ICT AT THE INTERSECTION OF PUBLIC POLICY/EDUCATION: 
Emerging Technologies, Ubiquitous Learning, and Educational Transformation

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The Core Challenge We Face

- Shifts in the knowledge and skills society values
- Development of new methods of teaching and learning
- Changes in the characteristics of learners

Emerging information technologies are reshaping each of these—and changing how we learn and know.
A Vision for ICT in Education

If we were to redesign education not to make historic models of schooling more efficient, but instead to prepare students for the 21st century—simultaneously transforming teaching in light of our current knowledge about the mind—what types of scalable, sustainable learning environments might sophisticated technologies enable us to create?
The 2010 NETP

- Response to Congressional mandate for five-year plan for educational uses of technology
- Plan for *transforming* education with technology in response to urgent need to remain competitive in a global economy
- Reflection of increased understanding of how to support learning and of growing capabilities enabled by technology
Enabling Technology Trends

Digitally Simulated Experiences

Mobility – Lifewide Learning

Social Interactions for Learning
Perennial Challenges in Classrooms

- Classrooms are barren places without rich resources or ways to simulate the real world.
- Students are bored compared to the many forms of engagement they have in the rest of their lives.
- Teachers are the only way increasingly large numbers of students can get help personalized to their needs.
- Paper and pencil, item-based assessments cannot measure deep knowledge and sophisticated skills.
Next Generation Interfaces for “Immersive Learning”

- **Multi-User Virtual Environments**
  Immersion in virtual contexts with digital artifacts and avatar-based identities

- **Virtual Reality**
  Full sensory immersion via head-mounted displays or CAVES

- **Ubiquitous Computing:**
  Wearable wireless devices coupled to smart objects for “augmented reality”

*January 2009 Science*
EcoMUVE

- Funded by the Institute of Education Sciences of the U.S. Department of Education
- Middle school science
  - Ecosystems, causal complexity
- Two MUVE-based modules implemented over 2 weeks within a 4-week ecosystems curriculum
- Timeline: July, 2008 – June 2012
  - Completed first set of large-scale field trials
  - Early results very encouraging.
Ecosystems have complex causal dynamics.

Even after instruction, students often retain misconceptions.

In our experience, MUVEs can help students engage in authentic science inquiry and gain deeper understanding.

Our goal is to develop EcoMUVE as a MUVE that, as part of a larger curriculum, will enable a richer understanding of ecosystems and complex causality.

We also want to demonstrate the potential of MUVEs for rich situated learning in classrooms.
Pond Ecosystem

Modeled after Black’s Nook Pond in Cambridge, MA
Change Over Time
Non-Obvious Causes

Things have been pretty quiet in this duck pond, until now. Oh boy – here comes a large number of bacteria. There are a lot of them down here. They are good at getting energy out of molecules that other organisms consider waste. Through the process of respiration, they can get their energy from dead plants and animals. They break apart molecules that were once locked up in dead plants and animals. In this process of decomposition they make the atoms and molecules that were once a part of other organisms available to be used again.
Hi, I'm Manny. We've been working really hard to get the new housing development ready for the open house. I'm probably going to have to work overtime every day this week to get these lawns in shape! I think this extra fertilizer I picked up should do the trick.

Professional Turf Fertilizer (40 lbs.) Contains nitrogen, phosphorus and potassium – nutrients essential for plant growth. Apply 1 pound for every 1,000 square feet of turf. Apply only as directed. Avoid applying before it rains to prevent loss of nutrients before they are taken up by plants.
Interaction Between Biotic and Abiotic Factors

Runoff causes increased phosphate levels, leading to increased plant growth. Plant decomposition by bacteria consumes oxygen, causing the eventual fish kill.

http://ecomuve.gse.harvard.edu
Assessing Sophisticated Performances Based on Rich Observations
NSES Model of Inquiry

