New Technology-based Models for Postsecondary Learning

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- Funded by NSF, sponsored by CRA, hosted at MIT
- Co-Conveners: Chris Dede, Harvard; Eric Grimson, MIT
- Participants:
  Daniel E. Atkins,, U. Michigan
  Lori Breslow, MIT
  John Cherniavsky,, NSF
  J.D. Fletcher, Institute for Defense Analyses
  Diana Oblinger, EDUCAUSE
  Roy Pea, Stanford
  James Pellegrino, U. Illinois—Chicago
  Bror Saxburg, Kaplan
  James Shelton, US. Dept. Education
  Russell Schilling, DARPA
  Greg Tobin, Pearson Higher Education
  Ellen Wagner, Western Interstate Commission Higher Education
Types of Postsecondary Learning

- Colleges and Universities
- Military Training and Development
- Workforce Training and Development
- Informal Learning to Attain Capacity for Reaching Personal Goals

Rethinking Learning Outcomes

- Expertise as tacit rather than explicit
- Distributed understandings and performances rather than “in the head” knowledge and skills
- Situation resolution rather than solving routine problems
- Affective and social dimensions of competence given equal weight with cognitive
Rethinking Educational Processes

- Credentialing/certification based on competency rather than time
- Many sources of accredited learning, based on alternative business models and new marketplaces
- Continuous improvement via analytics applied to rich databases and embedded A/B experiments
- Generic tools and media repurposed for learning

Evocative

Gödel, Escher, Bach: An Eternal Golden Braid

Douglas R. Hofstadter

Pulitzer Prize-Winner
20th-anniversary Edition With a new preface by the author

A metaphorical fugue on minds and machines in the spirit of Lewis Carroll
“Next Generation”
Motivation and Learning

- Virtual Peers in Complementary Study Group
- Synchronous Back-Channel with Archives
- Virtual Worlds
- Local Augmented Realities
- Virtual Performance Assessments

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 issue of *Science*
**EcoMUVE Module 1: Pond Ecosystem**

Modeled after Black’s Nook Pond in Cambridge, MA

[Image of a pond]

http://ecomuve.gse.harvard.edu

<table>
<thead>
<tr>
<th>Role</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naturalist</td>
<td>Find out how the populations of pond organisms: largemouth bass, bluegill, minnows, and great blue herons change over time. Use the field guide to learn about the different fish species. Use the atom tracker to find out what happens to the carbon atom on different days. Measure the turbidity in the water (and use your eyes) to see changes over time. Work together to create a concept map that represents the causal relationships of the pond ecosystem based on whole team’s observations.</td>
</tr>
<tr>
<td>Microscopic Specialist</td>
<td>Find out how the populations of microscopic bacteria, bluegreen algae, and green algae change over time. Use the atom tracker to find out what happens to the carbon atom on different days. Use the atom tracker to find out what happens to the oxygen atom on different days. Use the atom tracker to find out what happens to the phosphorus atom on different days. Measure chlorophyll a in the water on different days. Measure the dissolved oxygen in the water on different days.</td>
</tr>
<tr>
<td>Water Chemist</td>
<td>Use the atom tracker to find out what happens to the carbon atom on different days. Measure the dissolved oxygen in the water on different days. Measure the dissolved oxygen in the water on different days. Measure the pH in the water on different days. Measure the nutrients (phosphates and nitrates) in the water on different days.</td>
</tr>
<tr>
<td>Private Investigator</td>
<td>Gather clues from the landscaper, the golf course manager, the utility worker, the park ranger, the birdwatcher, other people near the pond. Observe the weather on different days; collect measurements of temperature, cloud cover, and wind speed. Measure the temperature in the water on different days. Measure the temperature in the water on different days. Measure the nutrients (phosphates and nitrates) in the water on different days.</td>
</tr>
</tbody>
</table>
EcoMOBILE:
Ecosystems Mobile Outdoor Blended Immersive Learning Environment

- Taking on scientific roles
- Individualized pathways
- Making connections
- Seeing the unseen

NSF DRK-12
http://ecomobile.gse.harvard.edu

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<th>Microscopic Specialist</th>
<th>Water Chemist</th>
<th>Private Investigator</th>
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<tbody>
<tr>
<td>Observe pond for similarities to EcoMUVE</td>
<td>Observe duckweed</td>
<td>Observe pond for similarities to EcoMUVE</td>
<td>Talk to virtual golfer</td>
</tr>
<tr>
<td>Observe virtual fish</td>
<td>View 3D model of duck</td>
<td>Measure dissolved oxygen</td>
<td>Observe storm water pipe overlay</td>
</tr>
<tr>
<td>Calculate fish population size</td>
<td>Video of starch decomposition by bacteria</td>
<td>Video of how oxygen dissolves in water</td>
<td>Find inlet and outlet of pond</td>
</tr>
<tr>
<td>Collect macroinvertebrates</td>
<td>Observe virtual bacteria</td>
<td>Measure water temperature</td>
<td>Talk to young girl about what a watershed is</td>
</tr>
<tr>
<td>ID macroinverts and calculate tolerance index</td>
<td>Measure pH</td>
<td>Measure phosphates</td>
<td>Measure turbidity</td>
</tr>
</tbody>
</table>

Work together to create video that summarizes the health of the pond based on whole team’s observations
Seeing the Unseen

Animated models of photosynthesis and other atomic-level processes.

