MOOCs and Beyond: How Technology Will Continue to Challenge Higher Education

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Hunting and foraging

Agricultural revolution

Industrial revolution

Rise of the ‘world system’

Post-information revolution

Diffusion accelerates technology adoption
Communications technology accelerates diffusion

World’s technological installed capacity to store information

The total world's information, which is 1.8 zettabytes, could be stored in about four grams of DNA.

Harvard stores 70 billion books using DNA. Research team stores 5.5 petabits, or 1 million gigabits, per cubic millimeter in DNA storage medium

http://www.computerworld.com/s/article/9230401/Harvard_stores_70_billion_books_using_DNA
Statements about the future

- **Technology**
  - Technology is disrupting all aspects of higher education
  - Technology will lower costs, improve outcomes

- **The nature of institutions**
  - The role of the faculty will change dramatically
  - Universities are about to get unbundled
  - Universities need to lower their cost

- **The nature of society**
  - More, if not most, learners, will be able to get by with higher education alternatives
  - Many of us in traditional higher education are doomed
  - Society will bifurcate
Background propositions

- The rewards of investments in technology go disproportionately to the most capable individuals
  - The most capable learners *tend* to receive more benefit from technological enhancements than less capable learners

- Choosing college is a complex decision
  - Cultural, social and economic factors affect the decision
  - Wealth stratification plays a role (and it has for 2,300 years)
  - It isn’t an entirely rational decision

- Information technology (IT) does matter
  - IT can improve productivity
  - IT can enhance short-term and mid-term competitiveness
  - But, advantage from IT does not follow it’s procurement, but is marrying with business processes and organizational capital
Future job demands

- Middle skill jobs have received little wage growth and job growth since 1980.

- High skilled jobs, especially those with advanced degrees, have experienced the best wage and job growth.

- The work force middle is getting ‘hollowed out’.

- The recession may have accelerated the trend.

- The demand for masters level and above education is likely to increase. E-Learning is likely to play a role in filling these gaps.
Higher education has a ‘last mile’ problem

- Education in any form is struggling to address families and communities with economic and other readiness problems.
- Free or low-cost educational content does not easily solve readiness problems which have a multitude of factors.
- For profit models rightfully struggle with ‘last-mile’ problems. Public policy matters!

All the ‘low hanging fruit’ has been picked. (The Great Stagnation, Tyler Cowan)

In 1900, 0.25% went to college (1 in 400). In 2009, 40% of 18-24 year-olds were enrolled in college, 70% of all high school graduates were enrolled in college. (Tyler Cowan & NY Times)

Those that have the social, economic, cognitive capabilities are in the higher education system.
What would Abraham Lincoln think of a MOOC?

Abraham Lincoln
- Autodidactic
- Books, books, books
- Became a skilled military strategist
- Penchant for poetry, Shakespeare, politics and history

My nephew
- Not an autodidact
- Good worker, smart kid, but…
- It takes a village
- After a few low-security colleges and much money borrowed
- He has found an intellectual home
### Small class, large class, books & MOOCs

<table>
<thead>
<tr>
<th></th>
<th>Small class</th>
<th>Large class</th>
<th>Book</th>
<th>MOOC</th>
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</thead>
<tbody>
<tr>
<td>Student-teacher</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
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<tr>
<td>interaction</td>
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<tr>
<td>Student-student</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low-mid</td>
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<tr>
<td>interaction</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Quality of instructor</td>
<td>Low-high</td>
<td>Low-high</td>
<td>Moderate-high</td>
<td>Moderate-high</td>
</tr>
<tr>
<td>Convenience</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>High</td>
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<tr>
<td>Overall experience</td>
<td>??</td>
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Conclusions about the quality of the experience need to take into account what the learner is capable of and what they need.

Déjà vu?

http://www.thelongtail.com/conceptual.jpg
The hidden gem: personalization technology

- In all this noise, I am seeing a significant trend towards adaptive learning technology with different approaches taken by emerging vendors (e.g., Knewton, LoudCloud, etc.)

