Innovation and Change with Technology: Realizing the Educational Potential

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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
  - Big Data

Educational Innovation and Transformation
TECHNOLOGY IN MIT EDUCATION

**Internet Labs:** 2003

**MIT Shakespeare Project:** 1992

**PIVoT:** 1999

**MIT Mathlets:** 2006

**Visualizing Cultures:** 2002

**TEALsim:** 2004

**Project Athena:** 1980's

**Internet Labs:** 2003

**MIT OpenCourseWare:** 2002

**STAR Tools:** 2007

**xTutor:** 1999

**MITx:** 2012

**PIVoT:** 1999

**MITx:** 2012

**Visualizing Cultures:** 2002
## Context: MIT Core Principles

<table>
<thead>
<tr>
<th>Students &amp; Faculty Proximity</th>
<th>MIT’s core advantages are its reputation and its ability to <strong>bring together world-class students and faculty</strong></th>
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| Inseparability of education and research | The faculty value both research and teaching highly, and would be uncomfortable with proposals that decrease the research emphasis  
**Research and teaching should continue to be linked and synergistic**  
Improving the quality of the on-campus experience is a high priority |
| Uniqueness of the MIT community | Preserving the quality of the MIT community is a high priority, and strengthening it is desirable  
MIT is unwilling to compromise on student standards for enrollment in degree programs  
**Intimate student/faculty interactions should be preserved and enhanced**  
Faculty time is the limiting resource in innovation |
| MIT values | **Excellence**: MIT should be an intellectual leader in all of its chosen fields  
**Entrepreneurship**: The culture of entrepreneurship and faculty autonomy must be preserved  
**Single-class faculty**: Any expansion of the faculty would need to adhere to MIT’s relatively tight definition of faculty, in which **all faculty participate in teaching, research and service.** |
What is TEAL?
Technology Enabled Active Learning

Ten Year Ongoing Experiment:

A merger of presentations, tutorials, and hands-on laboratory experience into a technologically and collaboratively rich environment
Rethinking Teaching Roles

Prof. John Belcher TEAL Founder
Non-profit venture founded by MIT & Harvard

Expand access to quality education

Improve on campus education

Advance research
Why MOOCs and Online?
MIT’s exertions to reestablish hands-on
iLab: If you can’t come to the lab... the lab will come to you!
The iLab Vision

- Order of magnitude more lab experiences
- More lab time to users/researchers
- More sophisticated labs available
- Communities of scholars created around iLabs sharing educational & research content
• **Flipped classrooms** – prior to class students view online lectures or readings and answer concept questions, class time used for more interactive learning (14.73r, 18.05r, 8.02r)

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

• **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
Reimagining education @MIT: Blended Learning with MITx

3.091x
Introduction to Solid State Chemistry

• “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\textsuperscript{th} week flags

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<tr>
<th>Year</th>
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<td>2011</td>
<td>56</td>
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<tr>
<td>2012</td>
<td>29</td>
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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
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.
FUTURE OF EDUCATION > OPPORTUNITIES

• New digital tools enhance learning
  - enhanced student engagement and success in face-to-face and online settings (gaming, simulations, visualizations, toolboxes)

• Better information for instructors on student performance
  - learning dashboards that allow instructors to adjust instruction in real-time and continuously improve courses

• Research data used to improve learning
  - big data generated by MOOCs used to identify opportunities to improve learning online and on-campus

• Online “cognitive tutors” offer more effective personalized, adaptive learning based on a new science of learning
  - addressing varied abilities of students (preparation, capacity, motivation) with alternative pathways based on cognitive science
Institute-wide Task Force on the Future of MIT Education

Task Force Coordinating 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.
MIT Integrated Learning Initiative (MIT ili)

- 100 years of results that have not been applied in classrooms
- MITili combines Cognitive Science, Behavioral Psychology, Economics, Engineering, Design and Neuro-imaging
- Now possible to instrument and apply digitally
### Inspiration
- Scratch
- First Robotics
- **MIT K12 Videos**
- Edgerton Center

### Informal
- Edgerton Camps
- Splash
- Spark
- **MITES**

### Formal
- AP courses

### Pedagogy
- Hands-on learning
- Projects
- STEM-focus
- **Entrepreneurship**

### Teacher Training
- [Scheller Teacher Training Program](#)
- More coming
Collaboration

To improve the professional and academic prospects of high school students in underserved communities in India

