In the old days, you could have beautiful, pre-rendered pictures or animations, but with only limited, branching interaction (think of the PC game *Myst* or the arcade game *Dragon's Lair*). Or you could have fast, interactive animation that was of only very poor representational quality (think the arcade game *Asteroids*). Now, with 3D video cards and very fast processors, there is no longer a tradeoff of one for the other. You can have detailed *and* highly responsive environments.

SOME VENDOR FUN

Fidelity is simulation accuracy, loyalty to the original. To have some fun with vendors, watch how they loudly play up the fidelity in the content area where they have strengths, while desperately hoping you won't look at the other two areas. (They don't fully realize that a large number multiplied by zero still equals zero.) Only these three types of content types together, systems, cyclical, and linear, contribute to a simulation's true fidelity.

COMING UP NEXT

Is *SimCity*™ a game or a simulation? The answer has a profound impact on all educational experiences, from nursery school to med school.

8

THE THREE ESSENTIAL ELEMENTS TO SUCCESSFUL EDUCATIONAL EXPERIENCES

Simulations, Games, and Pedagogy

I made a perfect simulation about growing a company.
The only problem is that it takes twenty-five years to play.

—With apologies to Steven Wright

It's better to give than receive . . . advice.

IF THE THREE CONTENT TYPES ARE SYSTEMS, cyclical, and linear, what are the best ways of learning them? The answer is through (everyone together now) simulations, games, and (no looking at your notes) pedagogy.

GAMES AND SIMULATIONS

Games and *simulations* are almost always lumped together. Education and training conferences have special *games and simulations* tracks. Committees formed at universities and corporations are tasked to

study the use of *games and simulations* for their students. People bring me in to build things that are *games and/or simulations*.

The two areas seem inextricably linked. And for good reasons. Computer games use abstracted but robust simulations. Simulations and their interfaces are getting more game-like.

Many educational philosophers have become tied up in the Gideon knot of what is a game versus what is a simulation, and how the two differ. I have been sucked into some of those conversations myself, and always hated myself in the morning for it.

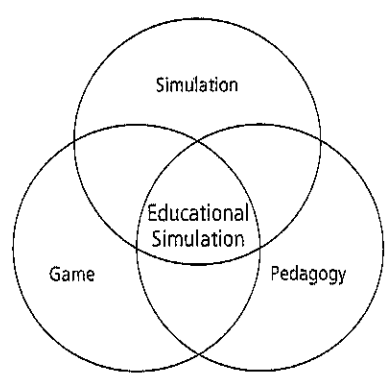
Here's a better way. Rather than thinking about *games* and *simulation*, it is more productive to think about the distinct *elements*, namely:

- *Simulation* elements
- *Game* elements
- *Pedagogical* elements

Ultimately, the careful use of all three will result in the appropriate educational experience (Figure 8.1). It is getting the right use of each, and in the right proportions, that represents the challenge for all future instructional designers (and with computer game designers as well).

There is a practical benefit to this perspective. Take any educational program or experience about which you care. This works especially well with a program that you have revised at least once. As we go through the three elements, look at each of them as *places to evaluate and ultimately improve your existing program.*

Figure 8.1. Educational Simulations Happen at the Convergence of Three Elements.



SIMULATION ELEMENTS

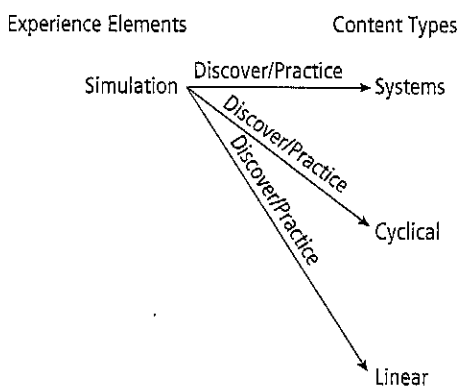
Simulation elements selectively represent objects or situations, and selectively represent user interaction. Simulation elements enable discovery, experimentation, role modeling, practice, and active construction of systems, cyclical, and linear content (Figure 8.2). Which means they enable a transferability to the real world.

To learn about *systems* in a simulation, users balance conflicting strategies and then discover diverse and often unscripted outcomes. Do we choose *A* or *B* or *C*?

