Blended Learning in the Department of Materials Science and Engineering

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13 November 2015

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
- 3.054x: Cellular Solids: Structure, Properties and Applications (January 2016)
- Several smaller scale projects that make use of the MITx platform

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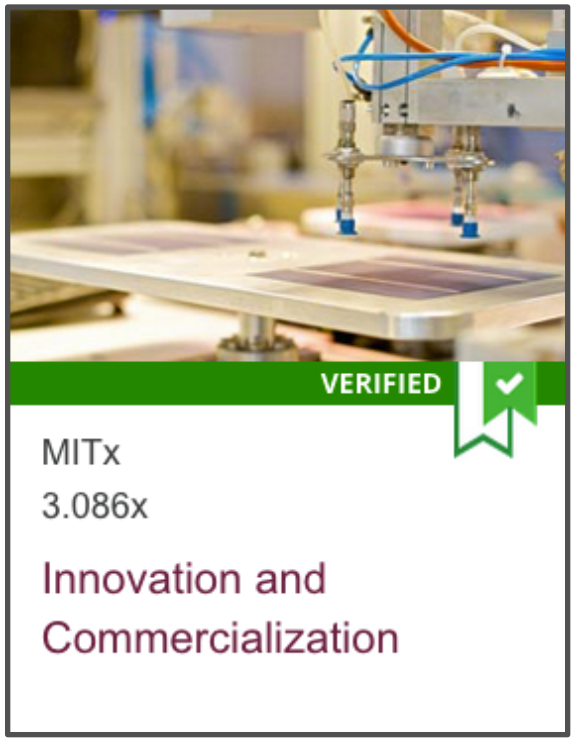
An Overview of 3.086

- 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



Prof. Eugene Fitzgerald
Dr. Andreas Wankerl

Residential Incorporation

Online Lecture Videos →

Increased interactivity during course time:

- Socratic Discussion Sections
- Guest Lecturers

Online Exercises →

Enable students to quickly learn and practice essential research skills:

- Define good questions
- Identify and utilize good research sources

Project Software →

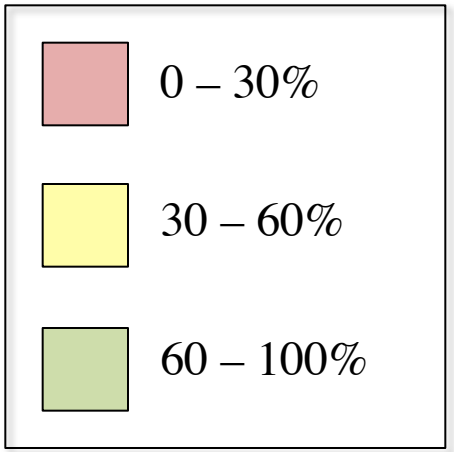
Facilitate student project development

- 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

Percentage of Projects Demonstrating Desired Metric

Metric ID	2014	2015
1	20%	7%
2	7%	31%
3	27%	31%
4	27%	31%
5	20%	46%
6	13%	54%
7	20%	54%
8	27%	62%
9	33%	62%
0	27%	69%
11	40%	69%
12	33%	77%
13	40%	77%
14	67%	77%
15	27%	85%
16	60%	85%
17	60%	85%
18	73%	85%
19	80%	85%



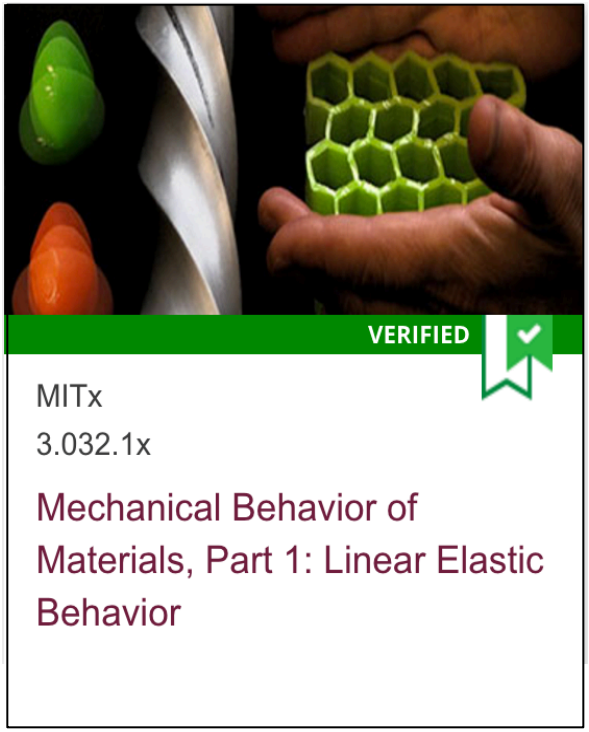
Note: All 2014 assignments were completed individually; 2015 assignments were done in groups of 1-3

