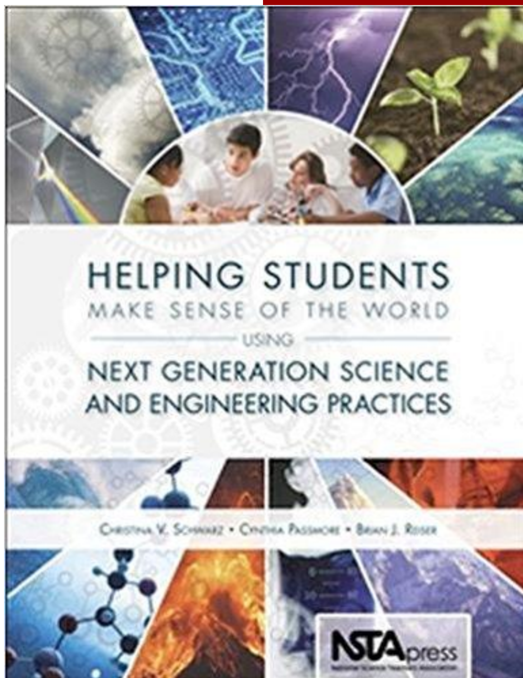
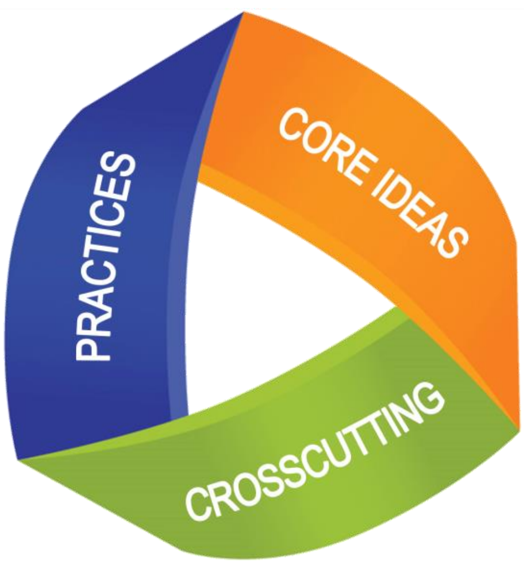




Swimming into the Science and Engineering Practices

What do scientists and engineers do?

- Write down verbs to describe things that scientists and engineers do.
  - Work on your own for 2 minutes

Science and Engineering

Groups of 4-6

- Work to combine your lists.
- Write one verb per post-it and place them on the chart paper for your group. (3 minutes)
- Display posters and do a "gallery speed walk". (2 minutes)
- Take notice of:
  - Common words
  - Surprising or unexpected words
  - Patterns
  - Observations

Dimension 1: Scientific and Engineering Practices

1. Asking questions (science) and defining problems (engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (science) and designing solutions (engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Multiple ways of knowing and doing that scientists and engineers use to study the natural world and design world. The practices work together – they are not separated.

Practices Sort

- Sort your science verbs into these 8 categories
- You will be basing your decisions on first impressions of the titles only. Don't worry about exact definitions.
- Take your post-its from your poster and sort them with your group. Label with the #s 1-8 or "missing".
  - Use the Missing category for anything that you feel does not fit into the practices.
- Transfer your post-its to one of the 9 posters after you have sorted. (10 minutes total to sort & post)
- Do another gallery speed walk (2 minutes)

Practices Sort Discussion

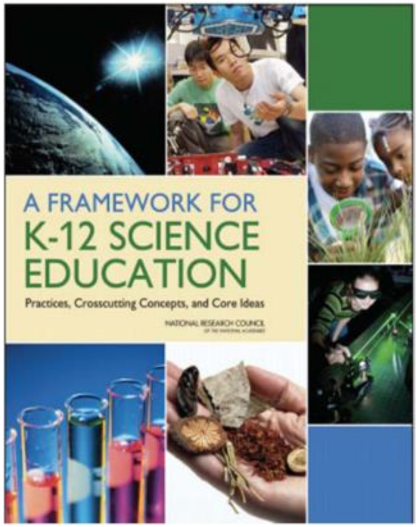
- Were there any words that were sorted into different categories by different groups, or that you felt could belong in different categories?
- What words ended up on the missing poster? Any ideas about where these could be placed?
- Which posters have the most words?
- Which posters have the least words?
- Any other observations?