To learn about *cyclical* content in a simulation, users practice their execution, including timing and magnitude. We know we are going to do *A*, but we are not sure if we should do it now, or wait a moment (or a day or a month). And we might not be sure how hard to do *A*. Soft A, or intense A?

Timing and magnitude are just as critical in executing professional skills such as negotiating, consultative sales, or relationship management as they are for hitting a tennis ball, dancing, driving, or having a romantic weekend in the city. Doing the same thing a bit too early or a bit too late, or a little too hard, or a tad too soft can have none of the positive effects, or even the opposite effect, of doing something the right way. (If you don't believe me, go on a date.) This type of content, also including *muscle memory* content, forces a user to adjust his or her timing almost imperceptibly in multiple, repetitious rounds (or cycles).

Figure 8.2. Simulation Elements Impact on Content Types.



Both *systems and cyclical content* are subtle. Both can best be acquired through practice (or, if that doesn't work, practice).

Linear skills teach you *A* then *B* then C. Simulations also teach linear skills. Even when working with simulated systems, specific linear strategies might often enough work well:

- Car needs fuel; stop at the gas station.
- Fourth down and twenty-five yards to go; punt.
- Break a law; don't go on talk shows proclaiming your innocence.

There are also grander linear patterns that emerge from the interactive experience in general, just as from our own experiences:

- Birth; life; death
- Briefing; mission; debriefing
- Think your parents never have sex; know your parents have sex but still don't want to think about it
- Trust political commentators; don't trust political commentators

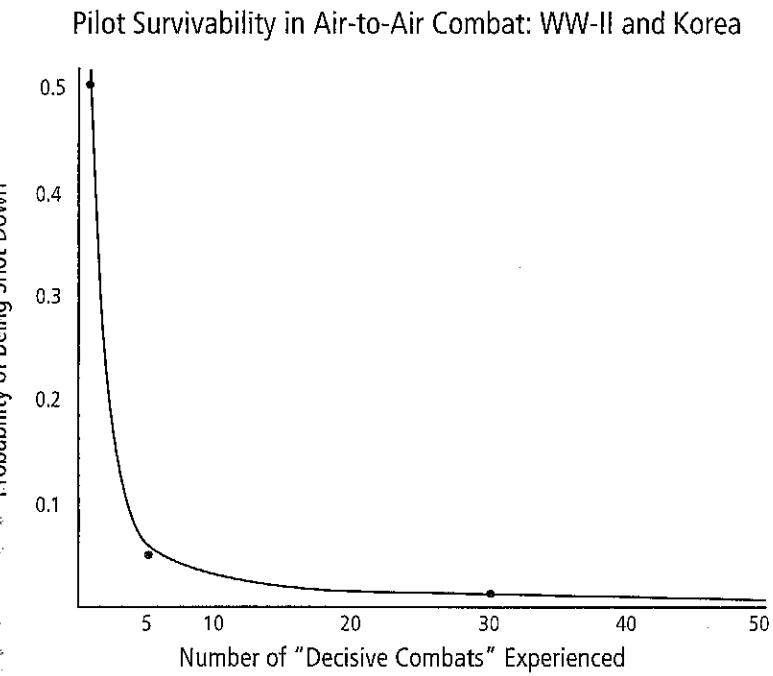
Good simulations also work because practice makes people better at what they do. In both World War II and the conflict in Korea, for example, the more experience a pilot had, the less chance he had of being shot down (Figure 8.3). (This, by the way, contradicts one philosophy of learning, *motivatism* (I may have made that term up) that suggests if a learner is sufficiently motivated, he or she will pick up everything needed on his or her own. I can only imagine that most pilots in combat conditions were highly motivated not to get shot down.

Specific Elements

Simulation elements include:

- The appropriate use of linear, cyclical, and systems content
- The appropriate use of simulation genres, including branching stories, virtual products/virtual labs, interactive spreadsheets, flight simulators, as well as new genres to be introduced
- The appropriate use of genre elements, including modeling, artificial intelligence, graphics, and interface
- Feedback from a decision (or series of decisions) that shows the natural consequences of the behavior

Figure 8.3. The Evolution of a Combat Ace.



