

Running Head: COMPUTER GAMES

Computer Games in the Classroom: A History and Brief Review of the Research

John W. Rice

Texas Center for Educational Technology

University of North Texas

Paper presented at emPowering the Future, Texas Center for Educational Technology Higher

Education Cadres Conference, Denton, TX.

Abstract

Computer video games are derived from a broad range of related fields, including virtual reality, simulations, and synchronous computerized communications. This paper will examine origins of each field and how they converged in the study of computer video games. The paper will then offer a brief review of the research illustrating the investigation of computer video game applications in the field of education, and conclude by finding areas of need for current and future research.

Computer Games in the Classroom: A History and Brief Review of the Research

Computer video games as defined here are games played out graphically within a computing environment. They share characteristics with home console games. Consoles are technically also types of computers, but most people differentiate games designed for personal computers as computer video games. Consoles will be mentioned briefly in the history section as they are a related topic. Interest in applying computer video games to educational purposes has piqued in recent years as the abilities for games to simulate complex phenomena has increased along with personal computing power. The purpose of this paper is to illustrate the developmental history of computer video games, briefly look at some of the current research efforts in the field, and to discern fundamental questions remaining to be explored.

History

Ideas about Information

All computer concepts, including games, are based on earlier ones surrounding information retrieval and manipulation. Notions of information residing in an abstract space for the purpose of future retrieval derive from the ancient Greek poet Simonides, the first to develop “memory palaces,” or mental knowledge maps resembling physical structures (Johnson, 1997). The idea that a physical machine could produce an infinite amount of information based upon finite input was theorized (with a failed attempt at implementation) by Charles Babbage in the 19th Century. His machines were conceived as advanced computational devices. Babbage stated he could tap the infinite measure of time within a finite mechanism in order to solve any number of problems (Gershenfeld, 1999). This idea is a key one, and proved fundamental in the development of digital computing, and later complex computer games.

The modern example of an information retrieval device most researchers point to as seminal is found in an essay published near the conclusion of World War II by Vannevar Bush (Shenk, 1997). Bush outlined a device he called the “Memex” which could sort through reams of electronic text (microfilm, as Bush envisioned it at the time). Foreshadowing hypertext, Bush stipulated his machine, built into a desk, could allow researchers unprecedented access to the world’s libraries and let them keep permanent records of their searches (Bush, 1945).

Video Games

The first documented mating of computers to electronic graphical output for the purpose of playing a game occurred in 1958 at Brookhaven National Laboratory. A facility devoted to peaceful applications of nuclear energy, Brookhaven held open house events every year allowing public tours of the facilities. Using spare parts, a government physicist named Higinbotham hooked up an oscilloscope to one of the lab’s computers, and programmed a simple ball-bouncing tennis simulation. Players watched the four-inch round screen while using two paddlewheels to control the ball, simulating a tennis match viewed from the side at mid-court. The simple diversion proved very popular at two Brookhaven open house events in 1958 and 1959. Reasoning that his simple game was made with existing technology, Higinbotham never bothered to patent the idea (from a personal profit perspective, the U.S. government would have held the patent anyway, as Higinbotham was a government employee at the time). In Higinbotham’s mistaken opinion, the idea was too obvious to be profitable (Flatow, 1992).

The Digital Equipment Corporation (DEC) PDP-1 computer offered a cathode-ray screen. In 1961, Massachusetts Institute of Technology (MIT) received a model. A programming team led by Steve Russell at MIT then coded what many consider to be the first graphical computer game, Spacewar, in 1962. At least it was the first widely disseminated graphical computer game.

Soon spreading to other campuses and corporations with access to the DEC PDP-1, Spacewar became a worldwide phenomenon (Juul, 1999).

Widespread commercial exploitation of video games waited until a few years after the first patent was filed in 1964 by Sanders Associates, a maker of television add-on products. The idea was to avoid expensive mainframe computers and provide home users a simple box that could display graphical gaming elements on a television set. Magnavox purchased the rights to the patent and released the Odyssey, the first home video gaming console, in 1972. Nolan Bushnell attended an early product demonstration in 1971. While the Odyssey system offered several different games, Bushnell was most interested in the electronic Ping-Pong game. In 1972, Bushnell founded the Atari Corporation, and commissioned a coin arcade version of video Ping-Pong called PONG (Winters, 2004). Later, PONG was sold to the home market. In defending its patent, Magnavox asserted it applied to all video games, and the legal wrangling with Atari and other companies persisted into the 1980s, often drawing Higinbotham into the fray (Flatow, 1992).

