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Learning and Teaching with Electronic Games

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Although notions of gaming and play have been around seemingly forever, there is a recent surge of interest in the possibilities of using electronic gaming for teaching and learning. There are gaming conferences (e.g., Games + Learning + Society - http://glsconference.org/2007/), gaming journals (e.g., Game Studies - http://gamestudies.org/), educational game summits (e.g., Federation of American scientists - http://www.fas.org/game-summit/), and gaming initiatives (e.g., Serious Games - http://www.seriousgames.org/). Foundations and granting agencies are also showing an increased interest in the use of electronic games (e.g., MacArthur Foundation - http://www.macfound.org).

Part of this excitement is due, no doubt, to theoretical arguments and empirical findings about the possibilities of using video games in education (e.g., Squire & Jenkins, 2003; Gee, 2004; Kafai, 1998). A second reason is the rapid increase in availability of programs for game development. Free, open-source and shareware development tools include ALICE (http://www.alice.org/), RPGMaker (http://www.enterbrain.co.jp/tkool/RPG_XP/eng/), Microsoft’s XNA (http://msdn.microsoft.com/xna/), Game Maker (http://www.gamemaker.nl/), and Blender (http://www.blender.org/). Open source game engines include Unreal Tournament (http://openut.sourceforge.net/), IRRLICHT (http://irrlicht.sourceforge.net/), the Quake engine (a basis for many other games; http://www.idsoftware.com/business/techdownloads/), and Second Life (http://secondlife.com/developers/opensource/).

A third (and by no means final) contributor to this resurgence is the rapid increase of use of video games by youth today. A Pew Internet Study found that 70% of college students play video, computer, or online games
MMOGChart (http://mmorpgchart.com/) reports over 12,000,000 active subscribers to Massive-Multiplayer Online Role-Playing Games (MMORPG). The resulting notion is that if electronic gaming is becoming a natural and ubiquitous part of everyday student life, can we and shouldn’t we investigate how it is and could be used for learning and teaching?

The simple answer is yes; simple answers, however, lead into very complex questions. Some of those questions include:

- Educational gaming can bring a tremendous amount of motivation to a learning environment. Does the novelty wear off? Is there a time-frame of use for particular games? If so, are there substantial teaching and learning opportunities with games post-novelty, or does there have to be dynamic and continuous changing of games?
- Games come from many different genres, including first-person shooters, role-playing, action, adventure, card, puzzle, and sports. Some are single-player, and some are multiplayer; some are handheld and some are online. Are there game genres that work better for certain educational content or different grades and ages?
- Gender and race are (and should be) very important components in the study of gaming. Recent research has begun to examine these areas (e.g., Leonard, 2003; Brown, R. M., Hall, Holtzer, Brown, S. L. & Brown, N. L, 1997; also see the Children NOW website for their report on “Fair Play” http://publications.childrennow.org/publications/media/fairplay_2001b.cfm). How do we select and/or build culturally-responsive games? How do we successfully build culturally-responsive curricula around games that may not be responsive?
- Many educational games of the past have been skill-and-drill (the common example given is MathBlasters). One could argue that there is a place for skill-and-drill in learning; others might suggest that educational games need to be built on constructivist or social constructivist theoretical frameworks. What would such a game look like?
- If one adopts a notion of differentiated instruction as a pedagogical approach, does that mean that it is acceptable that not all students will enjoy gaming? Does that also mean that different students will select different types of games? What would the implementation of such an approach actually look
like in the learning environment (e.g., the classroom), particularly related to hardware, software, and instructional content?

- Computer games have ratings (see http://www.esrb.org/index.jsp). Should educators accept these ratings as is? Should educators, particularly those in post-secondary, use games with mature ratings?

- Major software companies have not spent a tremendous amount of time or resources creating *edutainment* games, suggesting that there is no money in such ventures. As such, many (not all) education games are developed by those that do not necessarily have the resources to build games that compete with their commercial counterparts. As such, many students are bored or uninterested with home-grown products. How do teacher-developers compete? Should they? Additionally, there seems to be a tremendous potential for collaborative work between education and industry; how do educators make that happen?

- A majority of research is based on existing, recreational game use. There is not necessarily anything wrong with this; researchers have shown great potential for said games (e.g., Squire, 2006). However, is there evidence to suggest that game development is also critical for students (Kafai, 1998)? Are there content areas that are more suited for game use rather than game development, and vice versa? What are the best instructional strategies to help students and teachers design games?

