New Standards Inspiring a New Instructional Approach

2018 TSTA Conference

TSTA
Tennessee Science Teachers Association

Instructional Methodology

Instructional Design Tools

↓

Curricular Structure

↓

Instruction

Everything has a structure, or not.

Instructional Methods

- ✓ Seven Step Lesson Plan (M. Hunter, 1970's)
  - ✓ Anticipatory Set, Statement of Objectives, Instructional Input, Model, Check for Understanding, Guided Practice, Independent Practice
- ✓ Conceptual Change Model (G. Posner, et. al., 1982)
  - ✓ Commit to Outcome, Expose Beliefs, Confront Beliefs, Accommodate the Concept, Extend the Concept, Go Beyond
- ✓ Five E's (R. Bybee, 1987)
  - ✓ Engage, Explore, Explain, Elaborate, Evaluate
- ✓ Gather, Reason, Communicate (B. Moulding, et. al., 2015)
  - ✓ Gather Information, Reason with Ideas, Communicate Understanding

Common Features of Instructional Tools

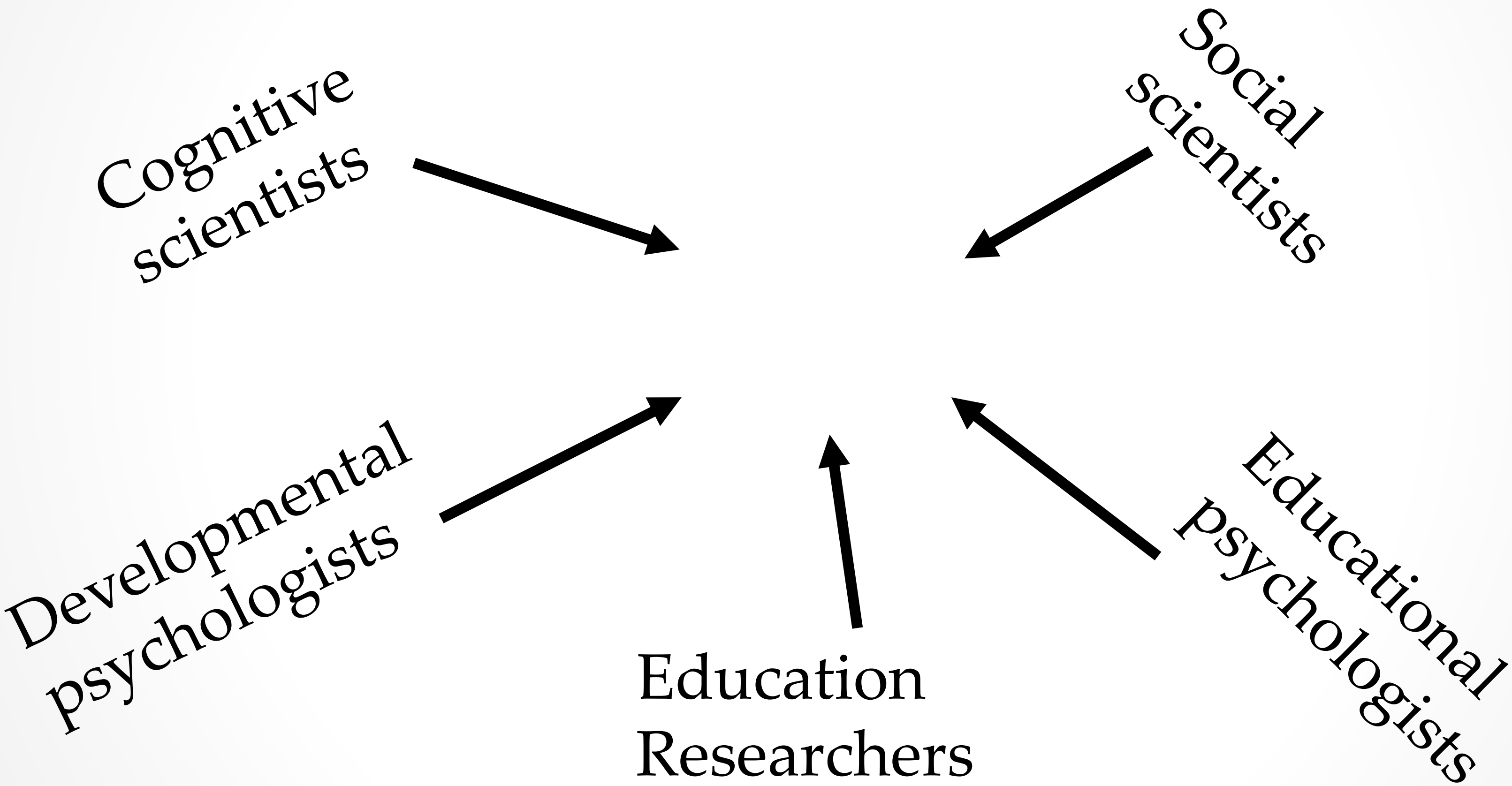
- **Most methods or tools are primarily linear**

Anticipatory Set→Objectives→ Instruction→Model→ Check Understanding→Guided Practice→ Independent Practice

