Authentic Meteorology Learning Experiences: Student Use of Analogies to Describe Convective Storms

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BACKGROUND

What is an analogy and why is analogical reasoning important?

- Analogous situations are similar to each other in specific ways (Kastens & Shipley, 2025)
- Analogical reasoning allows students to draw connections between well understood and lesser understood phenomena
  - Students can align the two phenomena which draws attention to the important relationships
  - Using knowledge of one phenomena, students can make inferences about the lesser-understood phenomena from the well understood phenomena

What promotes alignment?

- Spatiotemporal proximity (Gentner & Hoyos, 2017)
- High similarity
- Common labels

How does language relate to analogical reasoning? (Gentner, 2010)

- Common labels invite alignment
  - Cap (bottle) and cap (inversion layer)
- Naming promotes reification by analogy
  - CAPE (non-physical energy) compared to physical processes
  - "Breaking the cap" promotes analogies to breaking

METHOD

Interviews

- Joined a Convective Field Study with Valparaiso University's meteorology students May 12-22, 2025
- Interviewed 13 students who had various levels of experience and 2 instructors (5 women, 10 men)
  - Asked for analogies for breaking the cap and CAPE

Analogy Mapping

1. We identified instances of analogies from the interview transcripts.
2. To compare the meteorological phenomena to their analogs, we identified the essential components of the meteorological phenomena and the components of the analogs.
3. We identified the important similarities and differences between the essential components of the analogs and the corresponding meteorological phenomena.
4. We mapped the alignment of the analogs to the meteorological phenomena

What Makes a Good Analogy?

- Many aligned components
- The ability to make inferences between the analog and the phenomena
- Knowledge of the analog should allow for insight into the phenomena

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DEEP VS SURFACE ANALOGY MAPS

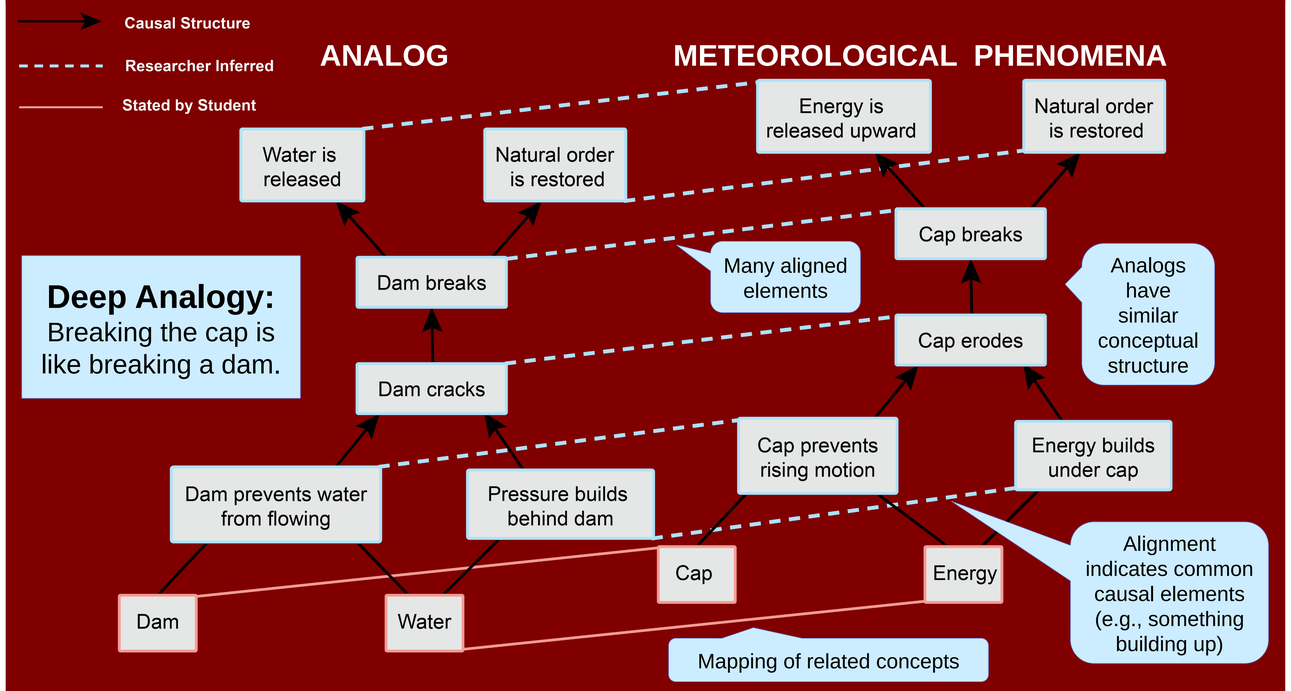


Figure 1. From Los Angeles Times

Image of an intact dam. Pink arrows represent water pushing against the dam, inhibited by the dam, in red. Blue arrows depict the flow of water if the dam were to break.

