What, you ask, does this have to do with science and engineering practices in K–12 classrooms? The producers of *Sesame Street* decided that STEM practices were important enough that they are using them as substantive themes for the season, if not longer. Children watching *Sesame Street* will have been introduced to practices such as asking questions and defining problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics; constructing explanations and designing solutions; engaging in arguments using evidence; and obtaining, evaluating, and communicating information. True, these are sophisticated statements of practices, but many students will be introduced to them when they enter elementary classrooms.

In this article, I present the science and engineering practices from the recently released *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC 2011). I recognize the changes implied by the new framework, and eventually a new generation of science education standards will present new perspectives for the science education community. I am especially sensitive to the challenges for those students in teacher preparation programs and classroom teachers of science at all levels. Questions such as "Why practices and why not inquiry?" and "Why science *and* engineering?" are reasonable, and I will discuss them later. But to provide background and context, I first discuss the practices.

Understanding and applying the science and engineering practices

This section further elaborates on the practices and briefly describes what students are to know and be able to do, and how they might be taught. Figures 1 through 8 are adapted from the National Research Council (NRC) framework, with changes for clarity and balance. I have maintained the substantive content.

Even before elementary school, children ask questions of each other and of adults about things around them, including the natural and designed world. If students develop the practices of science and engineering, they can ask better questions and improve how they define problems. Students should, for example, learn how to ask questions of each other, to recognize the difference between questions and problems, and to evaluate scientific questions and engineering problems from other types of questions. In upper grades, the practices of asking scientific questions and defining engineering problems advance in subtle ways such as the form and function of data used in answering questions and the criteria and constraints applied to solving problems.

In the lower grades, the idea of scientific and engineering models can be introduced using pictures, diagrams, drawings, and simple physical models such as airplanes or cars. In upper grades, simulations and more sophisticated

Scientific "Methods:" memorizing steps of scientific method

Scientific "Processes:" observing, clarifying, measuring, inferring, predicting

Scientific "Inquiry:" learning science concepts and using the skills and abilities—more emphasis on activities and investigations to learn concepts.

Scientific "Practices:" Include all of the above, but expands science to a way of thinking.

Why not continue to use the term "Inquiry?"

Science practice involves doing something and learning something in such a way that the doing and learning cannot really be separated. Thus, "practice"... encompasses several of the different dictionary definitions of the term. It refers to doing something repeatedly in order to become proficient (as in practicing the trumpet). It refers to learning something so thoroughly that it becomes second nature (as in practicing thrift). And it refers to using one's knowledge to meet an objective (as in practicing law or practicing teaching).

(Michaels, Shouse, and Schweingruber 2008, p. 34)

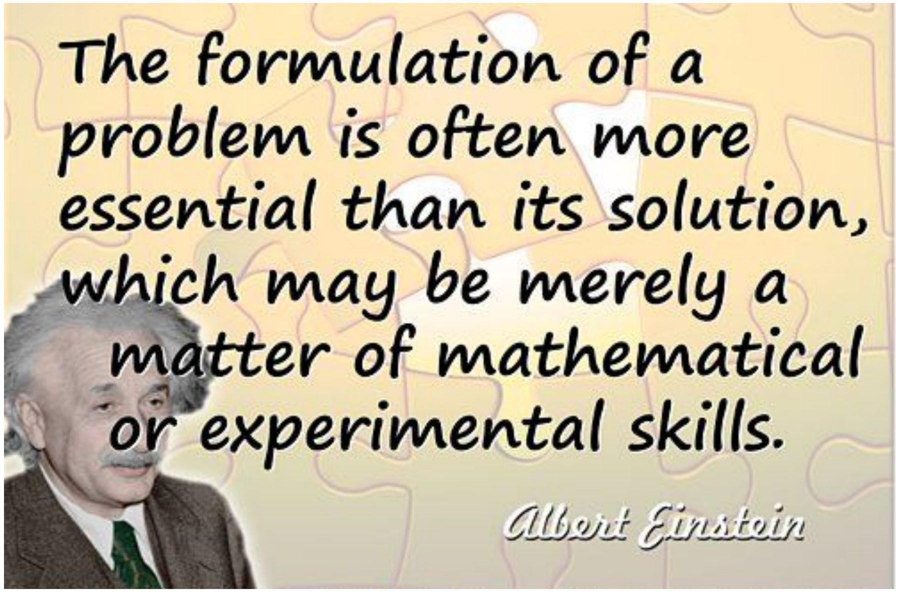
To help students become proficient with the practice of science, activities should become the basis for learning about experiments, data, evidence, models and tools, mathematics, evaluating claims, and developing explanations.