- Other personalization techniques (e.g., text mining, neural networks) that incorporate other forms of student data (e.g., cognitive, non-cognitive, personality tests) can be brought to bear in this problem of matching educational content and interactions to learners.

- The industry is moving to development of technology that relies on more data about the learner that delivers deeply personalized experiences that know how to alter text, images, pace and content to my abilities. This kind of technology could have a profound impact on what goes in and outside of a classroom.

- What kind of tradeoffs exist between the cost of personalization and the benefits of personalization?

- What does the combination of ubiquitous mobile devices, big data tools and personalization bring?
Potential services

■ Reminder services
  • Upcoming classes, assignments, tests, events

■ Predictive support
  • Micro-segment prediction of academic difficulty, involvement, integration
  • Non-cognitive factors, social network analysis in models
  • Behavioral cues around registration, financial aid applications
  • Digital footprint analysis (use of degree progress tools, academic ‘category’ involvement, walking across campus)
  • Recommend friends, study groups, student groups, foster peer-interactions

■ Real-time analytic integration with LMS content consumption
  • Detect lack of comprehension, difficulty, frustration
  • Recommend peer tutoring, additional materials, tutoring services
  • Call students in the middle of?

■ Parent portal
  • *With the student’s permission*, let the parent see key learning performance indicators, alerts, etc.
Vendors: Can we keep it open?

- How content gets matched to students is psychologically complex.
- Several theories of how humans learn give many insights.
- Students differ in the following abilities and attributes: visual-object, visual-spatial, reasoning, cognitive reflection, need for sensation, need for cognition, various verbal abilities, confidence, persistence, prospective memory, etc.
- We need an open architecture to promote rapid experimentation, testing and sharing of what works and what doesn’t.
- Is it fair to hide from the world what works in improving education?
How technology can affect cost and quality

- **High effectiveness**
  - Small F2F class
  - MOOC + PT + F2F
  - MOOC + PT
  - Current MOOC approach
  - Broadcast class

- **Low effectiveness**

**Scale vs quality tradeoff**

- **Low volume**
  - F2F = Face-to-face
  - PT = Personalization technology, adaptive learning technology

- **High volume**
The debate

- Constructivists/social learning versus reductionists/cognitive psychology
  - ‘Mind as sacred space’ versus ‘brain as decomposed machine’
  - Learning as a social-emotional interaction with humans versus learning as cogno-neuro-sensory interaction with information

- Social constructivist, subjectivist, humanist
  - I as teacher am the one who personalizes things
  - Students construct their knowledge via indeterminate, emergent social interactions
  - I don’t see how IT has a significant role in this, except to support ease of student interaction with each other and with content

- Cognitive reductionist, positivist, technocrat
  - An IT system can on the fly determine which content/people you the learner may need next, learning follows principles of progression
  - Students differ in the cognitive skills in ways IT can address
  - IT can be a more complete feedback-driven learning environment
What is this about cloud?

- The new outsourcing
  - Cloud represents a new way of integrating technologies (and business processes) so that the institution relies on external vendors for basic services
  - Cloud is very real, very big and will transform IT
  - Morgan Stanley May 2011 analysis expects adoption to be about 51% of organizations and about 22% of the IT workload run in the cloud in three years. On premise growth in servers is expected to be flat or shrink

- What makes cloud computing unique?
  - Widely used, well understood and generic components
  - Quick provisioning and de-provisioning
  - Flexible contracting and procurement
  - Is there a future for cloud futures?

