moving learning games forward

obstacles opportunities & openness

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an Education Arcade paper

the education arcade

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Made possible by a generous contribution from the William and Flora Hewlett Foundation.

The notion of using video games for learning causes some to cringe, others to leap for joy, and many to ask questions about this learning medium. These questions often come from people and organizations that are considering delving into the world of learning games but don't know if this is advisable or don't know where to start. The goal of this paper is to answer those questions about learning games and to help plot a path for people and organizations interested in developing or fostering the development of video games for learning. The paper starts by making a case for learning games grounded in principles of good fun and good learning. From there the paper explores the commercial games market, gleaning lessons from this rapidly growing and diversifying place. In order to address the concerns of those who see "edutainment" as a dead market, the paper analyzes the downfall of edutainment in the 1990s and establishes how the current movement differs. As there are many applications of games related (more or less) to learning games, the paper lays out the ecology of games with a purpose beyond play. Much of the rest of the paper establishes principles and best practices for moving the field forward in a positive direction. The paper should provide a good grounding in the field and both motivate and inform those wanting to participate in this rapidly growing domain.

A New Case for Educational Games and Learning through Play

Those who believe in using games in education usually start from a common set of assumptions. They observe that game player's regularly exhibit persistence, risk-taking, attention to detail and problem solving skills, all behaviors that ideally would be regularly demonstrated in school. They also understand that game environments enable players to construct understanding actively, and at individual paces, and that well-designed games enable players to advance on different paths at different rates in response to each player's interests and abilities, while also fostering collaboration and just-in-time learning.[1]

Even starting with these shared notions, advocates for game-based learning tend to adopt one of two very different approaches to designing games for formal education. One group sees the skills students develop playing games as essential to a 21st century education, and conversely see little progress happening in schools still shackled to a 19th century factory model. They focus on the habits of mind and dispositions needed to collaborate, innovate, problem-solve and communicate effectively in a knowledge-based economy. They observe with some accuracy that these skills can all be gained from engagement with commercial, off-the-shelf (COTS) games, or through social networking, blogging, and other forms of user-generated content that fall under the larger banner of participatory culture. They focus on these skills often to the exclusion of traditional academic subject matter, and at least insofar as game-based learning is concerned, they assume the institution of school is highly resistant to reform and find alternate venues and opportunities to foster learning. They imagine the important learning will take place outside of school, and question what value school adds to the process. Clearly many COTS games provide opportunities for learning. Examples vary from simulations such as *Roller Coaster Tycoon* or *Civilization* that require planning, quantitative skills and significant analysis to Massively Multiplayer Online Role Playing Games (MMORPGs) like *World of Warcraft* (WoW) or *Eve Online*, which promote communication, collaboration, and problem-solving skills.

[1] Much has been written on this subject, but nowhere so comprehensively as in James Paul Gee's *What Video Games Can Teach Us About Literacy and Learning* (2003).

In contrast, the second group tends to concentrate only on applying games in traditional school settings with traditional methods and outcomes. They may pay lip service to 21st century skills, but they look at the learning that occurs in COTS games and ask, "Why can't we use the form of these successful games to instead foster learning in more traditional academic areas?" In order to integrate games into the existing school environment, they must address several common concerns of teachers:

- Their need to cover mandated content areas;
- A healthy skepticism of new technologies (combined with a lack of infrastructure for these technologies);
- An unfamiliarity with games, and no easy route to game competence.

In addition, proponents of games in school also have to overcome the objections of those parents, teachers and administrators who see games as insufficiently serious, that they are "just play." The solution to all these difficulties tend to be games that can be played in very short bursts of class time, games whose simplicity make them easy to grasp immediately, and games that are stuffed with, what can be recognized as, factual content—often referred to as Integrated Learning Systems (ILS) (Oppenheimer, 2003). These games are often curricular, attempting to teach subject matter that is otherwise advanced through textbooks, lectures, or problem sets (for example *Alga-Blaster*, *Knowledge Munchers*, and *Word Island*). Sadly, while they may go by the name "games" they usually end up bearing little resemblance to the games mentioned above that promote learning of 21st century skills, instead being little more than interactive quizzes. The resemblance to a game is meaningless when the activity is nothing more than answering multiple-choice questions and when success is measured solely as the percentage of correct answers given expressed as a "score" and presented with a fun animation.

If the first group *embraces games* and *abandons school*, this second group often *embraces school* to the *detriment* of anything that looks like *real gaming*.

In spite of their striking differences, we've pointedly avoided suggesting that these impulses—to promote new modes of learning on the one hand, and to adapt to the classroom on the other—are mutually exclusive. One might advocate that games can both build 21st century skills and channel those skills in traditional academic fields. One could also argue that just because such games might be in the service of school, they don't necessarily have to be designed to blend into outmoded forms of schooling. It is unfortunate that when talk turns to how games should be implemented in education, the models that are proposed tend to land heavily at one end of the spectrum or the other.

We start with some sympathy for those who favor unrestrained gaming over schooling. We see enormous creativity in gamers. Gamers build businesses around clothes they create for their Sims, build tools for others to use to mine gold in *WoW*, create novels around plots from favorite games like *Final Fantasy* and *Zelda*, hack Wii controllers and mod their Alienware PC cabinet, engage in Cosplay (costume play) around their favorite game characters, act as tour guides for newbies in MMOs, trade virtual goods and earn a living doing it, and make films inside game engines. These films cover topics ranging from a player's love of the game of baseball (*see* Sean Coon's "Mets vs. Red Sox, Game 6 machinima," a perfect re-enactment of the 10th inning of the Buckner game in 1986, reproduced in Nintendo's *RBI Baseball*), to an obsession with snack foods (myndflame's epic *WoW* production, "Illegal Danish Super Snacks"). Jim Munroe's seminal piece "My Trip to Liberty City" (2003) can be read as an animated travelogue through *GTA III*; but it is first and foremost a documentary of the day in the life of man, the player.

However, technology alone does not create or encourage good learning and creative practice. We tend to believe that the children who make the most of these technologies do so in the context of families and communities of practice (and sometimes schools) that support their efforts, or at the very least have modeled some of these same dispositions, like the technology "godparent" from a Filipino 5th-grader's "extended parenting network" who purchases her a Nintendo DS and cell phone, "so that the girl can have access and learn how to use technology." (Bell 2008). As of this writing, there is insufficient evidence that this self-directed learning and creativity is the rule, not the exception. For example, a study from the University of Michigan of children using computers in public libraries suggested that disadvantaged children were far less likely to spend time with single applications or sites, and tended to skim surfaces rather than dive deeply (Neuman & Celano, 2006). Structure and support from outside influences such as afterschool program, parents, or a teacher's in the classroom are needed for most kids to excel with these technologies. As such, we are not ready to concede there is no role for school in helping them make the most of these experiences. Quite the opposite in fact, we believe schools can and should play a critical role in fostering learning in association with game play. And while many schools may not be ready to immediately embrace this role fully, many of the existing assets (including structure, people and goals) of school can contribute positively.

Whatever the failings of school, the academic disciplines of math and science, history, literature, language study remain vitally important, as do the abilities to read critically and communicate persuasively both in and out of school. In all of these fields, talented teachers and researchers have identified pedagogical approaches that are forward looking and well-adapted to the changing environment of the Internet age, approaches that rely on the same thinking skills that games exercise. There is no reason to believe that the kind of creative energy exhibited in game wouldn't be applicable to these disciplines. And talented teachers have long known that non-academic texts from novels to theater to film all have a role in sparking interest and curiosity in students, as have informal experiences such as museum visits and competitive challenges such as science fairs.

We are therefore prepared to argue that:

1. games can engage players in learning that is specifically applicable to "schooling;" and
2. there are means by which teachers can leverage the learning in such games without disrupting the worlds of either play or school.

To succeed, we must look at where the strengths and challenges of both classrooms and games lie and situate "learning games" at the most productive intersection of these separate environments. We will examine these issues through concrete examples of existing best practices, and speculative designs currently under development at MIT's Education Arcade, and elsewhere.

Last, it is important to acknowledge that games and learning has a history that predates the advent of modern video games, including a rich history in the design of children's software. This history has taught us several important things, not the least of which is that players determine how they learn. The productivity of gaming environments lies in the fact that kids among themselves are free to discover and create learning and teaching arrangements that work for them. So while it is important to understand how the qualities of games themselves support learning, it is equally critical to address how players take on active roles in determining how, when, and why they learn.

The Role of Play

The starkly obvious difference between games and traditional schooling is that good games always involve play, and schooling rarely does. Before we discuss what constitutes play in games, it's worth stepping back to look at play in the broader sense to understand how learning environments can effectively incorporate play, and how play often incorporates learning.

Think for a moment about a child at play with dolls or action figures or Lego blocks. To the outsider, the play is likely to look somewhat scattered: the child will be working fiercely one moment constructing a building or acting out a story, and then just as abruptly the child will shift gears, knocking down what she's built, or hurling dolls across the room in gleeful enactment of imagined disasters. Whether the child has been exploring the physical nature of things, her nascent understanding of familial and social roles, or obliterating everything she's just accomplished, the child at play is exercising freedom along five distinct axes:

1. freedom to fail;
2. freedom to experiment;
3. freedom to fashion identities;
4. freedom of effort; and
5. freedom of interpretation

Freedom to Fail: One doesn't actually fail at play per se, but one is free to do things at play that would look like failure in other contexts. Think of the block tower that inevitably collapses, or the sand castle fated to disappear with the tide. At play the child has unlimited freedom to undertake such doomed enterprises, and learns as much about the nature of things from failure as from success. Every fall off a skateboard, every crumpled up drawing, every lost game of Candyland is a small failure. Fortunately, children at play don't have adults looming over them, fretting about the cost of these failures, and so children are free to learn from failure and move ever closer to mastery of their world.

Freedom to Experiment: This correlates closely with the freedom to fail, but suggests in addition that within the play space the player has some room to maneuver and invent new approaches to whatever task is at hand. It isn't sufficient that the child can build towers with blocks, but in fact she can engage in a wide array of activities with those blocks, experimenting with uses she has invented for herself. Experimentation would be meaningless without the ability to fail regularly, and the freedom to fail would amount to little if players were constrained in where they could seek that failure.

Freedom to Fashion Identities: At play, the child isn't simply examining the nature of the physical and social worlds, but is also exploring her identity in those worlds. That identity is not a fixed thing, but rather something that is itself "in play." Using dolls, a child will try out the roles of both mischievous child and stern parent. In fairy tales children imagine what it means to be a dragon, and what it means to slay one. The child is practicing when to be aggressive, when cooperative, when assertive and when docile. Only by trying on these identities do children begin to define themselves.

Freedom of Effort: Watching children play tag, Peter and Iona Opie (1969) noticed that a child will run vigorously for 20 minutes to evade the tag, and then abruptly stop in the middle of the school yard to receive the tag. They

observed that children regularly exhibited this pattern of alternating between intense and relaxed play. It is easy to overlook this quality of play, but if we stop to imagine play in which a uniform effort is expected, we quickly sense the presence of a controlling adult.

Freedom of Interpretation: Learning *about* games and learning *with* games take place simultaneously. One cannot learn about or from games without engaging in their play, yet we must always remember that there is no "one" game: the individual, social, and cultural motivations of any player affect what is experienced through play and no two players ever experience the "same" game. This creates a challenge for those looking to games to provide a standardized context for learning.

Play and Games

What we've largely described above is "free play"—the sort of play a child pursues entirely on her own terms. This play has no agenda, and the child's goals are entirely intrinsic and personal. Games by contrast, tend to have defined goals. Most games have "win" states, and even those that don't end in victory usually have clear ways of demarcating success through points or other quantifiable outcomes. In addition, games have rules that structure the play, and that guarantee fairness by being applied transparently and equitably to all players.

At first blush, games, with their rules, constraints, and externally defined goals seem to be at odds with the freedoms of play. But within the proscribed space of a game, players regularly exhibit all of the freedoms of unstructured play. Most players undertake games in the knowledge that failure is a possibility. They show a willingness to experiment in their game-play, and to try on different roles from leader to follower, novice to expert (Gee, 2003; Squire & Steinkeuler, 2005). Finally, the freedom of effort described above remains present in any voluntary game.

By offering challenges that seem worth attempting, games channel players' efforts, while still affording them the freedom needed to manage their individual experience in ways that are self-directed and beneficial to their own development. In games, children submit to arbitrary rules and structures, but only if they can continue to be playful. The promise of games is that *we can harness the spirit of play to enable players to build new cognitive structures and ideas of substance*.

Last, in defining games it is important to discuss the link between play and games, which is the act of gaming. For the purposes of this paper gaming constitutes the sum total of activities, literacies, knowledge, and practices activated in and around any instance of a game. Gaming is play across media, time, social spaces, and networks of meaning; it includes engagement with digital FAQs (or Frequently Asked Questions), paper game guides, parents and siblings, the history of games, other players, as well as the games themselves. It requires players to be fluent in a series of connected literacies that are multi-modal, performative, productive, and participatory in nature. It requires an attitude oriented toward risk-taking, meaning creation, non-linear navigation, problem-solving, an understanding of rule structures, and an acknowledgement of agency within that structure, to name but a few.

Gaming also requires what Jay Lemke and others have referred to as a "stance of playfulness," a cognitive attitude tied directly to the creative, improvisational, and subversive qualities of play. Huizinga would call this the *lusory attitude,* the attitude required of players in order to play. To play a game is in many ways an act of faith that invests the game with special meaning—without willing players the game is a formal system waiting to be inhabited, like a recipe for baking or choreographer's score. As designed systems, games offer certain terms of engagement, rules of play that engender stylized forms of interaction. Gamers not only follow rules, but push against them, testing the

limits of the system in often unique and powerful ways. Yet it is in the moment when "pushing against" is transformed into a meta-reflective "questioning about" that learning truly takes place.

Play and Adults

In providing the above examples, we've stuck with descriptions of young children at play, as it is in childhood that the features of play are most easily recognized. But the same freedoms are visible in the play of adults. Mastering the most adult of games, golf, would be impossible without the ability to fail often, and quite spectacularly. And no one would get good at poker if they couldn't experiment, or try on different identities. Anyone who regularly plays tennis knows that sometimes you come to play hard, and sometimes you decide to relax and just volley. Without the five freedoms of play, none of these activities would be worthy of the name "leisure."

The Prototypical "Game", "Gamer" and Other Myths

The world of *learning* games is currently reaping the benefits, not only of conceptual advances in the way designers and developers are linking learning and game play in the world of commercial games, but also from the rapid advances in the video games industry.

For many years the advances in the video game industry were primarily reserved for higher bits and resolutions. But the last several years have seen great technical and conceptual advances in video game designs, which ultimately can contribute greatly to the cause of learning games. The rise of the Nintendo DS and Wii platforms, as well as casual online and cell phone games, have shown that video games can take many forms and reach diverse audiences (Kirriemuir, 2002; Mok, 2002). This is critical for the learning games sector, in that it cannot be resigned to serving narrow privileged audiences. Instead they need to be able to reach learners of all types. These next generation ideas are already inspiring educational innovation, and demonstrating that educational games have learned a lot this time around.

These changes in the commercial world of games are critical for understanding the world of educational games for a number of reasons. *First*, the changes in commercial games have opened up new audiences that are greatly expanding the potential reach of educational games. As noted above, titles like *Brain Age*, *Wii Fit*, and *Diner Dash* all contain engaging game mechanics that are ripe for adaptation within both formal and informal learning environments. *Second*, these changes have expanded the types of educational games that are feasible, growing the conceptual areas that they can reach. This is due, in part, to greater experimentation with content and game mechanics that resulted from an expansion of technologies and game genres. *Third*, they are changing the perception of the nature of video games, making them more accepted in a greater diversity of places. For example, gaming is becoming part of activitiesnow a regular activity in senior centers, in libraries and museums, as well as within the workplace, as in the case of companies like IBM, who have developed game-like training programs in virtual environments for their employees. And *finally*, they are providing cheaper and easier ways to reach everyone, making open access to games a reality. As the videogame industry has sought new markets for their games, they've had to create new business models as well, which have dropped price points and led to the creation of smaller, more affordable games. Many casual, online games, for example, can be played for free and the typical cost of a Nintendo DS game cartridge runs $19.99, rather than the $49.99 cost of console games.

