

Strategies for Conceptual Change: A tour of Misconceptions



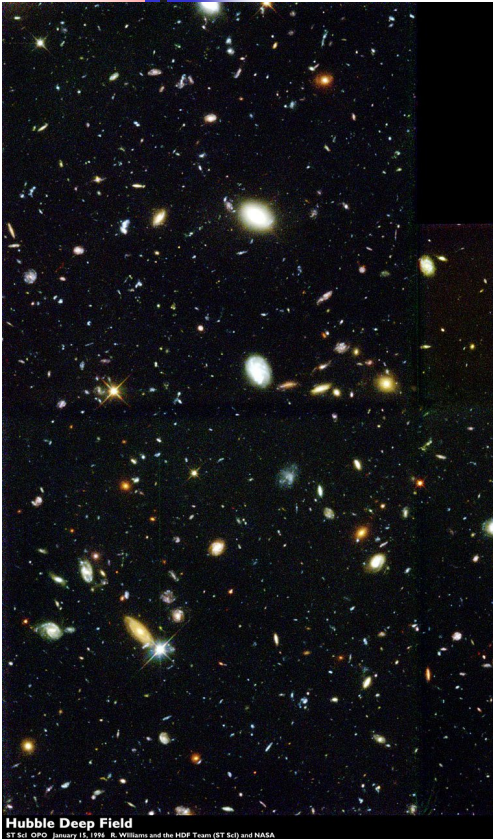
Dr. Evan Richards

Physics Education Research (PER)

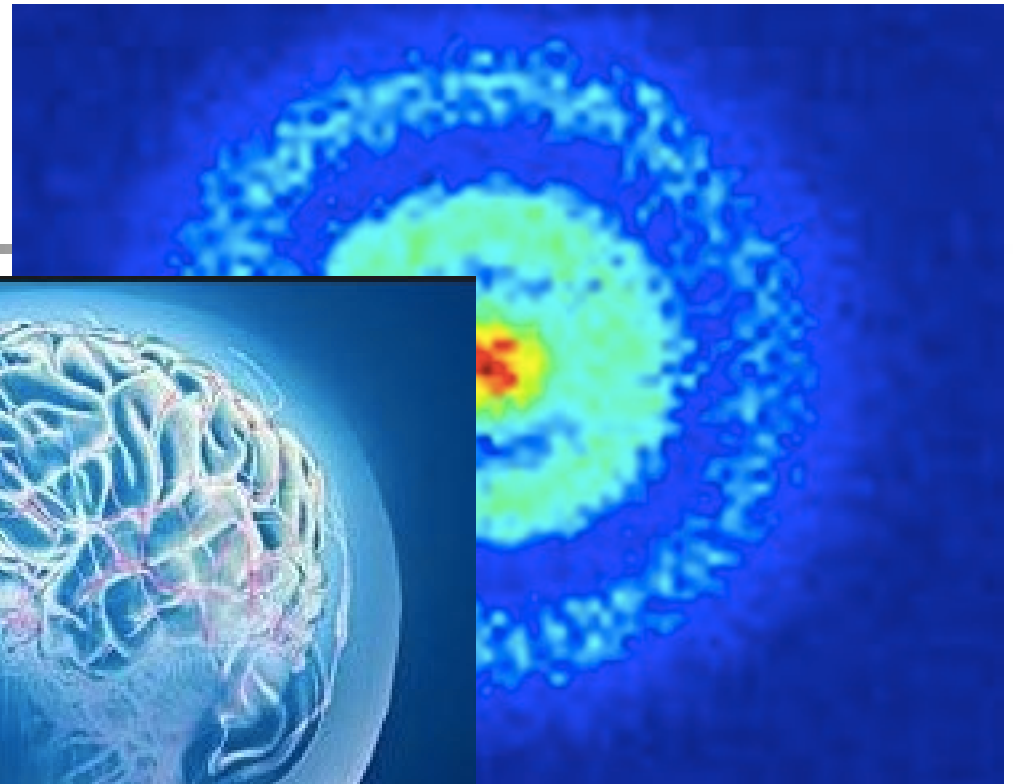
Lee College Physics Faculty



PER?



Hubble Deep Field
11:50:00 January 15, 1995 R. Williams and the HDF Team (ST ScP and NASA)



Stodonla, et. al. (2013)

From,
https://www.spacetelescope.org/science/deep_fields/



Surface Issues

(Just the “Facts”)

It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.”

