Simulation Nation

Inventive computer sims can turn dull lessons into hyperreal experiences-if we can get educators to use them.

by Marc Prensky

Articles in the media on the use of some particular technology in schools are generally pretty formulaic.Typically, they begin with a glowing quote from a teacher, who bubbles, "I use [insert technology] with my classes, and it's the greatest thing since sliced pasta."

Then they throw in a few case studies, ideally from different parts of the world and various types of schools (say, urban and rural) for the requisite diversity. Toss in a few more highly enthusiastic instructors and a ringing endorsement from a student, and -- boom -- you're home free. "I should look into that," thinks you, dear reader.

If that's the kind of article you are looking for, keep looking, because this article on computer-simulation technology is, rather, about how and why yet another technology that could be enormously powerful for our kids' learning is getting short shrift in our educational system -- despite the successes we can, in fact, find and cite. Simulation is not just another in the long line of passing fads (or short-term opportunities) in educational technology. It is, rather, a real key to helping our students understand the world.

Computer-simulation technology is a way of looking at objects or systems that encourage a learner not only to wonder, "What would happen if . . . ?" but also to try out those alternatives virtually and see the consequences. It is a way for learners to acquire experience about how things and systems in the world behave, without actually touching them. I call it interactive pretending.

Because so many of the things we need to understand these days are either too complex, too vast, too small, too far, or too dangerous to be experienced directly, we can no longer rely, as we did for so long, on hands-on learning. Simulation provides us a solution and is, in fact, the only way to experience, try, and learn many of things we really want to

know about (and want our students to learn about.) Because of this factor, simulation is absolutely fundamental to education -- and has always been so.

Several principles are key for educators to understand:

Simulation is not new. It has been with us for as long as there has been education. At its core, simulation requires no other technology than the ability to think. Most simulations take place entirely in the mind, via mental what-ifs: A lawyer plays through an upcoming trial in his head. A skier visualizes herself slaloming down the course. Our best teachers have always used mental simulations with their students, as when they announce, "What if the South had won the Civil War?" or "Imagine if penicillin was never invented." It requires nothing more than a teacher who can think through the possibilities with students and help them envisage possible consequences and outcomes. Computers help by overlaying a lot of the details, but simulation always comes back to a person asking, "What if ?"

Simulation helps us understand complex issues. This is particularly true of complicated computermodel simulation. Today, we can model amazingly complex behaviors while providing relatively simple inputs and clear sensual outputs. With these simulations, students learn about a complicated thing (say, an airplane), system (the weather) or behavior (management), and, without risk of damaging anything or getting hurt themselves, make a wide variety of assumptions and changes and see the results.

Simulation is real-world experience. Professional simulations are used every day in just about every profession: City planners simulate all the factors that make a metropolis thrive or die. Military planners simulate conditions, battles, and equipment. Traders simulate financial markets. Weather forecasters simulate daily and long-term climate. Doctors simulate the effects of drugs, transplants, and other interventions. Ecologists simulate changes in the environment. Engineers simulate the effects of natural and artificial forces on buildings and bridges. Computer-network engineers simulate conditions on the Internet. Scientists use simulations continually.

How Do We Know They Work?

OK, you're convinced. But how do you get the school board (or even your own principal) to back you? Proving the effectiveness of any given teaching technique for learning is a task fraught with problems, if not downright impossible. The trouble is that keeping constant everything else besides the teaching technique in question (the students, the time, the material, and so on) is untenable. In addition, students may learn different things from various techniques -- some of which, although valuable, are not measured by our usual evaluations.

But for those who can be satisfied with real-world acceptance, rather than pseudoscientific studies, we have lots of empirical evidence that people learn from simulation, and that simulations therefore have great teaching value:

NASA's astronaut training puts learners through simulated events. Airlines have pilots go directly from the simulator to the yoke of a 747. Medical students learn the physical relationships of body parts and how systems work together. They have progressed from learning on cadavers to working with physical simulators and, more recently, onscreen simulators. If a prospective doctor can learn about a complex piece of anatomy or a difficult procedure from a simulator, certainly our kids can learn the frog's interior layout from a sim like Froguts.

The corporate world provides useful data about simulations designed to change behavior and obtain results (which is exactly what we hope will be learned in many situations but is something that few, if any, of our standardized achievement tests measure). In one comparison of learning certain management techniques, performance of teams led by people who had learned through a simulation called Virtual Leader, by Simulearn, beat the teams whose managers had learned via the standard method (coaching) by a margin of 22 percent.

All the above evidence, of course, overlaps.

So, giving our kids a simulation of, say, a piston engine and expecting them to understand how the engine works and then fix the engine in reality is not only realistic but also in line with what occurs in the best of our business communities.

Credit: David Julian

The Sad State of Sims in Schools

Given that simulation (1) is an important key to producing learning and understanding, (2) will play a big part of the student's professional life, and (3) is a teaching tool that demonstrably works, it certainly makes sense to ask the question "What is the state of simulation in our K-12 schools?"

Sadly, the use of simulation in elementary schools and secondary schools is far more infrequent and unorganized than it could, and should, be. Why? The reason we don't see more simulation used in K-12 classrooms is not that lots of good educational simulations

don't exist. (See "Sims vs. Games".) Nor is it the case that teachers aren't using simulation; some do.

