Digital Learning and the Innovative Transformation of Education

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Technology and Open Influence

Technology

- Networks; Devices; Software; Architecture; Processes
  - Mobile Computing
  - Cloud Computing
  - Data Visualization & Analytics
  - Simple Augmented Reality
  - The Semantic Web
  - Game-Based Learning
  - MOOCs?

Open

- Content
- Tools/Applications
  - Finding; Getting; Using
  - Knowledge
- Enabling Resources
  - Legal
  - Policy
  - Community

Educational Innovation and Transformation
Non-profit venture founded by MIT & Harvard

Expand access to quality education

Improve on campus education

Advance research
• **Flipped classrooms** – prior to class students view online lectures or readings and answer concept questions, class time used for more interactive learning (14.73, 18.05, 8.02)

• **Online assessment** – students do assessment problems online and get instant feedback (3.091, 8.02)

• **On-line instruction modules** (including visualizations, interactive simulations) that students can access on-demand

• **Summer @future** – pilot program to expand academic calendar with 5 blended MIT classes for MIT students during Summer 2014

• **Entrepreneurship Bootcamp** – top MOOC students invited to campus for intensive one-week experience during Summer 2014
3.091x
Introduction
to Solid State Chemistry

Reimagining education @MIT: Blended Learning with MITx

- “Treasure chest” of problems (412)
- 277 videos
- 164-page e-text
- No home-works, no exams
- All proctored weekly quizzes
- Learning objectives for each module,
- Assessments linked to those learning objectives
Early Results from

**Freshman 5\(^{th}\) week flags**

<table>
<thead>
<tr>
<th>Year</th>
<th>Freshman 5(^{th}) week flags</th>
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</thead>
<tbody>
<tr>
<td>2011</td>
<td>56</td>
</tr>
<tr>
<td>2012</td>
<td>29</td>
</tr>
<tr>
<td>2013</td>
<td>3</td>
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</table>
Embedded Assessment

• Mastery of concepts
  – Putting mechanisms directly in course materials for students to check their understanding
  – Primarily for formative (self-check, understanding) not summative (exams or formal assignments)
  – Strengthened by tie to learning outcomes, content

• “Embedded Assessment”
  – MITx Courses
  – Open Embedded Assessment: Assessments anywhere, anytime
Interactive Simulations: Physics

TEALSim Exploration: Point Charges

This simulation illustrates the field pattern created by two point charges with opposite signs of charge. In this simulation, the position and charge of each particle can be modified in real time, and the field configuration will update itself accordingly. All three field visualization techniques can be applied to show the overall electric field of the two-charge configuration: vector field, field lines, and "grass seeds".

(Please be patient - the simulation may take ~20 seconds to load)

More about this simulation: show
STAR: Software Tools for Academics & Research: star.mit.edu
Innovative tools to bring the practice of research to the process of learning

➡️ StarBiochem
protein visualization

➡️ StarGenetics
genetic cross simulator

➡️ StarOrf
gene finder

➡️ StarMolSim
materials modeling

➡️ StarHydro
hydrology visualization

➡️ StarHPC
parallel programming

Expose students to the discovery aspect of research and to the processes of doing research using interactive technology
Virtual Game-Like Laboratory
Rich Set of Autograded Exercises

Chemical Equations

H1P2: DECOMPOSITION OF AMMONIUM NITRATE

Solid NH₄NO₃ (ammonium nitrate) decomposes on heating to 400°C, forming N₂O gas and water vapor, H₂O.

(a) Write a balanced chemical equation.

(b) Calculate the number of grams of H₂O that will form on decomposition of 0.10 mole of ammonium nitrate.
Interactive Auto-graded Problems

Numerical Response

S1E1: NEWTON'S LAW

The next three segments cover review material that 3.091x will rely on over the course of the semester. Check your understanding with each exercises, and see the screencast at the bottom of the page if more information is necessary.

A ball of mass 2.5 kg is pushed along a frictionless surface with a constant force of 15 N applied. Calculate the acceleration of the ball. Express your answers in m/s².

May use randomization, tolerances can be specified
- MOOC offered Spring 2013
- Campus class uses MOOC to support “flipped classroom” model
- Students watch MOOC videos, and do related exercises and online homework
- Class time used for interactive team-oriented work and presentations
Why?
MIT’s exertions to reestablish hands-on

Rogers: Learning by Doing

Massively Flipped Classrooms using edX Platform

ESG

Concourse

TEAL

6.01, 2.007
Why?