- What are the benefits
  - Lower long-term costs. But you need to include all costs including facilities, electricity, replacement, risk
  - Place focus and attention of internal IT staff on high-value activities
    - Technology tool adoption
    - Information adoption
    - More direct support of core processes in teaching and research
Cloud tools

- Software as a service (SaaS)
  - Software hosted elsewhere. Higher education has been steadily adopting SaaS
  - Examples: Hobson’s CRM, ServiceNow IT support

- Infrastructure as a service (IaaS)
  - Infrastructure hosted elsewhere. Higher education has NOT yet adopted this technology. General purpose server computing can be hosted with a vendor or consortium
  - Amazon’s elastic computing and storage solutions are examples of ‘generic’ cloud
  - Large vendors are bringing custom, enterprise cloud solutions forward now

- Platform as a service (PaaS)
  - This includes tools to create applications in the cloud
  - Examples include Microsoft Azure, Force.com

- High performance computing (HPC) as a service may be coming
  - National labs have long since been an ‘outsourced’ provider of HPC
  - Expect more HPC university consortiums, offerings be large vendors
  - Cost of electricity, generic workloads make HPC as a service attractive
What does this mean for data centers?

First, let’s look at an institution’s data center of the present…
Now let’s look at an institution’s data center of the future…
Business intelligence

- Universal data impedance theorem
  - Those who have the data, don’t use it. Those who could use the data, don’t have it

- In higher education, we have lots of data. Uses include:
  - Improving building utilization and student success, scheduling of courses given constraints of faculty skills and availability, room characteristics and courses students need now to graduate on time
  - College and unit access to data concerning operations and outcomes; faculty, researcher and clinician productivity
  - Recruiting and enrollment management; retention and student engagement

- Data relationships are complex
  - Institutions need a common definition of basic terms, need time to learn the data

- The information value chain is complex
  - While centralized units historically have provided data, colleges and units will increasingly need their own data close to their own decision makers. BI will be a federated affair

- The right to define data becomes a point of conflict
  - Warfare is often merely ontological
  - We need agreement among parties and clear, explicit terms
  - Agreed upon data stewardship and data sharing terms and approaches
  - Sharing: data is community property, information is a community product
Big data and analytics

- Big data refers to analysis on very large data sets
  - Biomedical data, web text mining, student interaction data
  - Any large and/or fast-moving data set that becomes cumbersome to manage using traditional approaches

- Top vendors are all competing intensively with new products
  - Oracle, Microsoft, SAP, IBM, niche players

- What is new?
  - Ability to dramatically speed up data preparation and data query time
  - Ability to drill down to details very easily, no performance degradation
  - Ability to develop new applications with real-time analytics at the core
    - e.g., student retention/success alerts & reminders, course recommendations based on likelihood of success
Process improvement has a role

- **Complexity**
  - Higher education has an a large number of and a high degree of complexity in the interactions we have with students, patients and customers. There is no other ‘product’ or ‘service’ like it. We should be mindful of this
  - We all bought ERP-like systems. Now we have to use them better!

- **Imagination**
  - The levels of automation and efficiency that organizations can achieve are well above and beyond nearly anyone’s current conception
  - It takes innovation to make significant, if not radical *improvements* in processes that touch students, faculty, staff, external agencies
  - This work is effortful, potentially distressing, but necessary. It requires perseverance

- **Stepwise and incremental**
  - Simplify, standardize, digitize, automate, consolidate, monitor, measure, enhance

- **Areas of focus**
  - Purchasing, travel, payroll, grants administration, internal approvals, recruiting, enrolling, advising, provisioning, scheduling, healthcare workflow, IT itself (ITIL/TQM) etc.
  - All things adminstrivia. How can we create administration-free zones?
  - How lean can we get?
Process improvement tools

- **Workflow tools**
  - Approval, monitoring, escalation and routing. These tools help coordinate what people do in a timely fashion

- **Additional ERP adoption**
  - Supply chain management, e-procurement, inventory management (for institutions with inventory issues), electronic HR systems including manager self service, electronic performance reviews, electronic medical records, etc.