Yet despite the numerous ways in which the gaming market itself has started to open up, many people considering diving into the educational games market, either as producers of games, or as consumers, are often reluctant to enter because they feel that they are not "gamers" and are turned off by their perceptions of "modern video games."

These perceptions of what games are (are or aren't) continue to cast a heavy shadow over the games and learning space. For example, to many, a "game" is a First Person 3D immersive experience, in which the player is executing missions in a dark world, either through an avatar or perhaps a vehicle. There is a lot of shooting and explosions, and massive budgets behind the immersive world. The game may be single player or multiplayer, but involves hundreds of hours (or more) of game play to reach any level of mastery. These games are played by "gamers" who have high end, game-tuned computers and peripherals, gaming skills that they have developed through near countless hours of game play, and the disposable time in which to invest in these games. Statistically speaking, these gamers are young males (McFarlane, Sparrowhawk, & Heald, 2002).

These games exist. These gamers also exist. However, they actually represent a small minority of the gaming community. In a recent (2006) Parks Associates study of Americans who play games, they defined a number of types of gamers based on their playing habits. These include:

- *Power gamers* who are the prototypical gamers mentioned above
- *Social gamers* who enjoy gaming as a way to interact with friends.
- *Leisure gamers* mainly play casual titles. Nevertheless they prefer challenging titles and show high interest in new gaming services.
- *Dormant gamers* love gaming but spend little time because of family, work, or school. They like to play with friends and family and prefer complex and challenging games.
- *Incidental gamers* lack motivation and play games mainly out of boredom.
- *Occasional gamers* play puzzle, word, and board games almost exclusively.

Of these categories, Power gamers represent only 11% of the gaming community (though they do represent a disproportionately high 30% of revenue). Dormant gamers, on the other hand, represent 26% of the gaming community, and the combination of Dormant, Social and Leisure Gamers make up greater than half of the gaming community. This is a significant proportion of the population (representing 29 million households) that enjoy interesting challenging, and often social, games.

The diversity of the gamer community has several implications. *First*, one size does not fit all. There is not a single game or type of game that will satisfy everyone. Instead, a diversity of games is required to fill the needs of this market. *Second*, the games associated with Power Gamers are missing large segments of the market. As a result of this, there are a lot of missed opportunities. *Third*, for the needs and wants of many players, the budgets for game development are not being invested according to their desires. Rather than a few big budget games, a greater diversity of challenging, yet simple games may satisfy greater numbers. Together these factors contribute to a much *more hospitable place for educational games*, than was present in the marketplace even a few years ago. Gamers are demanding different types of games, even including games that are intellectually challenging. The commercial sector alone is unable to meet this demand, and instead must rely on collaboration from a network of contributors from academics to teachers to content experts.

Sea Changes in Platforms

In the last few years, the industry has begun to respond to this diverse community. Led primarily by Nintendo's DS handheld, and Wii console, the notion of many types of games for many types of gamers has begun to be embraced. These platforms have begun to ***redefine the nature of games***, opening up the possibility for new kinds of games in the marketplace, and putting powerful and inexpensive platforms in the hands of tens of millions of people.

Not so many years ago Nintendo was chastised for not shifting its market focus from young kids to teens and young adults as the Playstation (I & II) and Microsoft's Xbox sprung to life and captured the majority of the video game market. Meanwhile Nintendo's Game Cube languished and the Game Boy platform was looking pretty dated. Nintendo's first move was to introduce the Nintendo DS, a new handheld that introduced a second screen to the Game Boy platform. This screen was touch- sensitive, allowing the user to press on the screen with a stylus to game, as Personal Digital Assistants (PDAs) had done for years. The introduction of the touch sensitive screen, along with a new wireless capability that allowed players to play in networked, multiplayer mode, allowed Nintendo (and licensed developers) to create games with interesting and (in many ways) more intuitive controls. While the market of traditional mobile gamers (males from 8-25) could use the typical buttons to control games, other games took advantage of the touch screen to create games that appealed to girls and a broader adult audience.

Figure 1. The original Nintendo DS platform showing a traditional (upper) screen as well as a touch sensitive (lower) screen.

Nintendogs was an early success that brought both girls and adults to the platform. This game challenged players to care for a virtual dog that "lived" on the DS. Caring for the dog required a combination of petting it (on the touch sensitive screen), giving it verbal commands (using the built-in microphone), and even taking it for walks where they could interact with other Nintendogs (facilitated by the built-in wireless networking). Introduction of these multiple styles of play appealed to a broader audience and providing an indication to the games industry that there were untapped models for games, and corresponding untapped audiences.

These audiences were later tapped again on the DS but the successful game *Brain Age*. *Brain Age* purports to lower your "brain age"—the mental age that is calculated from expected average cognitive functions of a specific age of people—to an optimal value through a series of diagnostics and what might be best described as "mental calisthenics". These are activities that involve anything from basic math and logic to activities that "stretch" your brain. In the former category are games like the one shown in Figure 2 where the player needs to complete the mathematical expression with the correct operator. In the latter category are games such as one in which the player needs to say the correct name of a color that is written in a different color font (e.g. the word "blue" written a red font should be pronounced "blue" but is often mispronounced "red" by players, a cognitive challenge that makes ").

All *Brain Age* games involve alternate sets of input that employ either the stylus or the microphone. The combination of activities, advertising (to lower your brain age to an "optimal" level), and input methods has made the game (and consequently the platform) appealing to a wide range of adults, fueling interest in a platform that is in many ways technically inferior to the competition. In addition, Nintendo was able to reframe "play" as a serious endeavor for an audience that had traditionally seen play as frivolous. *Brain Age* alone spawned a whole new genre of games termed "training games," rebranding their play as a form of creative work. A combination of alternative games and alternative modes of interaction have again demonstrated the potential breadth of the gaming market. Further, *Brain Age* showed that ***learning games can also be fun and have mass market appeal***. While one doesn't learn academic content explicitly in *Brain Age*, the games are clearly of an educational bent and quite appealing. *Brain Age* spawned more intellectually challenging games on the DS, such as *Professor Layton and the Curious Village* and *Phoenix Wright: Ace Attorney*, showing the continued demand for these kinds of games, and also showing that a cheap, portable platform can be successful in reaching non-traditional gamers and be embraced by older gamers (including teachers).

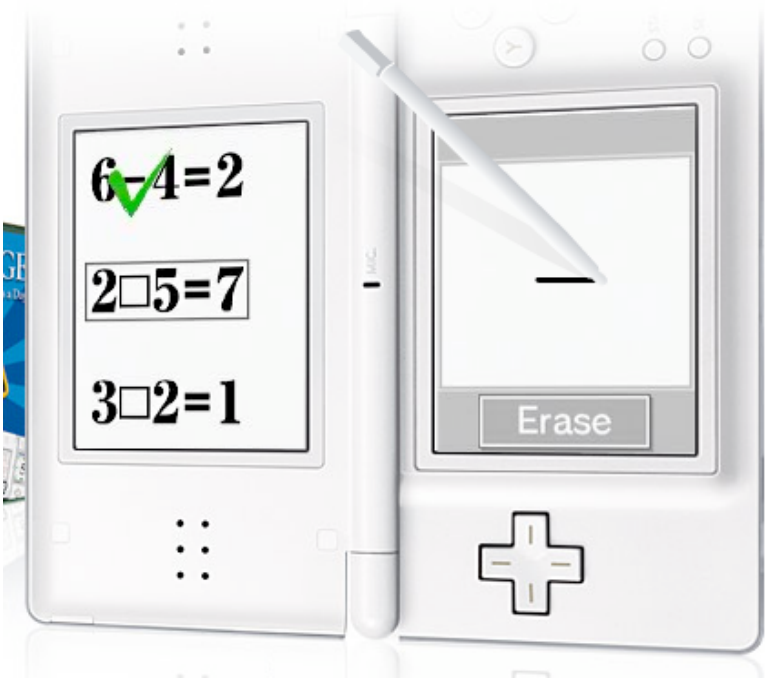

Figure 2. One of the activities in Brain Age 2 that simply requires specifying the mathematical operation to make the expression true.

As phenomenally successful as the DS has been for Nintendo, Nintendo's home console, the Wii, has arguably been even more successful (the DS has sold nearly 75 million units as of Spring 2008, while the Wii has only sold about 25 million but the DS has roughly a two-year lead on the Wii). Now, over 1 ½ years after the Wii's release, you still can't find them online or in stores without some luck. This is despite (or more likely because) the Wii has again bucked many trends in the video game industry. The Wii doesn't play DVDs or High Definition disks as its third generation counterparts the Playstation 3 (PS3) and Xbox 360 do, nor does it offer the high fidelity in-game graphics or rely on multi-button controllers that its counterparts do. Yet as of this writing, the Wii has outsold the Xbox 360 by nearly 50% and the PS3 by about double.

Advertisements for the Wii, shows an obvious divergence in branding from its competitors. Commercials show adults, kids, women, and just about every ethnic group playing games. The focus is on the people playing, and not on screenshots of the game or sexy images of the console's design. The ads typically don't show people sitting on the couch playing, but instead they are standing and, interacting with each other and laughing. Wii games are often social and the games are simple to get started. You control the by waving your arms about in natural (or silly) ways, and many games can be completed in a matter of minutes. Wii systems can be found in senior homes and recreation centers for kids; but also find welcome homes in many adult living rooms. Again, this is a platform that is both gaining acceptance with, as well as changing the image of, games with the audience—which is critical in introducing games to education.

The aesthetic of the Wii may have as much to do with its success as does its unique controller (the Wii Remote or "Wiimote" as it is often known) and choice of games (which notably is tightly controlled by Nintendo). Many Wii games primarily are played by "Miis"—little computer generated characters that players can customize to look sort of like caricatures of themselves. The Miis however are clearly caricatures. Their bodies are bulbous configurations of simple 3-D geometry and their arms are detached from their bodies. This somewhat silly aesthetic invites play, and it has appealed to a large number of fans. Players can enjoy themselves casually without feeling pressure to perform perfectly in the game. While this may not appeal to the "power gamer," it certainly invites the rest of the gaming population to come and play.

The many modes of interaction of the Wii and the simple aesthetic have lessons for educational games. ***Educational games need not replicate the expensive 3D graphics or multi-button controllers*** typically associated with consoles to create a highly engaging experience. This opens up new possibilities for lower budget and more innovative projects in this space.

Figure 3. The difference between Wii tennis (top) and tennis on the Xbox 360 (bottom) is stark. Look at the clearly computer generated surface and even the fact that the arm is not connected to the characteristic "Mii" on the Wii, whereas the Xbox 360 provides a photorealistic look.

Casual Online Games

One of the fastest growing markets in the United States, and perhaps the world, is in "casual games". These are games that can be played for a few minutes at a time and are easily learned. They can be "ports" of real world analog games like *Hearts* or *Scrabble*, as well as original computer games like *Bejeweled*. The single biggest demographic for casual online games are women between the ages of 35 and 50. This market is huge (estimated at $2.5 billion

with nearly 40% of households engaged in 2007) and growing rapidly (estimated by at least 20% market growth in dollars, and grew by nearly 80% when measured by households from 2006 to 2007) (Schleiner, 2001).

This model is important for the world of learning games, because it demonstrates the way that many non-traditional gamers like to play games. They play for short periods of time in games that are simple, fun and ubiquitously available. And they really are ubiquitous. Many casual games are played on cell phones, which have found a good match between the simple interface available (number keys), the time people have (a few minutes waiting in line) and simple but compelling gameplay. There is compelling evidence that learning games should at least look to this segment as much as they do to the hard-core gaming models in order to engage large audiences.

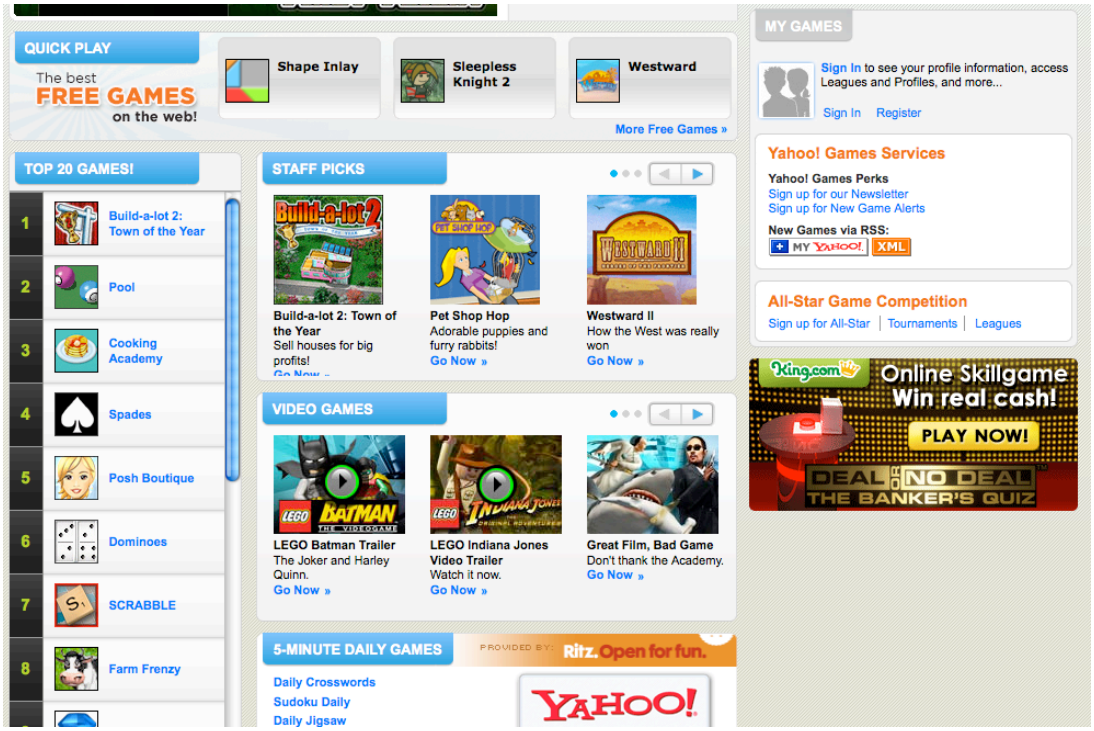

Figure 4. The world of casual online games as seen from Yahoo's game portal. The games shown here are simple games including analog ports (like Scrabble and Dominoes) as well as original games. From http://games.yahoo.com

When a Game is Not a Game

While there is quite a bit of debate in academic circles over the exact nature of games (definitions typically include combinations of rules, goals, feedback, fantasy and fun) there are some commonly agreed on relatives of games that are clearly not games. Despite the agreement of experts on the exclusion of these related categories, they often get lumped in with games anyway, simply because they may be fun and involve new media. Primary among these are *social networks* and *virtual worlds*.

The social networking phenomenon has taken off in the last few years. Initially fueled by the powerhouses Facebook and MySpace, which teens and college students have used to connect with their friends, social networks now include just about every corporate application, as well as niche applications that connect hobbyists and alumni alike. While networking with friends, colleagues and people of similar interests is in many cases fun, it lacks most of

the criteria (rules, goals, fantasy, etc.) that would make it a game. Certainly social networking, like just about any activity, can be turned into a game. Many games can be embedded in social networking applications as well. See, for example, the popular (and controversial) game Scrabulous, a Scrabble clone that is played asynchronously online within the Facebook social network in the style of "chess by mail", which has been adopted by millions of Facebook users. Smaller examples abound as well. A version of one of the first educational games, *Oregon Trail*, can now be played within Facebook, as can a game about parking in NYC, called *Parking Wars*. Ze Frank's *Color Wars* recently ignited thousands of players in games played across Twitter, and new games are introduced daily into MTV's teen-oriented social network the N. One reason for the popularity of gaming within social networks is the casual nature of the interaction they support, as well as the fact that most are free to play.