Individualized Pathways
Making Connections

Transformed Social Interaction (TSI): Augmented Gaze
**TSI: Facial Identity Capture**

- Capturing exploratory paths
- Analyzing usage of guidance systems
- Interacting with animated pedagogical agents
- Attaining “powers” through accomplishments
- Documenting progress and transfer in similar settings

Path Analysis for Defined Tasks

Individual and Group Paths

Heat Maps

Usage of Individualized Guidance
Interacting with Animated Pedagogical Agents

Documenting Progress and Transfer in Similar Settings

- Student takes on identity of a scientist
- Students complete quests
- 60 minutes
- Four Phases:
  1. Orientation
  2. Problem Identification
  3. Experimentation
  4. Competing Explanations

http://vpa.gse.harvard.edu
Attaining “Powers” Through Accomplishments

Mysterious Mansion  Access to Special Experiences

“Next Generation” Motivation and Learning

- Virtual Peers in Complementary Study Group
- Synchronous Back-Channel with Archives
- Virtual Worlds
- Local Augmented Realities
- Virtual Performance Assessments
Interrelated Dimensions of Postsecondary Learning

Desired Outcomes of Postsecondary Learning

- Desirable Characteristics of Postsecondary Learning
- Organizational Strategies for Adoption and Scale
- R&D on Technology-based Teaching and Learning

Types of Outcomes for Postsecondary Learning

- Advanced Knowledge and Skills on Cognitive, Intrapersonal, and Interpersonal Dimensions
- Personal Development, Identity Evolution, and Socialization
- Increased Capacity for Better Opportunities in Work and Life
- Social Capital for Further Learning
### Dimensions of Advanced Knowledge and Skills

<table>
<thead>
<tr>
<th>Cognitive Outcomes</th>
<th>Intrapersonal Outcomes</th>
<th>Interpersonal Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive processes and strategies</td>
<td>Intellectual Openness</td>
<td>Teamwork and Collaboration</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Work Ethic and Conscientiousness</td>
<td>Leadership</td>
</tr>
<tr>
<td>Creativity</td>
<td>Positive Core Self-Evaluation</td>
<td>Communication</td>
</tr>
<tr>
<td>Critical Thinking</td>
<td>Metacognition</td>
<td>Responsibility</td>
</tr>
<tr>
<td>Information Literacy</td>
<td>Flexibility</td>
<td>Conflict Resolution</td>
</tr>
<tr>
<td>Reasoning</td>
<td>Initiative</td>
<td></td>
</tr>
<tr>
<td>Innovation</td>
<td>Appreciation of Diversity</td>
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### Desirable Characteristics of Postsecondary Learning

- Serves a wide range of learners
- Good return on investment by learners and by society
- Self-improving via research and continual feedback
Organizational Strategies for Adoption and Scale

- Develop authentic assessments based on outcome objectives
- Select initial innovations carefully so that strong models of learning are implemented
- Emphasize user-friendly interfaces
- Study design strategies for effective media that have scaled
- Accomplish tasks instructors/institutions want to relinquish
- Use organizational development strategies to change culture

Types of Research and Development Needed

- New Models of Technology-based Teaching/Learning
- New Models of Technology-based Assessment, Validation, and Authentication
- Human infrastructures, including support for cross-institutional collaboration
- Technical infrastructures, including support for shared data and tools, cross-institutional access
- Grand Challenges and other Clusters of Innovative Models
Sources for Illustrative Research Agenda

- NSF Cyberinfrastructure, 2003
- FAS Learning Federation Project, 2003
- CRA Cyberinfrastructure and Learning, 2005
- NSF Cyberlearning, 2008
- U.S. ED National Ed Tech Plan, 2010
- NRC Learning Science via Games/Sims, 2011;
- REAL Commission Recommendations, 2012
- U.S. ED Expanding Evidence Approaches 2013

Recommendations for Future Workshops and Meetings

- Creating and validating encompassing learning maps (desired outcomes, evidence for their achievement)
- Exploring competency based models for alternative certification and credentialing
- Scenario-based planning on alternative futures for postsecondary learning
Transformation of Formal Education

Link to a Pre-Release Version of the Report