Why Engineering?

-application of science content knowledge

-proposes solutions to human needs in the form of new products of new processes

SEP #1: Ask Questions and Define Problems



-Basis for scientific study.
- -What?
- -Why?
- -Who?
- -If...then?
- -How

-Once a problem has been defined, solutions can be proposed (engineering).

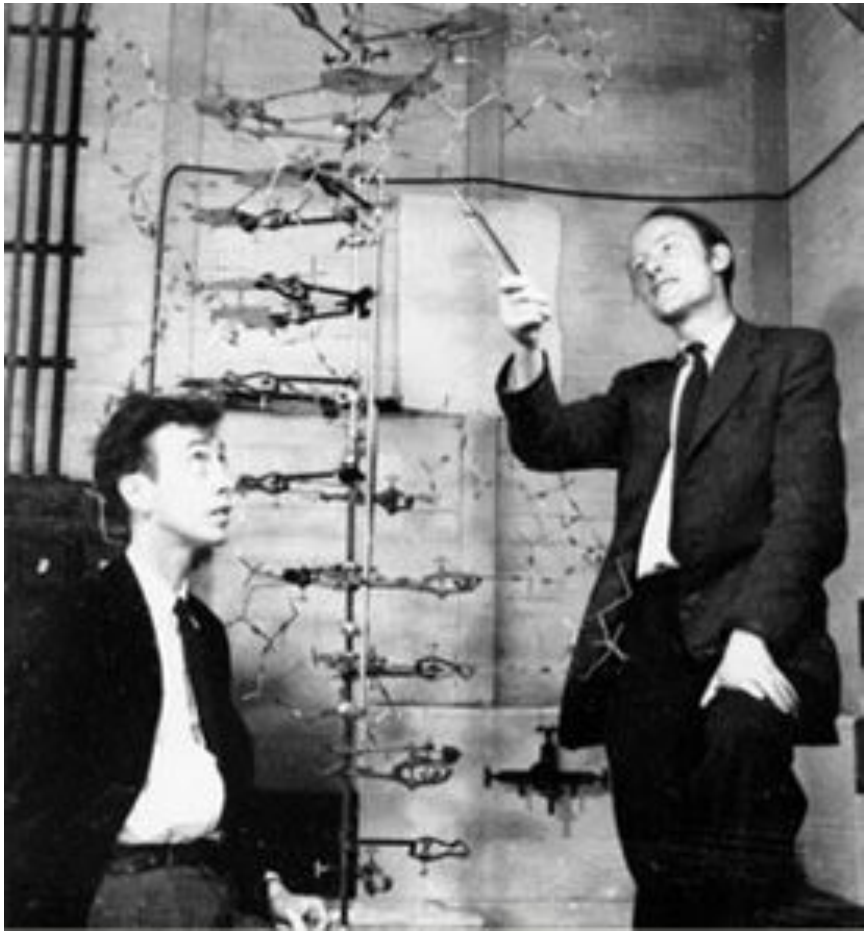
SEP #2: Develop and Use Models

- Models make our visualizations more concrete.

- We use models in teaching to help students SEE what we are teaching.

- Students may make models to demonstrate their understanding.