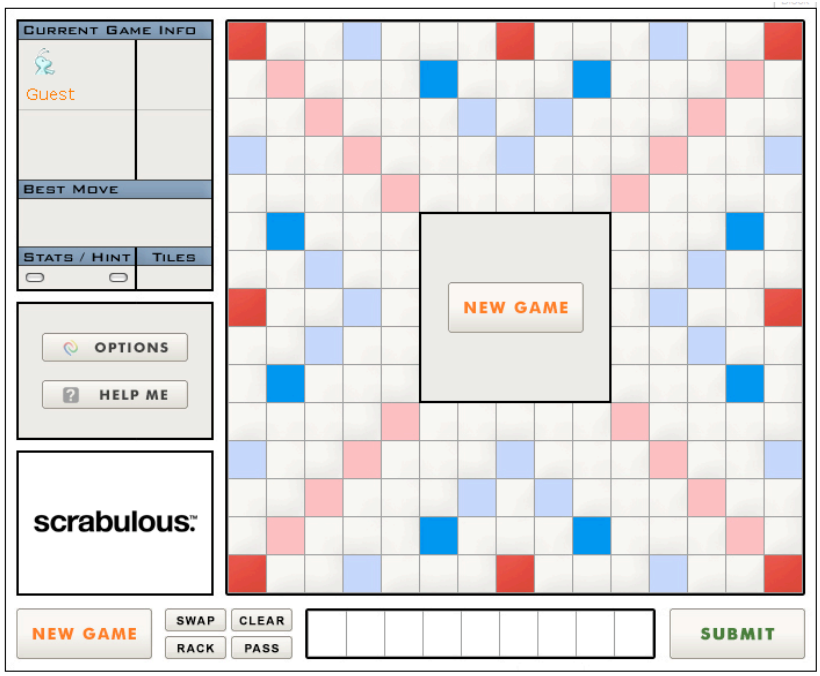

Figure 5. The popular game Scabulous (a Scrabble clone) can be embedded in Facebook pages and played through a social network.

Social networks themselves may also be powerful learning tools. There is much research that supports the notion of collaborative learning as an effective means of teaching and learning (Schwartz, 1999). Social networks may facilitate such collaborative learning, as they facilitate the formation of effective teams, permit communication within groups, and help strengthen individual and communal identities. Many businesses are seeking to tap into social networking to foster more effective teamwork. The use of social networks for education is very much in its infancy, though it does underlie NBC's recently launched iCue learning and gaming environment through what they call "peer networking". iCue is an online environment developed to engage teens in the events of history as they were perceived when they were "news." It is set up as a social environment in which one can play games about news-making events and people, but also contribute ideas to a larger structured community. This is one example of how social networks can help support games, and vice versa. Another can be found in ReMix World, the social network site at the heart of the Digital Youth Network, a program at North Kenwood Middle School in south side Chicago. DYN ReMix world operates as both a portfolio space for creative and academic work produced by students in the

school's formal and afterschool programs, and as a community space where kids express their opinions on current affairs, share information, call each other out, and engage in serious debate.

Many gaming communities use social networking as a way to exchange information about the games, to strengthen or form teams, as well as to provide help for new and struggling players. In this case the social networking application supports the game, but is not a game itself.

An even more common misclassification is the identification of virtual worlds as video games. Virtual worlds (the most popular of which are Second Life and Activeworlds) are (typically) 3D spaces that are inhabited by virtual representations of users. These worlds may be ornately decorated to model real world locations, or may be much more fantastical. By definition, these worlds don't have any pre-defined goals or much structure of any kind. They have been called "digital dollhouses", places where one builds virtual objects or landscapes where one can play with their digital representations, or "avatars." More academically oriented virtual worlds like Quest Atlantis and Whyville, both designed to engage kids in ideas connected to science, may use game-like elements like quests, experience points, and currency, but rarely function as games in and of themselves.

Confusion arises as newcomers to the discipline of games and learning are often lead to believe that making a game is simply a matter of representing some idea, concept or place in a virtual world. This approach provides the aesthetic and controls of a game, without building in some of the critical aspects of what make games powerful learning tools – feedback, structure, goals, or paths to progress.

Figure 6. An avatar is flying about in Second Life.

There is significant interest within the education community in using virtual worlds for learning as well. There are online universities, conferences, debates, and classes in Second Life. The efficacy of virtual worlds for learning is still a question at this point, seemingly dependent upon the audience, goals, and implementation. Many educators and

developers are hoping that they can use Second Life or other virtual worlds as "digital clay" which they can use as a base for making educational games. This approach has considerable merit, as the virtual world eliminates some of the "start up costs" of game creation by providing a realistic world with facility for movement and communication. Yet as developers attempt to mold this clay, they often find that it isn't quite as malleable as they had expected and has inherent limitations that make the virtual world less than ideal for the particular task at hand. That isn't to say that virtual worlds can't be used as a basis for games, or educational games[2], but there are distinct differences (e.g. defined starting and ending points, limitations on access, etc.) that make this mapping problematic. The future may lie in open source platforms that are more amenable to games.

The Boom and Bust and Boom of Educational Games

The history of computer-based learning games has a story arc that rises dramatically, and then plummets steeply[3]. In the early days of personal computers (1980s), creative minds drawn to the new medium explored a variety of approaches to learning games, ranging from behaviorist drill-and-practice exercises (i.e. *Math Blaster* Davidson/Knowledge Adventure, 1987), to open-ended environments suitable for either exploration or construction (i.e. *The Incredible Machine*, Jeff Tunnell Productions, 1993). Early practitioners were inventing new forms, and even the fundamentally limited drill-and-practice games were infused with a measure of creative energy and humor. For users of these early products, each new title represented another interesting step into unknown territory.

The CD-ROM Era

These products were first delivered on floppy disks and marketed alongside pure entertainment games in the few computer stores of the time. By the early 90's the adoption of compact disk (CD) drives, and improved processing speeds led to a flowering of products with increasingly rich art, animation and more sophisticated computational possibilities. As the educational titles proliferated they spawned their own industry complete with mail order catalogs for parents and teachers. The titles from this era include long-enduring titles like *Where in the World is Carmen San Diego*, *Pajama Sam*, and *Reader Rabbit*, but notably includes many more titles that were primarily relegated to the bargain bins of mass retail stores. Indeed this era saw a broad infatuation with CD's as the ultimate delivery mechanism. Publishers raced to develop interactive CD's that not only occupied the computer game and educational space, but that would, (as many people saw it) in theory, supplant traditional reference books (encyclopedias, atlases, etc.) if not eventually all book publishing. In many ways the CD became the product, rather than merely the delivery mechanism. Parents and teachers purchased "educational CD-ROMs", not "educational games", "educational references", or "multimedia guides". The CD-ROM was a method for delivering educational and entertainment content of many kinds, which muddied the waters of educational publishing, such that publishers focused more on the mechanism and marketing than the contents.

This era came to a crashing halt in the early 1990s with the sudden emergence of web-browsers, opening up the Internet and all of its free content to average users. The gold-rush mentality that previously animated CD publishing was abruptly redirected toward the Internet, and in that early delirium of the dot com boom, content was suddenly

[2] See *Quest Atlantis* - http://atlantis.crlt.indiana.edu/ as an example of an educational virtual world that has evolved to incorporate games,

[3] Scot Osterweil, co-author, lived through this era working with companies including Broderbund, The Learning Company, and others.

offered for free on-line, in the hope that money-making models would eventually emerge. Lego was a particularly strong player in this arena, recognizing the potential for web-based experiences to extend the brand and narrative worlds of their products, including games. Games and other products for children were a major part of this mix of web-served content, putting great stress on the market for shrink-wrapped, CD-based software. As was characteristic of many markets that emerged during the Internet boom, products were rapidly produced so that companies could be the "first movers". This left little room for the time intensive development of learning games.

The delivery mechanism itself also influenced the products that were produced. A CD had to be purchased. This investment meant that most people had access to only a few titles, and subsequently could and would in turn invest time into a more in-depth experience. When things started moving at "Internet speed," the way in which games had to appeal to their audience changed. They needed to be immediately and continually appealing, or the player could just leave for another site. Games became a means to attract people to a site, rather than the destination themselves.

There were other coincident pressures on the learning game industry that contributed to its decline. The rising popularity of personal computers led to their commodification. Software products that were once sold in specialty stores were now appearing on Wal-mart's shelves. Big box stores required publishers to offer products at lower prices, and for lower profit margins. The need to distinguish their products in this environment led publishers to invest heavily in licensing characters with built-in market appeal (Rug Rats, Sponge Bob, etc.) that would stand out on the shelf. In an environment of diminishing profits, funds that previously went into R&D were now dedicated to these licenses. Publishers had little choice but to recycle last year's product with this year's hot character.

The Sinking Edutainment Ship

The final factor in this perfect storm was the rising demand by buyers (i.e. parents) for products narrowly focused on improving school performance. Drill-and-practice, led by the *Math Blaster* and *Reader Rabbit* line of products, was always a large component of the industry, but the appearance of the *Jump Start* series represented a turning point. The product name appealed perfectly to parents' anxieties that other people's children were getting a jump-start on education and all the future rewards that would follow in its train. Not only did these products play to the cultural moment, but they also had the kind of simplistic marketing appeal that worked in the big-box retail environment. In its two-word title, *Jump Start* told parents everything they needed to know about the product, what marketers called the "why to buy." In response (representative of the industry at large) to the success of *Jump Start*, Broderbund Software, long regarded as the leader in creative software design, replaced its marketing manager with one new to the software industry, but experienced in placing packaged goods on store shelves. A diverse range of creative children's products were suddenly marketed in the "Active Minds" series, with uniform packaging and lengthy checklists of "educational" features. Development of new product slowed, and within a few years Broderbund was swallowed up by the less adventuresome Learning Company.

The checklists on the back of software boxes that narrowly defined academic skills worthy of developing, along with the catalogs that boxed software into specific academic categories also left little room for what became known as "Thinking Games". These games did not necessarily connect to academic standards, but clearly involved a diverse set of intellectual skills from problem-solving to creativity to quantitative skills. Games like *The Incredible Machine*, which challenged players to create various Rube Goldberg-esque contraptions, stand out in this category. In many ways these games represented the best of what the edutainment era had to offer, games that were simultaneously

fun and intellectually challenging, and in fact they were fun *because* they were intellectually challenging. These games had a hard time succeeding, neither being entirely at home in the educational or the entertainment aisles.

What once had been a diverse range of products was rather quickly reduced to one very limited model. At the height of the CD boom, all children's software products—whether designed for pure entertainment or with learning goals in mind—occupied shelf space in Toys "R" Us right next to the flashy entertainments designed for video-game consoles. By the end of the decade, Toys "R" Us had moved the video-games to the very front of the store (with increased security to protect from theft) while 'edutainment' products were relegated to ever smaller shelves at the back of the store, and from all appearances the store was not particularly worried about customers wanting to steal the products. The ever-shrinking edutainment space was eventually replaced a decade later with the "green aisle" at big box toy stores, which was dominated by the early childhood Leapfrog gaming systems. In some ways, Leapfrog redefined the learning games space, putting it back on the map in 21st century. And while innovative titles could be found, it quickly fell into the shelf-appeal licensing debacle that the CD-ROMs had faced previously, and the new generation of learning game systems became yet another method for delivering recycled content with a fresh coat of licensed characters.

Others have offered perspectives on the downfall of the edutainment era, including Mizuko Ito (2007), who chronicles not only the economic factors that contributed to this decline in children's software, but also brings an anthropologist's eye to the subject, observing the ways different products fit within long-existing approaches to children's play and learning. A major contribution of Ito's article is her categorization of three different genres of games targeted for children: Educational, Entertainment, and Construction. She describes *Educational* games that are largely drill-and-practice exercises tied to the narrow curricular goals of the traditional classroom. In her formulation, *Entertainment* games are more exploratory, narrative- based games that privilege play, and that stand decidedly apart from the institution of education. The third category, *Construction,* includes simulation games like *SimCity* and *Zoo Tycoon*.

As solid a foundation as Ito provides, there are two respects in which her article may not be as helpful in looking forward to new approaches to Learning Games, and understanding why the new era of games represents a different model and a new opportunity. The first is the degree to which her categorization may mask other possibilities for games that break genre. Ito is clear in suggesting that such genre-bending is possible, but she largely dwells on games that define rather than violate categories. We believe there is tremendous power in blending forms, and are particularly interested in the ways in which games might follow the form of Entertainment titles but nevertheless offer intellectual challenges that contribute to academic accomplishment (much the way *Macbeth*, or *Pride and Prejudice* can be tools for fostering intellectual growth while remaining "entertainment" properties).

Ito's article also treats the games industry as "mature" and suggests that there was something inevitable about the industry consolidation that stifled earlier innovations and led to the separation of her three genres into different market segments. While we would agree that there were powerful market forces that brought us to the present moment, we don't necessarily see the current situation as mature. The still-growing reach of the Internet and the proliferation of new game platforms (handhelds, web-enabled videogame consoles, cell phones) all suggest a market still ripe for innovation and creative destruction. There are new ways of finding, sampling, and buying games, and we believe over time negative factors such as big-box stores, and a limited number of dominant publishers will have a diminishing impact on the evolution of new games.

Barriers

Any story of the promise of educational games must attend to the barriers slowing or stopping their development and adoption. These barriers come from various sectors, including industry, academia, the market, schools, and even kids themselves. It is a story that begins with the emergence of the children's software industry in the eighties and nineties, as noted above. Then, as now, schools were slow to adopt new innovations, and were unable to make the organizational and instructional changes necessary to make good use of new learning technologies. Then, as now, uncertain markets made investments in educational games risky, particularly for an entertainment-focused videogame industry. Then, as now, the knowledge around effective play patterns for certain kinds of learning was limited, narrowing the scope of types of games being made. Then, as now, designing a good game was difficult, educational or not.

Now, as then, we face many challenges, but now we have this past experience and new knowledge and know-how that provides the potential for a new take on learning games. Recognizing the types of barriers facing the educational games space is important, for while not insurmountable, these barriers pose significant challenges, and will can only be overcome by a coordinated effort by funders, developers, schools, parents, and kids. These barriers include, but are not limited to:

Barriers to adoption:

- *Curriculum Requirements:* Historically, schools have been reluctant to give up textbooks or purchase educational technologies that are either not clearly linked to state standards, or that have not proven their efficacy. As a result, K-12 curriculum standards "lock down" the curriculum leaving no space for adoption.
- *Attitudes:* Some parents and educators have negative attitudes about video games, which are reinforced by a limited dialogue in the media around the relative merits of video games broadly. These attitudes take on a different flavor in the "chocolate broccoli" problem: Kids, particularly pre-teens, tweens, and teens shy away from games they are told are good for them, or labeled as educational.
- *Logistics:* Educators often find it difficult to integrate the play of game into the time structure of school day, which is often ruled by 45-minute classes. In some schools, access to computers is too limited for games to play a mainstream role in learning. For mobile games, the ban on mobile phones and other portable devices in schools is a large barrier to entry,
- *Support for Teachers:* Most teachers have little experience in integrating games into the classroom, and professional development programs most often do not include support in this area. Teachers lack the time, incentives, and support for this work.
- *Assessment:* While games may be especially good at teaching higher order skills, these skills are not typically assessed in standardized exams. New frameworks for assessment of these skills must be developed if games are to be leveraged within the performance-driven culture of most schools.
- *Evidence:* While this is changing, not enough studies have been done to date showing that learning games are effective. Without this evidence, the attitudes and barriers discussed above will be slow to change.
- *Uses of Games:* Examples of how games can be integrated into a range of curricular experiences is crucial; a limited set of these models exist currently.
- *Limited View:* People often have a limited view of the variety of games available, which narrows expectations around the viability of games to engage students.
- *Social and Cultural structures:* Existing social and cultural structures around education, school, learning, and play make the uptake of educational games challenging. These structures are incredibly difficult and slow to change, and pose perhaps the greatest challenge to the educational games space.