Mark Twain



Surface Issues (Facts)

- Where does coffee come from?
 - 1) Seeds
 - 2) Vegetables
 - 3) Beans
 - 4) Herbs



Coffee Cherries



From, <http://www.ncausa.org/about-coffee/10-steps-from-seed-to-cup>

University of Houston Clear Lake
Symposium

Surface Issues (Facts)

- What city is the national capital of Australia?
(No fair looking at your phones, etc. for the answer!!!)
- 1) Sydney
- 2) Canberra
- 3) Melbourne
- 4) Perth





Surface Issues (Facts)

- Nothing dramatic needed:

Just correct the student! (Slater, 2017)



Digging Deeper: Medium Level

- **Algorithmic Thinking** (Dockett and Mestre, 2014)
 - Naïve Notions (the “common sense” pitfall)
 - Resource Activation (using fundamental notions as building blocks)
 - p-prims (diSessa, 1993)
 - facets of knowledge (Minstrell, 2001)
 - conceptual primitives (Clement, 1981)
 - cognitive construals (Coley and Tanner, 2012)

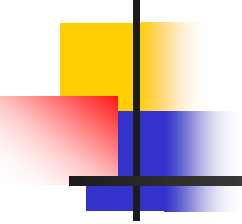
Medium Level: Naïve Notions

- No doubt that we have all seen these ideas from people:
- Heavier falls faster...
- Motion implies force...
- etc...



Think of the huge trees of a mature forest!

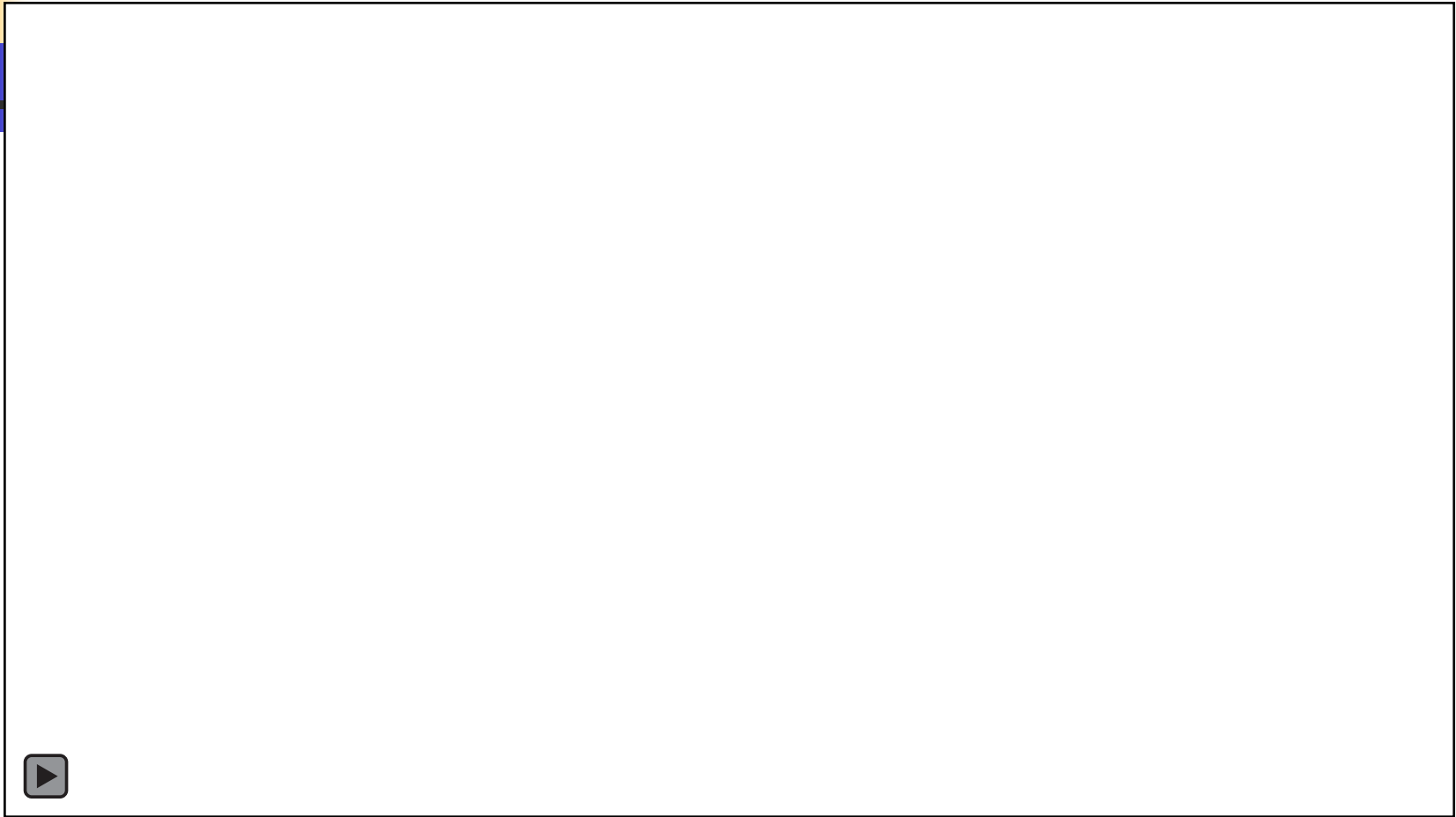
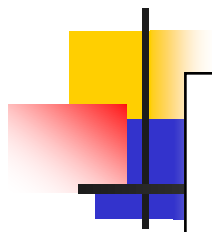