Virtual Reality

The nascent field of Virtual Reality (VR) saw pioneering efforts in Ivan Sutherland's "Sword of Damocles" device. Sutherland's efforts in the mid- to late 1960s produced a device incorporating an early head-mounted display system that predated effective computer graphics technology. After abandoning the device due to technical limitations, Sutherland went on to develop many of the foundational algorithms for computer graphics (McLellan, 1996).

The MIT Media Lab remains at the forefront of research in VR and educational gaming. The Media Lab holds a rare position in academia as a degree granting, research managing organization not housed within a specific department at MIT (Gershenfeld, 1999). A seminal

effort researchers consider an early indication of visual representation of data and its pedagogical potential came out of the Media Lab in the 1970s. The Aspen Movie Map was a multi-angled, pictorial recording of the streets of Aspen, Colorado. Placed on video disc, it allowed users to virtually travel the photographed city, choosing divergent paths at will. Media Lab researchers used the project as a platform for investigating virtual education and spatial learning (Mohl, 1981).

Simulations

Computer simulation game technology rests on the convergence of mechanical simulations with graphical technologies first visualized in the 1940s and fully realized in the 1960s. Martin Heilig's Sensorama machine, ca. 1961, is often considered the best early example of a mechanical simulator incorporating video VR (McLellan, 1996). Much of the research and development money since then has been focused on military simulations. Modern computer-based warfare simulations derive from real world simulations that can be traced to ancient warfare training efforts. The ancient board game of chess may be considered an extremely abstract simulation of warfare (Martinson, 2001). With the increased complexity of mechanical devices appearing in the 20th Century, combat simulations became increasingly mechanical as well. Airplanes were among the first devices to be mechanically simulated in the 1920s. The idea of simulating flight for training purposes was adapted to considerably more advanced trainers in the 1960s, culminating in lunar landing simulators developed by General Electric for the Apollo missions (McLellan, 1996).

Prensky (2001) states the Army asked Bushnell's Atari Corporation to modify Tank Commander for military purposes as early as 1978. As computer power progressed in the 1990s, the U.S. military became increasingly interested in commercial versions of computerized war

simulators which had become highly popular. The first person shooter (FPS), where players are involved in gun battle simulations, proved intriguing to the military due to reliance on teamwork and battle strategies. In 1995, due to budget considerations, the Marines began considering the adoption of modified versions of Doom II and other FPSs to supplement field training (Riddell, 1997). Eventually, the military began commissioning highly detailed simulations coded to military specifications. While commercial products may cost a few hundred thousand dollars and be developed successfully within 18 months, full blown military productions often require much more time and expense. The Joint Warfare System (JWARS) is estimated to have cost the Defense Department up to \$60 million (Peck, 2003), and is considerably more complicated than a typical commercial game.

Presently, as in 1995, commercial simulators available to the public are occasionally used by the military for training exercises considered less crucial than exercises handled by in-house programs (Peck, 2003). Although commercial war simulators are less costly and time consuming to develop, they may not offer players access to combat variables considered classified. On the other hand, some military applications have been released to acclaim and success, although government funding prevents profit-taking. America's Army, an FPS released by the military to the gaming public for free, has proven to be a successful recruitment tool (Peck, 2003). The U.S. military continues to successfully use computer games and simulations in training across all the services (Prensky, 2001).

MUDs and Cyber Interaction

One of the more influential early computer games of the 1970s was Colossal Cave, designed by Willie Crowther. Modeled after the popular paper game of Dungeons & Dragons, players used text navigation and a healthy dose of imagination to explore a cave, conquering

monsters and collecting treasure along the way. Shortly after the game's release and dissemination in 1976, Stanford graduate student Don Woods modified the game extensively and re-released it as Adventure. Woods' ideas were further improved by students at MIT, eventually resulting in a highly successful commercial game called Zork (King & Borland, 2003).

Having established the fun element of interacting with text-based computer games, it was a simple step for programmers to extend the interaction to the online world. In Britain, Essex University students Roy Trubshaw and Richard Bartle created the concept of Multi-User Dungeons, or MUDs. These were early attempts to engage multiple players simultaneously in text-based adventures similar to Zork, and are the ancestral components of all massively multiplayer online role playing games (MMORPGs) (King & Borland, 2003). MMORPGs today have outgrown their simple text-based beginnings. Graphically complex, and capable of supporting thousands of players simultaneously, their corporate owners often charge millions of users monthly fees to continue accessing online characters in persistent artificial worlds. The large sums of monthly fees from MMORPGs contribute to the billions earned annually by the video gaming industry (NASA, 2004).