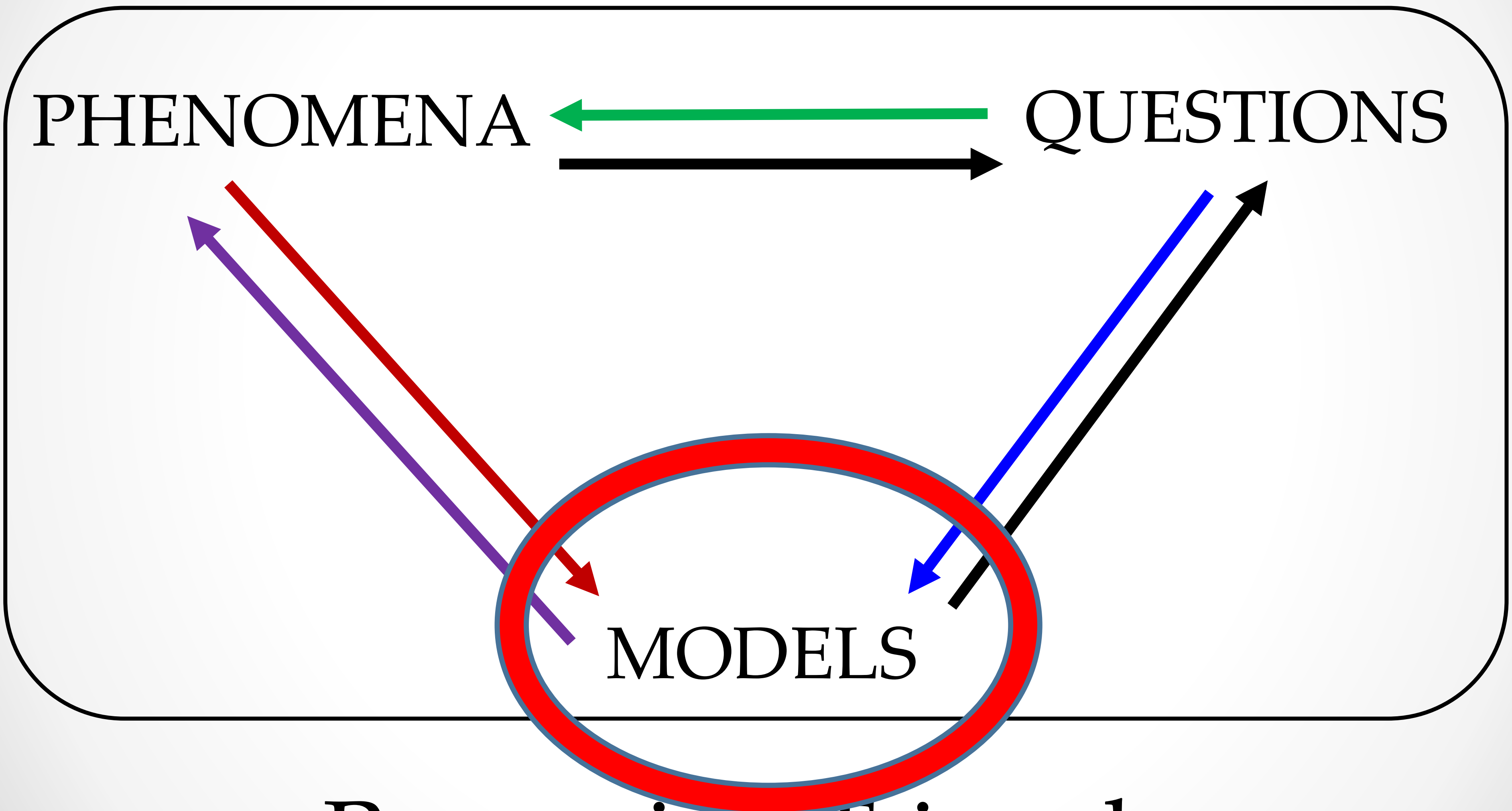
Engage→Explore→Explain→Elaborate→Evaluate

