Strategies for Conceptual Change: A tour of Misconceptions

Dr. Evan Richards
Physics Education Research (PER)
Lee College Physics Faculty
PER?

Stodonla, et. al. (2013)

From,

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

University of Houston Clear Lake
Symposium
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
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

University of Houston Clear Lake Symposium
Surface Issues (Facts)

- Nothing dramatic needed:

  Just correct the student!  (Slater, 2017)
Digging Deeper: Medium Level

- Algorithmic Thinking (Docktor 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 construls (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
…even for the most talented and best educated...

This is a tough one...
A Classic Example
Medium Level: Primitive Ideas

Primitive ideas are not necessarily a bad thing!

Example:
Closer = More
# Medium Level: Some Primitive Ideas leading to Misconceptions

<table>
<thead>
<tr>
<th>CLOSE MEANS MORE</th>
<th>It’s hotter in the summer because the Earth is at the closest approach to the Sun in its orbit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOTION REQUIRES FORCE</td>
<td>Spaceships need rockets on at all times to keep moving</td>
</tr>
<tr>
<td>INTERFERENCE</td>
<td>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)</td>
</tr>
<tr>
<td>CAN’T MAKE SOMETHING FROM NOTHING</td>
<td>Plant mass comes from the soil</td>
</tr>
</tbody>
</table>
Medium Level: What to do?

- Guided Inquiry Learning
- Predict-Confront-Resolve
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
Deep Level: Identity, Beliefs
Deep Level: Identity

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

- Me, “Challenge accepted!”
“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
What NOT to do!!!!!
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