- Game development for post-secondary education is often considered an initiative for computer science. There are gaming classes in education, but what should these look like? Should we be teaching our educators to program games as a part of their undergraduate or graduate career?

- Game software and hardware cost money; as such, equity is obviously a concern. Resource-heavy schools often have the luxury of purchasing game systems or game software. Other schools often have just enough money to purchase hardware, let alone software or gaming peripherals. Some schools cannot purchase technology period. Research that supports the notion that students learn from gaming is important, but what do we do about those that do not have access to game software or hardware?
• Students obviously also come from different backgrounds. Some families have multiple computers and multiple game systems at home; others lack basic needs. This social and cultural capital (Lareau, 2000) could drastically change what as well as who gets impacted by educational gaming. How do we study this? Are there specific research techniques that work well for a study of educational gaming?

• Some schools, particularly those schools that are labeled “failing schools,” often have set curricula. Each section of the day is segmented for a certain activity. All schools have standardized tests for students. Even if research suggests educational gaming is potentially useful, how do teachers fit gaming into a curriculum that is either set or is consumed by teaching to the test? How do educators convince parents, teachers, and administration about the importance of gaming in education?

• Anecdotally, when I tell some parents and some educators about educational gaming, they often suggest that learning isn’t always fun and the sooner students can understand that the better. If students learn some content through gaming, does that make other content un-enjoyable? If students have gaming in one grade and then move to the next where they do not, do we lose them? Finally, some students enjoy games in their spare time away from school. Does bringing in educational gaming make gaming boring for students? Does it make them feel encroached upon (as if before, gaming was solely in their domain)?

• Gaming is not new. How is electronic, educational gaming different than traditional gaming? In other words, what can we learn from the use of traditional games (non-electronic and either commercial or educational), and what is new about electronic games that needs to be taken advantage of?

• There is some debate about the definitions and the difference between games and simulations. Is this a difference that makes a difference? How does the use and or development of tools for teaching and learning?

• Multiple fields, disciplines, and research areas address ‘educational gaming.’ How does one learn to make sense of the different approaches and the nuances each discipline brings to the table?
learning and Teaching With Electronic Games

It is obviously impossible to answer all of these questions with one special issue of a journal. However, this issue of the *Journal of Educational Multimedia and Hypermedia* was put together to address many of these critical questions about electronic, educational games. The first article by DiPietro, Ferdig, Boyer and Black discusses a framework for educational gaming. There are many fields and disciplines that study electronic gaming. Computer science, English, journalism, literature and literacy, psychology, education, medicine, and business are just some of the few areas of focus for researchers who use electronic games to learn or teach content and/or concepts. DiPietro et al. argue that it is critical for existing scholars and students to examine multiple areas to be able to build a strong research base. They suggest that pedagogy, psychology, media effects, genre, and design are categories that can be used to provide a framework for understanding the various approaches to understanding educational, electronic gaming. A framework is merely a starting point, as the authors concede; however, an initial framework can act as a guide for cross-disciplinary conversations about gaming.

The next two articles in this special issue specifically address research on the use of gaming for teaching and learning. John Rice argues that although there has been positive evidence of the use of electronic games for education, there are major barriers for implementation into the classroom. He specifically suggests that negative perceptions, cutting-edge graphics, hardware, classroom time divisions, real-world affordances, and state standards are critical barriers that will continue to impede integration unless addressed by educators. Simon Egenfeldt-Nielsen addresses what he labels a *third generation* of educational gaming. He provides a literature review of educational gaming and critiques past research efforts, citing many of them as failing to ask and answer hard questions. In doing so, he addresses the notion of edutainment, some of the problems with edutainment, and the resulting barriers to implementation. He concludes with a discussion of theory-driven educational computing that may address some of these earlier edutainment issues.

Rice and Egenfeldt-Nielsen clearly suggest that although electronic, educational games have shown promise, the field has a long way to go, particularly regarding pedagogical considerations. In other words, what would a well-designed pedagogical environment surrounding the game look like? Or, what would a well-designed educational game look like? These questions and concerns set the stage for the final three articles in this issue. Debbie Reese suggests that game technologies can be used for educational purposes, particularly for the learning of complex concepts. She suggests that a
A structural approach to game design would afford experiential and reflective gameplay. She also addresses a preparation for future learning (PFL) approach and the relation to direct instruction.