- Engineers use models as prototypes

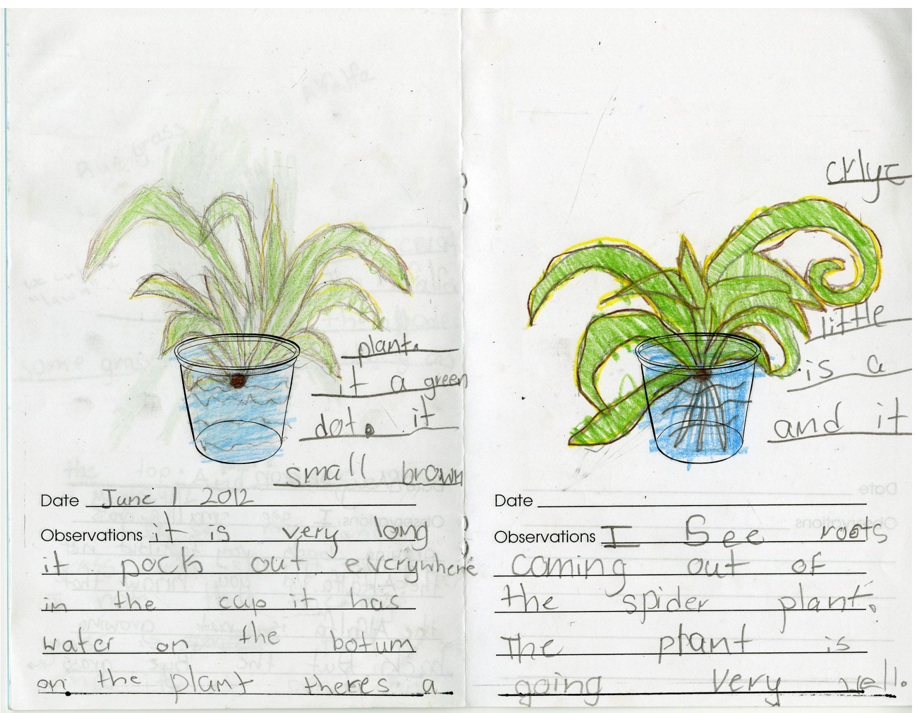


SEP #3: Plan and Conduct Investigations

- To answer questions we have defined (SEP #1)
- To test models we have made (SEP #2)
- Data is gathered.
- The design may need to be refined.
- Question, hypothesis, proper variable, analysis

https://www.youtube.com/watch?v=0CaGJ1MUZTY

SEP #4: Analyze and Interpret Data



- Look for trends
- Cause – Effect Relationships
- Correlations -- Causations
- Science Notebooks!
  - -Numbers
  - -Drawings
  - -Charts
  - -Graphs

SEP #5: Use Mathematical & Computational Thinking

Quantitative Observations

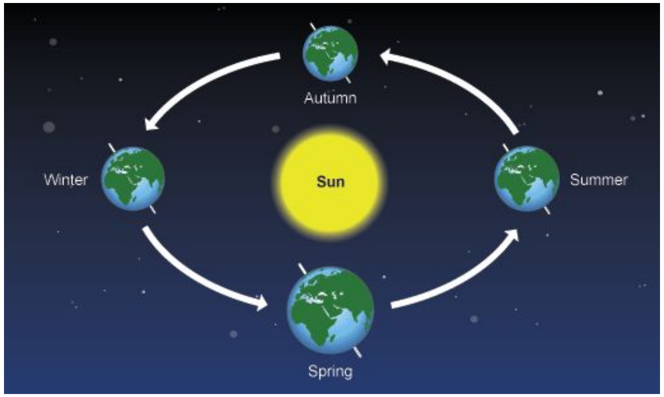
- Counting
- Measuring
- Collecting Data
- Graphing
- Calculating
- Predicting

If people do not believe that mathematics is simple, it is only because they do not realize how complicated life is.
-John Louis von Neumann

SEP #6: Construct Explanations & Design Solutions

- Investigations are learning experiences. Once the investigation is complete students should be able to explain their findings.

- Once students have seen an occurrence, what can be done to change it? How can the results be improved?



- 4.E.3B.2 Construct explanations of how day and night result from Earth's rotation on its axis.

- 4.E.3B.3 Construct explanations of how the Sun appears to move throughout the day using observations of shadows.

SEP #7: Engage in Scientific Argument from Evidence

2.P.3A.4 Construct scientific arguments to explain how animals can change their environments (such as the shape of the land or the flow of water.

Students construct a claims based upon what they have observed, they are then presented with opposing information and the opportunity to defend their claim.

1. Is this feeding behavior helpful or harmful to the land?
2. States with high numbers of boar should allow them to be hunted (killed)

SEP #8: Obtain, Evaluate and Communicate Information

- How do your students obtain information?
- How do your students evaluate information?
- How do your students communicate what they have learned?

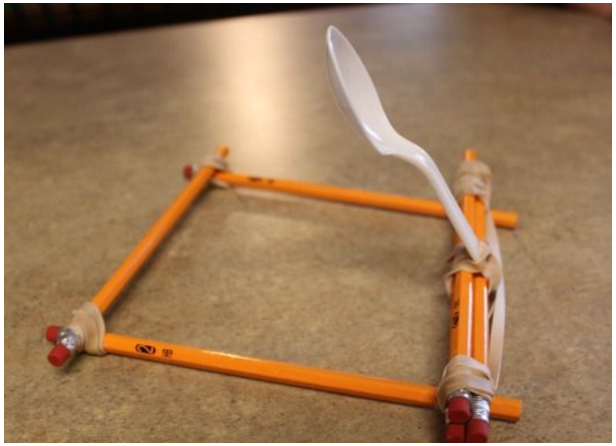
Communication Methods:

- ABC Book
- Advertisement
- Brochure
- Comics
- Commercial
- Diary
- Drawing
- Field Guide
- Letter
- Newspaper
- Collage
- Poem
- Oster
- Scrapbook
- Speech

SEP #9: Construct Devices or Design Solutions

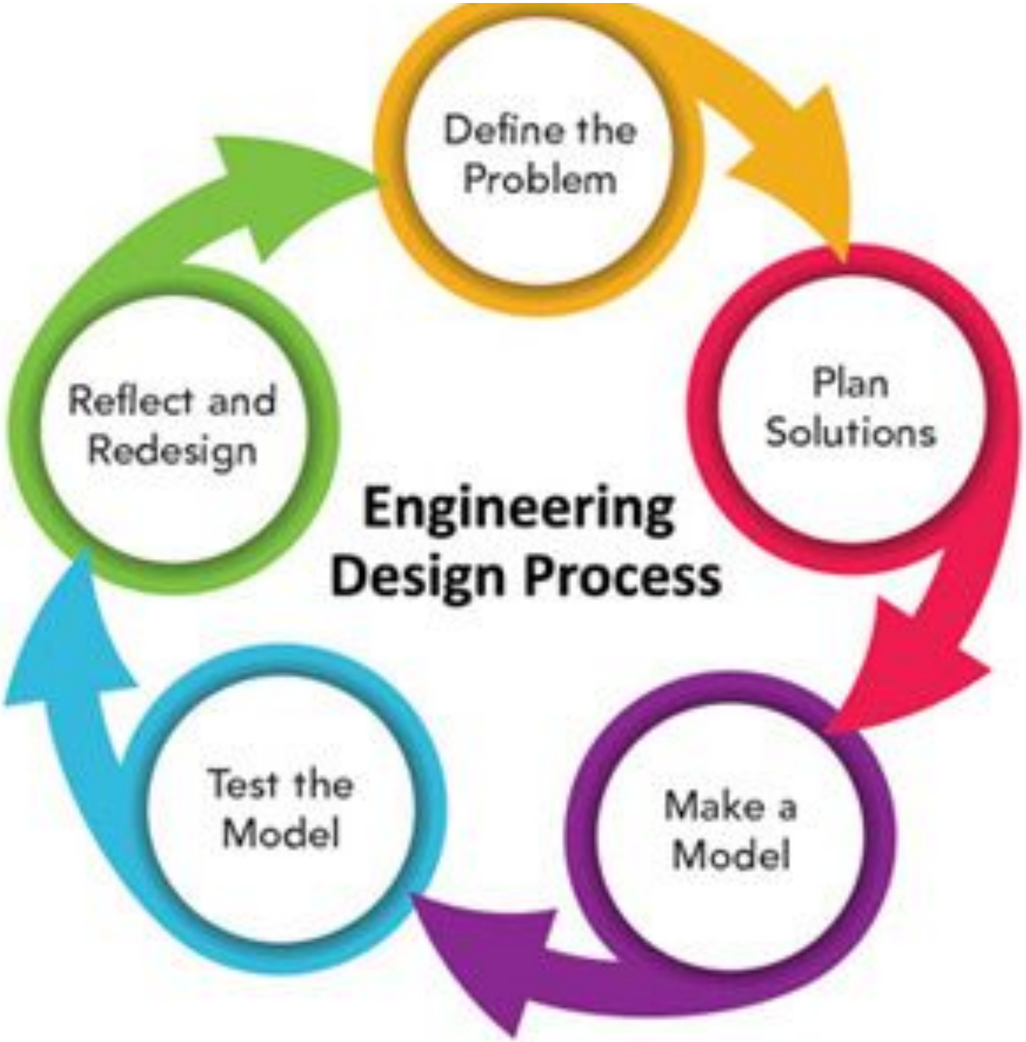
- Students are expected to ask questions, perform investigations, collect and analyze data, design solutions, revise solutions and communicate findings.

- **Engineering Challenges**
  - -Realistic
  - -Situational
  - -Open-ended
  - -Rely upon prior knowledge and skills



https://www.youtube.com/watch?v=kqNBA95s88Y

Engineering Design Process



In Conclusion…

- Science and Engineering Practices represent what scientists and engineers do as a matter of routine and illustrate how scientific knowledge and concepts develop through asking questions and conducting investigations, obtaining and analyzing data, constructing explanations, arguing claims supported by evidence, and communicating and evaluating information. They also describe how needs and problems are addressed through the design process that designs, constructs, tests, evaluates, and refines solutions.

  -SC Science Support Document, 2014

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Science & Engineering Practices, 2014