Barriers to design and development:

- *High development costs:* Videogames are expensive to make and maintain. Uncertain markets make investments a high risk for the videogame industry and educational materials companies, who then face most of the barriers to adoption described above.
- *Development Process:* Most videogame companies have specialized development processes that rarely include collaboration with learning scientists, teachers, or youth development specialists. The process is driven by the bottom-line market concerns, and it is easy to "cut-out" aspects of the game valued by the educators, such as reading and writing.
- *Playtesting in schools:* It is difficult for game development companies to gain access to classrooms and other educational contexts in which their games might be played. This limits the effectiveness of their internal evaluation process, which demands play of their product by their target audience.
- *Limited Sources of funding:* While this is starting to change, lack of funding for educational game development or the creation of educational game companies from venture capitalists, mezzanine funders, or banks limits the growth of the field. As noted in a recent report, this adversity to risk-taking is deepened by past experience of firms that lost investments in the education technology markets (Federation of American Scientists 2006).

Barriers to sustainability:

- *Gamers are fickle:* Gamers, like kids, change what they play for a variety of reasons, and loyalty to a product can be hard to find. Particularly for games that lack cultural or social cache, or replayability, this factor can impact the shelf-life of a game.
- *Speed of Change:* Technology changes so quickly that platforms are outdated quickly, exacerbating the funding challenge described above.
- *Maintenance and Support:* Games, especially those that are networked, required ongoing support, which can be costly. Funding often is not provided for this aspect of development.

Barriers to innovation:

- *Limited Data:* Because there has not been, to date, much reporting on game play data by groups outside of the videogame industry, the field has become locked into commercial industry data on demographics and genre.
- *Limited Pedagogical Paradigms*: Standard approaches to pedagogy in the classroom differ significantly from models present in games. Effective use of games and other new technologies is likely to be limited unless educational institutions are willing to consider significant changes in pedagogy and content, and rethink the role of teachers and other educational professionals (Federation of American Scientists 2006).
- *Limited Research*: In addition to the limited research into the form of games as learning environments there is an equal lack of work being done in the area of effective play patterns for learning. We don't yet know enough about the range of play patterns available for certain kinds of learning.
- *Limited Ambition*: Funded projects are often not ambitious enough –-they are tested with small numbers of players and don't scale. No scale means no impact.

The Ecology of Games with A Purpose Beyond Play

While the edutainment industry declined in the late 1990s, interest in using games for purposes besides entertainment started to grow again early in the 2000s with new models, new ideas and new goals that overcome of simply go around the obstacles that challenge the industry. The rise of the Serious Games movement began in earnest around that time, fueled primarily by interest in using games for military purposes, ranging from recruitment to training frontline personnel. Two popular games emerged – *Full Spectrum Warrior* and *America's Army*.

The Serious Games movement, created with funding through the Woodrow Wilson Foundation by David Rejeski and Ben Sawyer, sought to capture the interest in this field brought on by these military investments. The focus of the *Serious Games* movement is most commonly associated with what may best be described as "Games for Training". That is, *Serious Games* were initially conceived as being designed to train people for tasks in particular jobs. This might be training army personnel to better identify enemy combatants, or training insurance salesmen how to close a deal. These tasks may be *physical* or *cognitive*, or a combination of both. But they are characterized by their *specificity and applicability for particular work-related purposes*. While Serious Games may appeal to people simply interested in playing fun games, they are typically targeted at a captive audience.

Sparked by the increased interest in games more generally as well as the success of the Serious Games movement, the use of video games for a variety of purposes has garnered quite a bit of interest in the last few years. These uses span everything from advancing social causes to promoting better health to marketing. The class of games known as *Games for Change* (www.games4change.org) are being designed with a social or political agenda to get people to consider particular issues. Members of *Games for Health* (www.gamesforhealth.org) design games for both patients and practitioners with a medical purpose in mind. *Advergaming* is a popular form of advertisement that delivers commercial messages through games, which has also been included in this category of games that have purposes in addition to entertainment. And there are many more categories of this type.

There has been some confusion as to how to classify these types of games. This is an issue not only of nomenclature, but also of purposes, audiences, design principles, and metrics for success. While lumping all of these "Games with A Purpose Beyond Play" together recognizes some of the common features of these games, as well as some of the similar challenges and knowledge inherent in the community of developers and producers, it does not recognize the potentially critical pronounced differences (which may in fact be more important than the similarities).

In a talk early in 2008, Ben Sawyer (co-founder of Serious Games) and Peter Smith established a taxonomy of "Serious Games" in an effort to both point out the similarities and delineate the uniqueness of these categories.

The first thing Sawyer and Smith sought was to place all of these "Games with A Purpose Beyond Play" under the common umbrella of Serious Games. While this may be confusing due to the original usage of the term, it has nevertheless entered common usage and it does usefully describes a broad range of games.

Second, Sawyer and Smith identified axes to differentiate games – "Audience" and "Purpose" (Figure 7). Audiences include Defense, Industry and Education to name a few, while Purposes ranges from Advertising to Work to Research, notably including *Education* and *Training* as categories[4].

4 More information, and specific examples in these spaces can be found in Sawyer and Smith's original document (http://www.dmill.com/presentations/serious-games-taxonomy-2008.pdf)

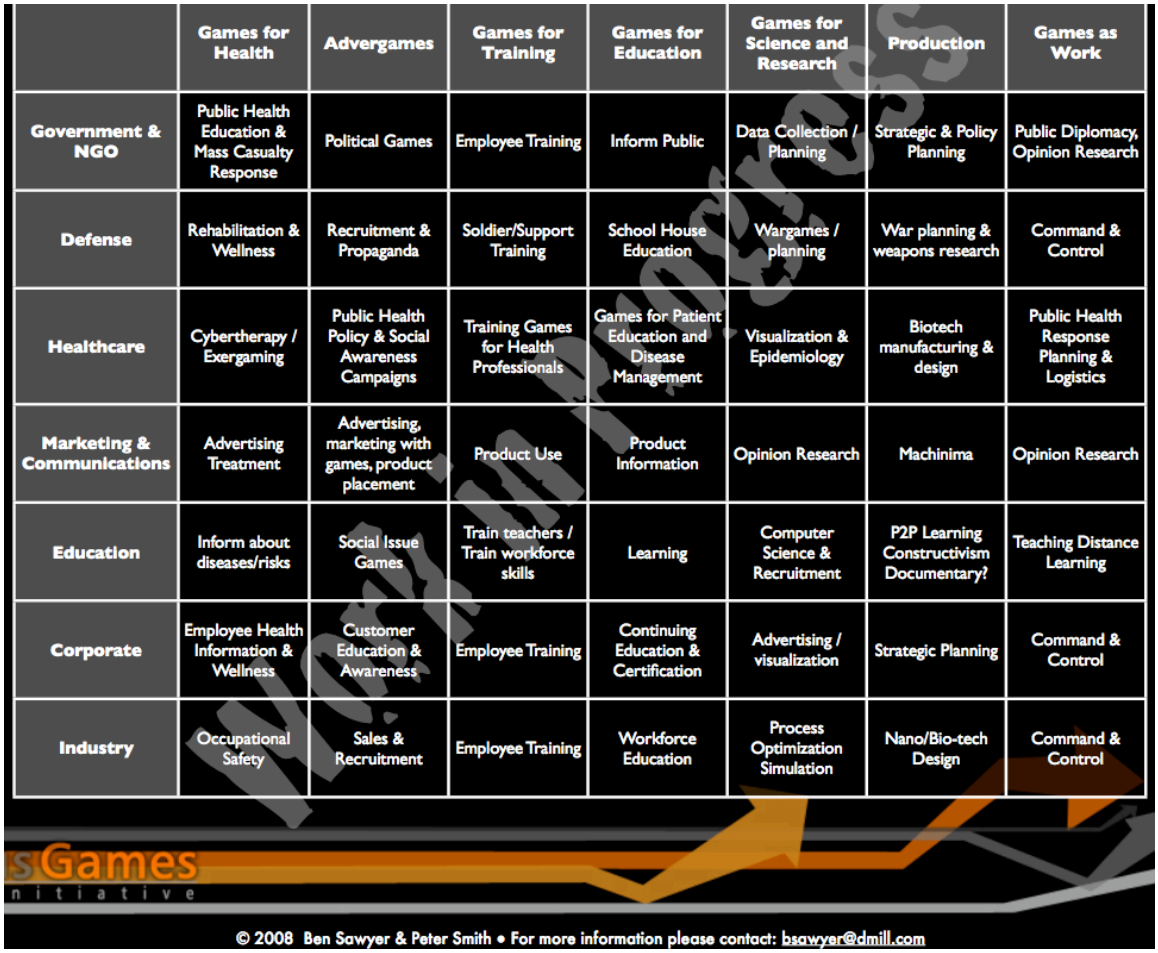

Figure 7 - The Taxonomy of Serious Games developed by Ben Sawyer and Peter Smith

For the purposes of this paper, we focus fairly narrowly on the intersection of the Education audience with the purpose of Education and Training. Other markets are certainly worthy of consideration and support, but the differences with these other purposes and audiences make a broader consideration difficult or impossible as well as counterproductive.

The space that we identify at this intersection includes the abovementioned Games for Training as well as what are known as Learning (or Educational) Games. Learning Games are differentiated from Games for Training in that they target the *acquisition of knowledge as its own end* and *foster habits of mind and understanding that are generally useful or useful within an academic context*. Learning Games may be associated with formal educational environments (schools and universities online or off), places of informal learning (e.g. museums), or self-learners interested acquiring new knowledge or understanding. Games in this space include MIT/Maryland Public Television's math and literacy game *Lure of the Labyrinth*, and the Federation of American Scientist's *Immune Attack*, as well as COTS games like *Civilization*, *Rollercoaster Tycoon*, and *SimCity*.

Note that above-defined intersection of an Educational Audience with Education and Training goals define subsets of Games for Training and Learning Games. In fact, this intersection includes much of the space of Educational

Games, but a relatively small portion of Games for Training, as we don't concern ourselves with the use of games in a corporate or military context.

The new vision for games in this learning space is to create games that are both engaging and educational. Unlike many of the games of the edutainment era that included a mix of discrete educational and entertainment components, the new model is to see them as inextricably linked, and wholly integrated.

Learning Games

Games vs. School and the Freedoms of Play

The freedoms of play are present even in mediocre games, yet they are all too rare in school. Unquestionably, the best teachers try to foster learning environments where children are free to pursue learning in open and exploratory ways, through what is traditionally defined as Constructivist (and/or Constructionist) learning. Yet the institution of school, as currently constructed, militates against the exercise of those freedoms. The emphasis on grades and high stakes testing leave few opportunities for failure or varied effort. Experimentation doesn't even make it into the one place one would expect to find it—the traditional science class—where labs are usually done according to rigid recipes with pre-ordained outcomes. The need for classroom order and regularity rule out the possibility of playing with ones identity.

If the spirit of play sits uncomfortably in too many classrooms, the logistics of game-play are even more problematic for schools: the need to march the students through mandated curricula leaves little time for supplementary activities; the effort of getting a classroom of students into a computer lab for the typical class period all but rules out activities of any length or substance; and, the very real concerns of teachers when confronted with new and unfamiliar technologies create an environment in which games just aren't likely to be adopted, or when they are, to be used in limited and unproductive ways.

If the above serves to further highlight the disparity between the worlds of games and schools, our purpose is not to offer discouragement, but rather to encourage a clear-eyed sense of the challenges in integrating the two. The design of good learning games can only emerge when the obstacles that stand in their way are fully accounted for. We believe that the answer lies both in the design of games meant to fortify academic learning, and in new and creative ways of imagining the integration of those games into schooling. For example, imagine the following as a list of ways games can be integrated into the classroom, in support of different intentions and purposes:

Games as "engines" or authoring platforms: AUTHORING SYSTEMS

In this scenario students use games to produce an artifact, be it a game (*Spore*), a mod (*Starcraft*), a video (machinima in *WoW*, the *Sims*, Second Life, etc.), a visual text (*Sims Family Album*), an avatar (Miis), a written text (MiLK, an sms-based game platform), or a body of code (Alice, Scratch). Rubrics for evaluation of these artifacts come not from the game, but from the design domain to which the artifact is related, as well as from the kinds of understandings the artifact was produced to express. Commercial, off-the-shelf games/web-based games can be used, as well as software platforms or virtual worlds with games embedded.

Games as content: CONTENT SYSTEMS

In this scenario, COTS or other games are used to deliver understanding about a particular subject or content area. For example, students play *SimCity* to learn about urban planning, or *Civilization* to learn about history. When games are used this way students must be provided with opportunities for reflection on and discussion of the content in spaces external to the game in order to allow students to see the game as part of a larger body of knowledge on that subject.

Games as simulations: MANIPULATING SYSTEMS

In this scenario games are valued as dynamic systems with which students can test theories about how systems work, as well as how certain principles of dynamic systems can be observed and played out. For example, students may play *Bridge Builder* to learn about bridges as systems of engineering, or use *Soda Play* as a way to test out physics-based theories. *Animal Crossing* could be played in order to have students work with elements of a capitalist economy and theatre games can be played to have students reenact situations or scenarios as a way to see how the system can be affected by manipulating certain factors. Simulations often include their own internal assessment measures (data) that can be used to assess student understanding of both micro and macro elements. Commercial, off-the-shelf games can be used, as well as web-based simulation tools or downloadable software.

Games as context: TRIGGER SYSTEMS

In this scenario games are used to create an experiential context for understanding around a topic, issue, or principle that a teacher can build on. For example, a math teacher might have students play *Dungeons and Dragons* as a way to have them explore probability, or *Pictionary* as a way to introduce ideas about forms of communication. When games are used this way students must be provided with opportunities for reflection on and discussion of the content in spaces external to the game in order to allow them to see the game as part of a larger body of knowledge on that subject. Depending on the amount of time available, commercial, casual, and non-digital games can be used. This approach can be paired with the use of games as engines—students can be asked to design a game as a way to immerse themselves in research around a topic. Later learning experiences can then build on what was learned in order to build a game.

Games as technology gateways: GATEWAY SYSTEMS

In this scenario games are used as a way to give students experience with technology, whether this is learning how to use a particular piece of software or platform (i.e. learning how to use a PC or browser) or kind of technology (mobile phones, wireless devices, writing, programming). Assessment models would be based on the effectiveness of a student with a system and their ability to use the system to do what they want it to.

Games as illustration: REFLECTIVE SYSTEMS

In this scenario games are used as contexts for student reflection. For example, a teacher might ask students to play a game and then discuss the choices they made: why did they choose that avatar skin over another one? Why did they choose to attack that country and not another one? What made them uncomfortable and what were they surprised at having chosen to do? Commercial, off-the-shelf, web-based downloadable games can be used, as well as board games.

Games as exemplars of point of view: POV SYSTEMS

In this scenario games allow students to take on certain identities and associated points of view. Students might play an RPG where they have to choose to play both a "good" and "bad" character and compare differences in strategy, choice, and values held by those characters. A teacher might ask students to use a theatre game to re-enact a familiar scenario, but told from several points of view, with the goal of each character being to shift the outcome of the scenario on their favor.

Games as Code Worlds: CODE SYSTEMS

In this scenario students use writing as the primary mechanic of game play, whether they are playing text adventures or designing or playing text-based mobile games. The emphasis here is in the use of writing as a both a mode of action and expression. Because writing itself is produced as an artifact of the game play, this writing can be assessed to capture student understanding. There is an opportunity to connect this approach to games with the introduction of a programming curriculum that might use authoring platforms like Scratch or Alice, or virtual worlds that support object creation like Second Life.

Games as Documentary: DOCUMENTARY SYSTEMS

In this scenario the play of a game is used as documentary evidence of student ideas/understanding. For example, students may be asked to play the *Sims* in such a way as to recreate certain social scenarios that they are interested in. Machinima or storyboarding with screenshots can be used to capture the details of the situation, which then can be used as the basis for additional discussion or reflection. Commercial, off-the-shelf, web-based downloadable games can be used.