- Identify questions that can be answered through scientific investigation (not independent of knowledge)
- Design and conduct a scientific investigation
- Use appropriate tools and techniques to gather, analyze, and interpret data
- Develop prescriptions, explanations, predictions, and models using evidence
- Think critically and logically to make the relationships between evidence and explanations
- Recognize and analyze alternative explanations and predictions
- Communicate scientific procedures and explanations
- Use mathematics in all aspects of scientific inquiry
An Immersive Model

- Student takes on identity of a scientist
- Students complete quests
- 90 Minutes
- Four Phases:
  1. Orientation
  2. Problem Identification
  3. Experimentation
  4. Competing Explanations
Actions as Basis for Assessments

Logfiles Indicate with Timestamps

- Where students went
- With whom they communicated and what they said
- What artifacts they activated
- What databases they viewed
- What data they gathered using virtual scientific instruments
- What screenshots and notations they placed in team-based virtual notebooks
- What hints they accessed

http://vpa.gse.harvard.edu/
### Logfiles: Events, Chats, Notebooks

**Database of Logdata** — Track students’ behaviors: where they went, what data they collected, path they took to solve problem

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Differences From Item-based Tests

Multiple Forms of Complex Measures

**Products of Inquiry**
Create conclusions and select evidence.

**Processes of Inquiry**
Gather data and interview people.
Formative and Diagnostic

- Formative, diagnostic assessment provides more leverage for improvement than summative measures.
- Formative, diagnostic assessment is richer and more accurate than summative measures.
- Potentially, formative, diagnostic assessment could substitute for summative measures.
Digital Teaching Platforms

- Instructional Designer
- Course Syllabus
- Open/Closed Repository
- Grade Book
- SIS
Teacher-Centered (Orchestra)
Disruptive Innovation Theory

Why Successful Companies Go Out of Business

- *Sustaining innovations* are incremental improvements in a product
- *Disruptive innovations* offer a new product initially not as effective as what is currently sold, but immediately meeting a specialized need (alternative is non-consumption) and potentially better in the long-run
- Over time, the disruptive product drives out the standard product (e.g., mini-computers)
Disrupting Class  Christensen, Horn, & Johnson, 2008

My Altered Version

- *Schooling* is the sustaining innovation (based on industrial model)
- *Customization* is the disruptive innovation (e.g., individual human tutors and the 2-sigma effect)
- Customization in online learning is the initial product that competes against non-consumption
- Inclusive, customized learning – *based on much more distributed “teaching”* – is the innovation that forces schooling to adapt
Student-Centered (Jazz Combo)
Enabling Technology Trends

- Digitally Simulated Experiences
- Mobility – Lifewide Learning
- Social Interactions for Learning
Many Mobile Devices
…and More to Come
Next Generation Interfaces for “Immersive Learning”

- **Multi-User Virtual Environments**
  Immersion in virtual contexts with digital artifacts and avatar-based identities

- **Virtual Reality**
  Full sensory immersion via head-mounted displays or CAVES

- **Ubiquitous Computing**
  Wearable wireless devices coupled to smart objects for “augmented reality”

January 2009 *Science*
“Overlay Devices”

- Wireless mobile devices offer substantial power, at a fraction of the cost for laptops and with greater mobility.
- Entertainment and learning are infused anywhere.
- One-to-one person-to-device ratio becomes affordable in education.

“Augmented reality” for entertainment and learning
Role of Mobile Broadband Devices

Enable learning anytime, anyplace

- Embedded information and experience provides authenticity and fosters transfer

- Rich data on students’ actions and performances enables customized instruction
Enabling Technology Trends

- Digitally Simulated Experiences
- Mobility – Lifewide Learning
- Social Interactions for Learning
The Spectrum of Web 2.0 Media

- **Sharing**
  - Social bookmarking
  - Photo–video sharing
  - Social networking
  - Writers’ workshops and fan fiction

- **Thinking**
  - Blogs
  - Podcasts
  - Online discussion forums
  - Twitter

- **Co-Creating**
  - Wikis—collaborative file creation
  - Mashups—collective media creation
  - Collaborative social-change communities

