Evidence from Blended Learning, a Flipped Classroom, and Mastery Grading

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Outline

• The motivation for change
• Course redesign – details
• Three implementations
• Lessons learned
An Anatomy Lesson
Domains Of Knowledge
Converting Theory Into Practice

AFFECTIVE feeling

COGNITIVE informing

PSYCHOMOTOR doing

Calculus

Rigor
Repetition
Precision
Limit theorem
Taylor series
Calculus
Rigor
Repetition
Precision

Limit theorem
Taylor series
... Building A Curriculum...
...More Building...
...More Building...

<table>
<thead>
<tr>
<th>Rigor</th>
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<th>F = ma</th>
<th>E = mc²</th>
<th>Experimentation Lab reports</th>
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<th>Periodic table</th>
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Calculus | Physics | Chemistry
Integrated First Year Experience

- Rigor
- Repetition
- Precision
- Limit theorem
- Taylor series
- F = ma
- E = mc²
- Experimentation
- Lab reports
- Experimentation
- Lab reports
- Periodic table
- DNA
- RNA
- Proteins
- Memorization
- Pre-med

- Calculus
- Physics
- Chemistry
- Biology
Second Year Maps to FE Exam

Circuits | Mechanics | Thermodynamics | Molecular Biology
---|---|---|---
Calculus | Physics | Chemistry | Biology
Cool, Now I’m Doing ‘Real’ Engineering

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<th>Design</th>
<th>Technical Elective</th>
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“Street Ready” Engineers

Capstone

Depth Elective

Experimentation

Design

Technical Elective

Circuits

Mechanics

Thermodynamics

Molecular Biology

Calculus

Physics

Chemistry

Biology
“Street Ready” Engineers

ABET a-k Outcomes

a) Math, science, engineering principles
b) Design conduct experiments
c) Design system component
d) Function on teams
e) Identify formulate solve problems
g) Communication
k) Modern engineering tools
Oops. Maybe We Missed Something?
Oops. Maybe We Missed Something?

f) Ethics
Oops. Maybe We Missed Something?

f) Ethics

h) Global context
Oops. Maybe We Missed Something?

f) Ethics

h) Global context

i) Life long
Oops. Maybe We Missed Something?

f) Ethics

h) Global context

i) Life long

j) Contemporary
Back Into Our Bag of Pieces
Alright, Now We’ve Got Our Pieces

English

History

...and other stuff

...and other stuff

...and other stuff

...and other stuff
“Street Ready” Engineers

Depth Elective

Circuits

Calculus

Physics

Mechanics

Thermodynamics

Chemistry

Biology

Technical Elective

Molecular Biology

Design

Experimentation

Capstone
Now We Squeeze To Find Room...

- Calculus
- Physics
- Chemistry
- Biology
- Circuits
- Thermodynamics
- Depth Elective
- Experimentation
- Design
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Much Better! : )
Course Design – Best Practices : )

- AFFECTIVE feeling
- COGNITIVE informing
- PSYCHOMOTOR doing
Did We Really Fix It?  : /
Did We Really Fix It?  : /
Did We Really Fix It? : /

- bad habits
- swapping majors
- laundry
- clubs
- Did We Really Fix It? : /
Outline

• The motivation for change
• **Course redesign – details**
• Three implementations
• Lessons learned
Intro To Environmental Engineering

• Really called, “Fundamentals of Environmental Engineering and Science”

• Course description,
  – “Course discusses fundamental chemical, physical, and biological principles in environmental engineering and science. Topics include environmental phenomena, aquatic pollution and control, solid waste management, air pollution and control, radiological health, and water and wastewater treatment systems. “
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Memorize vocab
Memorize unit ops
Memorize regs
Lecture-discussion
Reading
Homeworks

AFFECTIVE
feeling

COGNITIVE
informing

PSYCHOMOTOR
doing

Labs (wet and dry)
Tours
Presentations (oral)
(some) current events
So What Did We Do?

• Blended – some online (synchronous and asynchronous) and some face to face (synchronous)
• Flipped – students work on content ahead of lecture
• Mastery – divide materials into ‘must learn’ and ‘can learn’
So What Did We Do?

Delivery

• Blended – some online (synchronous and asynchronous) and some face to face (synchronous)

Pedagogy

• Flipped – students work on content ahead of lecture

Assessment

• Mastery – divide into ‘must learn’ and ‘can learn’
The Syllabus

• The course consists of 11 lecture modules
  – introduction, drinking water, sewage treatment, air pollution, solid waste, and hazardous waste

• and 14 laboratory assignments
  – conventional wet labs, tours, and oral presentations
A ‘Typical’ Module CONTENT

• Required exercises
  – List of 25 vocab terms
  – Assignment of one chapter from the text
  – Online vocab quiz (25 terms) [repeat until 100%]
  – 60 min summary lecture (voice over PPT)
  – Online lecture quiz (15 concepts) [repeat until 100%]
  – TED video; News story - comment on topic and comment on post from someone else
  – Written homework (about 60 minutes) [if wrong, resubmit]