Games as text: IDEOLOGICAL SYSTEMS

In this scenario games are "read" as texts that express certain underlying ideologies, values, beliefs, etc. In the same way that *Uncle Tom's Cabin* can be read as an expression of the antebellum South, *Animal Crossing* can be played and analyzed as an expression of late 20th century capitalism, *Chess* can be played and analyzed as a game about territorial conflict, or *Diplomacy* as a model of the intricacies of international diplomacy. When games are used this way students must be provided with opportunities for reflection on and discussion in spaces external to the game and ideally in relation to other media.

Commercial, off-the-shelf, web-based downloadable games can be used, as well as board games and other kinds of non-digital games.

Games as research: RESEARCH SYSTEMS

In this scenario students design games as a research activity, which produce material to be used in later learning experiences. Because a designer must be knowledgeable about the system he or she is designing, using game design in this way requires students to think through how their players are learning and what they need to know about the subject of the game. In this way, students not only research material to be used but also edit this material and are introduced to issues around credibility and point of view. Different kinds of research methods can be introduced as part of the work, as well.

Games as assessment: ASSESSMENT SYSTEMS

In this scenario games can be used as environments for assessing student learning of curricular content or state standards. For example, students might play Quest Atlantis to show their understanding of certain science concepts or they might play a MiLK game that centers on answering questions around certain academic content.

All of these uses of games integrate a 21st century skill critical to the design and play of games: systems thinking. Systems-thinking has been identified as a skill necessary in the 21st century (Federation of American Scientists, 2006). Researchers, game development executives and education leaders at the 2006 Summit on Educational Games, a national conference convened by the Federation of American Scientists, the Entertainment Software Association and the National Science Foundation, described video games as "able to teach higher-order thinking skills such as strategic thinking, interpretative analysis, problem solving, plan formulation and execution, and adaptation to rapid change" (Federation of American Scientists, 2006, p. 3). In addition, they point out, interactive games are the medium of attention for youth, who spend on average 50 minutes playing them each day (Roberts et al., 2005). While playing video games, young people perform complex tasks within rich and highly immersive multimedia-driven, interactive environments. Sample tasks include: running political campaigns (*Political Machine*) or football franchises (*NCAA Football '08*), building environmentally sensitive communities (*SimCity*), navigating virtual worlds they create (Second Life), managing complex social relationships (*The Sims 2*), or trying to find a diplomatic solution to the Israeli-Palestinian conflict (*Peace-Maker*). Don Menn (1993) claims that students can only remember 10 percent of what they read; 20 percent of what they hear; 30 percent, if they see visuals related to what they are hearing; 50 percent, if they watch someone model something while explaining it; but almost 90 percent, if they engage in the job themselves, even if only as a simulation.

Baking Educational Games

The process of designing and creating educational games can be thought of much like the process of baking. There are many attempts by a growing number of health conscious cooks to make things that are both yummy and healthy. It isn't easy to balance these two qualities. It is relatively easy to bake calorie-laden cakes filled with butter and transfats that are quite tasty, or one could make piles of oat germ laden sawdust that could reduce your cholesterol if only you could actually eat it. To get both of these factors balanced is hard, and there likely is no universal solution (other than perhaps iterative experimentation). Some recipes work really well for some groups of people, in certain contexts, with particular expectations. Similarly, in creating experiences that are both fun and filled with learning, the success of different recipes (mixes of media, immersion, styles of games, learning goals, mixtures of content, etc.) depends quite a bit on the audience, context, content, goals, and facilitation.

There are two recipes that are followed quite a bit today to create a blended balance of what you want and what is good for you. One recipe takes the yummy calorie laden cake and injects beta-carotene, vitamin D and calcium right into the cake. This is no doubt a delicious cake, but its nutritional content is highly suspect. Similarly, designers of educational games that try to inject content learning into a game where it doesn't fit may create experiences that are somewhat entertaining, but their educational value is highly suspect. If your spaceship requires you to answer a math problem before you can use your blasters, chances are you'll hate the game and the math. This is the strategy taken by most of the legacy edutainment games (e.g. Math Blaster), as well as many of the new attempts to create commercially viable learning games today (e.g. the immersive 3D math game, Dimension M).

Figure 8. A screenshot from the website of Dimension M, showing a disembodied math problem in the sky.

The other recipe simply takes all of the healthy content – wheat germ, oat bran, carrot juice, spinach leaves, etc. – and bakes them into something that looks like a cake. It sure is healthy, but just because it looks like a cake, doesn't make it tasty. Many people designing educational games follow this recipe. They take educational content and do something to make it look like a game (i.e. put algebra problems in a 3D virtual world, or place the periodic table of the elements into a shooting arcade). While there may be educational potential in such an approach, these games often "suck," as Ted Castranova found and documented in a recent article in WIRED (Baker, 2008). Just because it looks like a game, doesn't make it a game.

Figure 9. Ted Castranova's game, Arden: The World of William Shakespeare, which in his own words, "sucked".

In Baker's article, Castranova (a researcher of virtual economies) presents some tips for "Making Games That Don't Suck," which are good starters for anyone thinking about rushing into the game-making business, educational or not. Castranova created a game (a heavily modded version of *Neverwinter Nights*) to attract players to a world in which he could study their behaviors. The world turned out to be a great looking, but primarily "un-fun" experience, that did little to attract players. Castranova in turn advised:

- Don't be overly ambitious
- Go low tech
- Think about your audience
- Get a full-time staff
- Concede screw-ups

These are particularly relevant for the field of educational games, which is currently taking on the appearance of a gold rush, but which frequently operates without the resources of mainstream gaming developers. Throughout academia, industry, government agencies, and non-profits, many people are flocking to educational games as the silver bullet to cure our educational woes. While there is clearly power in the medium of games to teach and to learn from, educational games need to be thoughtfully designed and considered from both the educational and entertainment perspectives (as Castranova lays out) so that these games "don't suck".

So what is the magical recipe for a good educational game? While the perfect recipe may not exist, at least the beginning of the answer lies in the framing of the problem. "Making a game *out of* learning" will most certainly not be the way to approach the development of learning games. However, "finding *the fun in* that learning" and devising ways to focus on and enhance that fun as a core game dynamic is a good strategy. Finding that "play space" in the learning experience is where the fun can be found. Additionally, choosing the right technology plays into the decision, as Castranova indicates when he advises people to manage their ambitions and go low tech. We might amend that to "go with the right tech." Castranova likely has something similar in mind when he says, "consider your audience." In some cases, a game may require an expensive 3D virtual world, but in other cases a text-based game may be perfect, and yet others might be appropriate for mobile devices that you can take with you anywhere. Too much time and effort has been spent on trying to capitalize on the expensive 3D virtual worlds, and not enough on the smaller, less-flashy approaches, but both offer potential for educational games.

The Role of the Ivory Tower

Academia has a critical role in fostering the growth of the games industry, and the educational games sector in particular. Academia is the source of innovation. The commercial games industry just doesn't have the budgets, staff, configuration, history, or even the motivation to provide consistent innovation. A single failure can set a large company back quite a ways, and likely bankrupt a smaller company.

That is where academia can help. We can take risks and make mistakes. We can try the high-risk project that has a chance at being the next big disruptive success, but could also just fizzle. We can pilot and test new ideas just to

learn more. Of course, we must provide value to our funders and partners, but that value comes in the form of both our products and our learnings.

Academia should not be perceived as the cheap alternative to commercial production (partially because it may not be so cheap), but rather an important place for innovation as well as idea- and technology-generation. These are integral components to pushing the educational games movement forward. In turn, academics should consider how and when to forge partnerships with commercial entities and other facets of industry to both facilitate flow of knowledge. In this way, we maximize value to our funders and to the community at large.

At the Education Arcade, we produce some of our projects almost entirely in house, but we work with partners on content and audience testing of those projects. Other projects start as ideas and prototypes here before they move on to production with one of our creative and experienced commercial partners. And still others we play merely a supporting role in, helping out with advice and feeding back research into the design.

But we also have another role in fostering the educational games movement, and that is producing the designers, producers, programmers, and leaders of tomorrow. This is really the only place where we might temper the advice of Ted Castranova's viewpoint in WIRED. He advises getting a full time staff, but most of our projects have a mix of undergraduate students, graduate students, and staff assigned to them. Undergraduate students and graduate students certainly have schedules that ebb and flow, and even the best of them are only around for a short time, but they provide insight, perspective, and a lot of creativity and hard work to the process. We in turn, hopefully, provide them with the experiences and opportunities they need to develop the skills that they need to grow the industry. Of course, when it comes time to produce deliverables it is always beneficial to add dedicated staff to these teams who can provide leadership, continuity, and pick up the slack when necessary. But we should not forget this important role as academic institutions, or else industry may suffer and so will we when we are forced to play more games that "suck."

Learning Games Design Principles

Silver bullets aside, there are a number of principles that we should be looking to in order to advance the field of educational games. At present there are too few models for educational games, and what models we do have are imperfect. We can both improve existing models, and create many new ones if we broadly think about these principles.

1. Choose Wisely

While games are a powerful and exciting medium that many people and organizations are expressing interest in, they aren't perfect for everything. Games work well for many audiences, topics and contexts, but they may not be the best tool for *all* audiences for *all* topics in all contexts. Sometimes the limitation on creating a good game for a particular topic is the creativity and ingenuity of the design team (there are certainly examples of great games about non-obvious topics made by some very creative teams, like *Typing of the Dead* which combines killing zombies with learning to type, or *Diner Dash*, which uses a plate spinning mechanic to engage players in managing the workload of a waitress), but other times the fit just isn't there. We have seen many attempts at games about topics like Photosynthesis, but most of what results is not a game at all, but a more typical rote classroom activity (like

flashcards) with a score and the name "game" attached to it. One must consider what it is about this topic that may (or may not) be appropriate as the basis of a game.

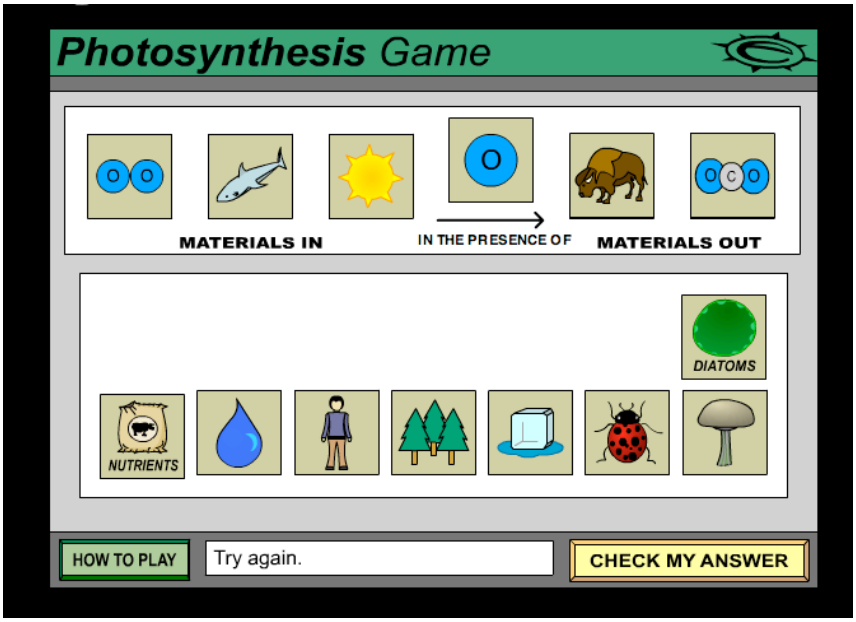

Figure 10. A photosynthesis "game" in which players simply have to drag the correct objects into the top row to complete the proper equation. From http://earthguide.ucsd.edu/earthguide/diagrams/photosynthesis/photosynthesis_game.html

For thoughts on choosing the right match between content and game mechanic see point number 5 below on finding the game in the topic instead of vice versa. But topics should not be forced—games should be one medium among many for learning in and out of the classroom.

2. Think small (sometimes)

The typical vision of educational games at this time are massive 3D multiplayer games. There are many reasons why one might choose this kind of environment and style of play, but there are also reasons why one shouldn't choose this style (e.g. some people get lost in 3D worlds, massively multiplayer games are expensive and complicated to make etc.). Sometimes the right choice is to make a small casual game, because that style of play meets the learning goals of the activity. Other times it might be useful to create a small prototype of a game to test the fundamental concepts before embarking on a major development effort. This isn't to say that there shouldn't be big fancy learning games, but rather that not all games need to be large and complicated. The scale and complexity should be chosen so that they appropriately match the learning goals and context. The field will do better to have more examples and models out there if we make many small efforts in addition to a few larger ones. Take the game *Free Rice* (www.freerice.com), for example, which has found its way onto the top list of gamers and educators alike. The rules of *Free Rice* are incredibly simple: Click on the answer that best defines the word. If you get it right, you get a harder word. If wrong, you get an easier word. Its game mechanic is even simpler: choose a definition. Through a simple rule set and simpler mechanic *Free Rice* has managed to engage millions of players in its play, increasing vocabulary skills the world around.

3. AAA Educational Games ≠ AAA Entertainment Games

Many developers are scared off from the developing educational games because they are convinced that the economics don't work. Commercially successful video games cost many millions or tens of millions of dollars to create. It is difficult to imagine an educational market that would be able to support those costs (though *Brain Age* may considered one viable game, while Leapfrog's success might be another). But that doesn't mean that an economically viable educational games market is a pipe dream. The details of these market forces and strategies are reserved for the companion paper, but one reason why this market is viable is because great educational games are not the same thing as great commercial entertainment video games. The first cost that can be reduced is aesthetics. The aesthetics of Wii games are much easier and cheaper to produce than the high definition platforms. Yet they work just fine for the audiences that enjoy playing these games. As another data point, in many studies of avid video gamers, it is found that gamers will often turn down the realism settings in their games.. This is partially because it gives their computers slightly better performance, and thus a competitive edge. But it is also because they begin to see past the superficial aesthetics of the game and play the game for how it feels rather than how it looks. Video game developers have a heuristic that says that the "aesthetics are what get the player to buy or play the game for the first time, but they stay for the game play and quickly forget about the aesthetics." In the educational games space, that original "sale" comes in many cases not from the aesthetics but from the learning goals. Players choose the games because they are *both* fun and educational. The educational value is definitely part of the purchasing or playing equation. People often ask why kids would play educational games when there are many purely entertainment games out there with higher budgets and better marketing. While in some cases the game may just be *that good* to outcompete all other forms of entertainment, it is more likely to be the case that the game is fun and educational, and that combination is appealing to kids, teachers, and parents. They may not displace all other game play, but they don't need to.

Furthermore, kids are comfortable moving through diverse digital media of varying quality on a regular basis, from high end games and DVDs to largely text-based sites such as My Space or Facebook. Kids understand that different production values are appropriate for different properties.

For example, the crudely animated Homestar Runner is an entertainment site for kids that receives millions of visitors every month, and over a thousand e-mails each day (Jenkins 2003). It's attraction is in the cleverness of its writing, and visitors see the funky production values as part of its charm.

In a slightly different vein, the award-winning *Samorost* is a problem-solving game with an aesthetic all its own. While not expensively produced, it nevertheless immerses players in an imaginative world far more inventive than those of traditional games. There is no reason that good learning games couldn't similarly appeal to players while embodying aesthetics that differ from the mainstream game industry.

Illustration from Samorost 2.