Simulations do not have to be interactive. Simulations elements can be

- A created atmosphere similar to the atmosphere in which the content will be used
- Written case studies, real or amalgam, without editorials, conclusions, or diagrams
- Videotaped case studies, real or amalgam, without editorials, voice-overs, text, conclusions, or diagrams
- A computational model "playing out" a situation

Context Alignment

What comes as a surprise to some is that accurate simulation elements are important, even when they do not directly apply to a specific learning objective. This could be any detail in the educational experience, no matter how small, that recalls the situation in which the skills will be applied.

Researcher Will Thalheimer explained to me one reason why: "The first thing that makes simulations work is *context alignment*. The performance situation is similar to the learning situation. Scuba divers can retrieve more information on land if they learned on land. The nugget there is that when you learn something, you are taking in everything—the learning method plus the entire environment. If you go into that context again, it allows you to search memory more effectively. When the learners enter a real situation, you want the environment to trigger the learning. That results in a 10 to 50 percent learning impact."

When I was a student (and every day I thank the stars I am not one now), I would, whenever possible, study for a test in the room where the test would be held. I would even reformat any electronic notes into the same font as the professor used for the test. It is scary how well that works.

Simulation elements will increasingly include reality as a prop for the simulation. With global positioning satellites (GPS) systems and cell phones/personal digital assistants (PDAs), simulations can use real locations as sets. Meanwhile next generation *virtual reality* systems can superimpose computer images onto real-time video goggles. Now soldiers, not just Alzheimer patients, can see snipers where there are none.

Reality can sometimes and selectively be substituted for any or all simulation elements. Obviously, safety, predictability, scalability, and cost-effectiveness have to be balanced against fidelity.

When to Use More

All of the three elements we will be discussing can be ramped up and ramped down. To create the first iteration of any educational simulation, we all guess as well as we can; but inevitably there needs to be some correction for subsequent versions. I ramp up the *simulation* elements if students are having a hard time transferring what they have learned, or if they need to better understand the systems and cyclical nature of the content.

When to Use Less

If students only need a high-level perspective or understanding, or if they are at the early part of a long learning curve, (or, and excuse me for being blunt, if a project is significantly under-funded [certain clients, you know who you are]), I lean toward including fewer *simulation* elements. And if there is no need to transfer a skill to real life, the use of simulation elements might be over-kill.

GAME ELEMENTS

Game elements provide familiar and entertaining interactions. Game elements increase the enjoyment derived from the educational experience. This can drive good will, but more importantly, drive more time spent with the experience, which increases learning, even taking time that had been "budgeted" for recreation by the learner.

Stuart Moulder was the former general manager for Microsoft's Game Studios. He is now in charge of Moulder Consulting, where he provides consulting services for game play, production, and strategic planning. According to Stuart, "Arbitrary (non-intrinsic) goals are often more motivating than real-world goals." The logic reads: Rather than make something take half as long to deliver, make it twice as long to deliver but a lot more fun.

Having said that, game elements are, from the perspective of both a student's learning time and your development resources, overhead. They do not support any learning objectives directly.

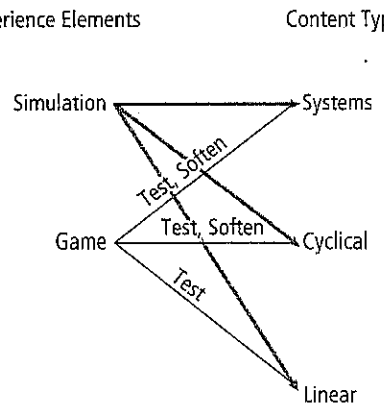
Getting a sponsor to pay for game elements is often difficult. Said University of Phoenix supplier Tata Interactive's Rupesh Goel, "Many colleges are apprehensive about any inclusion of game elements; they are worried that it might trivialize education." Corporations don't want to *waste* employees' time, nor pay for their vendors to *make games*.

Still, game elements are the spoonful of sugar that helps the medicine go down (the medicine go down, oh the medicine go down). Many simulation developers wisely and appropriately use game elements, but just as wisely and appropriately are reluctant to talk about them. In some cases developers may even pretend (read that, lie) to the sponsors that the contrivances weren't made.