• Optional exercises
  – TED video; News story – comment on topic and comment on post from someone else
  – Written homework (about 120 minutes)
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• Optional exercises
  – TED video; News story – comment on topic and comment on post from someone else
  – Written homework (about 120 minutes)
  – In class written quiz
You Can’t Get Sloppy

• Each required lecture
  – Must identify required and optional readings
  – Must include an outline
  – Must include learning objectives

• Homework problems
  – Must be selected to match the learning objectives

• Exam problems
  – Must be selected to match the learning objectives
Bloom’s Taxonomy Rules

• To design an effective module, you must identify ‘low level’ and ‘mid level’ verbs and you must match the lecture, homework, and exams accordingly

• The best strategy is to use a single concept map, but to include multiple levels of proficiency in the use of the concept
  – CWA = clean water act
    • Created in 1972
    • Includes NPDES and TMDL regulations
  – “every water body must be fishable and swimmable”
  – who’s to blame when someone dies of an E. coli outbreak?
A ‘Typical’ Module DELIVERY

• **Before the deadline**, complete all required exercises
• Required face to face lecture
  – Submit homework, read case study, individually write brief answers to open-ended questions, pair-and-share, employs [www.polleverywhere.com](http://www.polleverywhere.com) and discussion
• Optional face to face lecture(s)
  – Attended by ‘motivated’ students after they’ve completed reading assignment and listened to a summary lecture and completed written homework
• Optional quiz (in class)
  – ‘very tough’
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Lab’s Are Concurrent

• ‘Similar’ materials are covered in a hands-on format
• Handout read before the session
• Start with a ‘conventional’ mini-lecture
• Complete the lab in teams (pair-and-share)
• Submit written lab reports (that include motivation as well as data and analysis)
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What Did I Have To Do?

• Create vocab lists and online quizzes
• Create summary lectures and online lecture concept quizzes
• Create homework keys
• Grade online postings
• Select case studies and execute pair-and-share lectures
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Overview Of Teaching Schedule

• I offered an ‘intro to env eng’ course at Cincinnati using a conventional lecture-discussion format:
  – Summer 2001; Summer 2002
• I offered a ‘chemistry and biology’ course at Cincinnati using a conventional lecture-discussion format with a ‘cook book’ lab:
  – Winter 2001; Winter 2002; Winter 2003; Winter 2004
• I offered ‘intro to env eng’ course at S&T using a number of delivery methods and our existing lab:
  – Spring 2011
• **Modified course (blended, flipped, mastery) has been offered three times:**
  – Summer 2011; Autumn 2011; and Spring 2012
Grading

• A straight curve is used (90-100 = A, etc)
• Failure to complete a required exercise results in an ‘F’ for the course (allowed one miss)
• 100% on all required exercises is a 70% for the course and a C
  – Class is essentially pass / fail and pass consists of completing required exercises that you can repeat until you’ve mastered each and received a 100%
• Optional exercises are used to make up the remaining 30%
  – 15% for optional homework and labs
  – 15% for optional quizzes, midterm, and final
Adult Learners

- Autonomous and self-directed
- Have accumulated experiences that they share
- Goal oriented
- Relevancy oriented
- Practical
- Show respect and deserve respect
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Man ‘O Man Does This Polarize Students

• On my teaching evaluations, I have the following two statements side-by-side
  – “This guy is a jerk. He’s the worst teacher we have at S&T. He should be fired and his tenure revoked. I’m embarrassed we have someone like this as a teacher here.”
  – “This is the best class I’ve ever had! I knew exactly what was needed, I could work at my own pace, and the grading was fair, clear, and impartial.”
Student Evaluations

- Cincinnati ‘intro to env eng’ Summer 2001  n=19 4.0/5
- Cincinnati ‘intro to env eng’ Summer 2002  n=15 4.4/5
- Cincinnati ‘chemistry & biology’ Winter 2001  n=2 NA
- Cincinnati ‘chemistry & biology’ Winter 2002  n=10 4.4/5
- Cincinnati ‘chemistry & biology’ Winter 2003  n=12 4.6/5
- Cincinnati ‘chemistry & biology’ Winter 2004  n=5 4/5
- Missouri ‘intro to env eng’ Spring 2011  n=83 2.0/4
- Missouri ‘intro to env eng’ Summer 2011  n=15 NA
- Missouri ‘intro to env eng’ Autumn 2011  n=72 1.3/4
- Missouri ‘intro to env eng’ Spring 2012  in progress
Follow-up

• Summary statistics:
  – 90 of 190 earned an A
  – 15 of 190 earned an F

• I invited any student with an A to attend an informal dinner to learn about independent research...
  – 30 students attended!
  – 7 have completed independent research
  – 12 more have signed up for summer and autumn
Lessons Learned

• Don’t try ‘aggressive’ changes until you have tenure
  – Blended isn’t an ‘aggressive’ change (IMHO)
• Blended, flipped, and mastery all have unique benefits and challenges
• I personally believe that flipping and mastery produce a synergy that improves the benefits of blended
  – this is a hypothesis that I’d love to explore
• The difference between a zero miss policy and a one miss policy is night and day
Did We Really Fix It? YES! ; )

Blended

Flipped

Mastery
Questions?

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