What is the primary source of the tree's mass?

- A. the Soil**
- B. the Air**
- C. the Water**
- D. the Seed**







A Classic Example

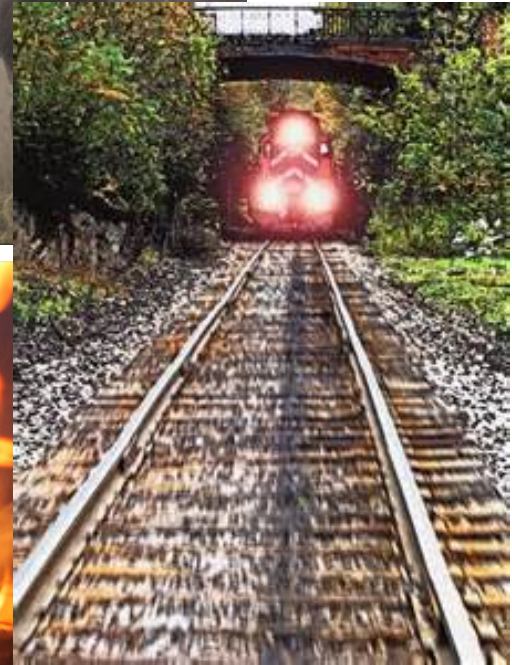


University of Houston Clear Lake
Symposium

Medium Level: Primitive Ideas

Primitive ideas are not necessarily a bad thing!

Example:
Closer = More





Medium Level: Some Primitive Ideas leading to Misconceptions

CLOSE MEANS MORE

It's hotter in the summer because the Earth is at the closest approach to the Sun in its orbit

MOTION REQUIRES FORCE

Spaceships need rockets on at all times to keep moving

INTERFERENCE

Net force on an electric charge near the positive charge of a dipole (the force due to the negative charge on the test charge is partially "blocked" by the positive charge)

