Active Learning in Ten Minutes
Subtitled “Drinking from the Firehose”

Alan Cheville
Oklahoma State University
I will show you three items. Your task is to figure out how they are related.

\[
\begin{align*}
\nabla \cdot \mathbf{E} &= \frac{\rho}{\varepsilon_0} \\
\nabla \cdot \mathbf{B} &= 0 \\
\n\nabla \times \mathbf{E} &= -\frac{\partial \mathbf{B}}{\partial t} \\
\n\nabla \times \mathbf{B} &= \mu_0 \mathbf{J} + \mu_0 \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t}
\end{align*}
\]
The Professor’s Dilemma: Part I

Late one night Dr. Smith was running simulations on the computer in his office. He preferred to work with the lights off to avoid eyestrain. Furtive sounds, soft voices and rustling papers, broke through his concentration. Peering through the blinds in the small window on his office door, he saw several students from his electromagnetic fields class sifting through the homework submission box outside his office. Interested to see what they would do he watched them find two or three homework papers, remove them, and leave. Alerted several hours later by the same furtive sounds, he watched the students quietly return the papers to the homework box.

Write down answers to these questions to submit before the start of class:
Question #1) What do you think the students were doing?
Question #2) Did Dr. Smith act appropriately by merely observing?
Emotions:
- Anger
- Disappointment
- Frustration
- Fear

Realizations:
- I could not change my reactions without becoming hardened.
- I can’t change my students or the society they grew up in.
- I can design a system that makes cheating impossible.
System Model

Lecture

Homework

Test
<table>
<thead>
<tr>
<th>Knowledge Type</th>
<th>Remember</th>
<th>Understand</th>
<th>Apply</th>
<th>Analyze</th>
<th>Evaluate</th>
<th>Create</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factual Knowledge</td>
<td>![Image]</td>
<td>![Image]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conceptual Knowledge</td>
<td>![Image]</td>
<td>![Image]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedural Knowledge</td>
<td>![Image]</td>
<td>![Image]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive Knowledge</td>
<td>![Image]</td>
<td>![Image]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bloom’s Taxonomy – 1956, 2002
**Bloom’s Taxonomy – 1956, 2002**

<table>
<thead>
<tr>
<th></th>
<th>Remember</th>
<th>Understand</th>
<th>Apply</th>
<th>Analyze</th>
<th>Evaluate</th>
<th>Create</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factual Knowledge</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td>Conceptual Knowledge</td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
<td><img src="image10.png" alt="Image" /></td>
<td><img src="image11.png" alt="Image" /></td>
<td><img src="image12.png" alt="Image" /></td>
</tr>
<tr>
<td>Procedural Knowledge</td>
<td><img src="image13.png" alt="Image" /></td>
<td><img src="image14.png" alt="Image" /></td>
<td><img src="image15.png" alt="Image" /></td>
<td><img src="image16.png" alt="Image" /></td>
<td><img src="image17.png" alt="Image" /></td>
<td><img src="image18.png" alt="Image" /></td>
</tr>
<tr>
<td>Metacognitive Knowledge</td>
<td><img src="image19.png" alt="Image" /></td>
<td><img src="image20.png" alt="Image" /></td>
<td><img src="image21.png" alt="Image" /></td>
<td><img src="image22.png" alt="Image" /></td>
<td><img src="image23.png" alt="Image" /></td>
<td><img src="image24.png" alt="Image" /></td>
</tr>
</tbody>
</table>

"Reading"  
Active Learning  
Project  

Cover the matrix!
Active Learning – Diversity

One implementation I use in a optics for engineers class is shown to right.

There is no “right” or “better” method!
- Fit methods to your learning goals.
- Fit methods to your beliefs and values.
- There are wrong ways to implement, however.

Avoid slipping back into lecture. Lecture harms students!

Team Building: *One week at start of semester.*

Case Study: *Identify needed knowledge.* Puts problem in context and demonstrates relevance. *What do I need to know to accomplish this task?*

Active Learning: *Acquire knowledge.* Concepts required to accomplish project are learned individually and corrected through peer interaction. *How do I fit these concepts into my understanding of our task?*

Design Proposal: *Organize knowledge.* Instructor identifies and has students correct misconceptions. *How will I accomplish this task?*

Construct Project: *Apply Knowledge.* Student teams test which concepts are applicable to real engineering project. *How do I apply what I learned in class to this project?*

Final Report: *Communicate knowledge.* Students achieve expert status by knowledge transfer. *Which of these facts is most important?*

After Action Review: *Assess Knowledge.* Students evaluate others’ contributions and assess learning gains. *How much did I learn?*
Comparison of scores on composite concept inventory up to 18 months after courses.

Results of Student Assessment of Learning Gains done from start of reform until third year.
Take Home Lessons...

90% of students don’t need help, they need a hug

Learning Goals → Project  Project → Learning Goals

Environment, environment, realistic environment!
• Case Studies enable simple context creation.
• Recreate the environment of practicing engineer.
• Make tasks realistic!

Since learning is predicated on prior knowledge students may learn different things, and this is o.k.