



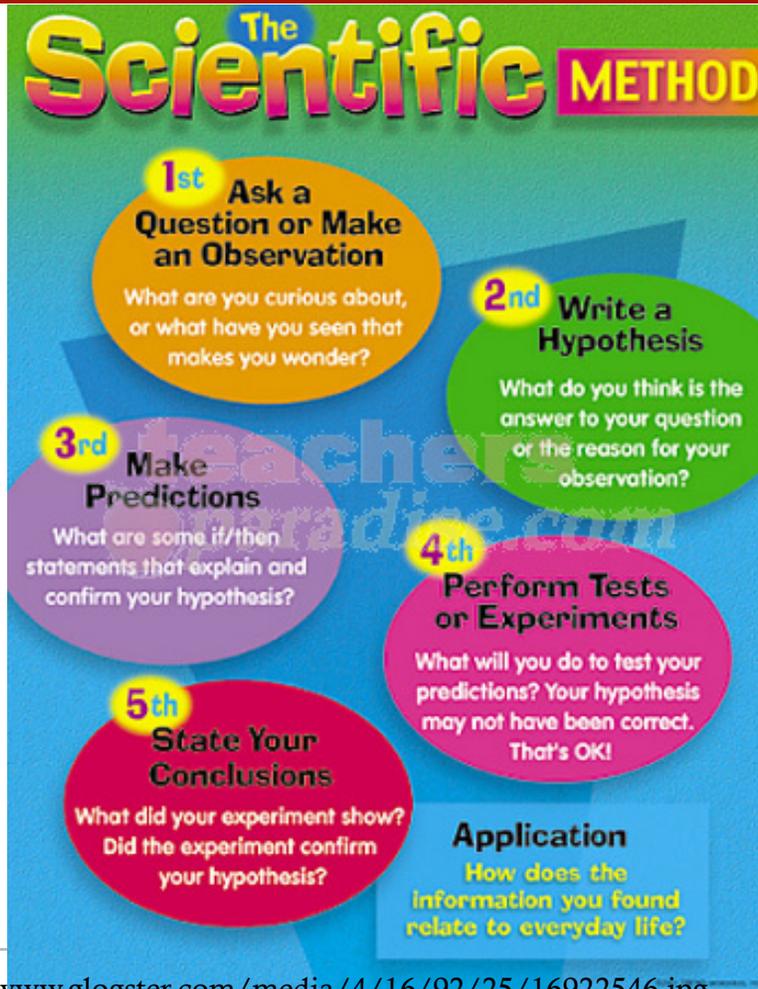
The REAL scientific method (and asking the right questions)

Erin Wood



Traditional Scientific Method

These are good practices, but only represent a small (and limited) view of what real scientists do.



Cookbook science

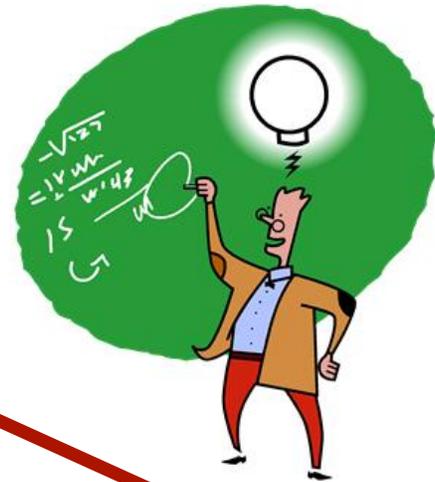


- Cookbook science usually involves a set of procedural steps for which only one solution to the problem exists
- It is useful! You must learn the ABCs before you can read.
- Requires reflection on processes afterward

v. REAL Science

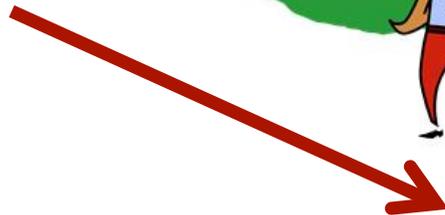
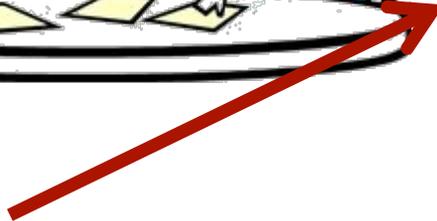


A Body of Knowledge



A Way of Knowing

A Set of Methods/
Processes



Tentativeness

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- Often no single “right” answer.
- Scientific knowledge is subject to change.
- Many ideas have remained largely unchanged for hundreds of years.



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Empirical Evidence

Science relies upon qualitative and quantitative data

"Don't look now, Newton, but that Einstein kid is finding loopholes."

Observation and Inference

- Observation
 - Uses the five senses
 - Often augmented with technology
- Inference
 - Involves developing explanations from observations
 - Often involves things that are not directly observable



Scientific Laws, Theories, and Hypotheses

Law

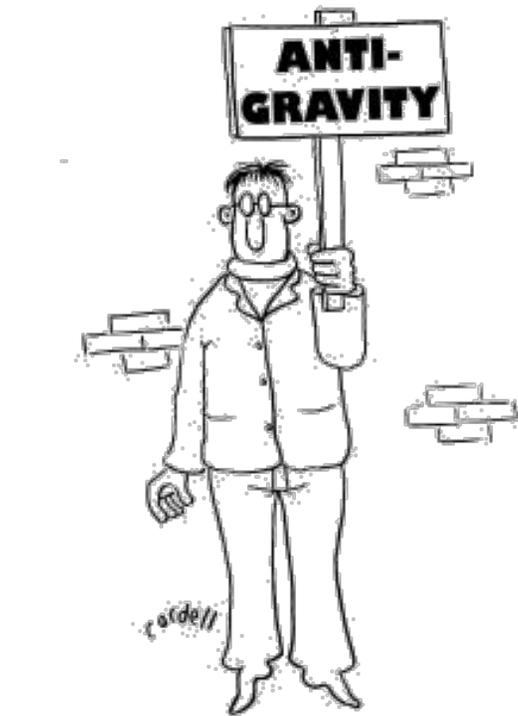
Description of relationships or patterns that are consistently observed in nature

Theory

Well-supported explanation of natural phenomena

Hypothesis

Proposed explanation for a fairly narrow set of phenomena



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Scientific Methods



- There is no single scientific method.
- Approaches include: observation, inference, experimentation, and chance discovery.

Creativity

An essential part of science

Objectivity and Subjectivity

- Scientists tend to be skeptical and apply self-checking mechanisms to improve objectivity.
- Intuition, personal beliefs, and societal values all play significant roles in the development of scientific knowledge.
- Scientific conclusions can be influenced by scientists' background knowledge.



Reflecting on the Nature Think-pair-share of Science

- Think for 1 minute and write down ideas
- Pair: Talk with a neighbor about ideas for 1 minute
- Share: Share with the class

Think about **one** of the science practices your group used in the “Mystery Tube” activity this morning and how it was used.

- Tentativeness
- Empirical Evidence
- Observation and Inference
- Scientific laws, theories, hypotheses
- Creativity
- Objectivity and Subjectivity

Asking better questions: Strategies to improve scientific thinking

- How might we collect better data? Could we change the experiment to change our data/result?
- What assumptions did you make before we began?
- Did your result differ from what you expected?
- How does your data support your hypothesis?
- What is your prediction based upon?
- Can you use your data to answer a question that was not asked? What question could you ask, and can your data answer it? What experiment could we do that could?
- What tools are you using to collect data? What would happen if we changed/ improved the tools?
- **11** What are the limitations of this experiment? Are there questions it can't answer?