EXAMPLES OF ACTIVE LEARNING

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An Active Learning Approach to Teaching Engineering

“Active learning engages students in the process of learning through activities and/or discussion in class […] It emphasizes higher-order thinking and often involves group work.”

Active learning increases student performance in science, engineering, and mathematics. Freeman et al, PNAS (2014)

Some forms employed by CASCE Lectures:

- Polling Questions / Think-pair-share
  - iClicker, Poll Everywhere
- One Minute Papers
- Interactive Lecture Demonstrations / Hands-on Activities

Interactive Lecture Demonstrations

<table>
<thead>
<tr>
<th>Hmm..</th>
<th>Predict</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huh?</td>
<td>Experience</td>
</tr>
<tr>
<td>/Woah.</td>
<td>Reflect</td>
</tr>
</tbody>
</table>

“students who passively observe demonstrations understand the underlying concepts no better than students who do not see the demonstration at all”

“Learning is enhanced, however, by increasing student engagement; students who predict the demonstration outcome before seeing it display significantly greater understanding.”

Classroom demonstrations: Learning tools or entertainment?
<table>
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<th>1. Relationship between stiffness and form</th>
<th>2. Relationship between steel and concrete design of reinforced concrete beams</th>
<th>3. Relationship between mass, stiffness, resonance earthquake engineering of buildings</th>
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<td><em>design of thin-shell concrete structures</em></td>
<td><em>design of reinforced concrete beams</em></td>
<td><em>earthquake engineering of buildings</em></td>
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1. Relationship between stiffness and form

*design of thin-shell concrete structures*

This is ‘cheating’!
Fingers cannot cross this line
How many Hershey’s kisses do you think that your structure can hold?

A: 0 – 4
B: 5 – 8
C: 9 – 12
D: 13 – 16
E: 17 – 20
F: >20

PollEv.com/cee262
OR
Text CEE262 to 37607
once to join then type A, B, C, D, E, or F

This image is a poll’s place holder.
Enter slide show mode (F5) to view your live poll.

You can resize this image to resize where your poll will load in slide show mode.

Make sure you’ve installed the PollEv Presenter app (pollev.com/app) and are connected to the internet!

If you need to duplicate this poll make sure to copy/paste the entire slide (not just the place holder image).
What general conclusions can you make about how to form stronger shells?

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What general conclusions can you make about how to form stronger shells?

- *it isn’t about how thin your structure is, it is about the FORM.*
- *curving a surface in one direction can create stiffness in other direction*
Find a partner (or two) and hold the sponge (beam) as shown with the **green side down**. Another person place a finger in the middle and push down.

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Where is the tension acting on this beam?

A. On the top (yellow)  
B. On the bottom (green)  
C. Everywhere (yellow and green)  
D. Nowhere

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2015 class response

- On the top (yellow): 10%  
- On the bottom (green): 87%  
- Everywhere (yellow and green): 3%

- Nowhere: 0%
FLIP THE SPONGE and hold the sponge (beam) as shown with the green side up. Another person place a finger in the middle and push down.

When you press down on the flipped sponge, is it now...

*stronger than before, weaker than before, or the same?*

Why is the sponge weaker when the yellow face is on the bottom?

*the bottom face is in tension and the yellow dried sponge cannot resist tension (like concrete)*

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In the reinforced concrete cantilever beam shown above, where should you place the steel bars?

A. Near the top  
B. Near the bottom  
C. In the center  
D. No idea!

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3. Relationship between mass, stiffness, resonance, earthquake engineering of buildings
Which of these "buildings" will sway the most in an "earthquake"?

A. Building 1  
B. Building 2  
C. Building 3  
D. Building 4  
E. It depends on the type of earthquake

PollEv.com/cee262  
OR  
Text CEE262 to 37607 once to join then type A, B, C, D, E

2015 class response

![Graph showing the 2015 class response to the question. The majority of responses are for Building 1, with 86% and 14% for the other options.]