Gather→Reason→Communicate

Last 20 years of research



Sense-making Framework©



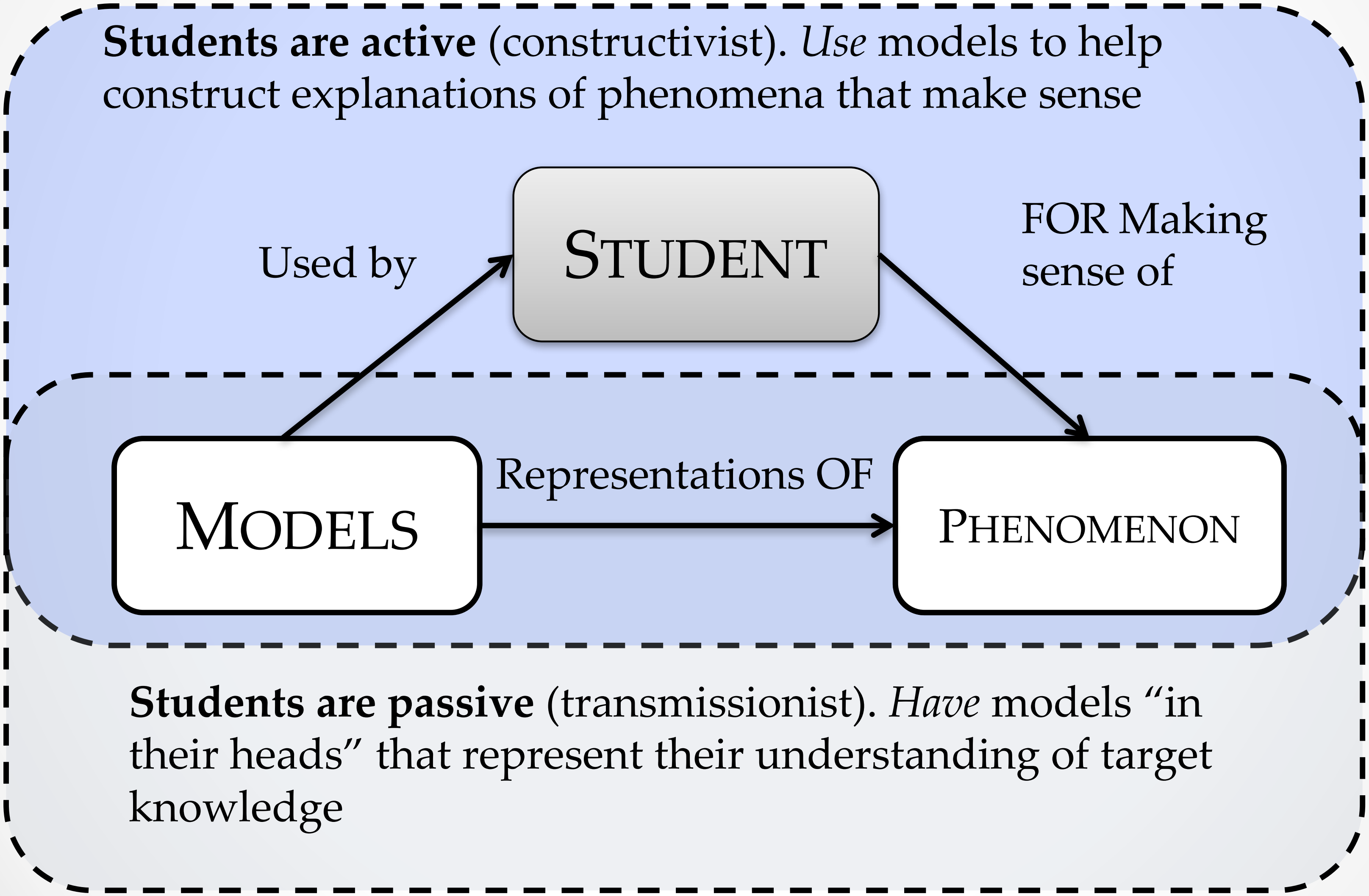
Reasoning Triangle

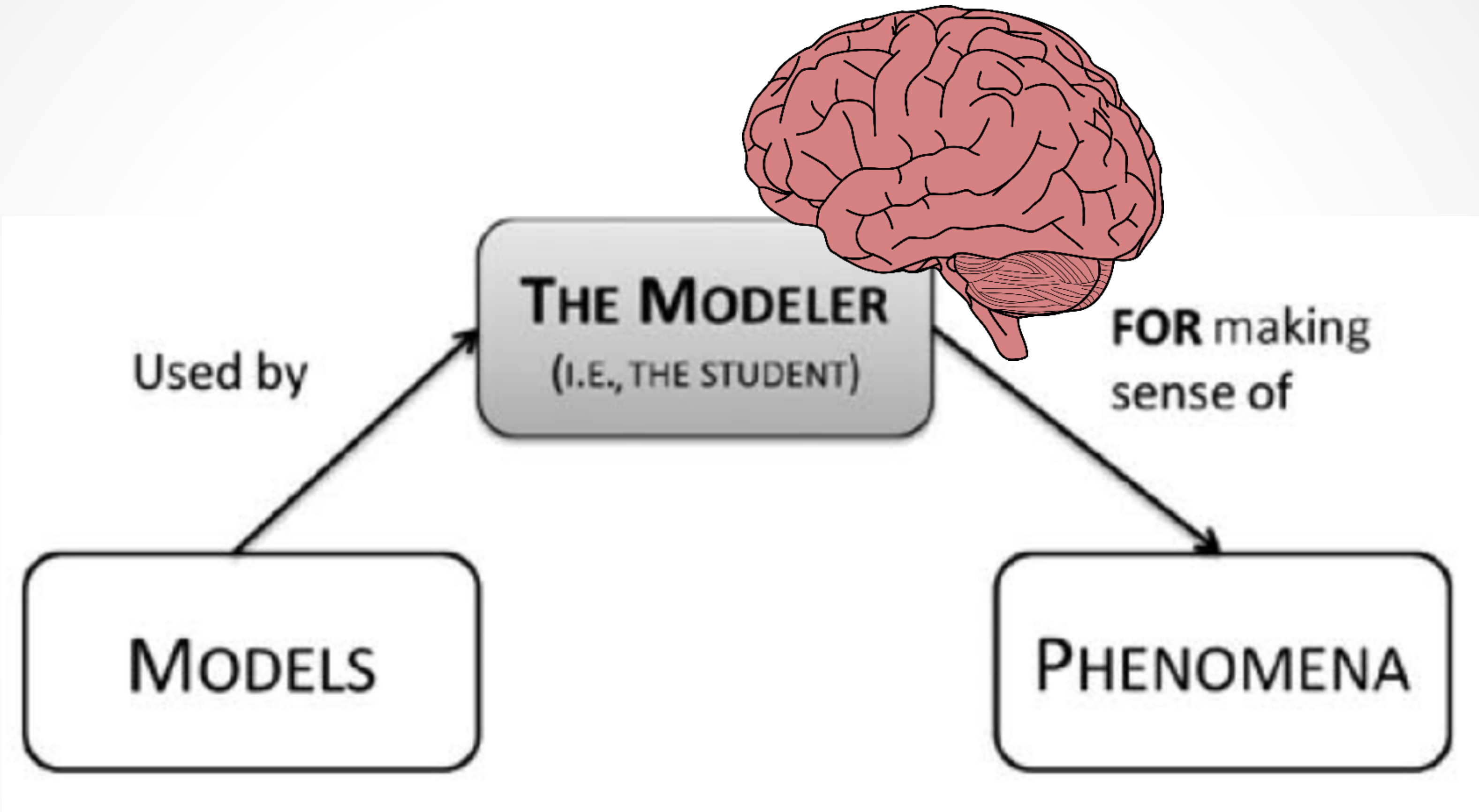
Framework for K-12 Science Education

"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, pp. 56-7).

"Models and theories are the purpose and the outcomes of scientific practices. They are the tools for engineering design and problem solving. As such, modeling guides the other practices."