There are many uses of game elements (Figure 8.4).

- Game elements can *surround* linear content that supports learning objectives.
- Game elements can *subvert* and *replace* simulation elements to make the experience more predictable and enjoyable—to keep, for example, engagement challenging, rather than fully accurate (where accuracy may be in fact harder, easier, or more dull). Games therefore encourage contrivances. Says Dr. Sivasailam "Thiagi" Thiagarajan, president of Workshops by Thiagi, a prolific writer, designer of hundreds of games and simulations, and perennial favorite at conferences, "There are built-in inefficiencies in a game. Obviously, there are more efficient methods for dropping a little white ball in eighteen holes than the rules of golf permit us to do."

Figure 8.4. Game Elements Impact on Content Types.



Specific Game Elements

One popular game contrivance that always intrigued me is *mixed scales*. This is most easily seen visually. The people in strategy games (such as *Rise of Nations*™) are smaller than cars, but only half as small. Cities are bigger than cars, but perhaps only five times as big. (This is not just a computer game thing. We also see this in almost all illustrations of the solar system, where a planet's *size* is scaled to other planets' *sizes*, their *distance* to the sun is scaled to the other planets' *distances* to the sun, but the *size* and *distance* to the sun are not scaled to each other.)

Mixed scales are even more prevalent "beneath the covers." In *Roller Coaster Tycoon*, a month lasts five minutes of real time. However, customers walk around the park in twice real time. So if you were focused on realism, any given customer spends about *five months* at a park. This drives subject-matter experts crazy. Rides cost a few dollars for a patron to engage, but only a few hundred to buy. And still, bigger rides cost several times more than smaller rides.

Other game elements can include (depending on the player [and yes, gender]):

- Simplified or abstract interfaces
- Use of established game genres, such as game shows, athletic competitions, computer games, card games, and kids games
- Clicking as quickly as possible
- Gambling models
- Putting the information into a clever song

- Certain exaggerations of responses to make play more fun
- Reliving the roles of heroes or role models
- Me, a name I call myself
- Fa, a long, long way to run
- Conflict
- Shopping
- Gratuitous, detailed, and entertaining graphics and sounds
- Creating order from chaos
- Choosing what your on-screen character looks like
- Mastering a simple cyclical skill (throwing a card into a hat, *Pac-Man*®)
- Competition between learners, including enabled by maintaining lists of high scores (this is especially effective with CEOs and salespeople)
- Any use of graphics of fireworks
- Accessible communities for competition, and/or sense of belonging
- Presenting a mystery or puzzle to solve
- Creating a huge and powerful force enabling you to not just defeat but humiliate and crush all of those who dare oppose you
- Making the player overly powerful or overly relevant in a resolution of a situation
- Immersiveness in a favorite or interesting atmosphere (SuperBowl, science fiction, graphic novel, film noir, 1973 Miami)
- Using new technology
- Having access to privileged information
- Choosing between multiple skill levels to better align difficulty with capability

When to Use More

I increase the use of game elements if people are bored, too taxed, and/or unmotivated to spend extra hours on the experiences.

When to Use Less

I wind down the game elements if people are feeling as if their time is wasted with trivial activities (especially if they are already fully motivated to learn the content as quickly and accurately as possible).

Simulations Punctuated by Game Elements

Ben Sawyer, a developer of one of the next generation simulations we will be talking about in the next section, suggests that game elements may be used to modify simulation elements after learners achieve certain levels of competency. For example, in a simulation designed to teach players to drive, there could be periodic "dream" or fantasy sequences. After players pass a module learning to parallel park in the real world, they might be treated to a driving sequence that asks players to get from point A to point B as fast as possible, ignoring all traffic laws and safety considerations. Or players might be allowed to drive in a low gravity environment, where if they hit a bump they would soar for a city block.

"We have to trust that learners can distinguish between reality and games, and take advantage of that to make the whole experience a lot more enjoyable," Ben suggests. That can easily motivate learners to spend more time learning the critical material. There is also a chance that during the game sequences, they actually learn more than first assumed, as they are given permission to forget the rules and try new approaches.

