How Immersion in Virtual and Augmented Worlds Helps Students in the Real World

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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
Situated Learning and Transfer

- constellations of architectural, social, organizational, and material vectors that aid in learning culturally based practices
  - apprenticeship (the process of moving from novice to expert within a given set of practices)
  - legitimate peripheral participation (tacit learning similar to that involved in internships)
  - high fidelity is not important unless essential for task (e.g., interpreting photographic images)
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”

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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 two weeks within a four week ecosystems curriculum.
- Timeline: July, 2008 - July 2011
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.
Module 1: Pond Ecosystem

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

Carbon Atom

Things have been pretty quiet in this duck pond, the bottom of the pond. Oh boy – here come the bacteria. There are a lot of them down here! Bacteria are good at getting energy out of materials 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.
<table>
<thead>
<tr>
<th>Naturalist</th>
<th>Microscopic Specialist</th>
<th>Water Chemist</th>
<th>Private Investigator</th>
</tr>
</thead>
<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
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
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The Evolving Mobile Experience

VOICE

MESSAGING

ENTERTAINMENT

COMPUTING
Always On, Always Connected Devices

- Always-on Connectivity
- All-Day Battery Life
- Security
- Location Aware
- Multimedia Performance
- Unprecedented Power & Speed

Snapdragon by Qualcomm
Beyond “Old Wine”: Augmented Reality

Augmented realities utilize mobile, context-aware technologies that enable participants to interact with digital information, videos, visualizations, and simulations embedded within a physical setting.

- Location-aware AR presents digital media to learners as they move through a physical area with a GPS-enabled smartphone or similar mobile device.
- Vision-based AR presents digital media to learners after they point the camera in their mobile device at an object (e.g., QR code, 2D target).
Sheung Wah
Kowloon (W)
Connaught Place
Airport Express Station
Edinburgh Place
Kowloon
EcoMUVE is going Mobile

http://ecomobile.gse.harvard.edu
Does augmented reality enhance learning on a field trip?
Texas Instruments NSpires with Vernier Environmental Probes
IN THE FUTURE YOUR MOBILE PHONE WILL ACT AS YOUR DIGITAL “6TH SENSE”
Why Immersion for Learning?

- allow simulated experiences otherwise impossible to deliver.
- increase engagement in learning by allowing students to immerse themselves in a virtual world.
- support new forms of interaction and collaboration
- enable embedded hints and tutoring delivered via situated, just-in-time processes.
- Increase — *and assess* — learner’s knowledge, skills, and self-efficacy.
- promote transfer to the real world more than other forms of instruction
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
Transformation of Formal Education
A Different Model of Pedagogy

- Experiences central, rather than information as pre-digested experience (for assimilation or synthesis)
- Knowledge is situated in a context and distributed across a community (rather than located within an individual: with vs. from)
- Reputation, experiences, and accomplishments as measures of quality (rather than tests, papers)
Core Principles of Professional Development

- Teachers teach as they were taught.
- The important issue is not technology usage, but changes in content, pedagogy, assessment, and learning outside of school.
- Continuous peer learning is the best strategy for long-term improvement.
Professional Development: Communities of “Unlearning”

- Developing fluency in using emerging interactive media
- Complementing presentational instruction with collaborative inquiry-based learning
- Unlearning almost unconscious assumptions and beliefs and values about the nature of teaching, learning, and schooling

Crucial issue for professional development