CAN'T MAKE SOMETHING FROM NOTHING

Plant mass comes from the soil

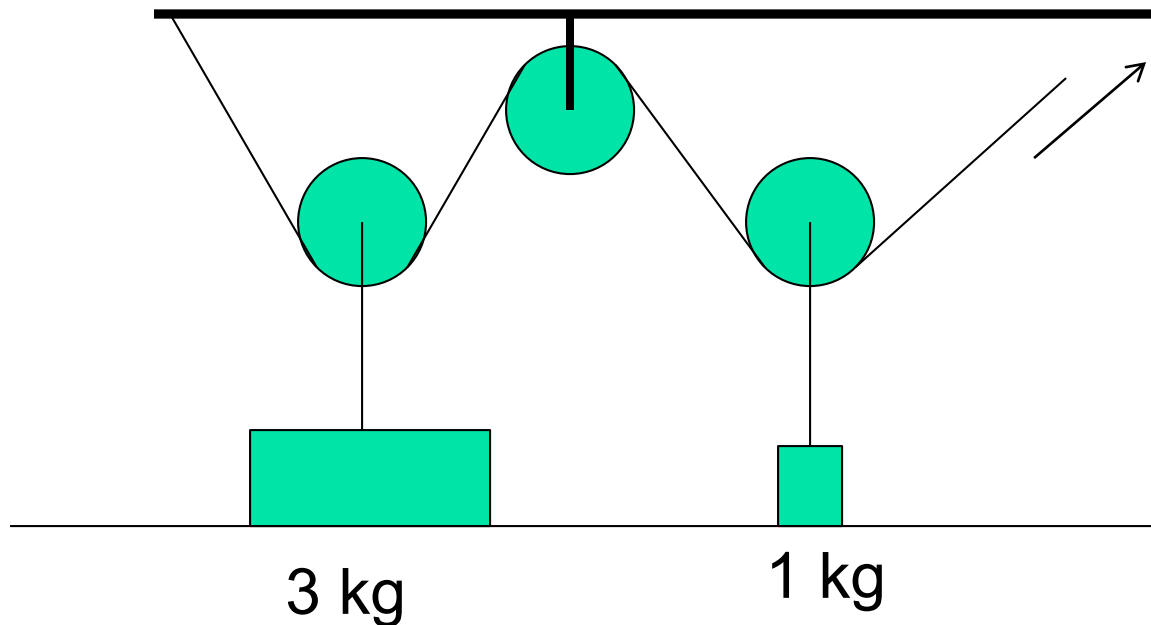


Medium Level: What to do?

- Guided Inquiry Learning
- Predict-Confront-Resolve

A Pulley Example

What will happen when you pull the string?



- (A) Both masses will move upward together
- (B) The 3 kg mass will move upward first, and then the 1 kg mass will move upward afterward
- (C) The 1 kg mass will move upward first, and then the 3 kg mass will move upward afterward



Pulley Video



Deep Level: Identity, Beliefs



Deep Level: Identity

- Student, “I am not a physics or science person...”



- Me, “Challenge accepted!”

Secret to Success!

PERSISTENCE

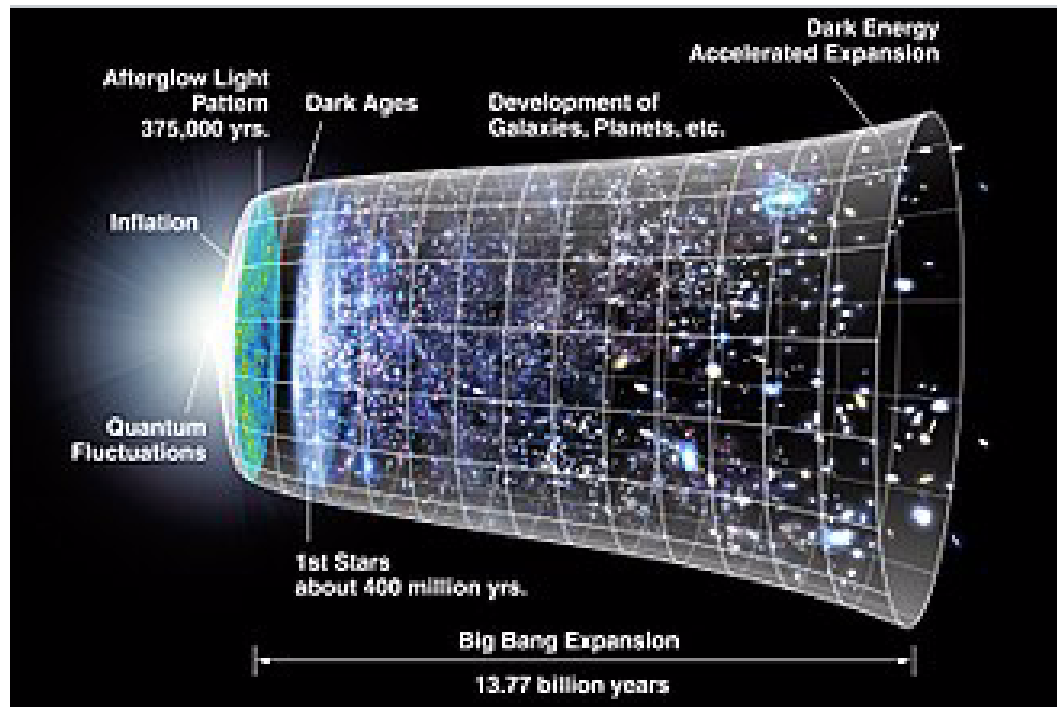
- “Nothing in this world can take the place of persistence. Talent will not; nothing is more common than unsuccessful people with talent. Genius will not; unrewarded genius is almost a proverb. Education will not; the world is full of educated derelicts. Persistence and determination alone are omnipotent. The slogan ‘press on’ has solved and always will solve the problems of the human race.” – Calvin Coolidge.