Why practices?

- They help students understand how science knowledge develops, the work or engineers, and how science and engineering are related.

- The actual doing of science or engineering can
  - Capture student interest
  - Motivate continued study

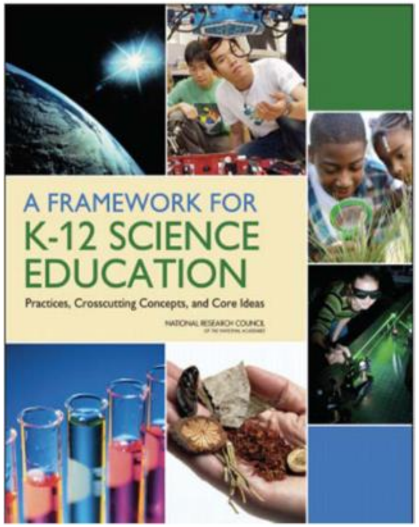
"*Any education that focuses predominantly on… the facts... without developing an understanding of how those facts were established or that ignores the many important applications of science in the world misrepresents science and marginalizes the importance of engineering*." K-12 Framework p. 43.



Understanding how science works

- The idea of science as a set of practices illuminates how science is actually done.
- The use of a set of practices is an important change from previous approaches.
  - Helps to avoid an overemphasis on experimental investigation at the expense of other practices.
  - Helps to avoid the misinterpretation that there is one distinctive approach common to ALL science.
  - The previous approach and use of the term "**inquiry**" was problematic because there wasn't an agreed upon definition for the term.

K-12 Framework, p. 43-44



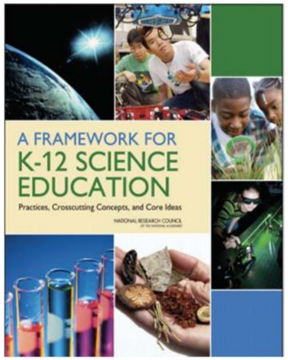
How Science & Engineering Differ, K-12 Framework p. 47-48