4. Put learning and game play first

Many traditional instructional designers will ask whether a particular learning game was developed by creating the technology (game) first and then choosing the learning goal that seemed to fit well with that technology (the techno-centric approach that people coming from a gaming background might choose), or whether the learning goals were defined first and then the appropriate technology (game) was created to fit that goal (the way many educational theorists might propose it should happen). The answer to this question should be "No". Neither of these should come first, as they should both be considered simultaneously. The former approach is likely to create a game where the learning goals feel grafted onto the game, as well as a game that doesn't have a coherent set of learning goals. The latter approach fails to recognize many of the realities of development in that every technology is not equally accessible to developers, nor does it recognize that game play is a critical element of design and similarly cannot be arbitrarily grafted onto learning goals. Good educational games will consider both the learning goals/content and the game play at the same time, with enough flexibility to iterate between the two to change one or both simultaneously. Of course this comes with bounds on the iteration. There may be some fixed set of constraints on both the technology and learning goals that are unchangeable–and of course, sometimes the combination just won't work (see #1)

5. Find the Game in the Content

In designing any learning game, it is all too tempting to simply graft academic content onto existing forms. Castranova's *Arden* attempts to situate Shakespeare's world in a traditional role-playing game. *Dimension M* grafts algebra equations onto a first-person shooter. While these projects may work, we prefer a different approach. We believe that in any academic discipline, there are elements that are fundamentally game-like. Often these are the

questions that practitioners enjoy mulling over, or playing with in their spare time, the kinds of musings that lead to "aha moments." For a historian, this might involve puzzling over the motives or needs of different historical actors, and pondering cause and effect. For scientists it might mean constructing models of phenomena based on incomplete evidence, and then testing them. While every academic discipline may involve a certain amount of drudgery or memorization, the role of games should not be to "sweeten" those activities, for once a game begins enforcing work, it ceases being a game, and ceases accessing those creative impulses so fundamental to play.

An educational game should put players in touch with what is fundamentally engaging about the subject, should help them build a scaffolding of core concepts, and should motivate them to go deeper. In doing this, we are not tricking the player into engaging with the topic (a claim that many games, particularly math games often make) but are rather enabling them to partake in those pleasures of the discipline that motivate its expert practitioners.

Not everything offered in the traditional curriculum lends itself to this approach, and educational game creators need to acknowledge that. In order to advance the cause of educational games we should be wary of overreaching by claiming that games single-handedly teach the subject matter, at least in the way the word "teach" is commonly understood. Games promote understanding, motivation, and enjoyment, and are terrific at immersing players in complex, feedback-rich problem spaces (Schaffer, 2006). And while they are most often not sufficient in and of themselves for a course of study, they can help many students advance beyond the temporary memorization of facts and procedures, attainments that are usually lost when classes stop. They can offer entry points into subject matter or ways of interacting with information that leads players to investigate further, outside the game. Building on the premise that learning is an immersive process mediated by social activity and technological tools, games and learning researchers have begun to show how the design of video games imbed effective learning principles in highly motivating contexts (Gee, 2003). Squire (2004), for example, in his work with low-income African American students engaged in playing *Civilization III*, both in a high school and an after school setting, found that the participants, especially those reported to be among the lowest performing, "developed new vocabularies, better understandings of geography, and more robust concepts of world history." *Civilization III* is a highly complex computer strategy game with its players succeeding by building empires—through a *recursive* process of trial and error—by way of managing resources, employing diplomatic and trading skills, and managing the advancement of culture and military power. Squire's participants were identified by their teachers as underachieving in history classes or otherwise disinterested in historical subject matter, yet they were able to engage in a game which asked them to account for a host of interacting variables, including, among others, the implications of working within six types of civilizations (e.g., American, Aztecs, Iroquois, Zulu, etc.), six government (despotism, anarchy, communism, democracy, etc.), and 13 geographical terrains (jungle, tundra, grasslands, flood plains and so on). Squire reports that engagement in this history-based game simulation, motivated some to ask questions like, "Why is it that Europeans colonized the Americas, and why did Africans and Asians not colonize America or Europe?" (Squire, 2006, p. 21)—questions, to be sure, that rarely surface in American history textbooks which tend to narrativize American and European history as the great westward expansion (Wertsch, 1998). Squire's research, like that of others in this new field, points to how the very design attributes of video games support learning (Squire, 2004). Squire's classic studies of Civilization III have shown that the play of games can work as a pathway toward engaging kids in research around topics they never would have considered relevant or of interest prior to the play of the game. In this instance, games can simply introduce players to possible futures for their own academic engagement.

6. Break the mold for where educational games are played. Think about playing them outside of class and discussing in school.

Since the spirit of play that infuses games and gives them their power is often not welcome in school, game developers need to think seriously about how their games will really be used. Even if we believe that school should look more like play, we should be realistic about how far we can advance that cause simply by introducing good games. The educational reform movement, going back over forty years to early work on *Logo* by Papert and colleagues, has bet that new technologies would inspire huge shifts in classroom pedagogy. Whatever currency their ideas have gained among more inspired or motivated educators, the countervailing tide of test-driven curriculum has largely swamped most efforts at change. We must therefore be more strategic in how we seed our work in the existing educational system.

This is not to say that the system is entirely hostile to the ideas of games in education. Quite the contrary, there is significant interest in the ways students are using all new technologies, but there are no easy on- ramps to adoption for today's educators. It is therefore incumbent on developers to imagine ways for schools to benefit from what games have to offer without requiring a major disruption of the current environment.

In a number of our games we have assumed that the student will be playing outside of class, whether at home or on internet-enabled computers in libraries or after-school programs. This enables us to accommodate a range of different play styles, and not narrowly tailor every activity to the typical 30 – 40 minutes of class time in a computer lab. It challenges us to design games that students can play without instruction or supervision, but that is in fact the hallmark of any good game design—the game should teach the player how to play.

Our model presumes that the students will undertake the hard work of exploration and invention without the pressure of the classroom, and with all the freedoms of play. The classroom becomes a place to discuss what strategies students used in playing the game, an opportunity to reflect on the learning that took, and to reify that learning by relating it to the curriculum. It is also an opportunity for students to demonstrate their expertise to their teachers, and to give teachers access to their thought processes.

The Education Arcade has pursued this model in designing *The Lure of the Labyrinth*. The game is web-served so that it can be played by students anywhere, and at any time. Student data is collected on a central server, enabling teachers to view students' accomplishments without requiring that gameplay occur during class time. The game is accompanied by curriculum that encourages teachers to follow this approach in deploying the game.

7. Harness the great "soft skill" learning from games but connect it with content.

Along with finding the game inherent in the content area, it is also important to leverage those skills sometimes referred to as 21st century skills. These include problem solving, analytical thinking, systems-thinking, credibility and judgment of information, technology fluencies, the ethics of fair play, collaboration in cross-functional teams, and accessing knowledge networks. As mentioned elsewhere in this paper, these are the skills exhibited by all serious game players, but all too often underplayed in educational games. Whether playing online or stand-alone games, players now routinely use such skills to connect with other players and enhance their own success in the game. Importantly, there are a key set of design principles that occur again and again in multiplayer games with social dimensions, (Ito, 2006; Salen, 2007)

- Layering of access to work (friendlocking profiles and access to other forms of shared content);
- Specialization (in contrast to standardization): multiple forms of expertise exist across the network;

- Mastery is specialized and not standardized; connected to specialization is the need to create conditions for moments not just of mastery but also of virtuosity;
- Competition and status;
- Sharing and recommendations;
- Reviewing and sharing feedback as a form of assessment
- Appreciation and validation (there is a celebration of what one knows and does);
- Collective, external artifacts produced;
- Distribution of expertise and knowledge across the community of practice

Educational games should be designed with similar principles in mind. In *Gamestar Mechanic (Gamelab, 2008),* a scaffolded game design curriculum was integrated into a game editor supporting systems and analytical fluencies, which was then folded into a social network space supporting critique, sharing, and collaboration. Players must spend time creating game labels for their games if they want to convince others to play them, as well as craft narrative messages that appear in intro and outro messages to each game's levels. In *Lure of the Labyrinth*, messaging was included as a function of the game, giving students the opportunity to write each other about their problems and successes with given activities. In fact, the game puts players on teams just so that they will have added incentive to engage in these behaviors. The game is also designed so that solutions to individual activities are different every time they are played. It is therefore impossible for students to communicate about the "right" answers, as every instance of game play is different. Instead, students must write about their problem solving strategies and the underlying game concepts. It is our contention that encouraging students to read and write about their thinking improves their reading, their writing, and their thinking. It exercises dispositions that will be important to them whether or not they remain engaged with the specific subject discipline.

8. Don't ignore, nor be too limited by, teacher training and readiness.

The model described above presumes that students can initiate game play without much help from the teacher. This relieves the teacher of the necessity of fully mastering the technology before introducing it. What the game should provide the teacher with are materials that help relate the students' game experience to existing curricula whether through discussion or other hands-on or paper and pencil activities. Provide materials and places for them to get started with and integrate them into the game process without having to be experts at the game. Strategy guides and FAQs that come with most games provide an excellent model for the design of such materials, and can be supplemented by the students themselves, as they grow to become experts in the game space. In addition, games should be designed so that teachers can access specific game experiences easily, without necessarily having to work their way through the game the way students do. This creates a relatively pain-free way for the teacher to introduce a lesson about a game activity into the classroom.

One strategy explored in *Lure of the Labyrinth* is encouraging teachers to let the students begin the game, and then to invite the students to teach the teacher how to play. The hope is to raise teachers' awareness of competencies that students may harbor but rarely demonstrate. It also models what is hoped to be seen in the classroom discussion of the game activity itself: when teachers introduce new concepts related to games students have already mastered, the students have the opportunity to investigate those concepts as practitioners, not as novices. This shifts role of teacher from dispenser of knowledge, to knowledgeable guide.

If games can be served online (as *Lure of the Labyrinth* and *Gamestar Mechanic* are, as well as upcoming games like *Spore* and *Sims Carnival*), it is possible to give teachers access to student performance on the game itself, and their participation in the games' collaborative spaces. Teachers can assess how far each individual student has advanced through the game, how they compares to their classmates, how well they use the game's networking features, and what their writing indicates about their command of the content.

If well-designed, the game may itself act as a tool for visualizing core concepts that will benefit not only students' understanding, but teachers' as well. Rather than requiring teachers to instantly change their approach to teaching, this strategy can introduce change incrementally, and integrate it into the classroom whether or not reform is happening on a broader scale in the system.

9. Play Everywhere and Anywhere

The traditional approach to playing games in the classroom is to play games *in* the classroom. Mobile games played on cell phones, PDAs, or iPods are becoming more common and more sophisticated. People can play these games for minutes at a time in the interstitial spaces of life – on the bus, waiting in line, and even while on the go. Look to the success of the Tamagotchi virtual pets, which are very simple games played for seconds or minutes at time over long durations. Educational games can emulate this style of play, and can be designed to take advantage of the interstitial spaces in students' lives – the time between classes, before school, after school, going to and from school, etc. Teachers no longer need to use class time to play games, but instead can use the class time to talk about data coming from the games outside of class. The game Palmagotchi models this style of play. It is a game based on the theme of virtual pets. But in Palmagotchi the virtual pets are birds living in a Darwinian Galapagos, and to keep the birds alive and thriving, players must learn about ecology, evolution, and genetics. The game takes place on wireless PDAs and sends data back to a central server that can be used to provide graphs of class-wide data to the teacher. These games can even take advantage of the students' locations (using location based services like GPS and wireless positioning) providing a way of integrating real world experiences with the virtual experiences of games. This approach has been taken in our Augmented Reality games that embed students in realistic real world scenarios.

Figure 11. – A screen shot (left) of an outdoor augmented reality game showing a satellite map, the player's current location (orange triangle) and game artifacts, and a screen shot of Palmagotchi showing the screen players use when selecting to mate birds.

10. Reduce, Reuse and Recycle

One of the oft-sited limitations on the development of educational games is the cost of development. While the development of unique assets, storylines, characters and modes of interaction necessitate some significant development for every project, there are many fundamental technologies and assets that may be reusable. For 3D games, many projects either develop their own specialized game engines (the core technology that runs a game) or use commercial engines. Developing new engines is expensive and complicated. Using commercial engines may also be expensive, and winds up only solving a small part of the problem since they are often not well suited to the specialized needs of educational games. Some open source engines exist, but they are dated and suffer from the same lack of specificity required for educational games. Many 2D projects are able to use more ubiquitously available tools like Flash, but these too have limitations for educational purposes, are often proprietary, and wind up incurring additional development costs for the missing key educational components. Products such as *Metaplace*, *Wonderland*, *Little Big Planet*, and *Sims Carnival* all support the design of games and all will be released within the next year, and should be explored for their potential to create learning games. In addition there is clearly a need for open source game engines designed for educational games. This does not mean *a single* game engine, but rather many engines. There should be at least one choice for each style of game, of which there are many.

The *openness* should not end at the game engine. Assets could be reusable. Creating characters, objects, and environments requires significant artistic investment. This is in fact, a common complaint of teachers working with kids in afterschool programs focused on game design: it takes too much time just to make the sprites, and little time is left for actual game design instruction. Why not commission a set of artists to design an open source library of Flash-based sprites, and a linked library of sprite behaviors? While it may be beneficial to have unique assets for every project to provide them with a unique identity, openly sharing and recombining these assets can lower production costs while placing the emphasis on other unique aspects of the game to create an identity. An open community that shares these assets could help everyone involved.

Sharing the actual code for individual games may have intellectual benefit, creating a community where ideas about gaming technologies flow fluidly. However, in practice reusable code is often not that reusable, and supporting an open source community of this sort would likely require significant investments without a clear benefit. It would also preclude many commercial partnerships, which have been very successful. Sharing assets and engines as well as ideas and algorithms are more likely to receive greater benefit.

There are many people that have sought "educational game makers" where "all you have to do is plug in the content." We do not advocate for this approach since this misses the mark that the content and the game should be integrally linked.

11. Define the Learning Goals

Many people are asking the questions "Do Games Help Kids Learn?" This question is the wrong question to be asking for three reasons. First, we cannot possibly answer such a broad question about all games. Nor could we answer a question asking whether "books are good". Each game is unique and in there will be great variance among them. The second problem is that the question assumes that games act alone. In fact one must consider the context in

which they are used. Are they facilitated in particular ways? What other materials are they used with? What training was provided for them? Finally, the question is problematic because it does not define what it is being assessed. What are kids supposed to be learning? Define the learning goals and assessments up front. If we want to be able to show measurable gains in learning we need to be able to clearly define the learning goals, and we should be able to define these a priori. Of course, these goals may change over the course of multiple interventions as formative assessments help focus the goals of the intervention. But if we do not clearly define these goals and defend their value, we cannot possibly hope to build a coherent body of knowledge around learning games. Some of these goals may be concrete and traditional (e.g. learning content in particular subject matter domains). These goals are relatively easy to assess, at least at a basic level, as current assessment tools may be used. However, even in the case of subject matter content, it is likely that researchers should be interested in new assessments that can evaluate the ability of students to transfer knowledge learned through games and solve novel problems, neither of which is traditionally assessed. Dan Schwartz's (2007) work is instructive in this sense, as he has developed a series of "teachable agents" that require kids to "teach" what they know to computer agents, who are then assessed by the teacher. Val Shute's work with Belief Nets is similarly useful, in its attempt to map novice to expert learning patterns across groups, assessing innovation and creativity across sets of choices made within a learning space. (Shute, 2007). Bob Mislevy's work around evidence-centered assessment design offers some insight into the change of thinking that is required to explicitly link learning goals and assessment within situated contexts, like games. Add to this, the desire to evaluate higher order thinking skills and new media literacies (or 21st century skills) and there is a big demand and necessity for new assessments that can help elucidate the learning that is happening through game-based experiences. Regardless, it is imperative that researchers and developers more clearly define their learning goals, and corresponding assessment tools be developed and shared *openly*.

12. Forge Partnerships – between academia, commercial companies, non-profits, foundations and government.

We've seen that current market conditions make it difficult for commercial publishers to innovate. Over the years, academia and non-profits, with the support of foundations or government agencies have shown a willingness to do so, but they are often challenged to bring their work to a level of finish adequate to reach beyond the test bed or pilot study. Nevertheless, these institutions are excellent laboratories for exploring new designs, prototyping ideas, and working experimentally with potential users.

It is therefore incumbent on these innovators to think more strategically about whether their work is purely speculative, or whether they are developing products that might have a place in the marketplace in the near term. If the latter, then in an early stage of development they should seek partnerships with professional developers and/or publishers, to at least scope out where future commercial potentials lie, and to take them into account as the design and prototyping evolves. Design is often improved when constraints are acknowledged at the outset, and thinking seriously about the market for a given product can improve the final outcome, provided the creators are still willing to take risks and stake out new territory.