Three Elements Converge

Three main elements converged to create modern interactive computer gaming environments currently considered state-of-the-art: computing power sufficient to graphically represent increasingly realistic three-dimensional virtual environments; a desire to sufficiently simulate a variety of real-world scenarios, particularly military ones; and the burgeoning field of Internet-based communications.

Research

Games have traditionally been dismissed by scholars, with an occasional exception from the likes of anthropologist Stewart Holmes, who released a seminal 800 page treatise on the games of North American Indians in 1903 (Juul, 2001). In the 1950s to 1970s, American teachers experimented with several educational paradigms and techniques, including the use of games within the classroom for pedagogical purposes. The basic skills movement resulted in the withering of these efforts, however, and effectively stymied widespread exploration of the use of games within classrooms (Gredler, 1996). Once personal computers became commonplace in the 1980s, and as computer power increased, so did the complexity of computer games. With this complexity and the widespread success of commercial titles, teachers have increasingly become interested in harnessing their power for teaching (Squire & Jenkins, 2003). Likewise, social scientists have determined that complex computer games are a phenomenon worthy of research (Juul, 2001).

Computer games have the capability to provide widespread enjoyment for users. Consequently, researchers feel learning opportunities may take place within the gaming environment somehow. Squire and Jenkins (2003) point to the educational cartoon films funded by Bell Laboratories in the late 1950s and early 1960s that were sparked in part by increased national science and math interest following the successful launch of *Sputnik*. Bell Lab's efforts of fusing school knowledge with an entertaining (though passive) medium were highly successful. It is widely believed that much more learning can take place within active environments such as computer games (Squire & Jenkins, 2003).

Researchers within the field of VR focus on the manifestation of artificial environments, in which it is hoped participants will suspend their disbelief. VR researchers suspect artificial

environments will likely never completely displace reality for this purpose (McLellan, 1996). However, computer game developers realize far less than total immersion can provide a level of realism that allows participants to easily suspend their disbelief and become heavily engaged, just as plays and books using minimum technology have done through the millennia (Laurel, 1991). Many successful commercial games are deliberately designed with simple interfaces, which nonetheless allow complex interactions within the games. Players do not demand completely realistic simulations in order to engage in (and learn from) a game (Manninen, 2003). Therefore, for instance, virtual tanks may be controlled with a keyboard and mouse rather than a realistic tank control panel, but players will not mind and will nonetheless remain engaged as they “drive” their tanks across virtual battlefields.

The question of how computer gaming might affect students’ preparation for standardized testing has focused on the digitization of traditional worksheets and their inclusion within software products. Deubel (2002) offered one of the better treatises on assessment of software products purporting to assist students in pursuit of increased scores on standardized tests, including games as a subset. She addressed several questions teachers should ask when assessing software for test assistance purposes, and offered considerations for teachers to weigh such as potential for modifications, curriculum alignment, and electronic tracking of progress.

Empirically demonstrating benefits of placing worksheet problems in a game, Lee, Luchini, Michael, Norris, and Soloway (2004) designed a Game Boy application for math problems and presented it to second graders who proceeded to exhibit greater work-through than the control group using traditional paper worksheets. Although Game Boy applications are not traditional computer-based products, research such as Lee and colleagues’ indicates worksheet

digitization results in higher engagement, at least initially, than traditional approaches for lower-level learning.

As games have progressed in graphical and computing complexity, the need for assessment of classroom appropriateness continues. High end commercial games have peeled away from lower level problem solving into advanced efforts featuring games requiring hours of higher level thinking in order to successfully progress through their artificial worlds (Gee, 2003a). Recent efforts have sought to quantify levels of higher order thinking within computer games, offering teachers basic guidelines in helping recognize cognitive impressions that games introduced to the classroom may have on students (Rice, 2005).