Science

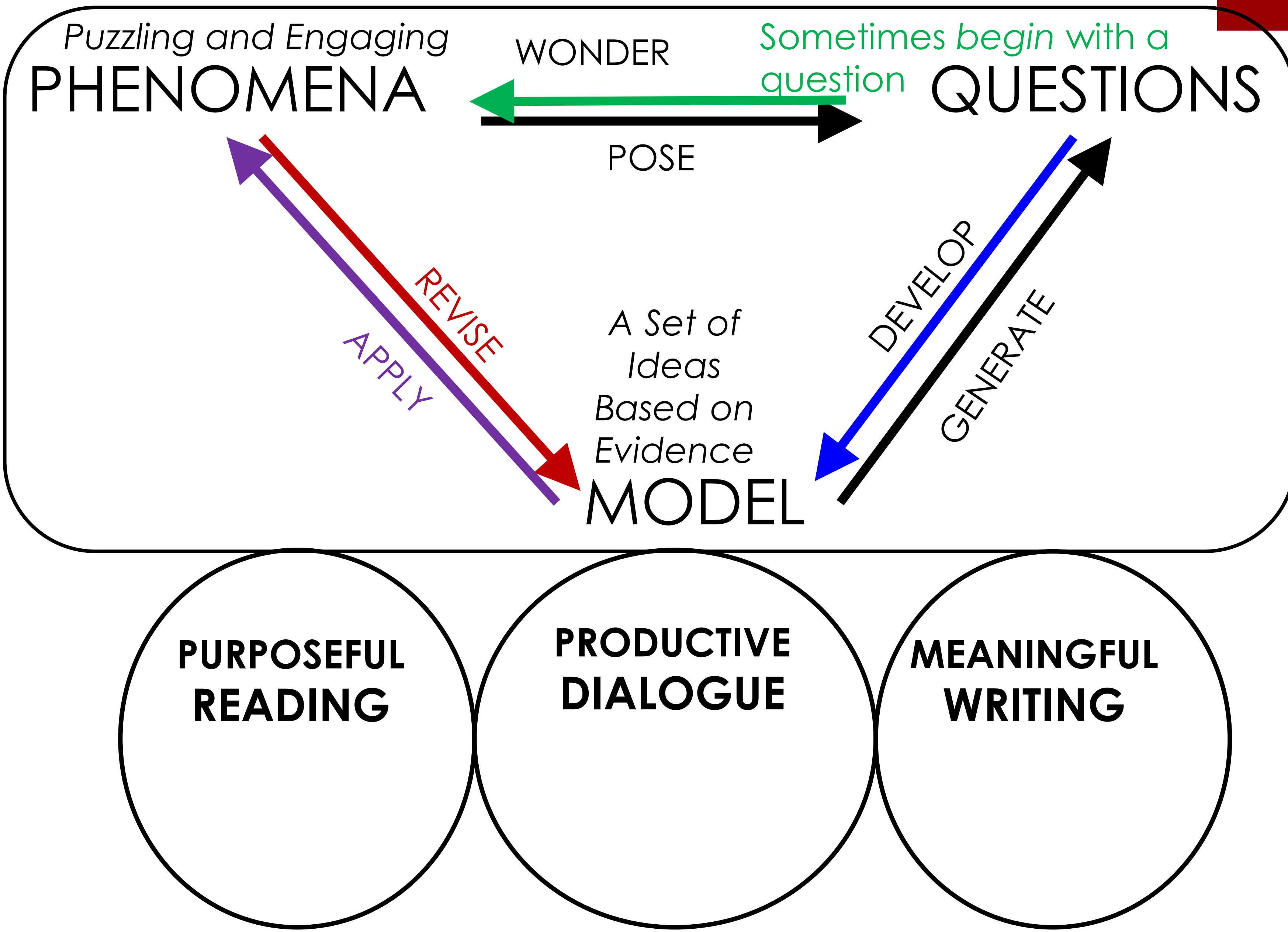
- Driven by curiosity, with aim to answer question about the world or understand an observed pattern.
- Evidence-based models, arguments, and explanations are key to develop and demonstrate understanding.
  - The aim is to find a single theory for a range of related phenomena.

Engineering

- Driven by finding solutions to problems; often has immediate practical applications.
- Goal of argumentation is to evaluate prospective designs and produce the most effective design for meeting specifications and constraints.
  - There is never one correct solution to a design challenge.

