CAMPUS TECHNOLOGY

Best of Both Worlds

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Advocates for immersive technologies are finding a foothold in higher education by combining virtual with real-world learning.

Aaron Walsh coined the term "immersive education" for a reason. "As educators, we know that people learn best by doing," he says. "When students are doing something rather than reading or learning about it, they learn better. Immersive environments help students retain more information and speed up their learning. There's an enhancement in the way they learn."

Walsh, a faculty member at the Woods College of Advancing Studies at **Boston College** and director of The Grid Institute, has been working in immersive environments in education for over a decade. He has won recognition from *Campus Technology* as one of our 2009 Innovators, as well as from organizations like *Computerworld*, which in 2007 named him as one of the 40 most innovative people in technology, citing his work on immersive education as an "...innovative, promising technology which holds the potential to significantly affect society in the near future."

Immersive environments-- which utilize technologies like simulations, virtual reality, augmented reality, Second Life (see photo at left), and the like-- have long held sway in the gaming world, where advances in digital, information, and online technologies have helped to create mind boggling artificial spaces that absorb users into an alternative or amplified reality.

Immersive education employs the same technologies, but unlike gaming, immersive education doesn't isolate students in an imaginary world, but rather uses the technologies to bridge the conceptual with the concrete-- giving students a virtual laboratory, if you will, in which to work out real-world problems. Walsh explained the reason behind this hybrid approach in a 2007 interview with the virtual weblog Terra Nova:

> Initially we wanted...all learning materials to be presented inside of the environment itself, thinking that a single seamless environment would be best. And while that may be the case for the entertainment industry...for education there's no reason why all content has to be delivered

inside of the virtual environment. In fact, it can be quite restricting to do so. Why not simply open a browser window when necessary, allowing students to use a wide variety of learning content that can't (and probably shouldn't) be shoehorned into the virtual environment?

An Immersive Future

IMMERSIVE EDUCATION advocates would like to see the technology move beyond medical and health care studies, where it has been having an impact for some years now. But does immersive education have a real future in general academia? Yes, very possibly, say some experts in higher ed.

According to "The Future of Higher Education: How Technology Will Shape Learning," a study of 289 higher ed and corporate executives conducted in 2008 by The Economist Intelligence Unit and the New Media Consortium (the latter a group of educational organizations focused on new technologies in learning),Web 2.0 technologies such as wikis, instant messaging, and social networking-- now common at colleges and universities-- are expected to decline in use in the next five years. By contrast, the study found, respondents expected online gaming and simulation software (the building blocks of immersive environments) to become much more prevalent in universities in the same period. Of the 189 higher ed participants in the survey, 68 percent said that advanced campus technology will be a core differentiator as colleges compete for the best students and faculty, and 83 percent believed that the strategic application of new technologies can greatly enhance a university's overall reputation.

Jason Leigh, director of the **University of Illinois at Chicago**'s Electronic Visualization Laboratory (EVL)-- which has created an immersive, 360-degree "cyber commons" classroom-- describes his university's move toward immersive education this way: "Instead of fighting the trend toward digital media, we want to embrace the skills students already know and give them an environment that would dramatically enhance the way they learn, with technology they can't afford at home. That's the role of a top university."

Beginning in Fall 2009, UIC students studying visualization and visual analytics, video game design, scientific visualization, and virtual reality will meet at the cyber commons, which is outfitted with a high-definition display wall with nearly 20 million pixels of contiguous workspace and 20 Gbps of networking capacity. Standing 6 feet high and 20 feet wide, the wall supports a montage of streamed and local digital media and information, such as high-resolution images, animations, websites, and PowerPoint slides. "In some ways the new display wall is almost a replacement for the traditional blackboard or whiteboard," Leigh says. "But the traditional blackboard is information-sparse.We want to bring into the classroom these new technologies in the hope that we can enrich the way students learn, teach them strategies, show them how to put lots of information together, and draw conclusions."

To download "The Future of Higher Education," go here..

Authentic Learning

According to Thomas Reeves, professor of learning, design, and technology at **The University of Georgia** and formerly a scientist responsible for designing interactive systems for military training and medical education, the best immersive scenarios are those that involve "authentic activities" that simulate the real world but that also engage students in real-life problems and events. "What I'm interested in is serious immersion in real-world activity," Reeves says. "For example, for a Unicef ecology program, we sent students into the field to assess new-growth and old-growth trees, local pig farms, run-off water, and so forth. Then we ran simulations of the same environment, and had the students bring data back from the real environment, then go into the simulation, integrate that with EPA and other data, and write research reports based on all this data. They went back and forth from real to simulated."

While immersive education has its detractors-- one comment posted on Walsh's blog interview, for instance, decries the approach as "fake education"-- Walsh staunchly defends its value. "An immersive environment engages the learner's mind and leads to better learning results," he says. "The military and medical industries have been using virtual reality simulations for over 30 years. Now we're using it for broad-based education."