Interest and attention continues in regard to the links computer role playing games (RPGs) and other complex computer games might have with higher learning. Academics have pointed out that students are learning plenty of things not normally taught within schools when they play advanced computer games. Gee (2003b) notes that most successful computer games use the competence principle, wherein players are encouraged to master game play that consistently approaches their current level of competence within the game, and the expertise principle, where players are encouraged to completely master a level before moving up to the next. While these two components of cognitive science are foundational within popular games, Gee stipulates they are often found missing within traditional school pedagogy. Gee expanded more on his ideas in what some consider to be the first successful academic book in the field: *What Video Games Have to Teach us About Learning and Literacy* (Foreman, 2004).

One of the hindrances to game research has been the disconnect social scientists have in studying the mundane, especially within their own cultures. Thus, early research on games focused on those of other cultures (Juul, 2001). An additional perceived difficulty in the field of

computer game research is the advancement of technology, along with a dynamic marketplace, making it difficult for researchers to pin down specifics on one platform or game before a new one is introduced. Mortensen (2002) studied the online MUD Dragon Realm, a text-based environment that operated in the 1990s. Dragon Realm closed in 1999 following a general transition of public taste (along with computing advancements and the rise of high speed Internet connections) to graphics-based MMORPGs, instantly rendering much of her work on purely text-based interactive fiction somewhat dated, at least by gaming standards.

Cultural studies and critiques of computer gaming have mostly ignored studying the games themselves (Squire, 2002). Many studies that have been made were centered on more salacious elements of computer games such as violence. Efforts to study how gaming affects violent behavior have suffered from a lack of strong research, however. Among the host of problems researchers face include an inability to identify identical variables to use on different types of games. Games classified violent may require one type of interaction (and corresponding coding for the data) while games classified non-violent may have another (Squire, 2002).

Several research efforts have focused heavily on the narrative elements of computer games. Narratives may be defined as the mental constructs users create when engaged in a game based on indicators provided by the developers (Ryan, 2001). Games set in the future may have space-based narratives while games set in dungeons may have medieval-based narratives. Narrative elements are something social scientists easily recognize, and published papers reflect this fact (Ryan, 2001). For justification to pursue this line of inquiry, researchers often cite Don's chapter in Laurel's *The Art of Human-Computer Interface Design*. Don (1990), stated that computers may act as storytellers once did in oral cultures. Laurel (1991) herself is also often cited for the sake of VR or game simulations not needing to be complex in order to be engaging.

Ultimately, the largest concern faced by educators is that complex computer video games providing environments most interesting to users are usually not set up to teach factual elements more efficiently transmitted through lectures and books (i.e., traditional school learning). Factual elements are often the focus within standardized, high stakes tests. Complex computer video games are perhaps best suited for teaching teamwork and advanced problem solving (Gee, 2003a), things which are not as highly emphasized in many school environs.

Some of the best efforts so far at designing complex environments for educational purposes have come out of MIT Media Lab's Games-to-Teach Project, an initiative funded in part by Microsoft Corporation. The Media Lab created *Revolution*, an advanced RPG for students that places them in a colonial town during the American Revolution. Game rounds in this complex simulation can be completed in about 40 minutes, an ideal time for classroom assignments. Students take the roles of village residents and learn what it was like to live during the American Revolution at the grassroots level (Squire & Jenkins, 2003).

The National Science Foundation (NSF) funded two high profile computer video gaming projects to explore the efficacies of educationally appropriate complex video games. The *Quest Atlantis Project* at the Center for Research on Learning and Technology at Indiana University explored using popular facets found in MMORPGs within an educational game. Students login to the world, explore with their avatars, and complete quests as they advance through the game toward Atlantis. Each area the students encounter have different quests, the solving of which results in the meeting of prescribed standards. Students complete the quests online and off, under adult supervision at partnering learning centers (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2002).

The Museum-Related Multimedia and Virtual Environments for Teaching and Learning Science at Harvard Graduate School of Education was another NSF-funded project. In partnership with the Smithsonian's National Museum of American History (NMAH) and other partners, this project developed a multi-user virtual environment experiential simulator (MUVEES) containing a virtual town set in America's past. Students explore virtual recreations of artifacts culled from NMAH archives and set about determining sources of river pollution in the town, all the while using critical knowledge and problem solving skills (Dede, Ketelhut & Ruess, 2003). MUVEES continue to be an investigative resource for exploring the experiential nature of high powered video gaming in education (Dede, Ketelhut, Nelson, Clark, & Bowman, 2004).

