Example Application: Learning Objectives
Created for Axial and Torsional Loading

Axial:
1. Distribution of the normal stress across a bar’s cross section.
2. Visualizing the stress distribution and the distortion of an appropriate stress element.
3. Real devices that produce axial stress.
4. Recognizing the two-force member simplification and its importance.

Torsional:
1. Difficulty understanding how a bar in equilibrium with two or more applied torques can have an angle of twist that is not zero.
2. Difference between shear and normal stresses.
3. Visualizing the stress distribution and the distortion of an appropriate stress element.
4. Real devices that produce torque.

Difficult Topics

Define Educational Goals based on
a. Developer Experience — In what areas do the students need to improve? What are the overall goals of the class?
b. Educational Theories - What level of Bloom’s Taxonomy does the goal work towards? Will the goals appeal to all Felder’s learning styles? What part of the Kolb cycle is the goal striving to improve?

Understand the Educational Goals
Generate Ideas

a) **Mind Mapping** - Mind maps organize idea generation and facilitate the discovery of categories of ideas. Mind maps begin with the problem statement or a sub-problem written in the middle. Ideas are then added by branching out from the main topic. As categories are observed or come to mind, the category is circled and members of the category radiate out from it. Example Application: Create a mind map of ALP concepts for Axial and Torsion loading.

b) **Analogies** - Analogies are a well-recognized tool for use in the idea generation process. Analogies can be thought of as products that perform similar functions to the active learning product we are developing. What in classroom lessons have you enjoined in the past? What positive classroom learning experiences can you remember? Example Application: How could these experiences be incorporated in an ALP for Axial and Torsional loading?

Define Difficult Topics

1. **Syllabus** - The topics that span the course content are identified in this step. These topics should represent the “essence” of the course.
2. **Prior teaching experience**
3. **Survey of other professors**
4. **Literature**
5. **Results from Concept Inventories**
6. **Student comments** - Student feedback on difficult topics are another viable source of information.
c) **Literature Review** - How has the topic in the past been taught? Review papers and articles. Organizing the topic found in a Mind Map for quick reference.

d) **Checklists** - When idea generation begins to trickle, they provide a tool for restarting the process.
   i. Felder’s Learning Styles
   ii. Kolb Cycle
   iii. Bloom’s Taxonomy
   iv. Lab to In-Class Activity Checklist

e) **External Sources** – Places to look for more ideas
   i. Internet
   ii. Reference Texts
   iii. Craft store
   iv. Hardware Store
   v. …

Generate Ideas

b) **Pugh Charts** - After generating a large number of ideas for activities, they need to be reduced to a workable number and be embodied into complete activities. A Pugh chart may be used to compare concepts across chosen criteria and relative to a chosen reference point. “S” or “0” means the same as the reference, “+” means better than the reference, and “-” means worse than the reference. Ratings are summed, negatives in concepts are attacked, and concepts may be combined.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Deformable rubber sheet</th>
<th>Deformable foam shaft (pool noodle)</th>
<th>Visualization of a stress element using a eraser</th>
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<tbody>
<tr>
<td>Shows stress element on a object well</td>
<td>-</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Shows axial loading well</td>
<td>+</td>
<td>S</td>
<td>+</td>
</tr>
<tr>
<td>Shows torsion well</td>
<td>-</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Shows bending well</td>
<td>-</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Low cost</td>
<td>-</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Easily visible stress element</td>
<td>-</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Example Pugh Section Chart

Deformable rubber sheet
Deformable foam shaft (pool noodle)
Visualization of a stress element using a eraser

<table>
<thead>
<tr>
<th>Concept</th>
<th>Criteria</th>
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<th>2</th>
<th>3</th>
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<tbody>
<tr>
<td>Deformable rubber sheet</td>
<td>Shows stress element on a object well</td>
<td>-</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Deformable foam shaft (pool noodle)</td>
<td>Shows axial loading well</td>
<td>+</td>
<td>S</td>
<td>+</td>
</tr>
<tr>
<td>Visualization of a stress element using a eraser</td>
<td>Shows torsion well</td>
<td>-</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Shows bending well</td>
<td>-</td>
<td>S</td>
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<td></td>
<td>Low cost</td>
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<td></td>
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<td>-</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Idea Selection
Idea Selection

- **Morph Matrix** - A Morph Matrix provides a way to organize concepts compared to educational goals and difficult topics. Fill in check boxes for the Educational goals and difficult topics covered for each concept created. Can two concepts be combined to cover more topics? What topics are not covered? Example Application: If time permits, return to concept generation for axial and torsional loading and work on concepts for the remaining topics.

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**Evalulate ALPs**

After creating an ALP, evaluate their effects on student learning. Is there a measurable improvement in students understanding of material?

Some ways to measure students understanding of the material:

- a. Short answer questions
- b. Solve a problem
- c. Multiple choice questions
- d. Free recall of facts remembered from lecture
- e. Exam grades
- f. Homework grades
Active Learning Product (ALP)

Design Methodology

Active learning products (ALPs) are hands-on lessons, demonstratives, manipulatives, multi-media tools, short projects, and homework activities that provide alternative approaches and complementary material to typical lectures or textbook materials on STEM topics. ALPs are meant to address the variety of learning styles and personality types of students. The purpose of this methodology is to systematically guide the process of developing ALPs. This methodology assists in making the development process efficient and effective for instructors with any background.
Understand the Education Goals and Objectives

- Define stakeholders and collect stakeholders’ input

**Contextual Needs Assessment Method**

<table>
<thead>
<tr>
<th>Usage Factor</th>
<th>Usage Context</th>
<th>Product Attribute Preferences Impacted</th>
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<tbody>
<tr>
<td>Class Size</td>
<td>~20</td>
<td>30-50+</td>
</tr>
<tr>
<td>Classroom</td>
<td>Virtual</td>
<td>Large lecture hall</td>
</tr>
<tr>
<td>Type of Students</td>
<td>Non-traditional</td>
<td>Traditional</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amount of possible scaffolding from life experience</td>
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</table>

- Define Educational Goals Based on Stakeholders Input
- Prioritize Goals and Determine Metrics
- Select topic(s) for developing ALPs based on goals and metrics