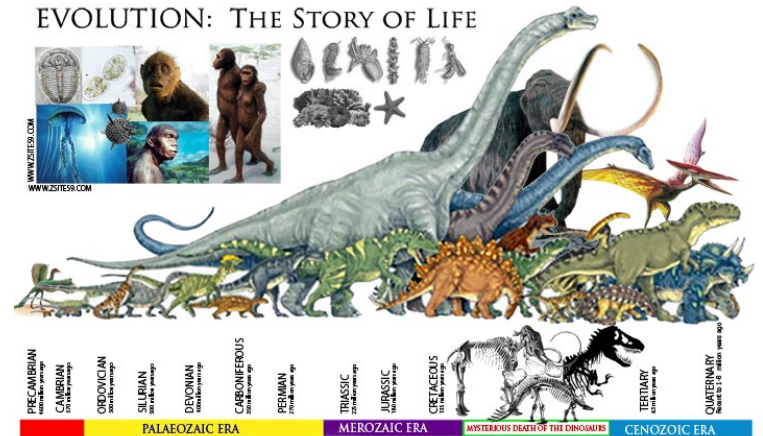
Shifting Personal Identity

- Explicit and Implicit Recognition (Wang, Hazari, 2018)
 - Do not only praise quality work (ER), but ensure that the task at hand is a genuine challenge (IR) and not busy work.
 - Promote feeling of accomplishment and successfully conquering a significant achievement – people see through busy work

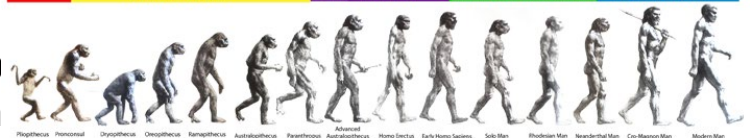
Deep Level: Personal Beliefs



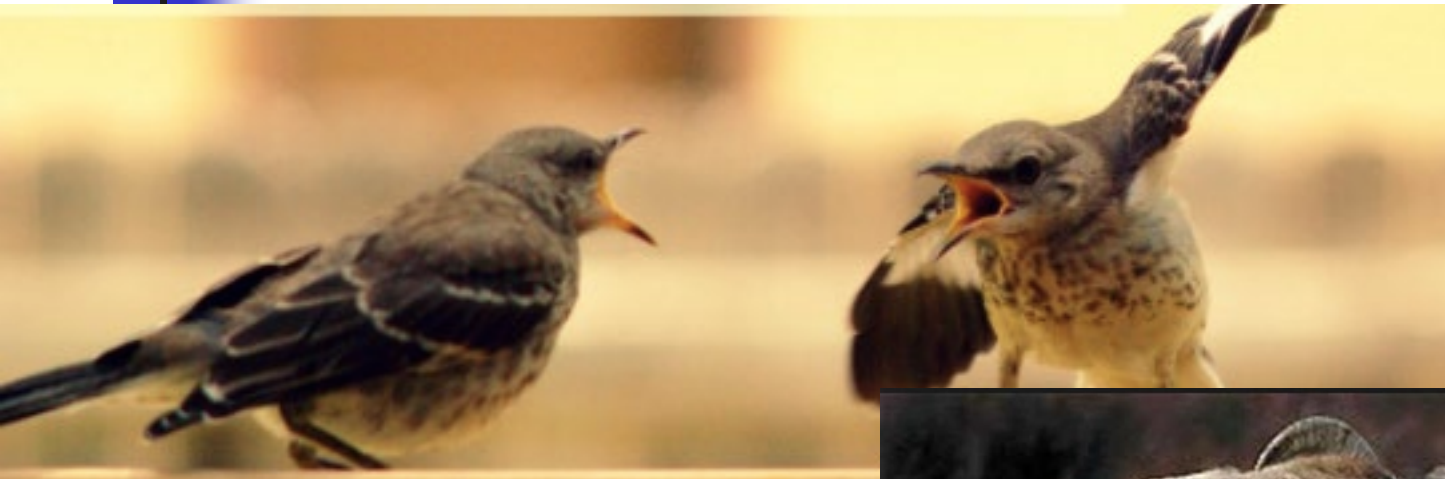
EVOLUTION: THE STORY OF LIFE



University of Houston
Symposium



What NOT to do!!!!



University of Houston Clear Lake
Symposium



Thanks!

- My thanks for the invitation to speak tonight!
- If you would like to chat more about Misconceptions or PER in general, I am happy to do so,
 - Email: erichards@lee.edu
 - Phone: 281-425-6310