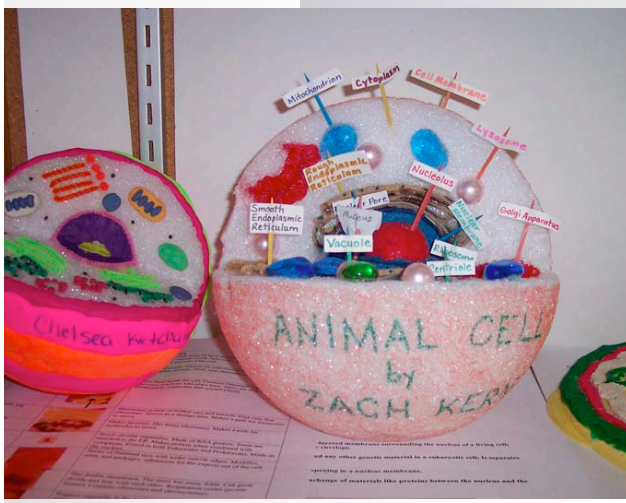
A shift in the instructional paradigm

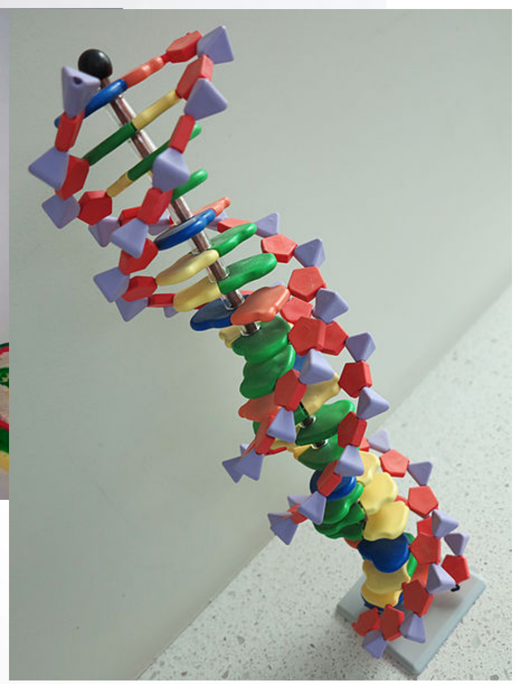




A model is a <u>set of ideas</u>.

Models "of" vs. <u>Models "FOR"</u>

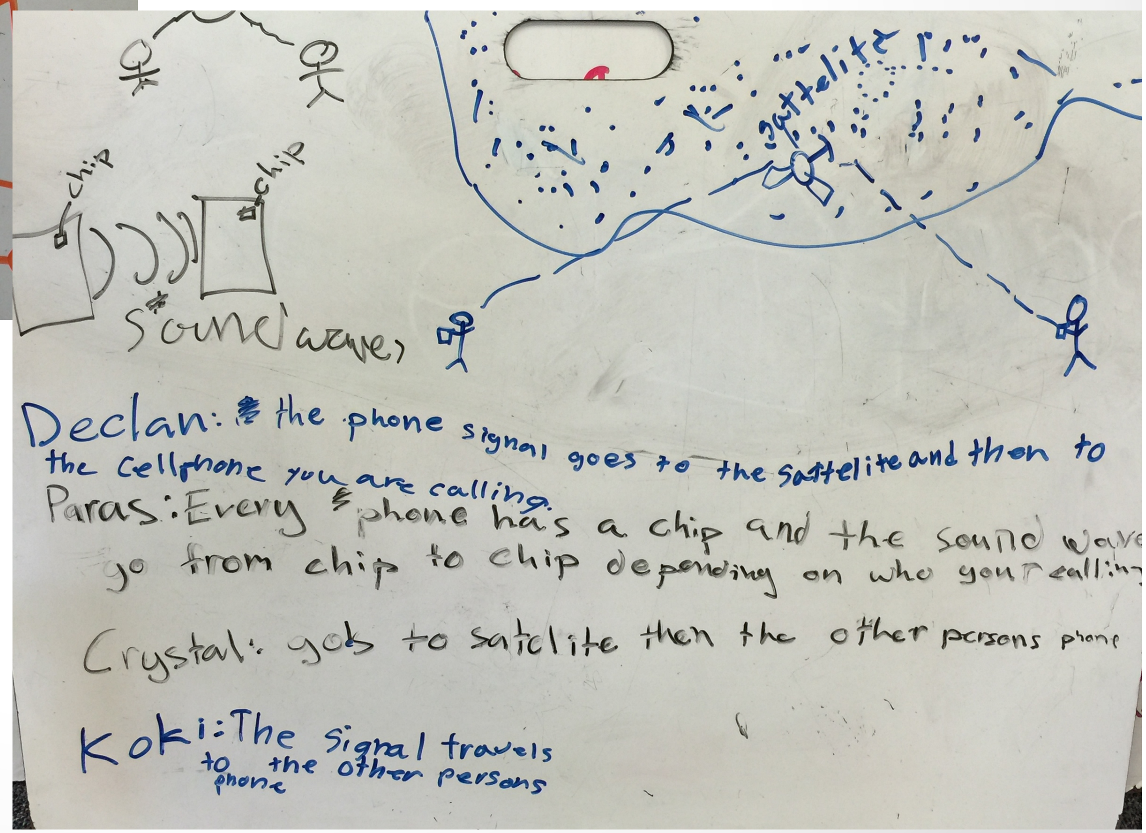




<u>Models FOR</u>:
Sets of ideas that help us to explain something puzzling about the real world.

Example:
The DNA model helps us to *generate explanations* about how DNA can <u>reliably</u> be copied during mitosis.

