Blended Learning in the Department of Materials Science and Engineering

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Overview: Materials Science Offerings on edX

- 3.091x: Solid State Chemistry
- 3.072x: Symmetry, Structure, and Tensor Properties of Materials
- 3.15x: Electrical, Optical, and Magnetic Properties of Materials and Devices
- 3.086x: Innovation and Commercialization
- 3.032x: Mechanical Behavior of Materials
- Several smaller scale projects that make use of the MITx platform
Overview: Materials Science Offerings on edX

- 3.091x: Solid State Chemistry
- 3.072x: Symmetry, Structure, and Tensor Properties of Materials
- 3.15x: Electrical, Optical, and Magnetic Properties of Materials and Devices
- 3.086x: Innovation and Commercialization
- 3.032x: Mechanical Behavior of Materials
- Several smaller scale projects that make use of the MITx platform
An Overview of 3.086

• Elective subject introducing students to the fundamental process of innovation

• Course centers on a project which students develop over the course of the semester:
  – Give students the opportunity to actually engage in the creative process of innovation
  – Provide a collaborative, project-based learning experience for the students

• Students must quickly learn to conduct in-depth research in a broad range of fields → technical literature reviews, searching SEC reports, patent searching
Residential Incorporation

Increased interactivity during course time:
- Socratic Discussion Sections
- Guest Lecturers

Enable students to quickly learn and practice essential research skills:
- Define good questions
- Identify and utilize good research sources

Facilitate student project development
- Allow students to keep detailed records of their research, thoughts, and developments
- Enable student-student interaction
- Give faculty greater insight into students’ thought processes and project evolution to facilitate mentoring and feedback
# Project Outcomes

Note: All 2014 assignments were completed individually; 2015 assignments were done in groups of 1-3

## Percentage of Projects Demonstrating Desired Metric

<table>
<thead>
<tr>
<th>Metric ID</th>
<th>2014</th>
<th>2015</th>
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<tr>
<td>19</td>
<td>80%</td>
<td>85%</td>
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</table>
Project Outcomes

• Examples of course-specific project metrics:
  – Project teams use intellectual property information to further their innovations
  – Teams identify industry structure information that pertains to the innovation
  – Identifies both who might purchase the innovation and why they might purchase it

• Instructors also observe a significant qualitative improvement in student project quality with the introduction of project management software
An Overview of 3.032x

• Provides an introduction to the mechanical behavior of materials, from the continuum to the atomistic point of view
• Core Materials Science and Engineering course taken by third-year undergraduate students
• Only core MS&E course devoted entirely to mechanical behavior
• Developed online version of the course using only standard edX tools:
  – Filmed lectures
  – Screencast examples
  – Demos
  – Online problem sets and exams: primarily numerical and symbolic type problems
  – Short feature videos

Prof. Lorna Gibson
3.032 at MIT: Fall 2014

• Professor gives live lectures. Videos are made available to the students:
  – Review
  – Missed classes (illness, interviews)
  – Course conflicts

• Problem sets:
  – Online problem sets are available to students for optional review

• Screencasts:
  – Gives students additional worked examples

• Of the top 5 students in the course, 3 of them did not attend lectures
Implemented a fully flipped classroom:

- Professor conducts tutorials
- TA conducts review sessions
- Students meet twice a semester for laboratory work
- Students perform their problem sets entirely online and receive immediate feedback about their answers
- Short homework quiz every Friday:
  - Quizzes are taken directly from homework problems
- Keeps lectures, problem sets, and feedback in sync
Mid-Semester Student Survey Outcomes

Prefer traditional class or flipped class
1 = Traditional
5.78/7
7 = Flipped

Like instantaneous feedback on problem sets
1 = Strongly Dislike
6.9/7
7 = Strongly Like

Feel you learn better with online Problem Sets
1 = Strongly Disagree
6.42/7
7 = Strongly Agree

Do you get sufficient time with the professor?
1 = Strongly Disagree
5.5/7
7 = Strongly Agree
Final Thoughts

- Elective course for upper-level undergrads
- Open-ended student-directed projects
- Students choose the topics to explore

- Required for all materials science majors (junior-level)
- Based on problem sets and laboratory work
- Students learn knowledge fundamental to their major

We can develop successful blended learning experiences for a wide variety of courses by matching our course development strategy to the specific needs of the course.