The Education Leverage Point: Climate Change

Chris Browne, Barry Newell & Paul Compston
Australian National University
SEng 2013 Conference
Super-Simple Carbon Cycle

UNITs
STOCKS: Gigatons of Carbon
FLOWS: Gigatons of Carbon / year

ATMOSPHERE
(≈700)

TERRESTRIAL/OCEANIC/GEOLOGICAL
(≈50,000)

CARBON CYCLE
(further simplified)

Still from Workshop Orientation Video
The Bathtub Metaphor

What if we stop increasing emissions?
Even at the current emissions rate, CO2 is released into the atmosphere nearly twice as fast as it is removed—so the bathtub will continue to fill.

How do we cause CO2 emissions?
Four-fifths is from burning fossil fuels. Nearly all the rest is from deforestation and other changes in land use.

How does CO2 cause warming?
It absorbs some of the heat radiation coming off Earth’s sunbaked surface and reradiates it back downward.

Where does our CO2 go?
Plants and soil absorb about a third each year, and ocean surface waters about a quarter. The rest stays airborne for a long time.

IN
350 parts per million
9.1 billion metric tons a year

OUT
5 billion metric tons a year

How much is too much?
No one is sure. Some scientists think we need to reduce the CO2 level back down to 350 parts per million (ppm)—equivalent to 745 billion metric tons of carbon—to avoid serious climate impacts. But if current emissions trends continue, 450 ppm will be passed well before mid-century.

Hasn’t CO2 been this high before?
Not for at least 800,000 years, say the oldest air bubbles found in Antarctic ice cores—and probably not for millions of years.

http://ngm.nationalgeographic.com/big-idea/05/carbon-bath
Atmospheric CO$_2$ Concentrations
Anticipated trajectory to achieve 400ppm

Anthropogenic CO₂ Emissions
Possible solutions?

Tubs & Pumps
A Physical Analogue
# Metaphorical Mapping

<table>
<thead>
<tr>
<th>Carbon in the atmosphere (natural cycle)</th>
<th>Tubs &amp; Pumps parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon in the atmosphere</td>
<td></td>
</tr>
<tr>
<td>Natural removals</td>
<td></td>
</tr>
<tr>
<td>Natural additions</td>
<td></td>
</tr>
<tr>
<td>Carbon stored in ocean/geology/land/soil</td>
<td></td>
</tr>
<tr>
<td>Anthropogenic additions</td>
<td></td>
</tr>
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</table>
## Metaphorical Mapping

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<thead>
<tr>
<th>Carbon in the atmosphere (natural cycle)</th>
<th>Tubs &amp; Pumps parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon in the atmosphere</td>
<td>Small tub</td>
</tr>
<tr>
<td>Natural removals</td>
<td>OUT pump</td>
</tr>
<tr>
<td>Natural additions</td>
<td>IN pump</td>
</tr>
<tr>
<td>Carbon stored in ocean/geology/land/soil</td>
<td>Large tub</td>
</tr>
<tr>
<td>Anthropogenic additions</td>
<td>IN pump</td>
</tr>
</tbody>
</table>
Anthropogenic CO₂ Emissions
Possible solutions?

Anthropogenic CO$_2$ Emissions

‘Slow down growth’ solution

Anthropogenic CO₂ Emissions

‘Level-out’ solution

Anthropogenic CO$_2$ Emissions
‘Flat’ solution

Anthropogenic CO$_2$ Emissions
Slow to react, rapid decline

Anthropogenic CO₂ Emissions

‘Immediate action’ solution

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Anthropogenic Emissions

Correct Solution
## Interesting Observation

<table>
<thead>
<tr>
<th>Correct</th>
<th>Incorrect</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Decrease</td>
<td>Stabilise</td>
</tr>
<tr>
<td>Matched</td>
<td>83</td>
<td>29</td>
</tr>
<tr>
<td>Mostly Matched</td>
<td>4</td>
<td>107</td>
</tr>
<tr>
<td>Mismatched</td>
<td>0</td>
<td>39</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>87</td>
<td>181</td>
</tr>
</tbody>
</table>

Participants who got it right, had a strong match between written and graph.

Participants who got it wrong, tended to have a mismatch between written and graph.
Would Electric Cars make a difference?
CARBON IN THE ATMOSPHERE

10,000 years ago

200 years ago

Today

Higher

Lower

inflow

outflow

tub
cylinder

TIME
We’re looking for more groups!

Chris Browne
PhD Student (Systems)
Research School of Engineering
ANU College of Engineering and Computer Science

E: Chris.Browne@anu.edu.au
W: http://cecs.anu.edu.au/user/4172
W: http://tubsandpumps.info (coming soon)

SEng 2013 Conference
18 September, Canberra