Design is a theme that is also addressed by Katie Salen in her article on a game study design in action. The article approaches gaming with a design as learning approach; she uses Gamestar Mechanic as an example of the design process. The key in this article is not only the process of the development of the game, but also the notion of having children learn to design games. Throughout her article, she discusses the notion of gaming literacies, a topic discussed in depth in the final article by David Buckingham and Andrew Burn. Buckingham and Burn argue that to teach through games, one must also teach about games. Using research from work in UK schools, the authors explore student production of games and cultural models students used in that development. They suggest that this type of game literacy might provide a useful basis for educational initiatives.

This special issue is an excellent introduction to many of the important topics in this emerging area of interest. The authors discuss frameworks for understanding educational gaming, past research, and future needs. Design, pedagogy, and literacy are all examined. Existing game use by teachers vs. the development of games by authors and/or students is also addressed. Most importantly, perhaps, is the diversity of ideas by people working in very different fields yet interested in the same area. Authors hail from different countries and have varied employment and educational backgrounds. Some focus on design, others on classroom use; all focus on what is learned or what can be taught with electronic, educational games.

There is an old story of a group of blind men who go and visit an elephant. Each touches a different part of the elephant to find out what it is like. Each leaves with a different perspective, thinking the elephant is a tree trunk, a snake, a spear, and so forth. Wikipedia has a short history of the tale and its debated origins (http://en.wikipedia.org/wiki/Blind_Men_and_an_Elephant). There are many morals to the story; one is that none alone would be able to fully describe an elephant. Only by working together could the group begin to get a more complete picture of an elephant.

Although we do have some research in this area, electronic, educational gaming is still catching its proverbial footing. We need more research in this area; this editorial is not the first to make such a call. However, the story of the elephant reminds us that this research effort will be strengthened by the degree to which we are able to interact with others. It is true that computer scientists have different interests in gaming for teaching and learning than media literacy researchers; cognitive psychologists may have a different ap-
approach than journalists. However, a continuous, cross-disciplinary conver-
sation will provide shoulders by which to stand on, footing to further our
research, practice, and policy efforts. This special issue is one such example
of bringing authors together from various disciplines.

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Insight.

Notes

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Towards a Framework for Understanding Electronic Educational Gaming

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Games and gaming have always been an influential part of society and culture. Within the last 35 years, due to numerous technology innovations, electronic games in many formats have become ubiquitous in everyday life. This ubiquity has meant that games and gaming have permeated into many fields and disciplines for multiple purposes including teaching and learning. Past research has examined the use of both electronic and non-electronic games, but the field of education still lacks a comprehensive framework for exploring the role of the games for teaching and learning, the relationship of educational games to other fields, and a synthesis of best practice for current and future design, implementation, and research. The purpose of this article is to set a framework for understanding past, current, and future research in educational gaming. In doing so, we also hope to continue a conversation within education as well as with other fields that advance research, development and practice within a common framework.

Introduction

Games and gaming have played influential cultural and social roles throughout the development of civilization. For instance, games have played a role in the establishment of social structures and the transmission of socio-cultural knowledge and beliefs (Mead, 1934). Ancient civilizations used
war games to develop strategies for engagement (Gredler, 1996). Today, militaries utilize computer-based technologies to provide an efficient, effective way to deliver immersive training and instruction (Herz & Macedonia, 2002; Prensky, 2001).

Games have been an interest area within education long before the electronic age, with research documenting positive learning outcomes in the use of educational games (Betz, 1995; Klawe, 1998; Levin, 1981). However, the current popularity of electronic games in contemporary culture provides a stimulus for research into the use of digital or electronic game-based environments. According to the Entertainment Software Association (ESA), in 2005, 35% of children under the age of 18 consider themselves regular players of computer and console games (ESA, 2005). The research that has been completed has justified this call, providing support of the positive educational benefits of gaming technologies (Gee, 2004; Raessens & Goldstein, 2005; Squire, 2005).