Von Trapp Reference

If you were reading through the above list of game elements, you found my Me and Fa references (a game element, in the list of game elements). The good part is that, hopefully, you smiled and it made you want to keep reading. The bad part is that it might have interrupted your focus and seemed like an unprofessional, distracting, and unwelcome intrusion, and well, pretty lame.

That is the balancing act that all game elements must walk. (This moment of self-reflection was brought to you by Thiagi. More on him later.)

PEDAGOGICAL ELEMENTS

At the highest level, an educational simulation's pedagogical elements are learning objectives, the reasons for building the simulation, and deciding what to simulate. Below that are wide ranges of more subtle choices.

It was the naïve hope of early educational simulation designers that the interactive experience would be sufficiently engrossing. They hoped that students would voluntarily spend hours exploring on their own, discovering and learning in a purely natural way. They thought their simulations would compete with the leading entertainment titles and other leisure activity for people's free time.

Sadly, they were wrong. Spending one session with a group of real students watching them interact with your simulation dashes those hopes quickly and decisively. Seeing the furrowed brows of dozens of participants is sobering. Seeing tears is downright discouraging.

Pedagogical or didactic elements surround the game and simulation elements, better ensuring that the students' time is spent productively (Figure 8.5). Pedagogical elements in real life include nametags, caller ID, and the warning on certain cars that a "Student Driver" is operating them.

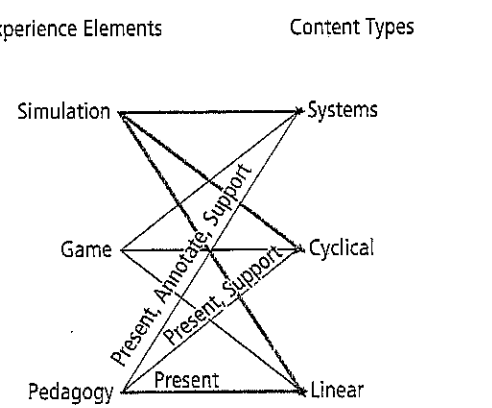
In educational experiences, pedagogical elements also help the learners avoid developing superstitious behavior, such as believing they are influencing something by a particular action when they are really not.

Specific Elements

Pedagogical elements include:

- Background material, including case studies, visual or text representations of systems models, and descriptions of interfaces to be encountered
- Scaffolding, such as letting the learner know what is going on and giving suggestions, either through voice or graphics

Figure 8.5. Pedagogical Elements Impact on Content Types.



- Diagnostic capabilities, including scoring
- Introductions giving tips
- Visualization of relationships
- Debriefing, including linking the simulation to the real world, either extending from narrow to broad, or broad to narrow
- Forced moments of reflection
- A pause button
- A speed-up/slow down switch
- A replay option
- Libraries of successful and unsuccessful plays
- Links to chat rooms where people can brag about how they achieved a high score
- Tests and quizzes
- Acronyms or other mnemonic devices to trigger memory of processes
- Coaching
- Pop-up prompting and help, either text or a voice, giving specific tips

When to Use More

I have ratcheted up pedagogical elements if people are lost and confused or don't see the relevancy of the experience to the real world (Figure 8.6).

