Scenario Based Learning
20 slides
20 seconds each
6 minutes, 40 seconds
965 words
no stopping
(the show must go on)
no questions
(until afterwards)
75% of engineering graduates are employed by “private industry or business”

82% of engineering students agreed with the statement “entrepreneurship education can broaden my career prospects and choices”

less than 20% of engineering programs “routinely practice” any type of business or entrepreneurship activity

only 16% of engineering faculty “routinely engage students” in entrepreneurship issues
Mechanical Engineering student:

5 “open elective” classes in four years

History student:

21 “open elective” classes
Orange Juice
Vitamin C

Orange Juice plus Calcium

Milk
Calcium
Scenario Based Learning

- Case Scenario (story, 6 pages)
- Lab Experiences (completed in groups of 4)
- Worksheets (record data, analysis)
- Homework (reflection and decision making)
Learning Content

- 17 core engineering concepts
- 15 entrepreneurial concepts

<table>
<thead>
<tr>
<th>Engineering Content</th>
<th>Madison Longboard 1: Choosing a Truck</th>
<th>Madison Longboard 2: Designing a Deck</th>
<th>Trek Bicycle Corporation: B-cycle Drive Train</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Free-body diagrams</td>
<td>Modulus of elasticity</td>
<td>Mechanical Advantage</td>
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<tr>
<td></td>
<td>Normal Force</td>
<td>Deflection</td>
<td>Output Load/Input Load</td>
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<td></td>
<td>Equilibrium Analysis</td>
<td>Neutral Axis</td>
<td>Gears</td>
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<tr>
<td></td>
<td>Moments</td>
<td>Cantilever beam</td>
<td>Speed Ratio</td>
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<tr>
<td></td>
<td>Moment Center</td>
<td>Bending stress</td>
<td>Multiple FBD’s</td>
</tr>
<tr>
<td></td>
<td>Planar Systems</td>
<td>Design for deflection</td>
<td></td>
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</tbody>
</table>

| Entrepreneurial Content | Business model | Value proposition | Revenue model | Cost model | Profit model | Vision statement | Mission statement | SWOT analysis | Business risk | Business uncertainty | Personas | Empathy map | Product planning | Interpersonal relationships | Vendor relations | |
|--------------------------|----------------|-------------------|---------------|------------|--------------|------------------|-------------------|---------------|---------------|-----------------------|----------|-------------|---------------------|-----------------------------|------------------| |
| Lab                      | Moveable weights, meter sticks, jeweler’s scale | Material samples, angle brackets, tube scale | Bicycle, blue tape, paint stir stick, tube scales |
Learning Theory

2. Hands-On Lab (Associating)
3. Team Discussion (Diverging)
1. Case Study (Converging)
4. Homework (Assimilating)

THINKING
Abstract Conceptualization

DOING
Active Experimentation

WATCHING
Observation and Reflection

Concrete Experience
FEELING

Processing Continuum
Perception Continuum

David Kolb
Learning Style Inventory (LSI)

Designing Education Lab
School of Engineering – Stanford University
Case Scenarios

Main Characters:
• Adam Probles
• Samantha (Sam) Brunhoff
Recent ME graduates
University of Wisconsin-Madison
Start-Up Business
Marathon Longboarding

Main Character:
• Matt Poster
Recent ME graduate
Madison Technical College
Urban Shared Bicycle
Choose a drive train

ML 1 - Trucks
ML 2 - Deck
Hands-On Lab Experience

Student teams of 4: 50-60 minutes

Truck Lab

Deck Lab

Bike Lab

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School of Engineering – Stanford University
In-Class Worksheets

Used to:
- Record data
- Calculations
- Free Body Diagrams

Encourages
- Communication skills
- Teamwork
- Peer instruction/learning

One worksheet per lab
Graded as homework
Homework

- Time: 20 minutes
- Chance to reflect on the learning
- Make a business decision/choice
- Ambiguous: more than one right answer
- Justify choice
Research Learning #1:
Introducing entrepreneurial content does not diminish the learning of engineering content

Pre-Post mean correct answers to Content Questions

<table>
<thead>
<tr>
<th>Questions</th>
<th>Correct Answers</th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Pre</td>
<td>Post</td>
<td>Increase</td>
<td>Difference</td>
<td>p ≤ #</td>
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<tr>
<td>Engineering (out of 10)</td>
<td>75</td>
<td>5.3</td>
<td>6.7</td>
<td>+26%</td>
<td>+1.4</td>
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<tr>
<td>Entrepreneurial (out of 10)</td>
<td>75</td>
<td>5.1</td>
<td>6.6</td>
<td>+29%</td>
<td>+1.5</td>
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<tr>
<td>Total (out of 20)</td>
<td>75</td>
<td>10.4</td>
<td>13.3</td>
<td>+28%</td>
<td>+2.9</td>
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</tbody>
</table>

# bold is significant

+2.9 mean correct answers overall – significant
+26% engineering – significant
+29% entrepreneurial – significant

Research Learning #2:
Students gain entrepreneurial self-efficacy by exposure to entrepreneurial concepts

<table>
<thead>
<tr>
<th></th>
<th>Pre Rating</th>
<th>Post Rating</th>
<th>Diff</th>
<th>p &lt;</th>
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</thead>
<tbody>
<tr>
<td>Entrepreneurial Self-Efficacy Rating</td>
<td>2.68</td>
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<td>Business Skills Self-Efficacy Rating</td>
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<td>2.63</td>
<td>+0.34</td>
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</table>

Bold – Significant p < .05

Research Learning #3:
This way of teaching results in high student satisfaction

Student Satisfaction with SBL Curriculum

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“Over the next five years, do you intend to work for ...”
Conclusions

- engineering students can learn business concepts
- without diminishment of engineering learning
- minimal change to instruction
- case scenario instruction is engaging
- builds business self-efficacy
Teaching Challenges

• Challenge:
  – Time. “Carving Out” classroom and assignment time for topics beyond those traditionally covered. Some topics are lost.

• Approach:
  – Carefully identify the key mechanics topics, concepts and procedures that are core to the course; reduce time spent on everything else
Teaching Challenges

• Challenge:
  – Introducing topics of design and business may be a stretch for some faculty

• Approach:
  – Partner with an expert in business and entrepreneurship
  – Engage TA’s – they may know more than you think
Teaching Challenges

• Challenge:
  – Finally … adds complexity, a touch of chaos, no doubt about it.

• Approach:
  – Also adds energy … as students work (and argue) with one another about how to use the mechanics and business ideas to make well thought out decisions on product direction.
Next Steps

• Two additional scenarios
  – Yosemite Bridge (Truss Analysis)
  – Baby Buffalo (Beams, S&BM Diagrams)

• Instructor Notes/Lab Videos

• Expand schools
  – UW-Madison, UC-Merced
  – Epicenter UIF
Bending Moments to Business Models: Integrating Entrepreneurship as Part of Core Mechanical Engineering Curriculum

Questions?

Kezia Alfred

Matt Bandelt

Jose Gutierrez

Sheri Sheppard

Sarah Billington

Paul Mitiguy

Designing Education Lab
School of Engineering – Stanford University