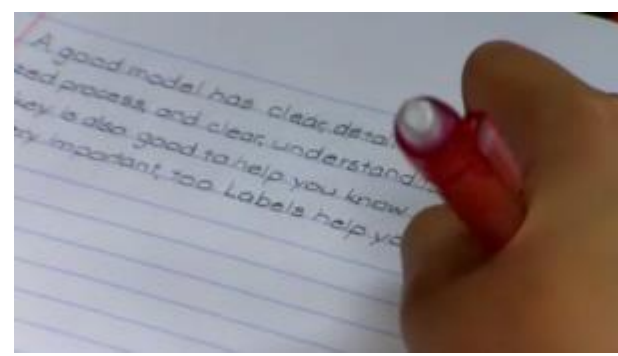


Sense-making and Literacy Framework©



The Framework Says

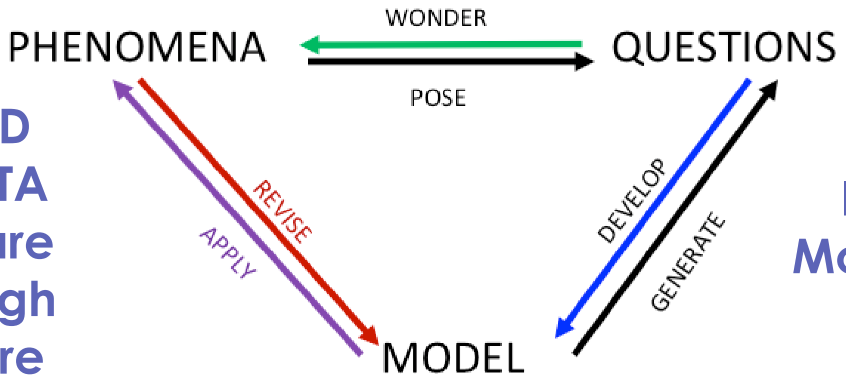
Models serve the purpose of being a tool for thinking with, making predictions and making sense of experience." And further "scientists use models…to represent their current understanding of a system under study, to aid in the development of questions and explanations, and to communicate ideas to others." (NRC, 2011)



The Reasoning Triangle and the SEPs

DEVELOPING EXPLANATIONS
Models are revised and applied to "answer" or explain, predict, and solve

QUESTIONING
Models help identify questions and predict answers



ANALYZE AND INTERPRET DATA
And models are the filter through which data are interpreted

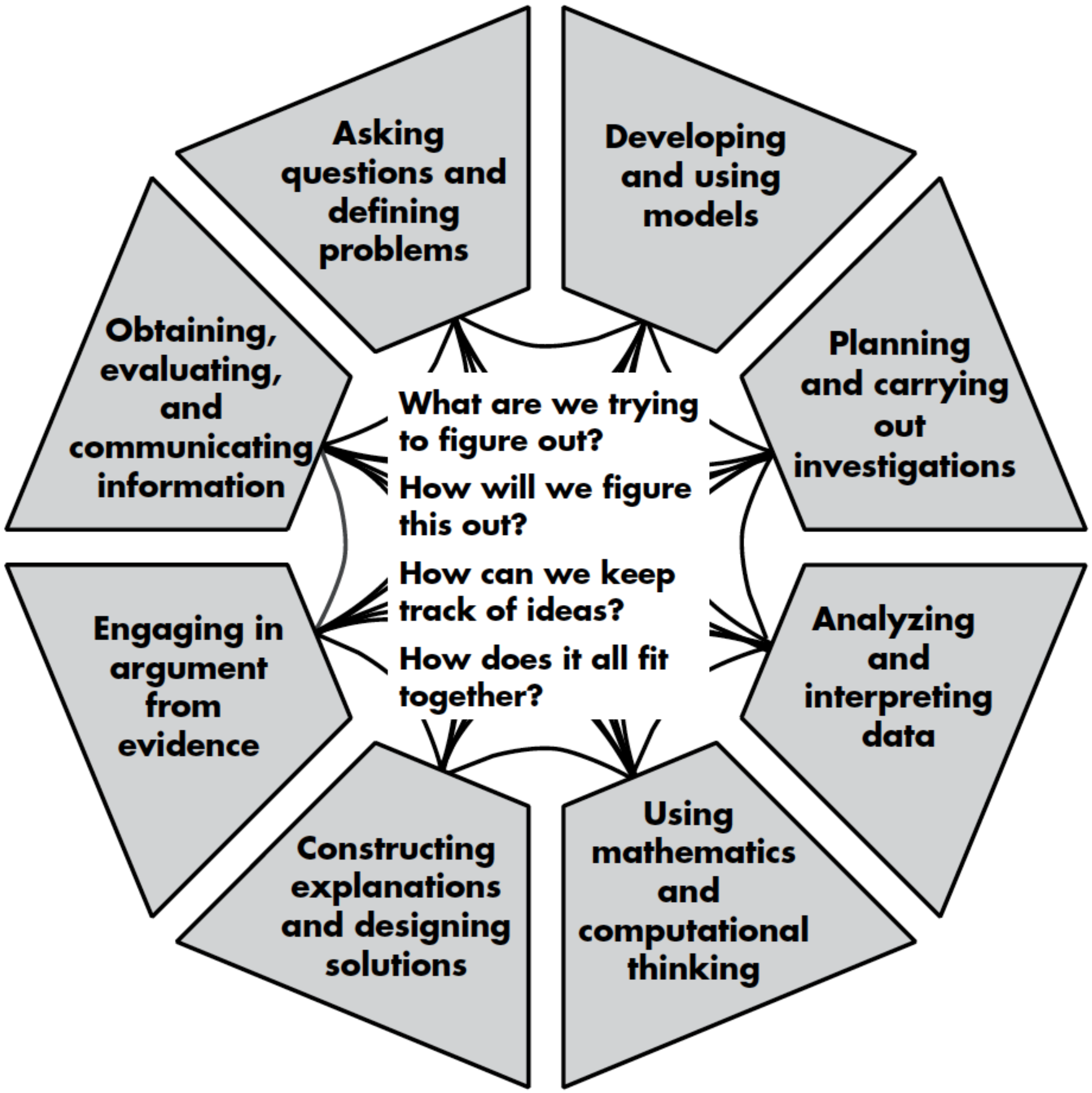
INVESTIGATIONS
Models help point to empirical investigations