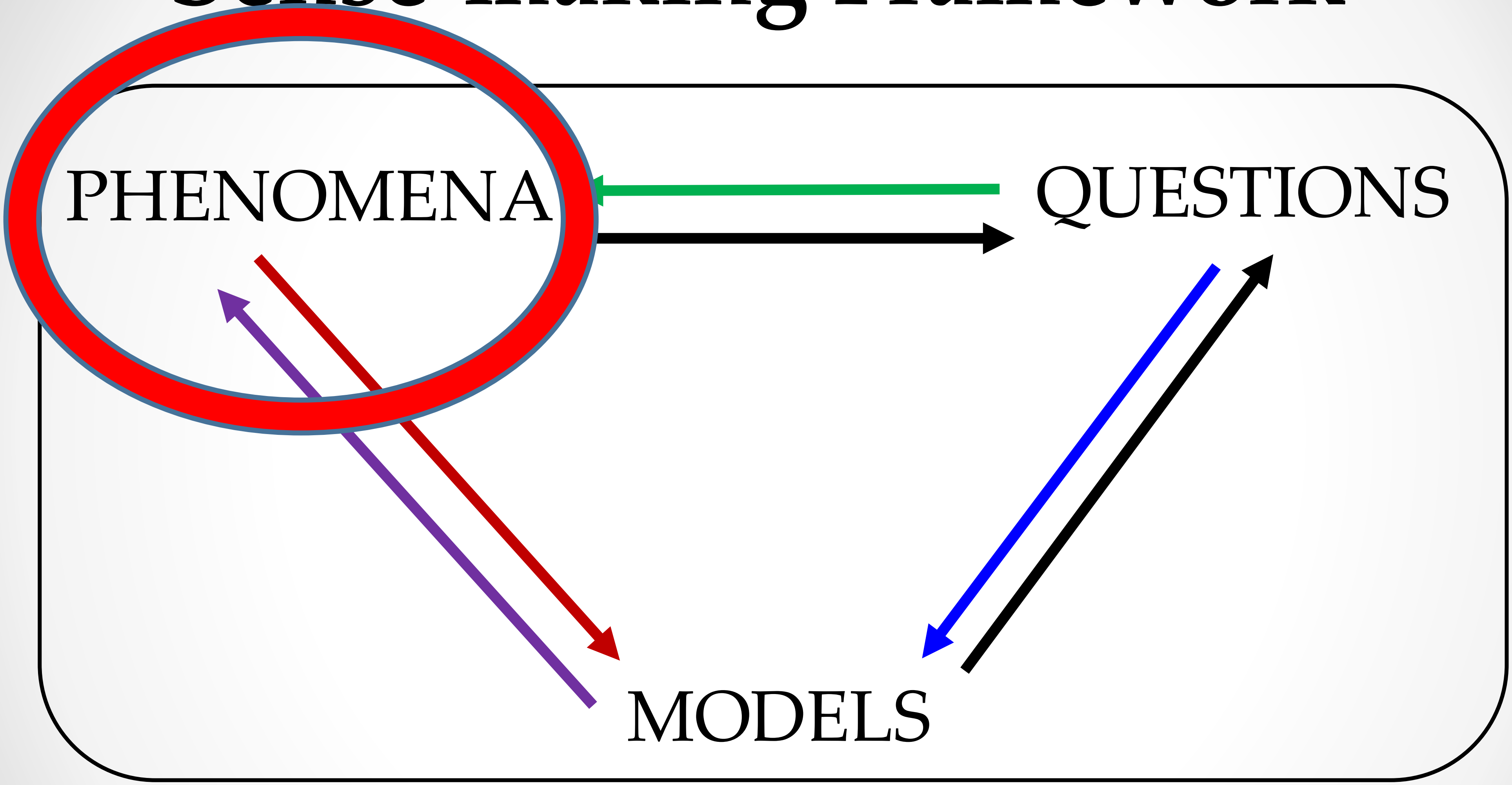
Students have Models



Models "FOR"

Models:	Phenomena:
Natural Selection	Traits change over time in populations.
Germ Theory of Disease	Disease starts and spreads in populations
Matter and Energy from Food (chemical reactions)	Animals have to eat to live.

Sense-making Framework©



Reasoning Triangle

Phenomena

- Because there is a natural tendency to explain and/or seek explanation, phenomena can act as a starting point for learning sequences.
- In science education at all levels we can and should be taking advantage of this.
- However, science is often taught as if everything were known.

Conditions:

1. Bottle on its side.
2. Bottle on road.
3. 6:12 am.
4. Cloud cover.
5. 60°F, no wind.
6. Night was calm.

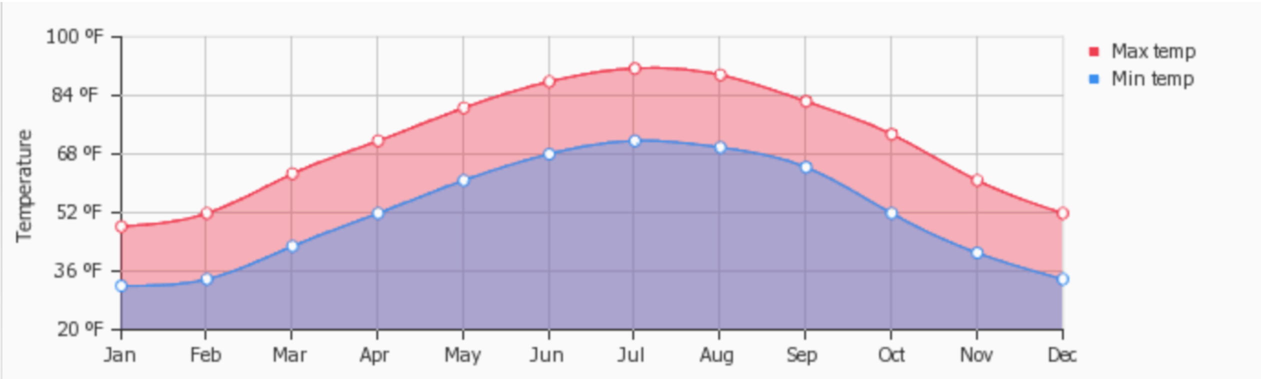
Phenomena

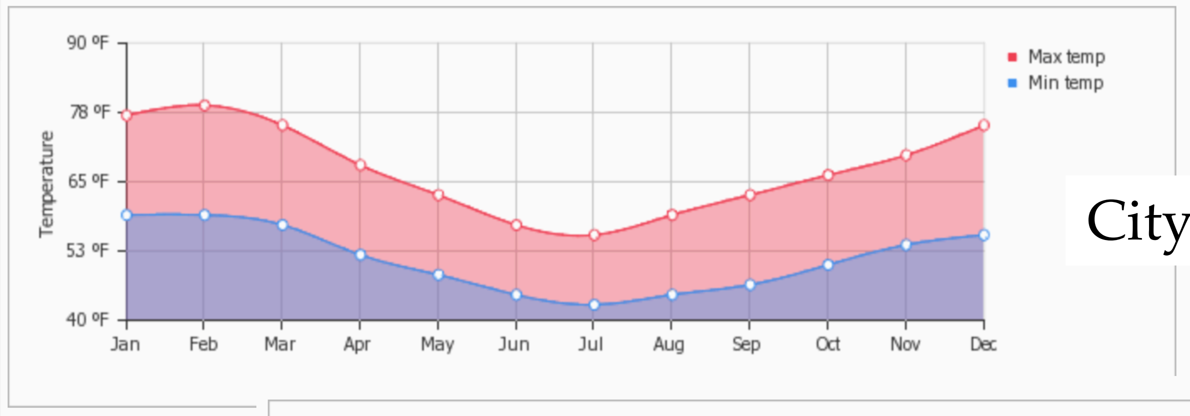
March 22, 2017

Phenomena

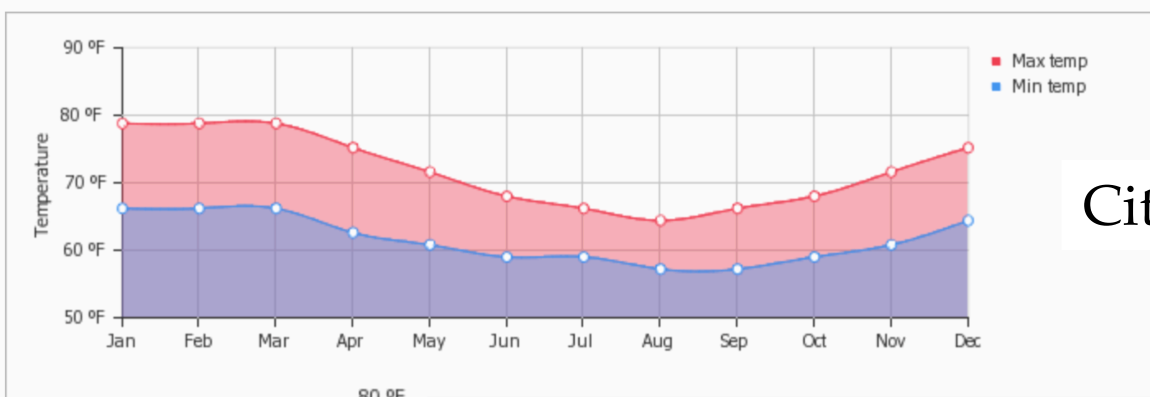
Dec. 9, 2017
Ontario, Canada
– 3ºC
After 2 days of – 9ºC

Data Sets as Phenomena

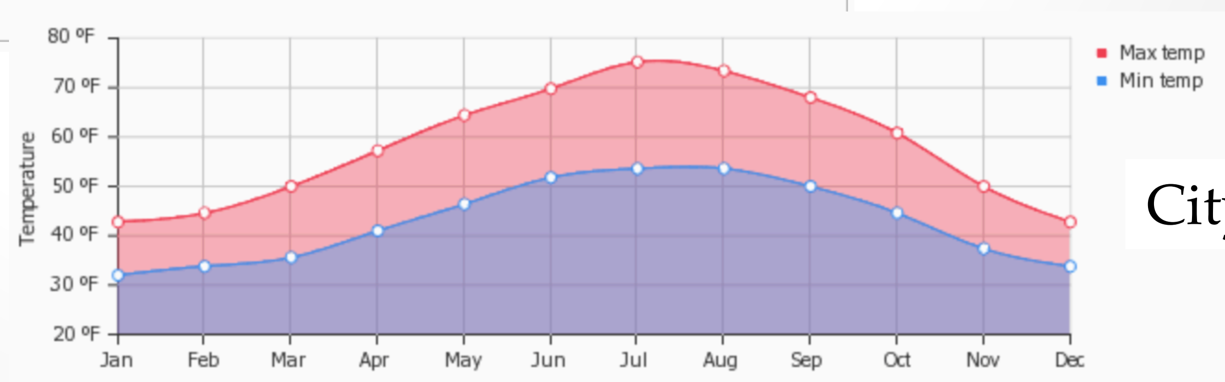




City A



City B



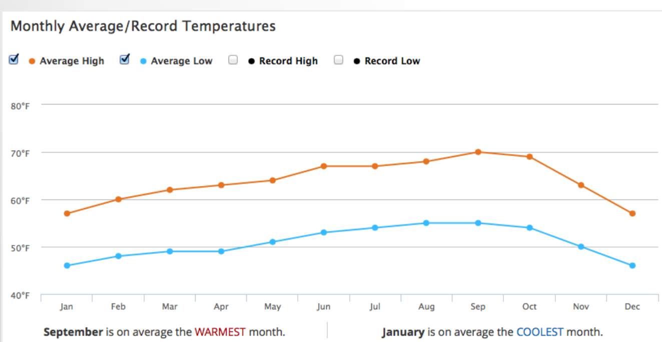
City C

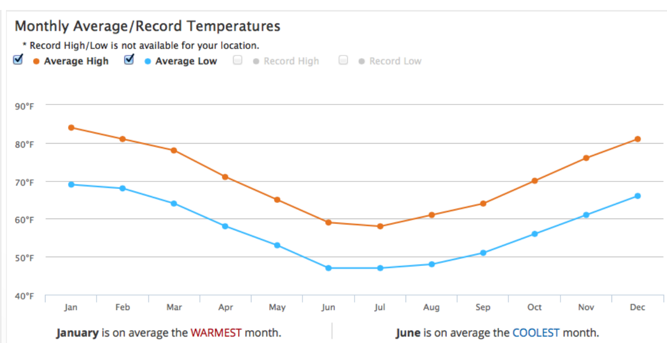
Phenomena

Bottle on side on playground
6:42 am
Clear sky
58˚F, no wind
Night was calm

Phenomena

- Phenomena don't have to be phenomenal
- Phenomena are all around us (become aware in a new way)
- Phenomena can be used in a variety of places and ways in a learning sequence – this a place where professional judgement operates

