Thermodynamics and the Learning-Centered University

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Engineering and Computer Science Faculty Meeting
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Outline

● Background
● Teaching method
  – Spend 50% of class time on group work
  – Use weekly quizzes to keep students current
● Assessment
● Conclusions
Background

- Personal motivation for this approach
  - Long term interest in getting students involved with discussion during lecture
  - Educational research shows benefits of active learning versus lecture for student learning
  - Survey data shows that students now spend less time outside of class doing work than previously

- ABET wants assessment and improvement

- Learning-centered university
Koester on a learning centered university (August 21, 2003)

- Learning in and outside classroom
- Specified learning outcomes
- Shift focus from teaching to learning
  - Learning is “cumulative consequence and judgments for all aspects of the learning environment”
- Document what students learn
ABET accreditation criteria are learning centered

- ABET has already focused engineering education on cumulative result
  - Having graduates meet overall objectives and outcomes is key to accreditation
  - ABET also emphasizes assessment and continuing improvement
  - Improvement means that we have to examine our practices as they effect student learning
  - ABET requires documentation of results
How to improve student learning in an individual class?

- Basic assumptions
  - Students do not devote much time outside class to work on homework problems to learn material
  - In class lecturing, without active student participation is not effective use of time
  - Students need motivation to learn material on a regular basis
- Each of these is addressed by the practices discussed here
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How Larry teaches thermodynamics

- The course is organized into twelve subject-matter units, each taking one week.
- Each unit has the following time distribution:
  - 30 to 40 minute lecture with student feedback on new course material on day N.
  - 75 minute group work session solving problems on new material with instructor providing help as needed on day N+1.
  - 30 minute quiz on material with 5 to 15 minutes of follow up discussion of quiz on day N+2.
**Weekly Schedule of Activities**

<table>
<thead>
<tr>
<th>Tuesday</th>
<th>Thursday</th>
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<tbody>
<tr>
<td>Quiz on previous week material – 30 minutes</td>
<td>Group problem solving</td>
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<tr>
<td>Feedback 5 – 15 minutes</td>
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<tr>
<td>Lecture on new material 30 – 40 minutes</td>
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Group problem-solving sessions

- Students self select groups (3 to 5 students)
- Problems handed out at start of class
  - Typically two problems to illustrate essential kinds of problems for week’s material
  - First problem is subdivided into steps that lead students through solution
  - Second problem does not provide steps
- Solutions posted on web after class
Instructor role in group work sessions

- Prepare and hand out problems
- Get students working and encourage group interaction in dysfunctional groups
- Answer group questions and interrupt all groups to clarify common questions
- Lead discussion in final five minutes to review what students have learned and give hints for unsolved problems
Typical semester schedule for 30 classes of 75 minutes each

- 24 days to cover 12 instructional units with the cycle of lecture – group work – quiz
- 1 day for introductory lecture
- 2 days to review for midterm and administer midterm
- 2 days at end of semester for final review
- 1 holiday
Course elements and weighting in final grade

- Homework assigned but not collected; solutions posted on course web site
- Quizzes count 30% of total grade
- Midterm 20%
- Final 30%
- Writing assignment 10%
- Design project 10%
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Students value of course elements for their learning

- Quiz
- Lecture
- Group
- Text
- Homework
- Writing
- Design
- Midterm
- Final

Spring 2003
Fall 2003

Very useful
Useful
Somewhat useful
Not useful
Students’ perceptions of course material and work required

- Time: Somewhat more in Spring 2003 compared to Fall 2003.
- Amount: About the same.
- Difficult: Much more in Spring 2003 compared to Fall 2003.
- Understand: Somewhat less in Spring 2003 compared to Fall 2003.

Graph showing comparisons between Spring 2003 and Fall 2003 for time, amount, difficulty, and understanding.
No statistically significant difference in grade distributions

- Spring 2003 (N = 20)
- Fall 2003 (N = 30)
Students self-evaluation of how well they learned course topics

- Properties
- First Law
- Systems
- Assume
- Entropy
- Max Work
- Eta_s
- Cycles

Very good
Good
Adequate
Poor
Very poor

Fall 2003
Conclusions

- Curricula to meet ABET 2000 are consistent with idea of learning-centered university
- This presentation covers one approach for teaching one course
  - Only two classes with a total of 50 students and no control group
- With this approach, students assess group work and weekly quizzes as most helpful items in learning