Additional pursuits in the field are ongoing at organizations like the Serious Games Initiative (<http://www.seriousgames.org>), which seeks to build links between the education community and the gaming industry. The initiative offers the competitive Serious Games Summit, an opportunity to showcase educational products. Past entries have included efforts like Virtual U., a college administration simulator. The Digital Games Research Association (<http://www.digra.org>), an entity providing education-industry partnerships, offers collaboration and communication opportunities. The Education Arcade (<http://www.educationarcade.org>) is an outgrowth of MIT's Games-to-Teach project, serves as a coalition between industry interests and educators, and encourages online collaboration. At least two journals are focusing heavily on computer video games: Game Studies (<http://www.gamestudies.org>), and the British-based International Journal of Intelligent Games and Simulation (<http://www.scit.wlv.ac.uk/~cm1822/ijjgs11.htm>).

Conclusion

The entertainment, military, medical, and industrial fields are not waiting for educators to research computer games and their potential for pedagogy, but are instead forging ahead in the development of increasingly complex educational games and simulations. Among the key questions facing educators: Do we want to incorporate the pedagogical powers of complex computer games in the classroom, and if so, how? The learning occurring in these games often is not directly addressed in standardized tests. Simple computer games promoting the use of digitized worksheets do hold potential for encouraging student practice, at least initially. The true power of complex computer video games, however, is demonstrated in the fact that one game may take anywhere from 50 to 100 hours to complete. MMORPGs may continue perpetually. During their time in the game, successful users will typically engage in higher order learning and integrate a host of newfound skills.

Should educators seek to harness these computer game learning processes for their own purposes? Will the introduction of complex educational computer games such as Revolution result in lower enthusiasm for students in traditional classrooms? How can educators and game designers take the best portions of current computer video games, such as complex three-dimensional VR environments, extensive story lines, and the online communication and collaboration capabilities found in MMORPGs, and turn these to educational advantages that can be quantitatively assessed on standardized tests? Should complex computer games be relegated for experiential purposes only, bringing students to deeper understandings of a few focused concepts? These are some of the questions educational researchers face as we move forward with computer gaming advances, a continuous stream of product developments, and an ever growing

potential for higher learning to take place within complex educational computer gaming environments.

References

- Barab, S., Thomas, M., Dodge, T., Goodrich, T., Carteaux, B., & Tuzun, H. (2002). Empowerment design work: Building participant structures that transform. In P. Bell, R. Stevens, & T. Satwicz (Eds.), *Keeping Learning Complex: The Proceedings of the Fifth International Conference of the Learning Sciences (ICLS)*, (pp.132-138). Mahwah , NJ: Lawrence Erlbaum Associates.
- Bush, V. (1945). *As we may think*. Retrieved November 14, 2004 from <http://www.ps.uni-sb.de/~duchier/pub/vbush/vbush-all.shtml>
- Dede, C., Ketelhut, D., & Ruess, K. (2003). *Designing for motivation and usability in a museum-based multi-user virtual environment*. [Online]. Retrieved April 15, 2005 from Harvard University, Graduate School of Education Web site: <http://muve.gse.harvard.edu/muvees2003/documents/AELppr.pdf>
- Dede, C., Ketelhut, D., Nelson, B., Clarke, J. & Bowman, C. (2004). Design-based research strategies for studying situated learning in a multi-user virtual environment. *Proceedings of the 2004 International Conference on Learning Sciences*. [Online]. Retrieved April 15, 2005 from Harvard University, Graduate School of Education Web site: <http://muve.gse.harvard.edu/muvees2003/documents/dedeICLS04.pdf>
- Deubel, P. (2002, February). Selecting curriculum-based software: Valuable educational software can help students rise to the challenge of standardized testing and assessment. *Learning and Leading with Technology*, 29(5). 10-16.
- Don, A. (1990). Narrative and the interface. In Brenda Laurel (Ed.) *The Art of Computer Interface* (pp. 383-391). Redding, MA: Addison Wesley.