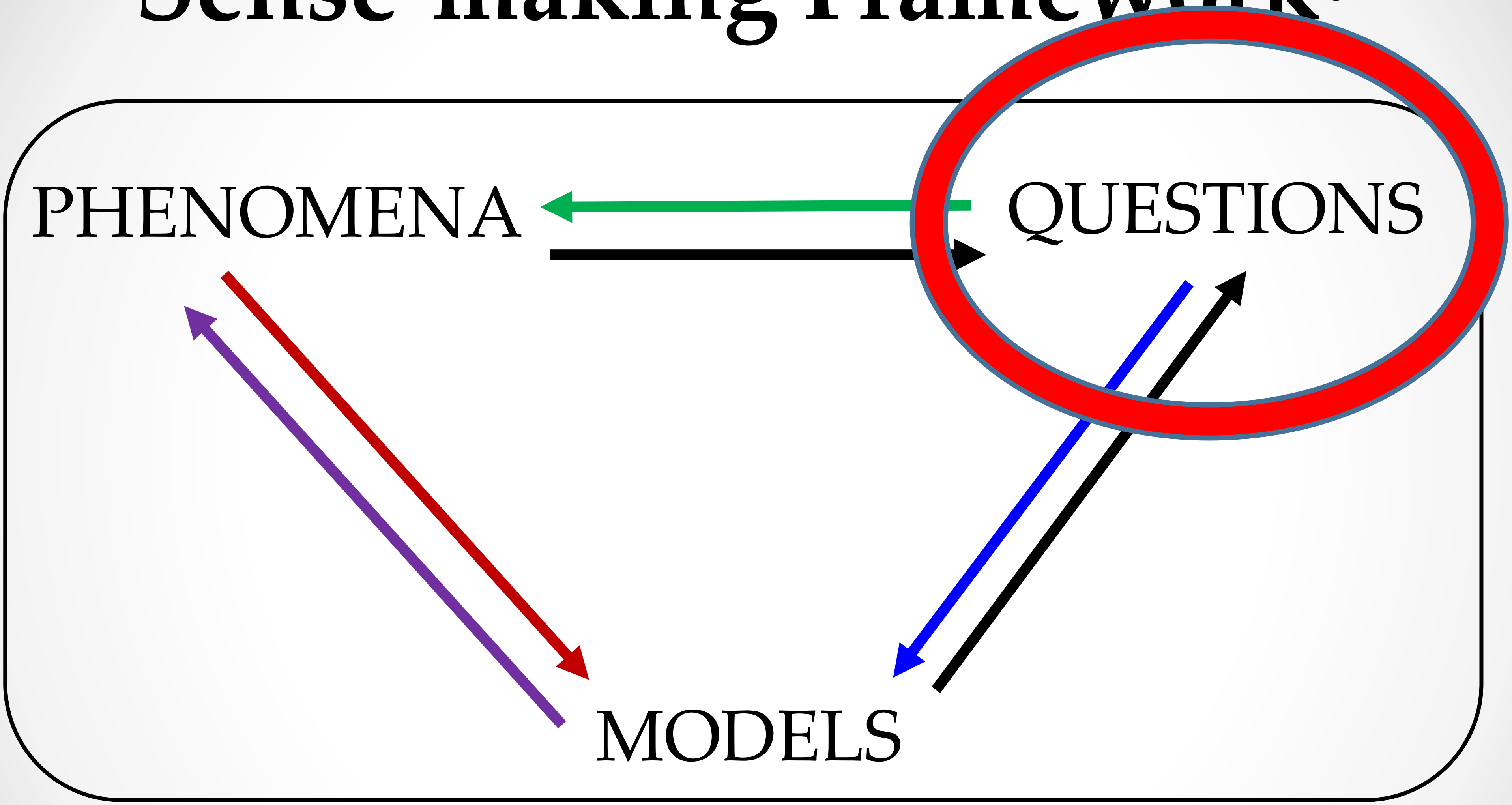




Phenomena can act as a useful starting place for instruction, act as a springboard for curiosity, and ground instructional sequences

BUT, they can only do this if we harness the wonder in specific ways by <u>asking questions.</u>

Sense-making Framework©



Reasoning Triangle

Phenomena → Questions

5 Whys –
an iterative interrogative technique for exploring the cause and effect relationships underlying problems or phenomena.

By repeating the question "Why?" each question forms the basis of the next question.

1. Why did this phenomenon occur?

Because ice splits rocks.

2. Why does ice split rocks?

Water gets into small cracks in the rock. Ice splits rocks because water expands when it freezes.

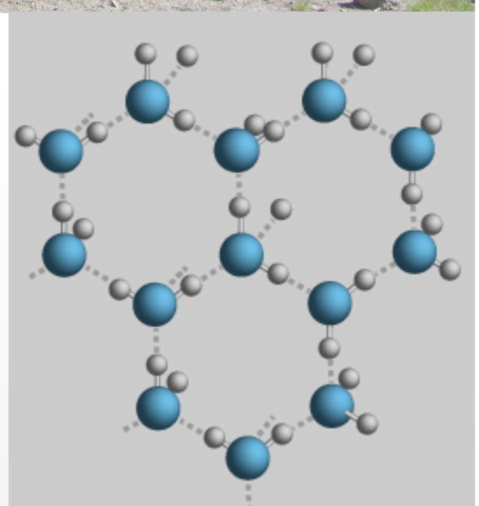
3. Why does water expand when it freezes?

Because in a liquid state water molecules move around one another easily and get very close together. As water freezes the molecules move apart.

4. Why do the water molecules move apart?

Because water molecules are sort of a “V” shape and above 0˚C they move around each other and arrange tightly. When they reach 0˚C they arrange into a new configuration (get “locked” in place), because of bonding, that takes up more space.

hexagonal lattice



5. Why does this configuration and bonding (being locked in place) take up more space?

Because at lower energies (temp.) hydrogen bonds form between H and O atoms and hold the molecules in an organized pattern. This arrangement means that each H and O in the mass of ice orients to their neighboring H and O in a repeating pattern held in place by the strength of the hydrogen bonds. And that pattern "spreads out" some to get into this arrangement (called an open crystalline structure).

Science is simply the word we use to describe a method of organizing our ***curiosity***.