13. Don't Ignore or Be Too Constrained by Academic / State Standards

No Child Left Behind, and the modern standards movement have undoubtedly changed the formal educational landscape. On one hand, it would be a mistake to ignore these standards entirely when developing any kind of educational intervention with the hope of being scaled. The standards are too far-reaching and too well entrenched at this point in time. And in many cases the standards can be quite good in defining a rigorous set of learning objec-

tives (even if those objectives aren't borne out by the supposedly corresponding standardized tests). On the other hand, the standards currently miss a good deal of what is valued in and out of the classroom. This includes higher order thinking skills, new media illiteracies, interdisciplinary learning, etc. In order to devise effective strategies for scaling educational games initiatives, the games (in their context) need to address relevant standards in apparent ways. However, to seize the value of games, and to better prepare well-rounded learners and citizens, designs should not be entirely beholden to existing standards. They should push the boundaries of learning, and drive the need for redefining standards to include valuable new skills and knowledge.

14. Not Just Who But What, Where, When and Why

It isn't just what games people play that matters, but where, when, and with whom. Learning games (and games at large) cannot be narrowly defined to only include a shrink-wrapped piece of software. Instead they consist of the social networks of people who play them, the mentors or instructors who shape the experience, the other activities (online and off) with which they are connected with, the place they are played, and the purposes they are played with, to name just a few factors. In the case of learning games, the social context includes peers as well as parents, teachers, and other mentors. Educational games will do well to build these communities into their games rather than building around them. Creating essential roles for teachers will lead to both more rapid adoption as well as a better learning experience for students as teachers can help shape the experience. Out of school, parents, peers, and mentors can also play a role, but this can be facilitated by the design of the games themselves. Games can, and should, be designed to both connect to the context in which they are played (including related activities) and be flexible so that they may be adapted and customized to new contexts.

Examples

While the field of learning games is still nascent, there are some good examples already emerging that demonstrate unique aspects and show the potential of this approach.

Zoo Scene Investigators

Zoo Scene Investigators (ZSI) is a game played on location at the Columbus Zoo. This location-based game is built on MIT's outdoor augmented reality platform. Augmented Reality (AR) games engage participants in activities that combine real-world experiences with additional information supplied to them by handheld computers. As students physically move about the physical space (e.g., a school campus, an outdoor plaza, a zoo, etc.), their location-aware handheld computers (e.g., Windows Mobile devices equipped with GPS) allow them to collect additional information by interviewing virtual characters, viewing rich media or accessing real or simulated data. Participants in AR games are often tasked with role-playing and collaboratively investigating a problem or issue in a game-like fashion. Players in this game (primarily middle school students) are equipped with location aware handheld computers through which they investigate a fictitious crime at the zoo. Through this investigation they learn about particular animals and the impact of the illegal wildlife trade. Players in the game must physically walk around the zoo in teams to collect the virtual information provided on their handhelds to apprehend the criminal and complete the game. This game demonstrates the means by which one can integrate games into informal learning environments such as museums, zoos and aquaria. It is also an example of games that integrate relevant, real world experiences with the virtual worlds of games.

Palmagotchi

The mobile game *Palmagotchi* (developed at the MIT Scheller Teacher Education Program) combines the ideas of virtual pets (such as the popular Tamagotchi toy) and the evolutionary story of Darwin's finches in the Galapagos Islands. Players maintain families of birds and islands of flowers. They monitor and feed birds in order to keep them alive. They also mate their birds with other players' birds in order to get offspring with desirable traits that maximize their chances of surviving various hazards in the game. The game is designed to be school-friendly so it is paced to require interactions every three to four hours so as not to disrupt classes, yet create some sense that the players must be vigilant to keep their organisms alive and well. Each interaction is designed to present the player with data that she can use to inform her decisions, though the only way that the player learns how this data maps on to success is through experience. In order to forage, a player looks across her current set of birds and decides which one needs to eat. After selecting that bird, she selects an island to visit. Once on that island, the player is presented with a list of flowers that she is able to "see" (only those flowers whose color is close to the bird's color preference). This game demonstrates novel ways of integrating games into schools without requiring games to be played at reserved times in computer labs. Instead games can be played casually anytime and anywhere.

Racing Academy

Racing Academy allows students to access accurate, real-time models of how cars work in the context of a racing game. Developed by FutureLab in the United Kingdom in combination with independent developer Lateral Visions, the UK Higher and Further Education Joint Information Services Council and the Department of Psychology at the University of Bath. Students build, maintain and race their vehicles, and in order to succeed they must monitor and analyze their cars' performances via data from various telemetry outputs. By participating in virtual communities of practice, students get to make complex decisions collaboratively, manipulating over 1000 parameters on their vehicles.

Ayiti: the Cost of Life

A creation of high school students in New York's Global Kids program and the developers at Gamelab, *Ayiti: the Cost of Life* is a strategy game that asks the question, "What is it like to live in poverty, struggling every day to stay healthy, keep out of debt, and get educated?" Set in rural Haiti, players must manage the lives of a family of five, struggling with minimal resources to achieve a stable, safe and healthy environment. The game is, as one might imagine, very difficult, but unlike some of the editorial games in the Persuasive Games movement, there are win states and a belief that no problem is unsolvable.

Gamestar Mechanic

Gamestar Mechanic, a collaboration between the University of Wisconsin-Madison and Gamelab, engages students in multi-modal thinking, engaging them in the concerns of technology, social concerns, artistic concerns and communication concerns. Set in a steampunk-world and designed with an anime flare, *Gamestar Mechanic* teaches students about game design by asking students to develop hypotheses for their designs, implement and test those designs while simultaneously describing and defending their designs to their teammates, becoming "socio-technical engineers." The *Gamestar Mechanic* team argues that by participating in and understanding the interactions of multiple complex systems, they are developing skills that are crucial for an increasing collaborative, networked, and high tech society.

Making History: The Calm and the Storm

Developed by Muzzy Lane Software, *Making History* teaches history, international relations, and political science to high school and college students. This multiplayer, turn-based strategy game feels similar to Civilization, except that it focuses on only 20 years surrounding World War II. Students take on the roles of the leaders of nations with historically interesting roles to play. Each student has a unique set of goals, leading to temporary alliances on certain issues. The game features four policy areas, including domestic, diplomatic, economic, and military policy. The original, self-published game was designed for use in classrooms, and each scenario can be played in 40 minutes or so. An updated version of the game was published by Strategy First for an entertainment market and sold through traditional retail channels.

Mind Rover: The Europa Project

MindRover was developed by CogniToy to help players learn to program. Specifically, players code artificial intelligence for robotic vehicles to help them navigate obstacle courses and overcome other challenges. The programming interface involves dragging logical pieces of the robots mechanics and setting a few parameters for each one. There are no lines of code. An updated version of the game allows players to export sets of instructions to actual robots, enabling real world competitions. The game encourages an exploratory approach to learning programming, helping players get programs running quickly so they can experiment and iterate.

Lure of the Labyrinth

Lure of the Labyrinth's target audience is middle school students, and its primary goal is the enhancement of pre-algebra math learning, with a secondary goal of improving literacy. It is a long-form puzzle adventure game played over many sessions, with a persistent narrative that evolves over time. In order to complete the game players must navigate complex mathematical spaces, and solve puzzles that embody the big ideas of mathematics. Playing on teams, students also have incentives to share their ideas about puzzle solving through an in-game message board, thereby bringing into the game space the kind of literacy activities usually reserved for game FAQs and interest groups. Teachers are encouraged to let students play the game in advance of encountering the same material in school, so that when the topic is introduced in the classroom students can demonstrate their hard-earned expertise, rather than meet each new subject as neophytes.

Opening Up Learning Games

With all of the many advantages and opportunities that learning games present, come a nearly equal number of barriers slowing or stopping their development and adoption. Overcoming these barriers will take a whole community. One way to create that community is through by making it "open". But the question remains in what way that "openness" needs to be manifest to create, grow and sustain that community.

Open is simultaneously an ideology, a practice, and a price (free). Each of these has implications for potential developers/contributors, end users, and the funders that make these initiatives possible. In this section we discuss some potential ways that *open* as a *practice* and as a *price* can help the learning games community, recognizing that each of these models (which are not all mutually exclusive) interprets and incorporates different aspects of *open*.

Open Standards and APIs

The ability to connect to applications and build upon them has become a crucial practice in building applications for entertainment and industry. Products such as *Facebook* have found that it is essential to have a community of people building applications that work within its framework. This strategy has worked well, with many community developed applications sustaining an even larger community of users. Game companies have been reluctant to even provide this level of openness. The closest parallels lie in the access that companies have provided to permit modifications (mods) of their games. This practice is most familiar in the genres of Role Playing Games (e.g. NeverWinterNights) and First Person Shooters (e.g. Quake III), where the game creators provide a set of tools for making new mods of the game, which include new characters, weapons and scenarios. There have been some big success stories with this approach, the most famous being Counterstrike, a mod of Half-Life, which ultimately was released as a separate product that outsold the original.

Pros and cons – This strategy is already embraced by some in the learning games movement, building educational games as mods of commercial games (the approach taken with *Revolution*, an extensive mod of NeverWinterNights). A more concerted effort that would facilitate creation of educational games specifically would likely be more successful. An API that would facilitate extension, not merely modification would make this approach even more powerful. But there are potential pitfalls here as well, including who would control and own the API, but more importantly an API needs to be built upon a product or multiple products. How those products would be paid for and sustained would need to be considered. One might assume that those products themselves could be open sourced and developed by a community, but that assumption has additional pitfalls (see below). A company could choose to give away an engine and charge for content or vice-versa.

Open Source Engines

This idea takes the engines built on open standards and APIs a step further by open sourcing the code to the game engine itself. This provides a low cost way to both develop and distribute educational games, avoiding (for the developer) the purchasing of engines that can be very costly, and further avoiding (for the end user) that cost being passed along to them. Open source products have been a remarkable success in particular success – the most famous of which is the Linux operating system, but also includes applications like the Firefox web browser. Several open source game engines already exist (e.g. Ogre), but their popularity has been limited, perhaps by the tradeoff between price and functionality/ease of use, which has suffered in many open source products.

Pros and cons – One may ask the question about why such a product (or products – game engines for different genres) don't already exist. Perhaps (like Firefox) they need a formal organization/foundation that can not only sponsor their initial development but sustain the community of developers and users. It may also be, from the commercial games industry perspective, that such an approach is unnecessary – that most of their development goes into assets and novel additions to game play that this approach would not help. But such an argument is not likely to come from the learning games community, where many developers would likely be happy to build on a solid set of shared features, concentrating on asset development, and content, contributing code when they are required to change the engine itself. However, unlike Linux, the end user community (teachers and learners) are unlikely to care about the product being based on an open source engine vs. something that is merely free (and closed source).

Open Content

Take the notion of *open* one step further, one can extend the openness from the engine to the game itself built on that engine, including its assets (characters, artwork, and other media). All developers and participants in such a

community contribute to its growth and sustainability by making it easier for others to enter and contribute to that community. For example, someone …

Pros and cons – While there have been some experiments in the creative arts in such a model, it is still quite untested. Open source cinema and free music have experimented in this space, but a reliable model has not been established. To many in the industry, the intellectual property ownership over their assets is what they see as the most economically viable option for making a living in this sector. It allows them to sell not only the primary product but a suite of related merchandise, from posters to T-shirts to toys. But others argue that this is an old fashioned model and that the right price of games is free (see Chris Anderson's forthcoming book, "FREE," for discussion on why everything will soon be free, but you'll have to pay nonetheless). With this perspective, companies locked into the idea of ownership over IP need to look to alternative business models and practices, for example selling software as a service, where you pay for hosted services, or paying for extras like training or support. Similarly, if the subscription is the primary source of revenue for a company, if others use that company's IP (really the community's IP under this model) to make merchandise that ultimately promotes the company's product than this is to the company's benefit.

Open Communities

Creating communities where ideas about successes, failures, technical achievements and conceptual breakthroughs are all shared can help reduce the financial and logistical burdens for all involved in the field. Such communities help not only in preventing a new initiative from repeating the failures of an old one, but also help to create connections that forge synergistic partnerships. For example, a developer with strong creative assets can partner with another partner with strong educational assets to produce better products.

Another role that community could play is that of community-sourced development. This development is not necessarily open sourced in the same way as that discussed above (though it could be), but the salient characteristic is that a large community of developers is producing products that are seen and reviewed by a similarly large community. The best products (which may ultimately emerge from partnerships formed through the community) rise to the top. These products may be open sourced or sold. The community itself is likely to be built on top of a tool or set of tools that is freely available, greatly reducing the startup costs.

Pros and cons – The idea of community is viscerally appealing. Community should benefit all of those involved. The challenges lie in starting up and sustaining that community, and preventing it from fragmenting into too many disparate pieces.

Community sourced development is also appealing, but not guaranteed to produce anything that is valued outside of the community itself. Such development likely needs a hand from outside.

Open Access

Open access means that the products that are produced are freely available to anyone. Like open content, there are few experiments in the creative industries to learn from. Multiple models from other industries exist, however, including providing completely open access (as is the case with some open publishing like The Public Library of Science and OpenCourseWare), or just access to a portion of the materials, requiring payment for other materials or perhaps support.

Pros and cons – In principle, open access is highly desirable, especially in a field like education where at least part of the goal is to level the playing field for all. The challenge comes in sustainability. There are big questions as to how development of new resources, and support of existing resources, is sustained without continued financial resources from the outside.

The Role of Foundations

There are a number of roles that foundations can play in this process (and need to play if learning games are to realize their potential for change).

Be Voices of Change- Clearly all of these challenges are too big to take on without broad support from communities, schools, and government. Foundations can help in spreading the word, and garnering additional support at all levels.

Create Communities – Help to create communities of varied partners that can help to solve some of these problems collectively and forge new partnerships.

Seed Infrastructure Development- Some of the above challenges require APIs, engines, or other technical infrastructure to build upon. While some of this exists already (in some stage of development) it may need to be improved, supported or created.

Create Examples – Funding small projects to Provide examples of both new creative/educational ideas, as well as new models of development/sustainability can go a long way (when shared with community).

Research New Models – There needs to be new research into models of development, marketing, and sustainability. The issues surrounding IP ownership in the creative communities needs to be better understood and new models that take into account the digital age need to be created.

Stepping Forward

This grand vision of the integration of gaming culture with school culture will require a tremendous effort on the part of all involved – schools, parents, academics, government agencies, non-profit agencies, gaming professionals, and others. Providing access for all students to the kind of playful, investigative, collaborative and well-supported education that we envision in this document will necessarily depend on school culture and gaming culture coming to a respectful, mutual understanding and comfortable integration. Certainly, teachers and schools will have to take brave risks to innovate, but the learning games community will need to meet schools, understanding the constraints on the system and individual teachers. This community must listen to schools' concerns and needs as well as observe unnoticed areas where it can help. This might include working to find the right way(s) to assess the hard and soft skills that students acquire through gaming so that leaders and innovators within schools have the right evidence to show their various governing and regulatory bodies. Teachers must have access to the training and support they require to feel safe taking risks in their classrooms. We must all learn the mistakes of the past and avoid repeating them. Finally, we must strive to push the boundaries of what games can be, in form and in function. As games move from being solely a technological tool to becoming a pervasive culture of play, we may yet unlock generations of curious, confident investigators and collaborators.

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Appendix A – Annotated Bibliography

High-Level Cognition Skills Strengthened by Video Games

Video games provide a practice space where players hone high-level cognitive skills like literacy, storytelling, collaboration, analysis, and leadership. These skills, while not always rewarded in standardized curricula, comprise a toolkit of 21st century competency that will serve students well whatever path they take and that employers increasingly emphasize in recruiting. Not surprisingly, these same skills provide the bedrock for effective civic participation in any democracy.

Collaboration

Case Study Game: *I Love Bees*

This alternate reality game attracted hundreds of thousands of players who collaborated to solve intricate and obscure puzzles under time and location constraints that made the game impossible for anyone to complete alone. The designers were overwhelmed by the collective intelligence of their players when the community solved all pre-existing challenges orders of magnitude more quickly than expected.