- Flatow, I. (1992). *They all laughed ... From light bulbs to lasers: The fascinating stories behind the great inventions that have changed our lives*. New York: HarperCollins.
- Foreman, J. (2004). Video game studies and the emerging instructional revolution. *Innovate* 1(1). Retrieved November 18, 2004 from <http://innovateonline.info/index.php?view=article&id=2>
- Gee, J. P. (2003). *What Video Games Have To Teach Us About Learning And Literacy*. New York: Palgrave Macmillan.
- Gee, J. P. (2003, May). High score education: Games, not school, are teaching kids to think [Electronic version]. *Wired*, 11(05). Retrieved November 14, 2004 from <http://www.wired.com/wired/archive/11.05/view.html?pg=1>
- Gershenfeld, N. (1999). *When things start to think*. New York: Henry Holt.
- Gredler, M. E. (1996). Educational games and simulations: A technology in search of a (research) paradigm. In David Johnassen [Ed.] *Handbook of Research for Educational Communications and Technology* (pp. 521-540). New York: Simon & Schuster Macmillan.
- Johnson, S. (1997). *Interface culture: How new technology transforms the way we create and communicate*. San Francisco: HarperEdge.
- Juul, J. (1999). *A clash between game and narrative: A thesis on computer games and interactive fiction*. Unpublished master's thesis, Institute of Nordic Language and Literature, University of Copenhagen, the Netherlands. Retrieved November 14, 2004 from <http://www.jesperjuul.dk/thesis/AClashBetweenGameAndNarrative.pdf>

- Juul, J. (2001). The repeatedly lost art of studying games. [Review of the book *The Study of Games*]. *Game Studies*, 1(1). Retrieved November 18, 2004 from <http://www.gamestudies.org/0101/juul-review/>
- King, B & Borland, J. (2003). *Dungeons and dreamers: The rise of computer game culture from geek to chic*. New York: McGraw-Hill/Osborne.
- Laurel, B. (1991). On dramatic interaction. *Verbum* 3(3).
- Lee J., Luchini, K., Michael, B., Norris, C., & Soloway, E. (2004). More than just fun and games: Assessing the value of educational video games in the classroom. In *Proceedings from Conference on Human Factors in Computing Systems* (pp. 1375 - 1378). Retrieved November 3, 2004 from <http://portal.acm.org/citation.cfm?doid=985921.986068>
- Manninen, T. (2003, May). Interaction forms and communicative actions in multiplayer games. *Game Studies*, 3(1). Retrieved November 18, 2004 from <http://www.gamestudies.org/0301/manninen/>
- Martinson, P. (2001). *Military history through simulations*. Retrieved November 14, 2004 from http://www.warfarehq.com/index.php?page=articles/wargame_articles/history_simulation.shtml
- McLellan, H. (1996). Virtual realities. In David Johnassen [Ed.] *Handbook of Research for Educational Communications and Technology* (pp. 457-487). New York: Simon & Schuster Macmillan.
- Mohl, R.(1981). *Cognitive space in the interactive movie map: an investigation of spatial learning in virtual environments*. Unpublished doctoral dissertation, Massachusetts Institute of Technology.

- Mortensen, T (2002, July). Playing with players: Potential methodologies for MUDs. *Game Studies*, 2(1). Retrieved November 3, 2004 from <http://www.gamestudies.org/0102/mortensen/>
- NASA Learning Technologies external benchmarking study of advanced technology applications. (2004). Retrieved March 28, 2005 from <http://learn.arc.nasa.gov/benchmark/docs/Benchmark2.doc>
- Peck, M. (2003). *Successful war games combine both civilian and military traits*. Retrieved November 14, 2004 from <http://www.nationaldefensemagazine.org/article.cfm?Id=1241>
- Prensky, M. (2001). *Digital game-based learning*. New York: McGraw-Hill.
- Rice, J.W. (2005). Assessing higher order thinking in video games. *Journal of Technology and Teacher Education*. (In press).
- Riddell, B. (1997, April). Doom goes to war [Electronic version]. *Wired*, 5(04). Retrieved November 14, 2004 from http://www.wired.com/wired/archive/5.04/ff_doom.html
- Ryan, M.L. (2001, July). Beyond myth and metaphor-The case for narrative in digital media. *Game Studies*, 1(1). Retrieved November 3, 2004 from <http://www.gamestudies.org/0101/ryan/>
- Shenk, D. (1997). *Data smog: Surviving the information glut*. San Francisco: HarperEdge.
- Squire, K. (2002, July). Cultural framing of computer/video games. *Game Studies*, 2(1). Retrieved November 18, 2004 from <http://www.gamestudies.org/0102/squire/>
- Squire, K. & Jenkins, H. (2003). Harnessing the power of games in education. *IN>>SIGHT* 3(1), 7-33.
- Winters, D. (2004). *Magnavox Odyssey: First home video game console*. Retrieved November 3, 2004 from <http://www.pong-story.com/odyssey.htm>