Walsh's declaration of the "broad-based" use of immersive environments in education is probably several years ahead of the reality (see "An Immersive Future?"). Nonetheless, there is no doubt that a small but growing number of universities around the country are using immersive education approaches to achieve critical educational outcomes. Here is a look at several of these projects, each using slightly different immersive technologies, but all seeking to enhance student learning by merging digital and real environments, to achieve the best of both worlds.

Immersive Education Building Blocks

SINCE THE MAJORITY of higher ed institutions are unlikely to have the funding or technology to create virtual learning environments, the Immersive Education Initiative (IEI)-- a nonprofit global alliance of universities, research institutes, and businesses-- offers free open-standards educational resources. The IEI is a project of The Media Grid, a standards group that provides free frameworks and technology to create immersive environments, using three open-source toolkits: Sun Microsystems' Project Wonderland, realXtend, and Open Cobalt.

Boston College faculty member Aaron Walsh directs the The Media Grid and the IEI project, and he and his colleagues are committed to disseminating "pre-made," "reusable" immersive environments for a growing array of academic disciplines-- such as biology, psychology, chemistry-- to achieve their goal of the broad-based use of immersive environments in education. "The body of material is growing," Walsh says. "We have specific and special-purpose simulators. In some, each of the learners needs to install the software and connect to virtual worlds.We also have group systems where a bunch of students can use the same computer-- this is good for K-12 students. Mixed-reality technologies are also available, where the software creates 3D environments in the air. Our

mission is to get the technology into the hands of educators. It is fundamentally a nonprofit activity, because this is technology that benefits humankind. Not sharing it would be like having access to books but not allowing people to read them. Our driving force is to educate people."

For more information, go here.

Virtual Practicum

Health care is probably the field that has and will continue to benefit the most from immersive education techniques because of its need to safely expose its students to the high-stakes, sometimes even life-and-death, experiences that they will be facing in their real-world practices.

One of the pioneers of using virtual environments in medical training is Joseph Henderson, professor of community and family medicine and director of the Interactive Media Laboratory (IML) at **Dartmouth Medical School** (NH). At the forefront of a movement to combine emerging technologies with new instructional design, Henderson has developed what he calls a "Virtual Practicum" for continuing medical education. What he and the IML team are trying to do, he says, is to mix old and new media and traditional and innovative teaching methods. "The pioneering aspect of our work is using technology to communicate. It's a combination of traditional education with the active things that students can do by using simulation and dealing with various pieces of information."

Henderson describes the Virtual Practicum-- whose modules students can download and install on their computers-- as a technology-based "virtual clinic" or "virtual mini-fellowship" that approximates the world of clinical practice. For example, a program on HIV patient care uses interactive video, sound, and graphics to move the student through a virtual clinic that includes an orientation, a learning resources room, encounters with a virtual patient, and interviews with real patients. By simulating actual medical practice, the Virtual Practicum teaches students to "work in the swamp," Henderson says. "Often, we teach theories and a systematized way of looking at the world. We don't prepare people to function in a less deterministic world where decisions are often made without all the knowledge."

A technology-based ‘virtual clinic' at Dartmouth Medical School **simulates encounters with patients** to prepare students for work in the real world.

He makes sure to point out, though, that the technology is only a backdrop to the human element. "A senior practitioner and mentor would act as a coach guiding the student," he says. "The simulations are activities where one is playing with pieces of the active world, like a pianist playing arpeggios. It's a reflective practicum in a technology-based environment."

The Augmented Anesthesia Machine

The merger of physical and virtual spaces, it turns out, can also achieve learning outcomes that had been elusive in only simulated or only physical environments. Over a decade ago, the Center for Simulation, Safety, Advanced Learning, and Technology at the **University of Florida** took on the

challenge of improving medical technician training to reduce the serious problem of operator error. According to one study, for example, 75 percent of anesthesia machine-related accidents resulting in death or brain damage are due to user error. Scientists at the center attribute user error, in part, to a lack of understanding of how the machines work, so they created a web-based simulation engine and dozens of downloadable medical-machine simulations to help address the conceptual gaps in students' technical training. These simulations make manifest the abstract inner workings of the equipment (for example, the invisible oxygen flow of an anesthesiology machine), something students don't get to visualize or experience when just working with concrete (and very opaque) equipment.

However, the center soon realized that they faced another challenge: Students' performance improved on conceptual testing (a 2006 study confirmed this), but some students were still not able to transfer that conceptual knowledge to the actual operation of the machine. "For some students it is difficult to take the VAM [virtual anesthesiology machine] and map it to the real thing," says John Quarles, a graduate student at the university who is doing his doctoral research on interactive computer graphics. The center needed a way to provide "some learning scaffolding," he explains.

