Utilizing Concept Maps to Improve Engineering Course Curriculum in Teaching Mechanics

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Evaluating Overall Student Learning

The current process is insufficient
Concept Map

Cone

such as a

such as a

consists of a

has a

which can be

which can be

Level 1

Level 2

Level 3

Flavor

which can be
Why can we learn from concept maps?

**Organizing Knowledge**
Students can easily place what they know in a concrete way that is accessible enough to be analyzed by instructors.

**Find Connections**
Educators can associate where students are having overlaps in the curriculum and what terms students associate the most.

**Improving Classroom Experience**
Educators can change curriculum if the concept maps do not match their planned outcome of the class.
In Class Labs
Students work in pods, or groups, to solve real problems

Exams and Problem Sets
In the ‘normal’ part of this class, students do work that covers the topics discussed in lecture.

Extra Content
Students make business and design choices that are directly related to engineering problems
The Assignment

Create a concept map on the overall class topics

Use Connector Words

List of Topics Given

90 students completed assignment
Point System: Encoding a Concept Map

04  Level One
    Assigned to the center term

02  Level Two
    Assigned to the terms connected to the center term

01  Level Three
    Assigned to the terms connected to the Level Two terms
Round 1 Results

Statics

- Equilibrium
- Forces
- Moments
- FBDs
- Analysis

- Friction
- Stress
- Structure
- Beams
- Trusses
- Loads

Materials
Design
Labs
Business
Round 1 Positive Outcomes

1. **Analysis and Forces central concepts**
   - Students grasped primary intentions of class

2. **Structure was mostly as intended**
   - Statics was center term, surrounded by three big concepts of class, which were followed by subtopics

3. **Uniformity**
   - The low levels of student created concept maps were similar and the same terms or synonyms were used by each student
Round 1 Issues

- Missed several key elements
  Shear stress, ethics, and tension were left out of a large amount of maps

- Focused on frequency
  Maps only were analyzed by how often a word showed up and did not take into account context.

- Synonyms
  It was difficult to combine synonyms as students would use many different words to describe the same topic.
How can we identify context?
Round 2 Analysis

- Allows for deeper insight into student thought process
- Sequence, not just frequency

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<thead>
<tr>
<th>Higher Level</th>
<th>FBDs</th>
<th>Lower Level Nodes</th>
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<tbody>
<tr>
<td>Statics</td>
<td></td>
<td>Joints Forces Friction</td>
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<tr>
<td>Statics</td>
<td>Assumptions</td>
<td>Axes External Forces</td>
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<td>Statics</td>
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<tr>
<td>Forces</td>
<td>Systems</td>
<td>Shear Tension</td>
</tr>
</tbody>
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Round 2 Positive Outcomes

**Successful Labs**
Students are using labs to analyze problems rather than just doing them.

**FBDs and Equilibrium mutually related**
Only pair pointing mutually connected, meaning that students understand that FBDs and equilibrium are dependent.

**Variety**
Students identified topics from nearly all of the course, including the more complicated joints, trusses, and loads.
Round 2 Issues

Absence of Ethics
Students either did not get a solid understanding of ethics or did not associate it with an engineering concept.

Isolation of moments
Not a lot of connections were made to the moments term, which has a reputation of being a difficult concept.

No Connector Words
Few students had connector words, and those that did used them in many different ways.
Round 1 vs Round 2
Engineering analysis involves forces found using math like dot product and vector product. [These] forces are found using formulas, equilibrium equations, [or] moments. Forces consider friction, [which are either] kinetic [or] static. Engineering analysis [is] done in reference to design, [which is] created for business plans. Design [is] usually of structures such as trusses [and] cantilevers. Structures [can be] analyzed by methods of joints, methods of sections, [and] rechecks. Structures must be ethically sound (meaning oversight and approval of licensed engineers [and using] safety factor above legal obligation), well-designed so [it] holds up given physical stress/strain [and] in equilibrium, [and] statistically determinant.
How can we improve concept maps

- **Providing list of words**: The structure of terms will make it easier for both students and educators.
- **Using in class examples**: Make it clear and easy by using an easy to relate to example like ice cream.
- **Emphasizing Importance**: Allow students to feel that their work will impact future class years.
- **Using connectors**: Teach and encourage students to relate their terms and explain in short connections.
The Assignment: Revised

Create an organized concept map on the overall class topics

Use Required Connector Words

List of Topics Required in Checklist
Using Concept Maps in the Future

• Create concept maps before and after quarter

• Use concept maps on individual topics rather than entire course

• Analyze concept maps with alternate point systems
Acknowledgements
Thank you!
Questions? Comments?