ARGUMENTATION
Argumentation is involved in both developing and evaluating models

MATH AND COMP REASONING
We use mathematics to formulate some models and mathematical reasoning to evaluate models

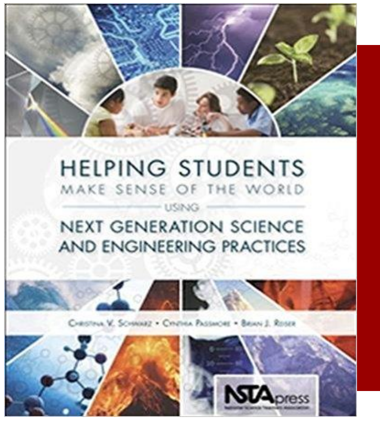
COMMUNICATING & EVALUATING
Models hold and organize relevant information and become the focus of communicating ideas

Figure 1.1
Sense-making and the science practices



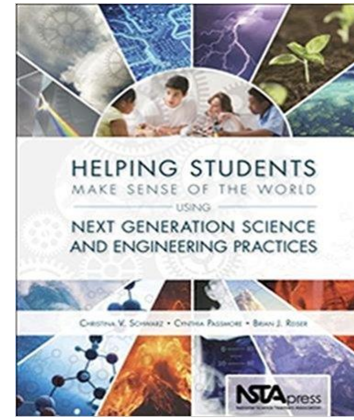
The science and engineering practices work together to achieve four parts of sense-making. This diagram illustrates how the practices always operate in conjunction with each other.

Unpacking a Practice Jigsaw



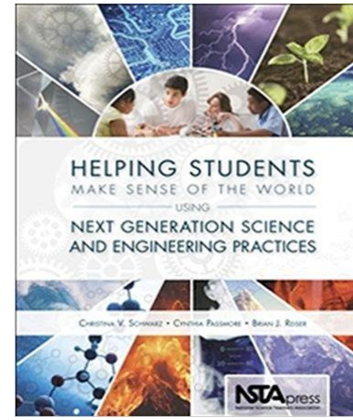
- Divide your grade-band group into 8 teams
- Team 1 – Ch 5 Asking Questions
- Team 2 – Ch 6 Developing and Using Models
- Team 3 – Ch 7 Planning & Carrying out Investigations
- Team 4 – Ch 8 Analyzing and Interpreting Data
- Team 5 – Ch 9 Using Mathematical and Computational Thinking
- Team 6 - Ch 10 Constructing Explanations
- Team 7 – Ch 11 Engaging in Argument from Evidence
- Team 8 – Ch 12 Obtaining, Evaluating, and Communicating Evidence