May 2009 *Educational Researcher*
Jenkins’ Framework for New Literacies

- **Play** — Experimenting with one’s surroundings in problem solving
- **Performance** — Adopting alternative identities for improvisation and discovery
- **Simulation** — Interpreting and constructing dynamic models of real-world processes
- ** Appropriation** — The ability to meaningfully sample and remix media content
- **Multitasking** — Scanning one’s environment and shifting focus to salient details
- **Distributed cognition** — Fluently using tools that expand mental capacities
- **Collective intelligence** — Pooling knowledge with others toward a common goal
- **Judgment** — Evaluating the reliability and credibility of different information sources
- **Transmedia navigation** — The ability to follow the flow of stories and information across multiple modalities
- **Networking** — The ability to search for, synthesize, and disseminate information
- **Negotiation** — The ability to travel across diverse communities, discerning and respecting multiple perspectives, and grasping and following alternative norms
KNOWS you and your surroundings

SENSES local content and services

LEARNs what you like

INTERACTs with networks

DISCOVERs relevant things

SEES with augmented reality

WHAT IF YOUR DEVICE HAD A 6TH SENSE?
Distributed Education

Who educates?

- Teachers in school
- Coaches, guides, and mentors in rest of life
- Self-directed learning through access to information and experience everywhere

How prepared?

- Schools of education prepare and certify
- Apprenticeships for each within all settings
- Self-directed learning through access to information and experience everywhere
Current State of ICT in Education

- Technology as hood ornament, not engine
- Device usage as the innovation
- What sells is ways to automate presentational teaching and assimilative learning
- Emphasis not on value, but on fear of misuse
- Pace of change driven by teachers’ comfort-level

Jet engine on a Stagecoach
Transformation of Formal Education
Key Policy Recommendations from 2010 NETP

- 1.1 States should continue to revise, create, and implement standards and learning objectives using technology for all content areas that reflect 21st-century expertise and the power of technology to improve learning.

- 1.3 States, districts, and others should develop and implement learning resources that exploit the flexibility and power of technology to reach all learners anytime and anywhere.

- 5.2 Rethink basic assumptions in our education system that inhibit leveraging technology to improve learning, starting with our current practice of organizing student and educator learning around seat time instead of the demonstration of competencies.
2.1 States, districts, and others should design, develop, and implement assessments that give students, educators, and other stakeholders timely and actionable feedback about student learning to improve achievement and instructional practices.

2.3 Conduct research and development that explores how embedded assessment technologies, such as simulations, collaboration environments, virtual worlds, games, and cognitive tutors, can be used to engage and motivate learners while assessing complex skills.
Key Policy Recommendations from 2010 NETP

- 3.2 Leverage social networking technologies and platforms to create communities of practice that provide career-long personal learning opportunities for educators within and across schools, preservice preparation and in-service education institutions, and professional organizations.

- 3.3 Use technology to provide all learners with online access to effective teaching and better learning opportunities and options especially in places where they are not otherwise available.

- 3.5 Develop a teaching force skilled in online instruction.
Key Policy Recommendations from 2010 NETP

- 4.2 Ensure that every student and educator has at least one Internet access device and appropriate software and resources for research, communication, multimedia content creation, and collaboration for use in and out of school.
- 4.4 Build state and local education agency capacity for evolving an infrastructure for learning.
- 4.5 Develop and use interoperability standards for content and student-learning data to enable collecting and sharing resources and collecting, sharing, and analyzing data to improve decision making at all levels of our education system.
Grand Challenges for Research from 2010 NETP

1.0: Design and validate an integrated system that provides real-time access to learning experiences tuned to the levels of difficulty and assistance that optimize learning for all learners and that incorporates self-improving features that enable it to become increasingly effective through interaction with learners.

3.0: Design and validate an integrated approach for capturing, aggregating, mining, and sharing content, student-learning, and financial data cost-effectively for multiple purposes across many learning platforms and data systems in near real time.