Scope (3 years):
1,650,000 students;
1,100 schools;
4,400 teachers;
4 states

Incorporating thoughtful pedagogical design & contemporary technology

Will help provide sustainable, quality learning experiences at scale in English, Mathematics, & Science (Physics, Chemistry, Biology)
Focus > conceptual understanding and application of foundational concepts through active learning > emphasis will be on “Learning by Doing” [skills + knowledge + attitude]
Value Proposition

- Scale as input not only as outcome
- Open in / Open out
- Focus on Professional Values and ethics
- Technology is integral
- Indian Languages
CLIx Platform Elements
Enabling Quality at Scale

- Interactive Tools
- Assessment
- Content Authoring
- Module Assembly (aka Publishing)
- Use Data
- Student Delivery
- TPD Delivery
- Content Management
- OpenEdX

Design work starts
Dev begins January 2017
Research Areas

The broad research questions are about:

- Implementation and scalability
- Teacher professional development and classroom processes
- Student agency and learning through technological affordances
- Partnerships and collaboration
Research Activity

• **Impact Evaluation 1/IE1**
  o To understand the nature and extent of impact of CLIx intervention at a systemic level - students, teachers, pedagogy, schools and local ecosystem - in CLIx intervention schools
    ▪ Sustainability of impact; stickiness of intervention

• **Impact Evaluation 2/ IE2**
  o To analyse the impact of CLIx intervention on students learning outcomes in the selected domain areas
    ▪ Impact of specific unique dimensions of implementation
Sample Research Questions

- What kinds of teaching and learning processes emerge during CLIx sessions? Why do these processes emerge in particular school contexts?

- How is CLIx adopted and implemented at each school? How, if at all, does equity concerns influence the implementation?

- What factors at the state level support or constrain the adoption?

- How do cases of CLIx-enabled schools compare and contrast across states at this phase of early adoption?
Diffusion of Innovation

- Object
- Resources
- Authority
- Consensus
- Linkages
- Environment

Source: Havelock and Huberman
CLIx Impact

• Raise social capital and expand opportunities for participating youth
• Transformation
• Quality at scale
• Global model for world-class engagement
Digital Learning and Educational Change:

What does Digital Learning mean as an agency for change both in formal and informal education?

- The educational value proposition and implications DL initiatives
- The factors that would propel these initiatives towards having a larger impact on education.
Research Methodology

- Design-based research
- Impact evaluations
- Process documentation
- Case studies
Challenges and opportunities?

1. Create and disseminate a new *lexicon* of science and technology in Creole languages

2. Create a new *culture* of deep learning—an antidote against “par coeur” (i.e., against rote learning of texts that few can understand)

3. Demystify deeply entrenched negative attitudes against Creole languages and enlist the unambiguous support of the public and private sectors, civil society and the international community.
Online Education: A Catalyst for Higher Education Reforms

April 2016

Kevin F. Willcox
Professor of Aeronautics & Astronautics
Co-Chair of CELP

Sanjoy Sanyal
Professor of Mechanical Engineering
and Dean for Digital Learning
Co-Chair of CELP

Philip H. Lipset
Assistant Director, MIT Washington Office

Final Report
MIT ONLINE EDUCATION POLICY INITIATIVE
Active Learning Eco-System

- Electric Vehicles
- Molecular Simulations
- Virtual Game-like Laboratory
- Access to telescopes, experts
- Maker Spaces
- iLabs
- Las Cumbres Observatory
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<tr>
<th>Inspiration</th>
<th>Informal</th>
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<th>Educator Prof. Dev</th>
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MIT Integrated Learning Initiative (MIT ili)

- 100 years of results that have not been applied in classrooms
- MITili combines Cognitive Science, Behavioral Psychology, Economics, Engineering, Design and Neuro-imaging
- Now possible to instrument and apply digitally
• **Recommendation 2**: Catalyze ongoing research, learning, and innovation about the future of MIT residential education.

• **Recommendation 7**: Extend pedagogical innovation to the world.

• **Recommendation 9**: Define a K-12 strategy through a special interest group.

• **Recommendation 10**: Create new opportunities for engagement between the MIT community and the world.
“The future of MIT education looks more global, modular, and flexible.”

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

- **Blurred Boundaries**
  - Permeability between institutions and sectors (k-12; Community Colleges; Global)

Heightened Interest + Urgency for Educational Research

- Key Fronts in Education
- Cognitive Science and Learning Research
- Discipline Based Education Research
- Social Sciences Perspectives on Education
- Education Technology
- Other Contributing Disciplines
Cognitive Science and Learning Research

The study of learning inside-out, that is, from the neuroscience and cognitive psychology perspective, has progressed greatly since the times of Ebbinghaus and his research on how memories fade after learning.