Unpacking a Practice Jigsaw



- Use the Team Assignment handout to determine what to read for each practice.
- For teams with 3 or more partners, split the "Partner A" reading. (For practice 1 & 6 – you can easily divide the "Partner B" reading as well)
- Close read and annotate your assigned section.
- Add important notes about your practice on your "Unpacking A Practice" Notetaker.
- Complete your reading and notes in 20-30 minutes

Unpacking a Practice
Jigsaw Team Discussion



- Share your findings from your portion of the reading with the rest of your team 5 minutes
- Prepare a poster to introduce your practice to the rest of your grade band using the information from your team's Unpacking a Practice Notetakers. (20 minutes)
- Each team will have 3 minutes to share their practice poster. Take a few notes on the provided handout about each practice
- Take a picture of each poster to refer to later! (Don't do this now– but make time to document)

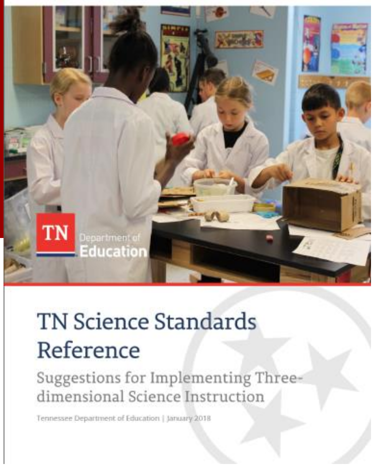
Progression of the SEPs Reference Guide p. 27-34

Asking questions (for science) and defining problems (for engineering)
to determine what is known, what has yet to be satisfactorily explained, and what problems need to be solved

Framework:	
Application to Science	*Application to Engineering*
While questioning and curiosity are innate human behaviors, scientists must develop questions that can be answered empirically.	Beyond noticing problems, an engineer is able to structure a problem in a task-oriented manner, identifying conditions for successful remediation as well as limitations on solutions, prior to engaging solution design.

Progression

	Early Elementary (K-2)	Late Elementary (3-5)	Middle Grades (6-8)	High School (9-12)
Science	• Students develop questions based on their experiences and begin to form testable questions.	• Questions generated by students are still based on experiences, and begin to incorporate relationships between two things.	• Questions originate based on experience as well as need to clarify and test other explanations. • Questions are asked that lead to explicit relationships between variables.	• Questions facilitate empirical investigation. • Questions about arguments and interpretations elicit further elaboration or investigation.
Engineering	• Students explicitly describe a design problem that can be solved using a new tool or improvement to an existing tool.	• Building on their ability to define design problems, students can incorporate constraints (such as time, cost, materials) and a limited number of criteria for solutions into their problem definitions.	• Students define design problems, invoking scientific background knowledge to define multiple criteria and constraints for solutions.	• Students define increasingly complex design problems for systems with interacting parts and include societal, technical, and environmental considerations.



Snapshots of Practice Card Sort – Let's Practice!

- Work in groups of 3 to sort the cards according to:
  - the Science and Engineering Practices in which learners are engaged in the snapshot AND/OR
  - the SEP the teacher could emphasize as a part of the instruction described in the card sort.

  - 10-15 minutes

Snapshots Discussion

- Take turns sharing a card your team felt least confident about classifying.
  - Discuss where different teams placed the card.
  - Use Unpacking the SEP Jigsaw readings to find evidence that would support the placement.
- Use Two or Three Before Me (Keeley, 2016) to discuss the card in focus.
  - Two or three different teams are encouraged to share their rationale for the placement, building off the explanation that came before them (e.g., "I agree with…" "I am not sure that is true. We thought…"). After 2-3 teams share, the teacher can provide additional insight on the best placement of the card.

References/Resources

- California Academy of Sciences – Practices Brainstorm and Sort https://www.calacademy.org/educators/practices-brainstorm-and-sort
- Introducing The NGSS. ASTE 2018. Workshop Activity *Snapshots of Practice*. Tiffany Hill.
- Keeley, P. (2016). *Science formative assessment: 75 practical strategies for linking assessment, instruction, and learning. Thousand Oaks, CA: Corwin Press*