But not nearly enough. Although it's impossible to tell precisely how much simulation is used, I began my research by asking people I thought would be the most likely to know -- professors in forward-thinking education schools, and experts in corporate simulations. After much thinking and searching, they collectively came up with exactly one teacher and a couple graduate students. Makers of simulation software, of course -- especially the software that is for sale -- do have their customers. And I hope that any teacher using simulations who reads this article will write to me and volunteer to become part of a database of teachers willing to share their own experiments and successes.

But of our 2.2 million teachers, I would be shocked to learn that even 1 percent use simulations in class. I'd be surprised if it were even one-tenth of that. It's probably more like one one-hundredth. (Please, folks, write in and prove me wrong.)

It is my strong sense that in America's K-12 educational system, simulations are being used only in isolated and nonsystematic ways compared to other teaching tools such as textbooks, videos, and traditional science manipulatives. This meager usage is detrimental to the education of our twenty-first-century kids, and must change.

Barriers

Why aren't simulations more widely used in our schools? Let's take a look:

Lack of Money. Cost is often cited as an issue, although it shouldn't be. School simulations either are, or are headed toward, being free. (See "A Side of Sims".) This is how it should be: If education is a public good, its tools should be freely available to all teachers and students. Sites such as Froguts, which started as a site with free registration, attracted a large number of teachers, and then began to charge, are, I think, a poor model. Even with relatively modest prices, they become unaffordable to, and unusable by, many.

As more and more free Internet simulations become available, providing similar offerings, those trying to make money by selling their simulations to schools, parents, or teachers are destined to change their policies or be left behind. Unfortunately, we lack business models that will allow creators to earn a living while letting public school students use their simulations at no charge. We need to find more.

Lack of Time. As long as we have extensive curricula teachers feel they need to cover by lecturing, time will be a barrier. There simply isn't adequate time in the school year to present everything, much less use alternative learning tools such as simulation. The significance attached to testing, which often causes everything in the class schedule that does not directly apply to the test to be eliminated, exacerbates this condition.

In addition, educators generally are not good at using simulations as part of curricular learning, or at including in our standardized testing the lessons simulations teach.

Traditionalist instructors who want to keep teaching the old hands-on way oppose attempts to replace traditional labs with simulations (at much lower cost). These teachers need to be reminded that simulation is how today's real scientists actually work and how many other professionals actually learn their job skills, whether manual, mental, or managerial.

Lack of Knowledge. Many teachers have never experienced simulation as learners and are unaware of its power and importance. A large number began their careers when the ability to simulate through computers did not exist. Some still think "simulation" is accomplished just by playing a video in class. They need to be taught that, though showing students a movie or an animation of something happening can be more instructive than just reading about it, true simulation (which is even more instructive) means that students can change variables and affect the outcome. As for teachers who say, "I don't know how to find simulations in my field," a Google search on "teachers simulation school" will call up plenty.

Lack of Technology. The best technology-based simulations available do require relatively modern computers or handhelds, and often global-positioning-system technology and broadband connections as well, which not all schools have. Therefore, extra creativity is often required to figure out ways to use these simulations- say, for example, as homework or computer-lab work. And let's not forget the many non-computer-based simulations available.

Lack of Sharing. In the age of the Internet, it seems logical that when something works for a teacher in one classroom, it should be quickly broadcast to everyone teaching that class or level. But our teachers, for the most part, are terrible at sharing. Those who have success with simulations owe it to their colleagues to post what they do on the Web -- as an HTML page, a Web site, a blog entry, or a video -- available for all to see.

Bust the Barriers

How do we eliminate the barriers?

Think of simulation as a free resource. Between noncomputer simulations and free simulations on the Internet, plenty are available. Help the creators of sites that charge understand that taxpayer money or philanthropy -- not teachers or parents -- should pay for school supplies and that they should find a better funding model than bait-and-switch (offer it free, hook teachers, and then charge them for it).

Use simulation not to invade teaching time but to make better use of it. Investigate whether particular simulations can replace some lessons or lectures. Assign online simulations to groups to try at home, in a lab, or an after-school program. Replace live lab time with computer simulation.

When technology is unavailable, try noncomputer simulations -- either ones that exist or thought experiments you and your students invent.

Educate yourself. An evening's exploration using Google and the links in this article will expand your horizons immensely. Find out what others are doing in your subject area. Assuming they are willing to offer their information (and I hope they are), we will share with you the names of all the teachers who write in to say they are using simulation. And don't be afraid to ask your students what simulations they like and use on their own.

Realize that you need not abandon preparation for standardized tests to conduct simulations; the exams can be simulated as well. A discussion of how to do this would be well worth some class time. (Hint: A review test is a simulation. Now ask, "What if . . . ?")

Finally, despite the disclaimer at the beginning of this article, endorsements from teachers are always useful, and you can find a number on the Internet.

The value of simulation is that it can, paradoxically, bring more reality into your students' learning, and it can do this for just about any subject or subject matter. As with all educational technologies, your two biggest resources for using it well (essentially the only ones that matter) are your peers and your students. Make good use of them both.

Marc Prensky (marc@games2train.com) is an internationally recognized writer and speaker who focuses on education and learning, and the founder and CEO of Games2train. He wrote "Adopt and Adapt" in our December/January 2006 issue.