So the question became: how to help these struggling students transfer abstract knowledge to the concrete domain? The center turned to work done in the 1990s by Paul Milgram and Fumio Kishino on "mixed reality," or what Quarles calls the "co-location of virtual objects and real objects in the same space." Using magic lens technology (a tablet-like digital overlay that filters physical objects to reveal hidden information or to enhance data), along with web cams and 2D optical tracking with infrared markers and infrared LEDs embedded in the anesthesia machine, the center created an "augmented anesthesia machine" or AAR. Essentially, the AAR is an actual anesthesia machine augmented by the overlay of a magic lens that reveals its inner functioning while the student operates the machine. For example, holding the magic lens tablet (about the size of a netbook computer screen) over the actual machine's oxygen control knob, and then turning the knob, the student will see on the tablet an animation of the direction of the real oxygen flow.

"It's as if you were looking at the inner workings through a window," says Quarles. This kind of immersive, mixed learning, he believes, significantly "improves training transfer into real world demands."

ARGH!

That bridge between the conceptual and real world underlies what researchers at the Local Games Lab (LGL) at the **University of Wisconsin-Madison** are doing in their development of "augmented reality" (AR) educational games. The LGL is a project of the university's Academic Advanced Distributed Learning Co-Lab (AADLC), whose mission is "to provide expertise, facilities, and administrative services to enable the research and development activities of our academic, K-12, government, and industry partners."

The LGL's specific charge is to work closely with local middle schools, community organizations, and nature centers to develop and study the educational effect of AR games designed to enrich

students' experiences of their neighborhoods and natural surroundings. Called Augmented Reality Games on Handhelds (ARGH), the project explores the use of emerging mobile technologies in learning.

Partnering with **Harvard University** (MA) and **MIT** in a three-year research project funded by the US Department of Education's Star Schools Program, ARGH is creating and testing location-based AR games for middle school education. Graduate students at the university design and build the games; middle school teachers who sign up to participate in the project receive a stipend and can earn continuing education credits.

Immersive=Engaged

HOW VALUABLE AN immersive environment is depends almost entirely on the student's level of engagement, **The University of Georgia**'s Thomas Reeves believes. In a 2007 report that Reeves co-authored with educators from universities in Australia, "Immersive Learning Technologies: Realism and Online Authentic Learning," the authors debunk the notion that the virtual world can substitute for or in any way threaten the real one: "Engagement with the task appears to be of greater import to both teachers and learners than an exact replica of a real-life learning situation, particularly for learning in higher education. Our research has indicated that it is not necessary for learning environments to comprise resource-intensive virtual reality, or highly realistic simulations utilizing custom-built projection rooms or visual and audio headsets…to be fully immersive." For the full report, go here.

In a typical ARGH game-based course, students walk around a real-world community or natural setting, using simple handheld computers equipped with Windows Mobile 5 and GPS software. As they walk, the game players see themselves as icons moving on a map. When they reach specific locations, the GPS software triggers virtual interviews, photos, videos, data, and other material that adds to or "augments" reality.

UW-Madison's ARGH project augments reality by **connecting students to virtual interviews**, photos, videos, data, and other informational material in real time.

"Let's say we're walking around the farmers market in Madison," says Mark Wagler, an ARGH project manager at LGL. "There's so much to see. There's music, food, people making marketing pitches-- it's a very rich environment. While we're walking around, the computer gives us additional information. A stand may be selling spinach. The computer could show a video interview with the farmers, and we could see the hoop houses where they raise their spinach, tomatoes, and flowers."

Next, says Wagler, the students might view old photos, learn the history of the market, and "interview" real or fictional characters. "To turn this into a gaming kind of environment, we would have roles-- you might be a restaurant buyer. We're all getting different information, but we have a common challenge: The market is going to close because the city is building a large covered building that will change this environment. The challenge is: What's the answer to this?" Each role

receives different information, so to come up with solutions, the students need to work collaboratively-- another benefit of the game.

This immersive environment is an improvement over traditional instruction, Wagler says, because the connections to actual places and people, and the variety of informational materials available to the students in real time, provide learning opportunities that would not have been possible otherwise. And while the games have been designed for middle schools so far, "the concept will work at any age level," he says.

He adds that future designs will also bring the games indoors, making them suitable for just about any environment. "Our games have all been outdoors because of the use of GPS," he says. "But you can do it with WiFi indoors in museums. We're working on new games for the iPhone that you can play indoors."

Wagler believes that immersive educational approaches like AR games work "very well in natural and cultural environments. You can use it for subjects from forestry to farming to biology-- a whole range of things that are outdoors.

Resources

Interactive Media Laboratory virtual clinics
Virtual Anesthesia Machine
Local Games Lab

But it's also useful for history, contemporary culture, economics, geography, sociology-- anywhere you can use data to augment actual observations. The field is new, but I can't tell you somewhere where it wouldn't work."

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