Poll locked. Responses not accepted.
\[ T_n = \text{time required to complete one cycle of free vibration} \]
\[ = \text{“natural period of vibration”} \]
\[ = \text{seconds} \]

\[ T_n = 2\pi \sqrt{\frac{m}{k}} \]

\( k = \text{stiffness} \)
\( m = \text{mass} \)

The only difference between the “buildings” in this example is \( k \).
k for #1 is smaller, therefore \( T_n \) is larger.
How does the “speed” (period) of your hand shaking (earthquake) relate to building height?

**RESONANCE:** If you shake it at its resonant period, you will get *large vibrations*.

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**Case study:**
Mexico City Earthquake

“The event caused between three and four billion USD in damage as 412 buildings collapsed and another 3,124 were seriously damaged in the city.”

Most affected buildings of intermediate height - between 5 and 15 stories... WHY??

PollEv.com/cee262 - OR -
Text CEE262 to 37607 once to join then type response
Why were most affected buildings of intermediate height - between 5 and 15 stories?

- They had the right/wrong natural frequency
- Those buildings' resonance coincided with the period of the earthquake
- The frequency with which the ground was shaking matched the Tn for the buildings
- Their natural frequencies matched the frequency content of the earthquake
- The earthquake frequency matched intermediate buildings' resonance
- Earthquake frequency caused the most shaking at those heights
- Because high frequency
- Lack of a strong foundation, quick large vibrations
- The frequency of the earthquake was close to the resonant frequency of the buildings
- The earthquake must have had a high frequency
- Shorter - closer to the ground; taller - better built
- The time of the earthquake cycle was between 5 and 1.5 seconds

Resonance: the ground motion period was similar to the $T_n$ of those buildings

How can we control the vibrations of tall buildings?

one answer: Tuned Mass Dampers
Tuned Mass Damper: Absorbs the energy in resonance

Front view

Side view

Tuned Mass Damper: Absorbs the energy in resonance

Front view

Side view

NO DAMPER
Tuned Mass Damper:
Absorbs the energy in resonance

WITH DAMPER

Front view

Side view

Tuned Mass Damper:
Absorbs the energy in resonance
What structural concept, topic, idea about structures, or person/engineer will you never forget, and why?

“I really enjoyed learning [...] about how the curvature of a shell was more important that its thickness. Learning through chocolate was very good positive reinforcement for this lesson.”

“I will never forget the concept of reinforced concrete/where the reinforcement should go [...] due to the demonstration in class with the sponges. Seeing how the green scrubbing pad handled tension [...] really made the concept “concrete” in my mind and “reinforced” it visually (puns intended).”

“I will never forget the idea of resonance in skyscrapers... because of the wonderful demo... It was amazing watching different blocks move with different frequencies... (seemed like magic!).”

“I really enjoyed learning [...] about how the curvature of a shell was more important that its thickness. Learning through chocolate was very good positive reinforcement for this lesson.”

“I will never forget the concept of reinforced concrete/where the reinforcement should go [...] due to the demonstration in class with the sponges. Seeing how the green scrubbing pad handled tension [...] really made the concept “concrete” in my mind and “reinforced” it visually (puns intended).”

“I will never forget the tuned mass damper because I found it so cool that a massive steel ball could counteract the effects of earthquakes!”
94% of surveyed students indicated moderate, good, or great learning gains from lecture demonstrations.

“[..] a great mix of well-curated lectures, labs to complement what we were *actually* learning, and well-thought out demonstrations [..]”

“I think Professor Garlock did a great job in [..] developing students understanding of the topics through a variety of tools, such as powerpoints, videos, and fun demonstrations.”

“The class was very good in teaching unfamiliar material in a very comprehensible way.”

“I thought the class was well taught and appreciated the mixture of lecture, storytelling, mini experiments, and labs.”

“I thought that the science of structures would be really hard to understand for someone with an english/history mind like me but it turns out that civil engineering is not too intimidating.”