- **More digitization**
  - Enterprise content management. Creation of ‘born digital’ documents. Retiring of paper documents. Digitize old paper documents to save storage space. Increased density in imaging related to medical, health science research

- **Advising tools**
  - 100% electronic student records. Student self-service tools. Degree progress monitoring by both the student and advisors. Automated alerts, reminders and notifications. Self service tools for other end users (public, patients)
The role of organizational capital

Investments in computers + people are synergistic

Organizational capital:

- Degree of self-managed teams
- Employee involvement in groups
- Diversity of job responsibilities
- Who determines pace of work
- Who determines method of work
- Degree of team building
- Workers promoted for teamwork
- Off-the-job training
- Degree of screening new employees for education

Volume operations versus complex systems

- Excluding the late 20th century, universities have been largely complex systems, delivering niche and customizable interactions F2F settings. Large lectures were added to increase output while reducing costs.

- Cloud, big data analytics, workflow tools, personalization technology and e-Learning approaches can begin to handle both high-volume classes/research and specialty classes/research.

What should this mean?

- IT should be directed to
  - Measurably, over time, lower the cost of administration
  - Enable growth in education and research (and revenue) via IT mediated learning, IT intensive research. Enable improved outcomes for both learning and research
  - Accelerate the development of business insight for both cost savings & growth

- IT should be a scalable infrastructure to help the institution find reallocations and new revenue while improving quality
**Is IT a tool or a capability?**

**Swords**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Process</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper, tin</td>
<td>Metallurgy</td>
<td>Bronze</td>
</tr>
<tr>
<td>Bronze</td>
<td>Sword-making</td>
<td>Superior sword</td>
</tr>
<tr>
<td>Superior sword, person</td>
<td>Training</td>
<td>Sword master</td>
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</tbody>
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**Information technology**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Process</th>
<th>Output</th>
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</thead>
<tbody>
<tr>
<td>Hardware, programming languages</td>
<td>IT component engineering</td>
<td>Standard component</td>
</tr>
<tr>
<td>Standard component</td>
<td>Enterprise architecture</td>
<td>Differentiating tools</td>
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<tr>
<td>Differentiating tools</td>
<td>Organizational development</td>
<td>Differentiated activity</td>
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</tbody>
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Current state

- General availability of key technologies (in progress)
  - Lecture capture
  - Learning management
  - Web conferencing
  - Research repository
  - Mobile devices
  - Open content
  - Virtual desktops
  - High performance computing
  - Cloud computing
  - Analytics, business intelligence
  - Messaging, communications, interactions, social media

- Improvement of support
  - Manage talent
  - Coordinate collectively
  - Automate/harden technology
  - Learn and improve

Future state

- Excellent adoption of key technologies
  - Select strategic opportunities for adoption
  - Identify and promote vanguard adopters
  - Decrease the time from initial idea to implementation
  - Tailor IT well for specific contexts
  - Foster faculty, student, staff IT skill development
  - Get feedback fast, iterate and refine
  - Help the stragglers
  - Understand fully the total user experience
  - Aggressively scan for new IT/approaches

- Transformation of support
  - Reallocate from basic support to core activities (analytics, computation and research, IT & teaching methods, innovation)
  - Aggregate technologies and increase scale, efficiency of investment
  - Insource and outsource appropriately
  - IT person: ‘Drop your tools’
What is changing?

- How we are conceptualizing IT as a capability
  1. Use of emergence and self-organization principles, internally and externally
  2. Fostering the growth of beneficial ecosystems
  3. Recognition of extreme temporality
  4. Sensitivity to the difficulties in transforming human cultures
  5. Renewed interest in how basic and applied sciences in many disciplines address complexity and innovation

*Because higher education has long since been bottom-up organizations respecting creative talent, we ought to have a leg up*
What are our impediments?

- **Humility**
  - “The problem with being so darned smart is you don’t know when you are being stupid!”
  - Yes, we have to adopt business-like approaches
  - Accountability to the citizenry

- **Multi-disciplinary futuring**
  - Finding people who can see the future and chart the institution’s path VERSUS finding people who want to ensure they describe the future but don’t have the background, orientation, skills, etc.

- **True teamwork, not more governance**
  - Trusting, communicating, self-adjusting, praising
  - Seeking to understand, value, care for each other
  - Humility
“To be absolutely certain about something, one must know everything or nothing about it.”

– Dr. Henry Kissinger
Questions?