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Analysis

Case Study Game: *Civilization*

Some teachers and afterschool programs use Civilization as a gateway for inspiring interest in, and building understanding of, history among previously disengaged students. Students' analyses of historical events gained much more depth and nuance after playing Civilization, as they had experienced the interconnectedness of so many factors in determining history.

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Design Principles for Good Learning Games

Game designers have accumulated a set of principles over the years that help make great educational games. These principles include allowing for multiple styles of play, embedding the play and learning in meaningful contexts, helping players feel empowered and in control, and making the play social. Not all principles are appropriate for all styles of games, however designers would do well to consider each of them for their games. The best games incorporate most of these.

Play and Gender

At their inception, videogames were traditionally targeted at boys, but recently companies like Nintendo and Electronic Arts have succeeded in expanding the market by allowing for different styles of play. In fact, The Sims, a virtual dollhouse and life simulator and the world's best-selling PC game ever, has a predominantly female audience. Online, casual games have attracted large numbers of middle-aged women, as well.

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Player Freedoms

Four freedoms of play are fundamental to allowing people to interact with games when and how is right for them, optimizing their experiences. The freedom to experiment allows students to direct their own learning process in ways driven by curiosity, and it encourages them to come up with new and varied solutions rather than regurgitating the "right answer." The freedom to fail eliminates the penalty for making mistakes that most schools impose. The fear of failure shuts down the brain's ability to think creatively. The freedom to try on identities gives players a

chance to view themselves in ways they usually don't. Without this freedom, students can't let go of destructive identities or effectively build identities of mastery. The freedom of effort allows players to do their best when they are most motivated to do so and to take it easy during the other times, maximizing engagement and preventing the resentment of feeling forced.

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Considerations for Formal/Informal Educational Structures

Educational games can exist both in and out of school, and can be surrounded by formal and informal structures. In general, designers can't assume that teachers will figure out how best to use an educational game as a teaching tool. Therefore, teacher training and support materials should always be provided. These materials and the design of the game should take into account classroom constraints. When these constraints are too onerous, the game should target an out of school audience. Finally, the game should clearly state, at least for the teacher, which knowledge or understanding it's trying to impart, and be transparent about its assumptions. This helps teachers and players focus their inquiry on those aspects of the game that were designed to be probed.

Teacher Training

Game designers should encourage teachers to solicit training from their students. The students who are playing the games will be expert at the rules and content in those games. By encouraging students to educate their teachers, they have opportunities to demonstrate expertise to themselves, their classmates, and their teachers.

- Becker, K. (2007). Digital game-based learning once removed: Teaching teachers. *British Journal of Educational Technology, 38*(3), pp. 478-488.
- NESTA Futurelab Teaching With [COTS] Games Guidelines for Teachers from http://www.futurelab.org.uk/resources/documents/project_reports/teaching_with_games/Guidance_for_Educators.pdf
- Fishman, B., Marx, R., Best, S., & Tal, R. (2003). Linking teacher and student learning to improve professional development in systemic reform. *Teaching and Teacher Education, 19*(6), 643-658.
- Fogleman, J., Fishman, B., & Krajcik, J. (2006). Sustaining innovations through lead teacher learning: A Learning Sciences perspective on supporting professional development. *Teaching Education, 17*(2), 181-194.
- Brunvand, S., Fishman, B., & Marx, R. (2005). Moving professional development online: Meeting the needs and expectations of all teachers. In J. R. Dangel & E. M. Guyton (Eds.), Research on alternative and non-traditional education: Teacher education yearbook XIII (pp. 205-232). Oxford, UK: Scarecrow Education.
- Fishman, B. (2006). It's not about the technology. Teachers College Record. Retrieved July 6th, 2006 from http://www.tcrecord.org.

Managing Classroom Constraints

Games designed for use in classrooms should have short play sessions to leave time for set up and discussion. They should have low technical requirements, and avoid potentially offensive content. Educational games designed for use outside of classrooms can avoid some or all of these constraints.

- Tüzün, H. (2007). Blending video games with learning: Issues and challenges with classroom implementations in the Turkish context. Case study of video game use in turkish classrooms, *British Journal of Educational Technology*, *38*(3), 465-477.
- NESTA Futurelab Teaching With [COTS] Games Final Report – http://www.futurelab.org.uk/resources/documents/project_reports/teaching_with_games/TWG_report.pdf
- Egenfelt-Nielson. (2005). *Beyond Edutainment: Exploring the Educational Potential of Computer Games*

Simulation Fidelity and "Right" Answers

Simulation games are best for helping students see connections between different influences in an integrated system. These games should be used to help students learn to ask the good questions, rather than memorizing facts or even relationships. A good simulation will have a transparent model that invites reflection and critique.

- Sicart, M. (2005). *The Ethics of Computer Game Design. Changing Views: Worlds in Play*.
- Schut, K.. (2007). Strategic simulations and our past: The bias of computer games in the presentation of history, *Games and Culture, 2*(3), 213-235.
- Gobert, J.D., Pallant, A., (2004). Fostering students' epistemologies of models via authentic model- based tasks. *Journal of Science Education and Technology. 13*(1), 7-22. (invited paper).

Evaluation, Assessment and Standards

When educational games are embedded in a classroom context, teachers will need to evaluate how well the students play the games and whether they've gotten enough out of that experience. This evaluation generally won't make sense using traditional testing models. Teachers should consider qualitative methods like essays, presentations, and portfolios. These methods allow students to demonstrate learning outcomes that would not show up on a standardized exam. Finally, many games are inherently collaborative, so teachers may need to revisit their policies on cheating and plagiarism.

- Gee, J.P. (2004). *Situated Language And Learning: A Critique of Traditional Schooling*. New York, NY. Routledge.
- Pink, D. (2006). *A Whole New Mind: Moving from the Information Age to the Conceptual Age*. New York, NY. Riverhead Books.
- Chen, S. (2005). Proof of learning: Assessment in serious games. *Gamasutra*. http://www.gamasutra.com/features/20051019/chen_01.shtml
- Loveless [NESTA] (2007). Creativity, Technology & Learning. http://www.futurelab.org.uk/resources/documents/lit_reviews/Creativity_Review_update.pdf
- Barb & Squire, K. (2004). Design Based Research: Putting a Stake in the Ground [Electronic Version]. *The Journal of the Learning Sciences, 13*(1), 1–14. http://inkido.indiana.edu/research/onlinemanu/papers/dbr-jls.pdf
- Tinker, R. (2007). *Potholes in the Road to Proving Technology*. The Concord Consortium. http://www.concord.org/publications/newsletter/2007-spring/perspective.html

Technological Considerations

When creating a learning game, the technology should suit the purpose. 2D technologies are often more approachable by non-gamers, and will run better on a wide range of computers. 3D technologies can feel more like a game and sometimes have benefits when the fidelity of the experience is more important than cost. Mobile technology is advancing quickly and provides the potential of creating experiences that span time and space in ways that computer games can't (like augmented reality).

2D Gaming

Flash is currently the heavyweight in 2D web game technology. In addition to its low technical requirements, it has been almost universally adopted by people with Internet access.

Open or Cheap Technologies

- Flash/Flex
- AJAX
- Torque 2D

Relevant Articles

- NYT (2007). *Doll Web Sites Drive Girls to Stay Home and Play*. The Raph Koster Website. http://www.raphkoster.com/2007/06/06/nyt-looks-at-kids-worlds-again/
- Shade & Grimes. (2003) *Neopian Economics of Play: Children's Cyberpets and Online Communities as Immersive Advertising in NeoPets.com*. http://artsandscience1.concordia.ca/comm/shade/word/neopets_oii.pdf
- Purushotma, R. (2006). *Play in Social Media*. From http://www.lingualgamers.com/thesis/play_blogs.html.
- Hawn, C. (2007). Time to play, money to spend. *CNN*. March 23, 2007. From http://money.cnn.com/magazines/business2/business2_archive/2007/04/01/8403359/index.htm?postversion=2007032305. Accessed 07/01/2008
- Unknown Author. (2005) *E-Society: My World Is Cyworld*. Bisinessweek Sept. 26, 2005. http://www.businessweek.com/magazine/content/05_39/b3952405.htm
- Jen S., (2005). *Whyville*. Education Arcade Conference: Gender in Games

3D Gaming

The following game platforms and engines are good tools for creating any kind of 3D game without programming them entirely from scratch. The ones labeled platforms tend to have an easier entry point for technical novices, where the ones labeled engines generally require deep technical understanding. The engines give more flexibility than the platforms in defining what the game will look and feel like.

Platforms – Less "Educationy"

- Darkstar
- Multiverse
- Second Life

Platforms – More "Educationy"

- Activeworlds
- Croquet
- Thinking Worlds – http://www.thinkingworlds.com

Engines – Open Source

- OGRE – http://www.ogre3d.org
- Panda 3D – http://www.panda3d.org
- IRR LICHT – http://irrlicht.sourceforge.net
- The Nebula Device 2 – http://nebuladevice.cubik.org

- Sauerbraten – http://sauerbraten.org
- jME – http://www.jmonkeyengine.com
- OpenSceneGraph – http://www.openscenegraph.com/index.php
- Quake III – http://www.idsoftware.com/business/techdownloads
- Delta 3D – http://www.delta3d.org
- Reality Factory – http://www.realityfactory.info
- Crystal Space 3D – http://www.crystalspace3d.org/main/Main_Page
- Yake – http://www.yake.org
- RealmForge GDK – http://sourceforge.net/projects/realmforge
- G3D – http://g3d-cpp.sourceforge.net
- Genesis 3D – http://www.genesis3d.com/index.php
- Second Life Viewer – http://secondlife.com/developers/opensource
- Blender Game Engine – http://www.blender.org

Engines/Toolkits – Cheap

- Torque Game Engine (3D) – http://www.garagegames.com/products/1
- Dark Basic Professional – http://darkbasicpro.thegamecreators.com
- Blitz Basic – http://www.blitzbasic.com/Home/_index_.php
- Unity – http://unity3d.com/index.html
- TV3D SDK 6 – http://www.truevision3d.com/phpBB2/index.php
- 3DGameStudio – http://www.3dgamestudio.com
- C4 Engine – http://www.terathon.com/c4engine/index.php
- 3Impact – http://www.3impact.com
- Cipher – http://www.cipherengine.com
- Beyond Virtual – http://www.beyondvirtual.com/2007
- Deep Creator – http://www.righthemisphere.com/products/dcreator/index.html

Mobile

Mobile technology is changing fast. Here are a few of the most predominant, both now and on the horizon: C#, BREW, WAP, J2ME, Flash Lite, Palm OS, Windows Mobile, iPhone, and Android. Some handsets have wireless connections through cellular networks, and others have WiFi. GPS is becoming more common. The result is that mobile platforms are getting more connected, more powerful, and more open. MIT's Teacher Education Program has developed a toolkit for educators looking to begin mobile game creation without bothering with all of the underlying

technologies.

Relevant Articles

- Ha, I., Yoon, Y., Choi, M. (2007). Determinants of adoption of mobile games under mobile broadband wireless access environment. *Information and Management*, *44*(3), 276-286.
- Zyda, M., Thukral, D., Jakatdar, S., Engelsma, J., Ferrans, J., Hans, M., Shi, L., Kitson, F., Vasudevan, V. (2007). Educating the next generation of mobile game developers. *IEEE Computer Graphics and Applications*, *27*(2).
- Hjorth, L.. (2006). Playing at being mobile: Gaming and cute culture in South Korea. *Fibreculture*, *8*(10).
- Ito, M. (2005). Mobilizing fun in the production and consumption of children's software. *Annals of the American Academy of Political and Social Science*, *597*. 82-102.
- Schwabe, G., Goth, C. (2005). Mobile learning with a mobile game: design and motivational effects. *Journal of Computer Assisted Learning*, *21*(3), 204-216.
- Future of Games: Mobile Gaming – Justin Hall – Handbook of Computer Game Studies
- *Anything that comes out of the Nintendo sponsored*. Handheld learning conference. http://joystick101.org/blog/?p=247
- Klopfer, E. (2007). Lightly augmented reality: Learning through authentic augmented reality games. http://www.spacetimeplay.org/stp_table.pdf

Examples

- MIT Scheller Teacher Education Program Augmented Reality: http://education.mit.edu/drupal/ar
- Nesta Futurelab Augmented Reality: http://www.futurelab.org.uk/
- Kanji Sonomama: http://www.amazon.com/Kanji-Dictionary-Sonomama-Rakubiki-Jiten/dp/B000O2S9VQ

Tools

- Christoph, I., Johann, F., Markus, R. (2005). The GameCreator: Self-Created Mobile Games on the Internet. Changing Views: Worlds in Play. June 2005.

Market Considerations

Distribution Difficulties – Commercial Channels

The traditional distribution channels for commercial games, like Wal-Mart and Best Buy, have so far not favored educational games that are frequently made with smaller budgets. Some games, however, have managed to sell directly into schools as well as through retail channels.

- The Business of Making Digital Games – Aphra Kerr – in Understanding Digital Games
- Economics of Digital Games – Alberto Alvisi – in Understanding Digital Games

- Castronova, E., Synthetic Worlds: The Business and Culture of Online Games. University Of Chicago Press, 2005.
- Buckingham, David & Scanlon, Margaret (2005). Selling Learning Towards a Political Economy of Edutainment Media
- Heather C. (2005). "Will Wright and the Model of Everything," Smartbomb: The Quest for Art, Entertainment and Big Bucks in the Videogame Revolution.

Distribution Difficulties – Education Channels

Game developers and publishers that target schools have a direct way of reaching their target market, but have to contend with small budgets and outdated technology. Frequently, these developers do better by distributing their games through the web, reaching both schools and independent learners.

Stakeholders Fear Change

- Becker K., & Jacobsen D. M. (2005). Games for learning: Are schools ready for what's to come? *Changing Views: Worlds in Play*.
- Federation of American Scientists. (2006). *Harnessing the Power of Video Games for Learning*. http://www.fas.org/gamesummit/Resources/Summit%20on%20Educational%20Games.pdf

Inconsistent Infrastructure

Educational game developers also have to contend with in equities in technological distribution throughout their target market. Particularly, schools in urban and rural settings frequently have fewer resources than suburban schools. And rural schools often have little or no Internet access.

- Tüzün, H., (2007). "Blending video games with learning: Issues and challenges with classroom implementations in the Turkish context: Case Study of Video Game Use in Turkish Classroom", *British Journal of Educational Technology*, *38*(3), 465-477.

Negative Perceptions

The negative perception that games are at best a waste of time and at worst corrosive has limited the potential of learning games for years. Non-gamers in particular have high fears about game addiction and desensitization to, or instigation of, violence. While violence is still common in games targeted at boys and men, new models of play targeted at wider audiences are changing this. Still, it will likely take some time for game stereotypes to catch up with the state-of-the-art.

Addiction

- Simkins, David, Yee, N., Kuo, J., Wilkins, J., & Huang, W. (2006). Motivation & Addiction Games Learning and Society panel. http://www.mediasite.com/presentation.aspx?p=16698.

- Charlton, J.P., Danforth, I.D.W. (2007). Distinguishing addiction and high engagement in the context of online game playing", *Computers in Human Behavior*, 23(3), 1531-1548.

Violence

- Bryce, J., & Rutter, J. Digital Games and the Violence Debate**.** *Understanding Digital Games*.
- Buckingham, D. *Will Media Education Ever Escape the Effects Debate?* http://www.amlainfo.org/home/conferences-and-events/nmec-2005/buckingham-2.pdf
- Gauntlett. (1998). Ten Things Wrong with Media 'effects' Model. http://www.theory.org.uk/david/effects.htm
- Jones, G. (2003). *Killing Monsters: Why Children Need Fantasy, Superheroes, and Make-Believe Violence*. New York: Basic.
- Unsworth, G., Devilly, G. J., & Ward, T. (2007). The effects of playing violent video games on adolescents: Should parents be quaking in their boots?. *Psychology, Crime, & Law*, *13*, 383-394. Classic Psychometric Paradigm study that failed to find any increase in aggression after playing Quake