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

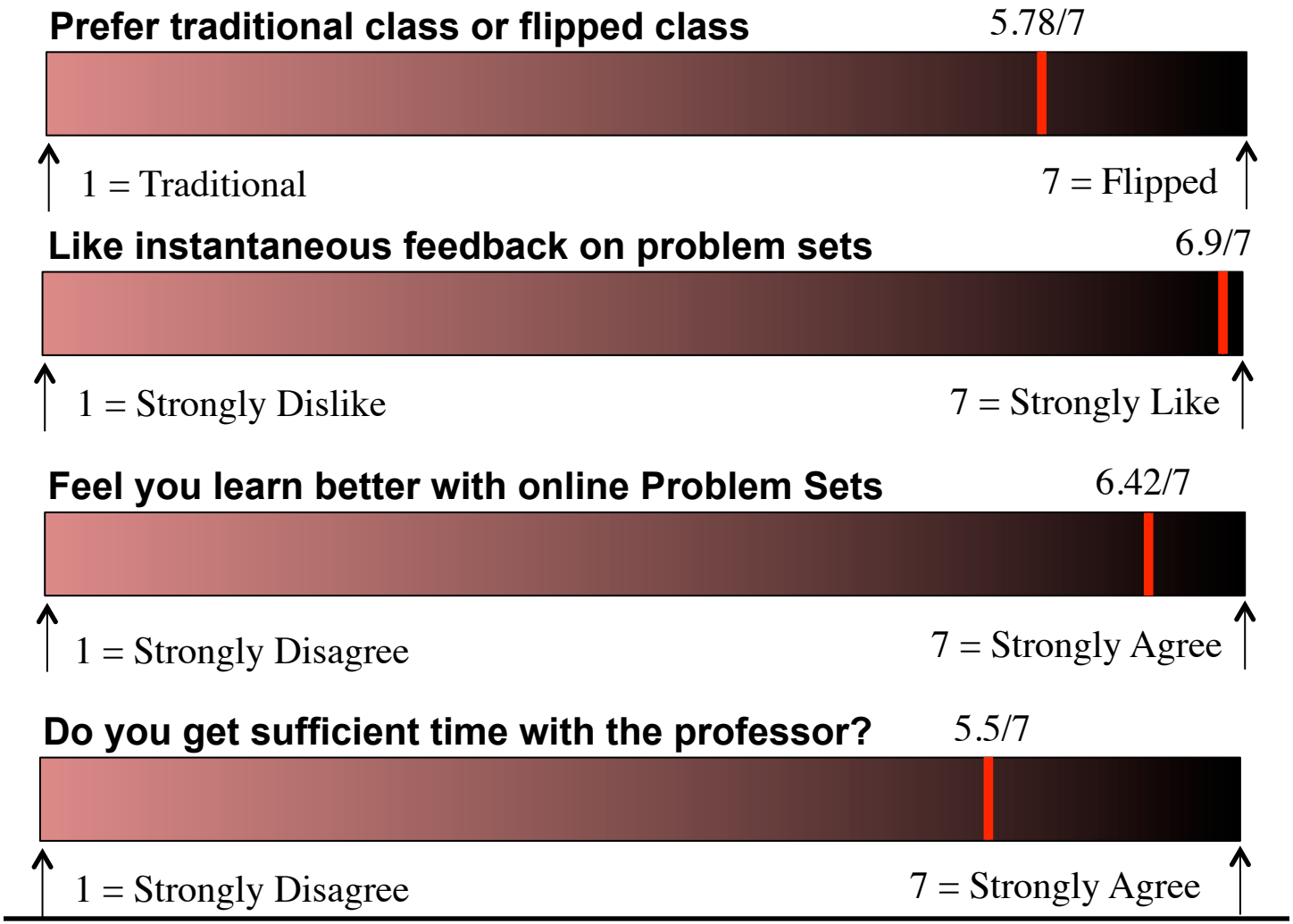
- Professor gives live lectures. Videos are made available to the students:
  - Review
  - Missed classes (illness, interviews)
  - Course conflicts
- Problem sets:
  - Online problem sets are available to students for optional review
- Screencasts:
  - Gives students additional worked examples
- Of the top 5 students in the course, 3 of them did not attend lectures

3.032 at MIT: Fall 2015

Implemented a fully flipped classroom:

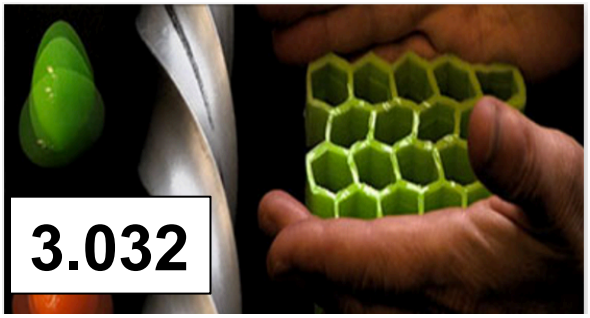
- Professor conducts tutorials
- TA conducts review sessions
- Students meet twice a semester for laboratory work
- Students perform their problem sets entirely online and receive immediate feedback about their answers
- Short homework quiz every Friday:
  - Quizzes are taken directly from homework problems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

Mid-Semester Student Survey Outcomes



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.