#### How Can the History and Philosophy of Science Contribute to Contemporary U.S. Science Teaching

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# Why should history matter to the teaching of science?

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7 min

# A bit of personal history

- 1963–6<sup>th</sup> grade science class
- All concepts were embedded in history
- Internal combustion engine? design history
   Firecracker> cannon> piston> flywheel> valves etc.
- Magnet –discovery history
  - Magnus w/cane>compass>poles> Oersted &EM>>
- Eye evolutionary history
  - sensory patch> deepened pit> lens>rod/cone> color
- very effective for me (and others)
- .....why?

When does embedding science content in history help?

- What kinds of effects?
- Interactions with domains & facets of science?
- How might effects vary with age, culture and individual differences?
- How might different slices/versions of history have different effects?

### Versions of History

- As a linear time chain of achievements?
- As description of a struggle?
- As a historical evolution of ideas over time?
- As historical accounts w/o people? (evolution, geology)
- As individual stories?
- As an account of a dynamic community?
- As any narrative structure with goals?
- As a straight line or with all detours and dead ends, misconceptions? (or light version??)
- As a myth with heroes and idealizations?
- costs and benefits to each

#### Kinds of Effects

- Motivational
- Cognitive

#### **Motivational factors**

- Make scientists seem more human
- Allow for failures, promote effort vs. entity orientation
- But...potential downsides- can de-motivate
  - Not all struggles are good (e.g., not worth it; adversarial; net loss; struggle for external vs. intrinsic reasons)
  - May interact w/ culture- struggle may work more in a culture that prizes effort vs. natural talent
- Different effects at different ages?
  - Younger children more optimistic? (Lockhart et al.)...less struggle talk than older who are more entity driven?
- Illustrating social dimensions—positive and negative

### **Cognitive factors**

- The problem of evaporating mechanism (Krebs cycle)
- Are goal-based narratives more cognitively sticky for mechanism?
  - Is it social, intentional, teleological, or merely causal?
- Does recapitulating conceptual change help foster it?
- Does history better inform method...or mechanism/content?
  - Relevance to teaching through errors
- Does history highlight naturalistic questions asked by scientists are those pedagogically more powerful (Deslauriers, Schelew, & Wieman, 2011)?
- Does history teach good arguments? (winning vs. learning)
- Distort history to make it most effective?
  - optimal path from early to present, omit worst detours/dead ends?
  - Staged? Start with ideal path, then complicate later, how realistic?
- How should teaching HOS differ for future scientists/historians?

#### Conclusions

 Embedding science content in history is multidimensional process with a wide array of potential consequences

- Many ways to present history, many effects

- Both Motivational and Cognitive effects could be either positive or negative
- Need for more systematic experimental studies of versions of history and of kinds of possible effects

   whether any effects unique to history
- Unclear why and when HOS works

# End

- Additional questions about relevance of
- Culture
- POS
- Domains

### Cultural effects

- Conveying what the culture is like
  - importance of community...discounting the lone wolf metaphor—deference networks -illusions
  - Appropriate discourse (arguing to win vs. learn).
- Interactions with cognitive and motivational
  - Collectivist/individualist
  - Traditional/developed
  - Cohort effects? (silicon induced blindness?)

# Philosophy of science

- What dimensions?
- Why science ever succeeds?
- The values of idealizations?
- Good vs. bad explanations?
- Good vs. bad arguments?
- Completeness and incompleteness of theories?

#### Domains

- Biology
- Physics
- Engineered systems