- Mind wandering
- Retrieval practice / testing effect
- Spaced learning and retrieval
- Interleaved practice
- Cognitive load theory
- Learning states and curiosity
- ...
Common Elements

• Infrastructure

• Faculty and teacher development

• Content assets (OER)

• Governance and leadership

• Vision
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
  – Big Data

Educational Innovation and Transformation
The MIT-Haiti Initiative

Goal: High quality STEM education through Kreyòl-based curriculum development & faculty training.

Central Ingredients:
1. Kreyòl as language of instruction
2. Technology-enhanced and open-education resources
3. Active Learning Practice
Transforming Pedagogy

• **Recommendation 2**: Catalyze ongoing research, learning, and innovation about the future of MIT residential education.

• **Recommendation 3**: Build on the success of freshman learning communities and consider future expansions of the cohort-based freshman community model.

• **Recommendation 4**: Use online and blended learning to strengthen the teaching of communications.

• **Recommendation 5**: Create an Undergraduate Service Opportunities Program.

• **Recommendation 6**: Explore online and blended learning models to improve graduate curriculum accessibility.
Opening Up Education: A Framework

Open Technology

Section Editor: Owen McGrath

Solutions work over time and that they can transfer easily across departments and institutions.

Open Content

Section Editor: Flora McMartin

Adopt and adapt each others’ teaching innovations as easily as we can build on research findings.

Open Knowledge

Section Editor: Cheryl Richardson

Means to capture and disseminate our pedagogic ideas as easily as we can write and publish papers.
Extending MIT’s Educational Impact

• **Recommendation 7:** Extend pedagogical innovation to the world.

• **Recommendation 8:** Support efforts to create a lasting community and knowledge base for MITx learners.

• **Recommendation 9:** Define a K-12 strategy through a special interest group.

• **Recommendation 10:** Create new opportunities for engagement between the MIT community and the world.

• **Recommendation 11:** Move forward to consider the types of certifications that can be supported through MITx and edX, and develop pricing methodologies and revenue-sharing arrangements for agreed-upon certifications.
“pK-12 will work as a catalyst to bring people together, not just people at MIT, but people all over the world, to amplify progress, ideas, solutions, and education at all levels.”

–Professor Angela Belcher

Bringing the essence of the MIT learning approach to pre K-12

http://pk12.mit.edu/
Open Education Resources

Learning Content
Full courses, course materials, content modules, learning objects, collections, journals

Tools
Software to support the creation, delivery, use and improvement of open learning content including searching and organization of content, content and learning management systems, content development tools, and on-line learning communities.

Implementation Resources
Intellectual property licenses to promote open publishing of materials, design-principles, and localization of content.
Interactive Simulations: Physics

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Virtual Game-Like Laboratory
Enhance the teaching capability of faculty

- On-site teacher training with OCW
- Symposium workshop for teachers and faculty in Haiti
- Create new Blossoms by Haitian scholars
- Expert guest lecturer to work with faculty and students
- Need support resources (people)
- A few students come to MIT in summers

Distribute MIT OER to Haitian partner universities with appropriate technology

- Use the diaspora to help with translation
- Learning Bus filled with content, engaging even remote areas
- Translation crowd sourcing => quality control
- Ship hard drives of all MIT OER content
- Identify and adapt most needed courses from OCW
- Localization needs for courses
- Identify 5 mathlet modules that could be translated and integrated

Create the opportunity for students to be immersed in technical environments

- Basic physics demonstration labs that can move around
- iLabs
- iLab project (like Makarere) at State University of Haiti
- Get access to all software tools for use on local intranet.
- Extend existing exchange programs to MIT

Create a national library of digital educational resources

- The School of Engineering of UEH is willing to participate.
CLIx Platform Elements
Enabling Quality at Scale

- Interactive Tools
- Assessment
- Content Authoring
- Module Assembly (aka Publishing)
- Use Data
- Student Delivery (TBD)
- TPD Delivery
- Content Management
- OpenEdX

Design work starts
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Research Activity

- Impact Evaluation 1 – systemic level (students, teachers, classrooms, principals and officials)
- Impact evaluation 2 – Student Learning outcomes
- Sustainability of impact among students, stickiness of intervention on students and teachers
- Studying how state specific unique dimensions of implementation impact intervention
Research Methodology

- Design-based research
- Impact evaluations
- Process documentation
- Case studies
- Policy Research, etc.
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