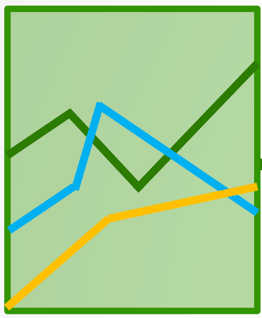
Tim Minchin

Scientist in the Crib

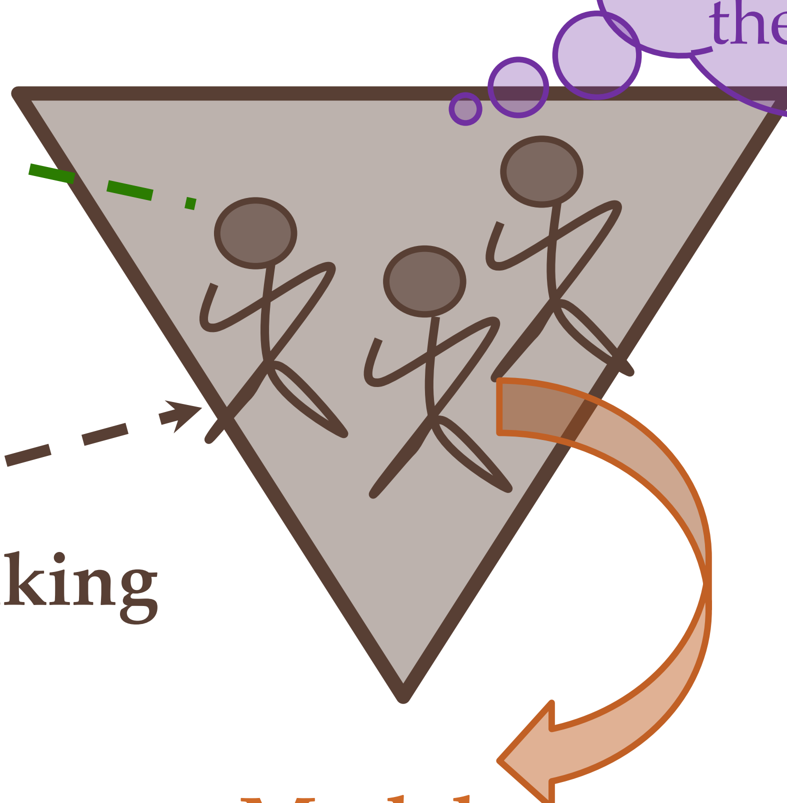
- The authors of "The Scientist in the Crib" advance a hypothesis that a baby is really like a scientist (and a scientist like a baby), forming ideas about the world, doing little experiments to test them, and refining or discarding ideas in light of experimental results. Indeed, the authors believe that children are driven by a need to explain, to understand, and this drive manifests itself during every stage of a child's development.

Alison Gopnik, Andrew N. Meltzoff and Patricia K. Kuhl

Phenomena:
Observations, data, or pattern in the data.



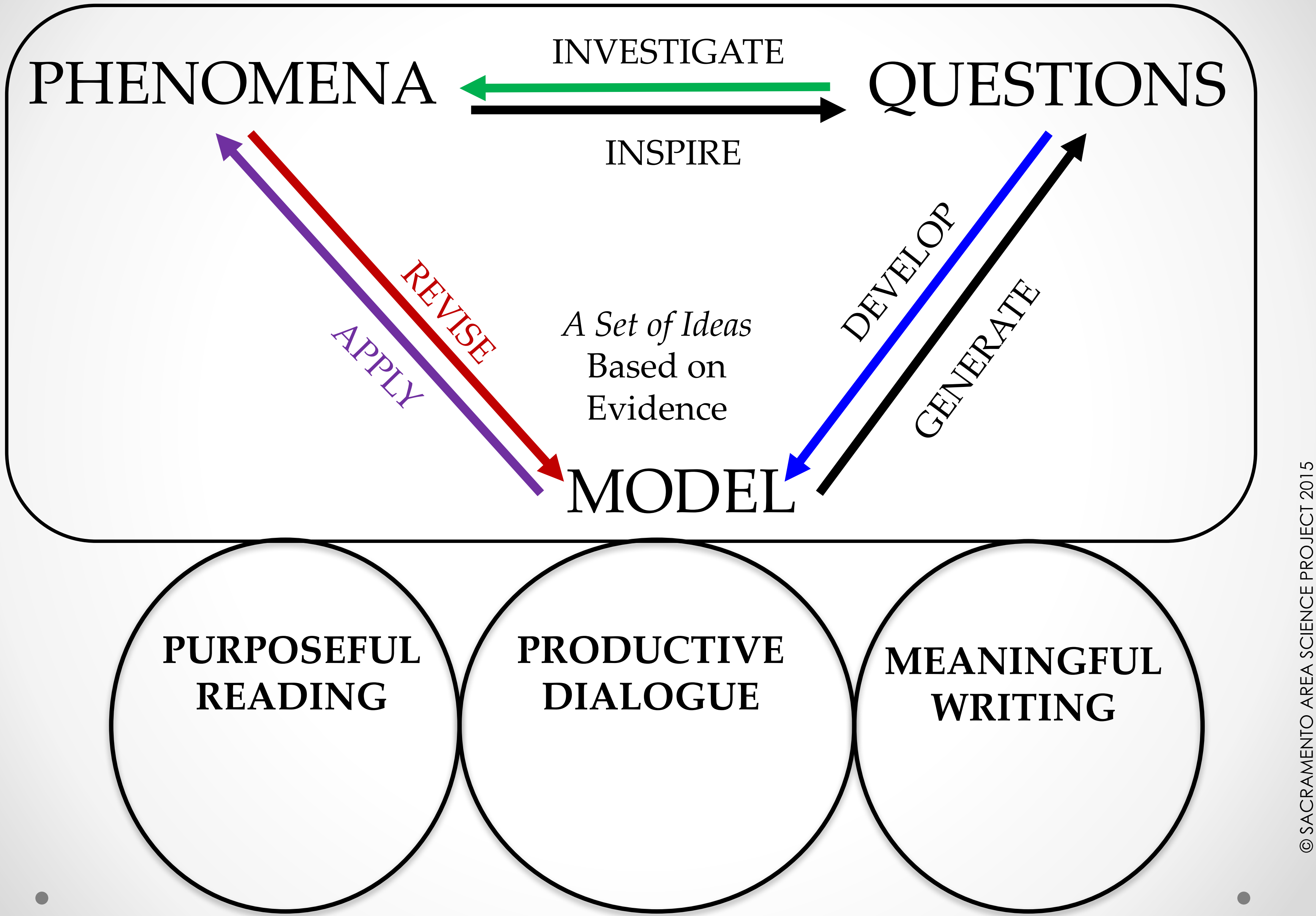
Questions:
Why does "THAT" happen? What *causes* the pattern?



Student Sense-making at the Center

Models:
Sets of ideas based on evidence that help us to generate explanations.

Sense-making and Literacy Framework©



Thank You

acbeauchamp@ucdavis.edu