• More modularity
• “Choose your own adventure” courses
• More research apprenticeship
• More field experiences
• More internships/travel

☞ More Magic Time
Institute-wide Task Force on the Future of MIT Education

Task Force Coordinating Group

Corporate Advisory Group

Working Group on MIT Education and Facilities for the Future

Working Group on the Future Global Implications of edX and the Opportunities It Creates

Working Group on a New Financial Model for Education

Community Engagement

Three Working Groups of Faculty, Students, and Staff
Charge to the Task Force

1. Propose an ecosystem for ongoing research, learning and innovation about the future of education.

2. Recommend a range of possible experiments and pilot projects – on our campus and beyond – that will allow us to explore the future of MIT education.

3. Evaluate the strength and sustainability of MIT’s current financial model and propose alternative approaches.

4. Develop a roadmap to enable this ecosystem and implement these experiments.

Institute-wide Task Force on the Future of MIT Education
Institute TF: Some Highlights impacting the “Business” Model

- **Modularity**
  - Alternate ways to learn: Pathways; Customization
  - Flexibility

- **Blurred Boundaries**
  - Permeability between institutions and sectors (k-12; Community Colleges; Global)
Concept-Based Learning & Modularity

Chemistry

John Essigmann

Bridge challenging concepts between courses with similar concepts

MechE

Ken Kamrin & Pedro Reis

Modularize mechanics and materials into discrete learning experiences

Aero-Astro

Wilcox, Darmofal, Radovitzky, Wang

Transform 16.20 & 16.90 to modular, active learning experiences, and enable self-paced completion of the courses
¡Lab: If you can’t come to the lab... the lab will come to you!
Constructionism 3.0

Neil Gershenfeld

Digital Fabrication, Fabrication for all!

Fab Labs
digital bits <=> physical atoms
A Fab Education

Fab Lab Barcelona

Fab Academy

MC2STEM
High School
Fab Lab
Active Learning Eco-System

- Electric Vehicles
- Molecular Simulations
- Virtual Game-like Laboratory
- Access to telescopes, experts
- Maker Spaces
- iLabs
- Las Cumbres Observatory
Future of MIT Education

The future IS here.

50 startups, five days, one bootcamp to change the world

15.390x Entrepreneurship 101

MIT hosts a unique experiment in blended learning.

- 1,000 local edX communities
- xSeries certificates
- MITx system for on-campus classes

PROFESSIONAL EDUCATION

TACKLING THE CHALLENGES OF BIG DATA

129 MIT students register

3K active registrants
Changing the Ecology and Economics of Education

*Recasting Resources, Relationships and Roles*

A
- Abundance
- Actionable access to resources, Learning experiences, Communities
- Alternate ways to learn: Models, Pathways

B
- Blended Learning
- Boundary-less Education

C
- Customization and continuous improvement, Learner feedback/Analytics/Open design
- Continuous education
3) Research in Learning on an Unprecedented Scale via “Big Data”

Online textbook

Videos

Assessments

Learner activity and performance
The Open Emerging Ecosystem for Learning

— Generative
  • **4Rs**: Reuse; Remix, Revise, Redistribute
    – Permitted by Technology, Legally and Policy

— Boundary-less
  • Access, Development and Use not limited by domain/community/technology/Policy
    – Bidirectional
    – Distributed locus of control
    – Individual to social learning

— New Structural Relationships
  • Access – Cost - Quality
  • Individual – Institution – Knowledge
    – Agency of the Community (Crowd)
    – Co-creation of Learning Opportunities
    – Disaggregation of educational services
      » Credentialing; Distributed over time and place
<table>
<thead>
<tr>
<th>Where could we be going</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visible</strong></td>
<td><strong>Usable;</strong></td>
</tr>
<tr>
<td><strong>Situated</strong></td>
<td><strong>Anywhere; Virtual; Blended</strong></td>
</tr>
<tr>
<td><strong>Receiving/Knowing</strong></td>
<td><strong>Affecting</strong></td>
</tr>
<tr>
<td><strong>Limited Term</strong></td>
<td><strong>Varying; Lifelong</strong></td>
</tr>
<tr>
<td><strong>Enrolled Student</strong></td>
<td><strong>Registered; Life-long Member</strong></td>
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<tr>
<td><strong>Dropouts</strong></td>
<td><strong>100% completion</strong></td>
</tr>
<tr>
<td><strong>DE as 2nd Class</strong></td>
<td><strong>Net-Enabled, Open as Central Modality</strong></td>
</tr>
<tr>
<td><strong>University</strong></td>
<td><strong>Metaversity</strong></td>
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