Problem Based Learning: A View From the Trenches

Amy Pritchett
AE3515: System Dynamics and Automatic Controls

<table>
<thead>
<tr>
<th>Professor</th>
<th>GPA</th>
<th>A%</th>
<th>B%</th>
<th>C%</th>
<th>D%</th>
<th>F%</th>
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- Required
- ‘Non-intuitive’
  - Frequency? Laplace transform?
- Jam-packed
- Often can only be taken in spring junior year
  - Pre-reqs
  - Class full
- Failure delays graduation a year
  - D-F-W rates 17-55%
Also taking a broader viewpoint...

Undergraduate (BSAE) Program Educational Objectives

1. Our graduates will have the necessary understanding of the essential disciplines ...

2. Our graduates will be well trained to function as professionals who can formulate, analyze, and solve open-ended problems that may include economic, environmental, and social constraints.

3. Our graduates will have good communication skills and be able to function well in teams and in a global environment.

4. Our graduates will be trained to be lifelong learners who can continuously acquire knowledge required to research, develop, and implement next-generation systems and applications.

Corresponding Instructional Format

1. Anything that transmits information or motivates finding the right information

2. Instructional format that:
   • Requires students to act as professionals
   • Creates ‘authentic’ experiences with formulating and solving open-ended problems
   • Problems can’t be canned or decontextualized away from broader context

3. Instructional format that:
   • Requires students to communicate
   • Requires students to work in teams

4. Instructional format that:
   • Teaches students on approaches to reflecting on knowledge and knowledge gaps, and translating this into effective information gathering and assembling of concepts
   • Requires students to research and investigate on their own, and identify key information needs
## Course Goals

<table>
<thead>
<tr>
<th>Foundational Knowledge</th>
<th>Fundamental Concepts (fairly long list)</th>
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<tr>
<td><strong>Application Goals</strong></td>
<td>Ability to break dynamic systems down into component dynamics which can be modeled as first and second order systems</td>
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<td>Use toolset of fundamental modeling concepts to create useful models of system dynamics</td>
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<td></td>
<td>Use toolset of controller design concepts to create useful compensators</td>
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<td></td>
<td>Develop practical insight as to how aerospace vehicles can be modeled, and how to describe dynamics</td>
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<td>Present to a technical audience that has requirements and shared vernacular and methods</td>
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<td><strong>Integration Goals</strong></td>
<td>Understand how many things can be observed in the s-plane</td>
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<td>Understand how earlier dynamics lessons can be taken further, with bigger math</td>
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<td>Be ready to envision an aircraft as a set of transfer functions or state space model</td>
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<td><strong>Human Dimension</strong></td>
<td>Approach a large class of problems with confidence that they can model its dynamics, and design a compensator -- insight into what is some sort of engineering magic instead of trial and error</td>
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<td>A desire to create a model basis and remaining in control of the analysis and design, rather than acting like monkeys with Matlab when modeling or designing</td>
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<td><strong>Learning-How-To-Learn</strong></td>
<td>Agency – taking charge of the situation rather than saying ‘you may teach me now while I play Angry Birds on my phone’</td>
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<td></td>
<td>Not trying to google a solution rather than figuring it out themselves</td>
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<td>Experience open-ended problems and reason through solution</td>
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Spring 2012: Problem-Based Learning (PBL)

+ Student teams given real problems
  - One problem at a time, 3-4 weeks each, 4 problems total
  - *Any student in the team may be asked to give the presentation at the end...*
+ Most classtime is used for teams to coordinate on solving problems (‘flipping the class’ 3 of 4 hours / week)
  - They’ll have to do plenty of research outside of class
  - They can request lectures on topics – ‘agile instruction’ 1 hour/week
+ Students ‘own’ the problem
  - Students may experience failure within a problem within the class – it’s the best learning experience!
  - But, they are carefully supervised and graded according to *how they approach the problem* by ‘facilitators’ – they are not abandoned
    - Facilitators: 4 graduate student volunteers + 1 TA
+ Grading a combination of:
  - Process measures (weekly inquiry sheets, periodic peer-evaluations)
  - Scores on problems
  - Quiz or mid-term after every problem, final exam
Problem #1

To complete this design plan, you will need to:

+ Design and build a prototype seismograph using cheap, common materials and without requiring specialized tools or systems.
+ Document the design in a manner that others can build it. Identify key tuning parameters that impact its sensitivity – and the likelihood of a large input saturating its measurement capability.
+ Develop the system’s transfer function (i.e. equation relating its output to any inputs created by moving its base), including an impulse (delta function), step and sinusoids (of any frequency) of constant or exponentially decaying magnitude.
+ Establish a calibration procedure for others by which they can test their seismograph and use their test results to parameterize a generic transfer function into a specific description of their system.
+ Establish how common measures of transient response following an input can be estimated from the transfer function.
+ Document the seismograph design, derivation of the general transfer function, and calibration procedure in a report.
+ Defend the same in a 15 minute presentation to a technical review panel such as would be hired by an NGO or scientific agency that is looking to mass produce and distribute such seismographs, with 5 minutes for them to question you. Such a presentation demands proper use of appropriate terms and nomenclature.
Problem #3
Pragmatic Issues

+ Writing a ~2 page problem statement is a black art
+ Finding facilitators: Mostly relying on graduate student volunteers
  - Ideal option would be 10 TAs at ¼ time each, but TAs are integers and only 1 TA is typically assigned to this course
    - Could be better worked if more courses were PBL and TA duties could be distributed across courses/sections
  - Volunteers recognized via AE8803 P/F “Teaching Practicum” – doesn’t count towards their degree
+ Finding/assigning rooms:
  - OSCAR generally only allows 1 room per course (maybe a recitation room) – not 10-20 breakout rooms
+ Course size:
  - Originally capped at 92 students – projected 10 groups, 9 students each
  - Phase 2 registration found an additional 32 students needed the course to take Senior Design in the fall – ended up with 10 groups, 12-13 students each
Grades So Far

<table>
<thead>
<tr>
<th>Grades</th>
<th>Percentage</th>
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<tr>
<td>A (&gt;90)</td>
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<tr>
<td>B (80-90)</td>
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<td>C (70-80)</td>
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<tr>
<td>D (60-70)</td>
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<tr>
<td>F (&lt;60)</td>
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Bars represent:
- Quizzes
- WeeklyInquiry'
- Problems
- Overall (Interim)
Most Recent Quiz Score

![Quiz 2 grade distribution graph]

- Grade [0,10]: 0 students
- Grade [10,20]: 3 students
- Grade [20,30]: 5 students
- Grade [30,40]: 5 students
- Grade [40,50]: 11 students
- Grade [50,60]: 12 students
- Grade [60,70]: 13 students
- Grade [70,80]: 18 students
- Grade [80,90]: 19 students
- Grade [90,100]: 28 students
- Grade [100]: 8 students
Some More C21U Musings...

+ Within classical instructional model sheer logistics – including TA assignments and OSCAR room assignments – can be profound obstructions
  - Especially, ideal of 1 facilitator per 6 students

+ If our community as a whole valued instruction at all levels then:
  - Upperclassmen could mentor as part of community – and professional development
  - Graduate students could facilitate groups as part of community – and professional development
  - Could extend to alumni relationships back to GT, and to outreach

+ Indeed, perhaps we not only seek lifelong learners, but also would like to be the source of lifelong teachers?