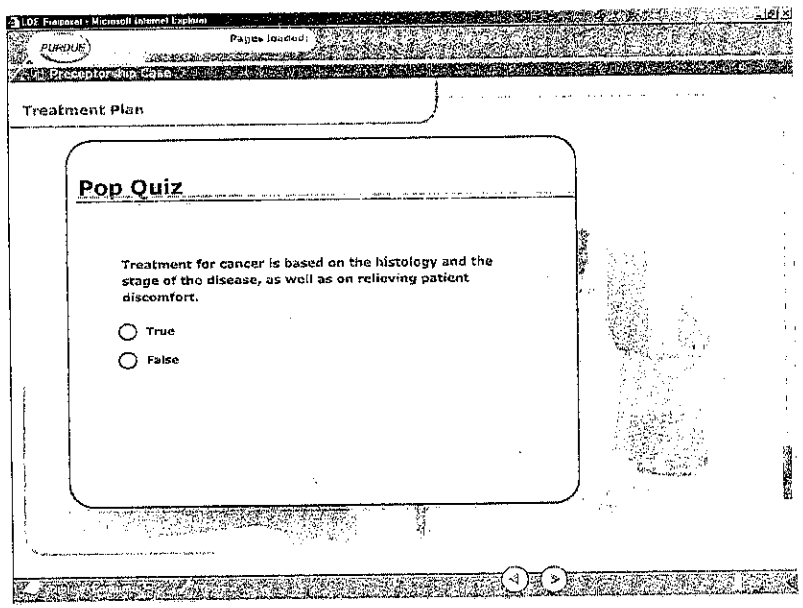
When to Use Less

I tone down pedagogical elements if people are feeling manipulated or not owning the material, not engaged by any simulation elements, or they feel that they are following directions instead of discovering.

Beyond the Sim

In some cases, the pedagogical elements to support a simulation are identical to the pedagogical elements to support a real-world engagement. In other cases, the pedagogical aspects such as background material are done so well that they become more used than the simulation. In both cases they become integrated into real life as a support system.

Figure 8.6. A Pedagogical Moment.



Source: © 2004 Purdue Pharma L.P. Used with Permission.

UNIVERSAL TRUTHS

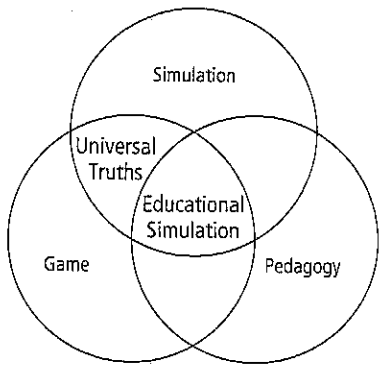
One property is necessary to understand the other three elements of simulation, games, and education, *universal truths*.

There are two ways of looking at universal truths (Figure 8.7). One is that these are simulation elements that are highly abstracted. The other is that these are refined game elements. Believe it or not, there are actually quite heated and prolonged debates in academic circles arguing one side or another (and that makes me want to be an academic less, not more). Summed up, universal truths either reflect our cultural wisdom or our cultural clichés.

Both are right, depending on the situation. When designers use universal truths as the core of a learning objective, they are simulation elements. When designers use them to get or keep a learner's attention, they are game elements.

There are some very high universal truths like creative problem solving and communicating. Here are some slightly lower-level universal truths.

Figure 8.7. At the Intersection of Game and Simulation Elements.



RACES AND CHASES *The game element:* Tag, you're it. First person through the culvert wins.

The high-level simulation element: Many tasks are competitive. Speed is an advantage. Roles can reverse.

ROCKS-PAPER-SCISSORS *The game element:* Rocks beat scissors. Scissors beat paper. Paper beats rocks.

The high-level simulation element: Nothing is invincible. Strengths and weaknesses are relative. Shifting strategies is important.

WHACK-A-MOLE *The game element:* Every time a mechanical mole pops up, smash it with a hammer.

The high-level simulation element: There is no universal defense. Problems shift quickly, so recognizing and reacting quickly is necessary.

I include Whack-a-Mole not only because I have used it a few times in learning experiences, not only because Whack-a-Mole is a good example of a universal truth, but also because I just like writing "Whack-a-Mole."

POWER-UP PILLS *The game element:* The Pac-Man eats the power pill and can now turn on its enemies. Getting the laser supercharger makes you a much more formidable space ship.

The high-level simulation element: Power shifts. There are accomplishments that change everything. Many of these advantages are short-lived.

EXPLORE, THEN BUILD, THEN EXPAND *The game element:* In strategy games, players generally follow a pattern of exploring, building up a base, and then planning and executing massive attacks on the enemy.

The high-level simulation element: Reap, then sow. But then reap again.

START EASY, GET HARDER *The game element:* In everything from jacks and hopscotch, to Doom, to courses, start easy and get harder as competence is displayed.

The simulation element: The better you get, the more challenges you will be faced with to continually test you, and the higher the rewards. (Yes, this is also a pedagogical element.)

DIFFERENT LENSES *The game element:* In computer games ranging from *Splinter Cell*® to *Deus Ex* to *Aliens vs. Predator*™ to *SimCity*™, you can change the way you see the world, from infrared to light enhancing to seeing through walls to layering crime rates to normal. Depending on where you are, each has its advantages and disadvantages.