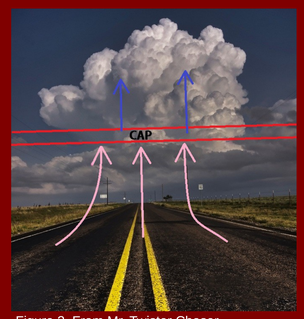
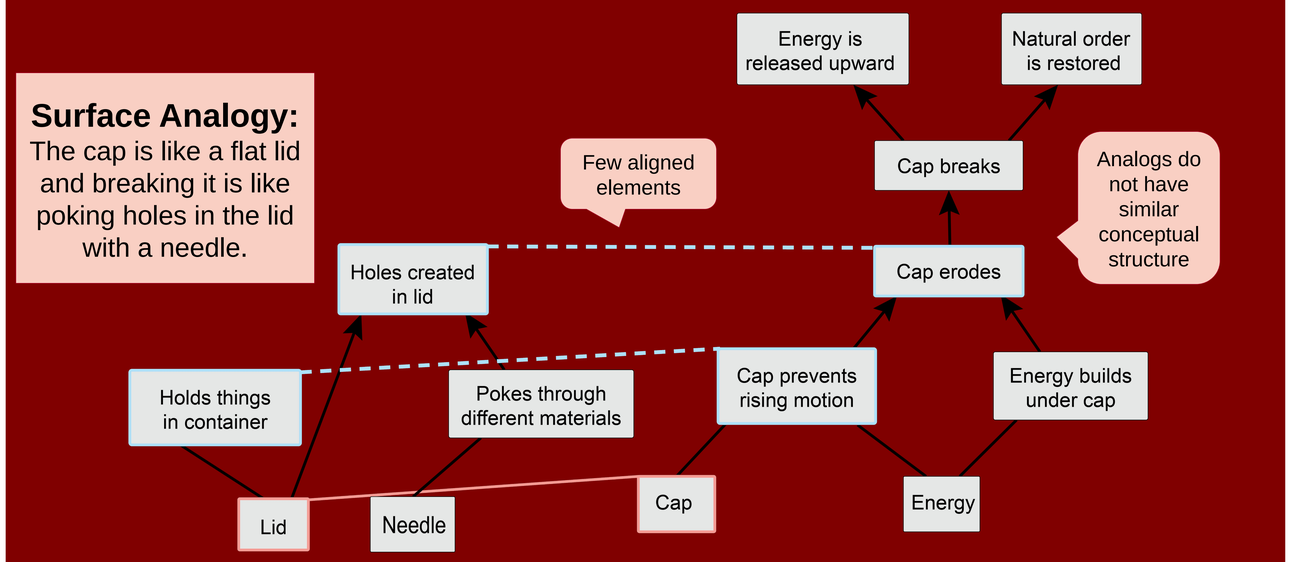


Figure 2. From Mr. Twister Chaser

Image of a storm where the cap has broken. Pink arrows represent air parcels rising, inhibited by the cap, in red. Blue arrows depict the air rising after the cap is broken.



TIPS FOR INSTRUCTORS

Progressive Alignment

- Start with a close match to phenomena then get more abstract
  - Closer analogies are easier to understand
  - Abstract analogies can lead to more in depth thought and understanding
    - Students become aware of underlying relationships

Clear Connections and Differences

- Just because an analogy is clear to the instructor does not mean it is clear to students
  - Instructor can draw or highlight connections.
  - It is important to differentiate the analog from the actual phenomena so that the analog is not the students sole mental model for the phenomena (Richland & Simms, 2015)

Analogies are the Heart of Scientific Discovery

- Have students think about the strengths and limitations of their analogies.
  - Allows for a deeper understanding and knowledge if inferences are possible.
- Practicing analogies will get students better at finding and using new analogies.
  - Working with analogies is a way to practice scientific thinking.

SHARE YOUR ANALOGIES

Other Student Examples:

- CAPE is like a ball held underwater.
- CAPE is like a trampoline.
- Breaking the cap is like removing the lid on a pot of boiling water.
- Inflow is like a vacuum cleaner.
- Pressure gradient is like a swimming pool.
- Hail stone layers are like tree rings.

Grab a sticky note and add your own meteorology analogies!

… is like …