Improving Conceptual Knowledge and Retention in Introduction to Engineering Thermodynamics

**Context**

**CBEN 210 at a Glance**
- **Enrollment**
  - Fall 15: 206
  - Spring 16: 74
- **Class size**
  - 30 to 72
- **Grades**
  - Avg. GPA: 2.84
  - DFW: 17.2%

**Motivation**

**Thermodynamics Knowledge**

1) **Procedural**: the ability to effectively solve domain problems
2) **Conceptual**: understanding of principles governing a domain

**Performance**

**Scores consistently lower on conceptual problems**

**Examples**

**Procedural Problem**: A piston-cylinder contains 0.155 kmol of an ideal gas at 325 °C. The gas is isobarically compressed to half the volume. Find Q (kJ). [963 kJ]

**Conceptual Problem**: True/False: If air is expanded in an adiabatic piston-cylinder, the temperature will increase. [False]

**Changes**

**Group work**
- Interactive
  - Group problems
  - Peer assessment
  - Partner explanations

**Scaffolding for retrieval**

**New material ↔ Existing networks**

**In-Class Activities**

- State to State
  - Ideal Gas or
  - Steady State or
  - Controls

**Reflection**

- Think of a real-life example/analogy
- Identify alternate approach
- Sketch process path on phase diagram
- Write an increase/decrease statement
- Find an intermediate step that can be verified

**Assessment**

**Conceptual Material**

- **Course Exams**
  - Procedural vs. Conceptual problems
- **Final Exams**
  - Historical comparisons
  - Exact same problems
- **Student Evaluations/Surveys**
  - Retention
  - Concept Inventory
    - Multiple choice, pictorial
    - Includes common distractors
- **Administered in later course**
  - CBEN 210
  - Retention Time Scale
  - Group work
  - Class Activity Topics
  - Reflection

**What is conceptual knowledge?**

“understanding of principles governing a domain and the interrelations between units of knowledge in a domain”

**Why are concepts important?**

- Help categorize knowledge
- Develop intuitive expectations of physical systems
- Engineering judgment
- Enhance knowledge transfer to new problems

**What makes concepts hard?**

- Often stem from misconceptions
  - need to “re-wire”
- Tied to high levels of learning taxonomies
- Require organizing key principles
  - like content experts

**References**


Rachel Morrish is a Teaching Associate Professor in the department of Chemical and Biological Engineering. She has taught at CSM for 6 years and in fact attended as an undergraduate. She teaches core courses in chemical engineering primarily at the sophomore and junior level including thermodynamics, material and energy balances, and summer field session.

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