The simulation element: Everyone comes with ways of looking at the world that are incomplete. Some of us develop the invaluable ability to switch lenses. Few of us still know when to use which lens or have the ability to switch rapidly between them.

Reminded and Invoked, Not Taught

Universal truths provide substantiation to pioneers who believe games are inherently educational. There are some who believe that:

- All game elements are universal truths, and thus
- All games are simulations, and thus
- All games are educational, and thus
- Everything that isn't a game isn't educational (phew!)

However, there is a risk at being over-enamored with universal truths. The tremendous amount of pedagogical elements required to make universal truths relevant makes them tricky to use effectively, and often results in their misuse. "Some experiences are so abstract, no one knows what they are for," commented Saul Carliner, assistant professor at Montreal's Concordia University, of some past programs with which he had been involved. "We would do group challenges like rope

courses and trust falls, and we never tied it back to anything. It was enjoyable, but not concrete."

Further, many students already have a gut feeling for the material, and so will feel as if their time is wasted. At the same time, like clichés, the accessibility and profoundness of universal truths cannot be denied.

THE INTERSECTION OF GAME AND PEDAGOGY

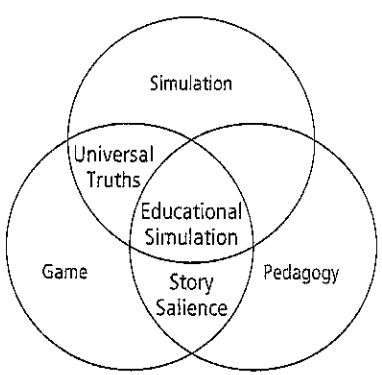
There is also an intersection between game elements and pedagogical elements. We discussed some examples, like hangman and word jumbles, in the chapter on game-based models. Two other categories worth highlighting are *stories* and *salience* (Figure 8.8).

Stories

A story puts the users in a position where they know what is going on and why they have to do what they are going to do. Gaming the story means making the players very powerful, pivotal, and/or desirable characters, unlike what they are in real life. It is not always necessary: *SimCity*™ and *The Sims*™ are great example of entertaining simulations without any story.

Cartoon strips can also fit here. A good comic can add both clarity and humor.

Figure 8.8. At the Intersection of Game and Pedagogical Elements.



Source: A Dream I Had Once When I Was Eight.

Salience

Exaggerating effects, both making results bigger and making results happen sooner, have both game and pedagogical impact. Contrast is at the heart of pattern recognition. And in both cases, they come at a cost of simulation accuracy.

A 1950s SITCOM

Dr. Freud suggested that we have three forces controlling our actions, the *ego*, *superego*, and *id*.

Anyone who thinks about educational experience elements might do well to think of even more powerful forces influencing their design—members of the 1950s sitcom family.

Dad, somber and straightforward, argues for the *simulation elements*. "Keep it honest, keep it real," he tells us from his dark, paneled office when he gets home from his mystery job at 5:05 p.m. "You are not there to do anything but capture the truth. Real interactions, and real consequences." Then he smokes his pipe.

Mom, perky but caring, argues for the *pedagogical elements*. She tells us from the kitchen, "Help out. Keep your sister from getting lost. Do unto others. Eat your vegetables. What are you doing to the cat?" Then she offers us some cookies out of the oven, and excuses herself to get her hair done.

And of course there is the older brother, who takes out the car without asking, never does his homework, and breaks the window while sneaking back in past curfew. He is always game. He tells us, "Don't tell Dad where I was or I'll kill you." Then he hits us in the shoulder.

OTHER RESOURCES

- Game Elements: Thiagarajan, Sivasailam, & Thiagarajan, R. (2003). *Design Your Own Games and Activities: Thiagi's Templates for Performance Improvement*. San Francisco: Pfeiffer.
- Universal Truths in Storytelling: McKee, Robert. (1997). *Story: Substance, Structure, Style and the Principles of Screenwriting*. New York: Regan Books.

COMING UP NEXT

Why are so many teachers and trainers obsessed with multi-player computer games, especially since most have never played them?