Unfortunately, providing a foundational research base and a framework for the study of educational gaming is difficult for at least two reasons. First, and foremost, a broad net has been cast by researchers in diverse academic fields such as media literacy, psychology, computer science and education; this has resulted in multiple perspectives regarding electronic game research. As with many areas of study, this research – and discourse about this research – has not necessarily been cross-disciplinary. This is not to suggest that game researchers do not attempt to understand the full context of their work; rather, it is to propose that gaming research does not neatly fall into one discipline. Students within this area need to understand the deep, historical context of non-electronic gaming, as well as the breadth of multi-discipline opportunities to examine electronic gaming. Second, although research on play and gaming is not necessarily new, research on electronic gaming is enjoying a rather recent resurgence; we do not have a large research base from which to draw important implications for teaching and learning.

The purpose of this article is to provide a research-based review of the breadth and depth of this field. It would be impossible in one review to document all instances of gaming research. However, the goal is to present a framework that might contextualize the field of educational video game research, and the resulting discussion might inform future research on the development, design, and application of electronic gaming technologies for teaching and learning. In doing so, we would continue to build the cross-discipline conversation as well as providing a research-based call for further study.
Setting the Stage for a Framework

An important task to be addressed before delving into the development of the framework is to define electronic gaming, and in doing so, to discriminate between electronic games, non-electronic games, and simulations. It is also important to highlight the role of play in electronic gaming as a theoretical underpinning of the framework.

**Electronic vs. non-electronic gaming.** Certainly, the notion of electronic games is grounded within the context of non-electronic games. In fact, there is an extensive literature base that addresses research within the area of non-electronic games. Yet, electronic games are inherently distinct and have unique features that separate them from their non-electronic counterpart. Jesper Juul (2004) identifies automation and complexity as two of these features. Since play within electronic games includes interaction mediated through electronic hardware such as a computer or gaming console, the application of games rules are applied automatically through the electronic hardware. This, in turn, allows for more complex game worlds.

It is important to note there are distinctions among different electronic hardware. Electronic games can be console-based or computer-based. The latest generation of consoles include Microsoft’s Xbox 360, Sony’s Playstation 3 and Nintendo’s Wii along with handheld devices such as the Nintendo DS and Sony PSP. While some games are console specific, many games can be played across multiple platforms. This framework specifically addresses electronic-based gaming, regardless of whether it is on a handheld, a console, or a PC.

**Theoretical foundations of play.** Most of the research documented within this framework is situated within its own related theoretical backing. However, a common thread within gaming is the notion of play as represented by the work of Piaget, Vygotsky, and Dewey. These theorists are consistently cited in relation to electronic game play, so their work will be used as a basis for making connections between offline and online play (Squire & Jenkins, 2003). The commonalities of these theories of play involve the active nature of the learner within an experience-based learning environment and the goal of negotiating through challenges and obstacles presented in an effort to make meaning. Piaget (1952) discussed the role of play as serving an important function in childhood, providing the learner with an anxiety-free opportunity to utilize existing knowledge to facilitate the acquisition of new knowledge. Electronic gaming environments present learning spaces for children, where their mental states can be challenged and states of disequilibrium resolved to support knowledge acquisition. Activity theory, as
presented by Vygotsky (1978), Cole (1996), and others, illustrates the role of these symbolic devices as mediating tools for individual’s construction of knowledge within society.

Learning that results from the interaction of an individual with their environment is also consistent with Dewey’s (1938) theories of play. Educational gaming environments provide a space where an individual’s function within them results in concrete experiences that are foundational to learning. These environments also support the individual’s subsequent reflection and repeated application of the knowledge to make it concrete. Theories of play rooted in the field of education support the use of electronic gaming technologies by justifying the educational value of play.

The convergence of individual and social development with electronic game play is consistent with their representation in classical theories of play. In order to discuss the value of electronic game play in consideration of classical theories, a foundational definition of play that underpins both must be identified. Roger Caillois (1961) defines play as choice-based, where action is undetermined within an environment that is not based on reality which is simultaneously rule-governed and uncertain. This definition of play provides a context for making connections with classical theories. Skills are developed as electronic game environments encourage dynamic, experience-based activity within the boundaries of the environment. The play-based engagement in electronic game play is reflective of John Dewey’s (1938) stance regarding the relationship of knowing and doing, where play supports this interaction and fosters the development of attributes that are valued not only in education but also in society (Rieber, 1996; Shaffer, 2005).

From the cognitive perspective of play’s value coming from Piaget (1951), symbolic engagement supports the development of abstract thought through the opportunities it affords for practicing mental processes within a non-threatening context (Rosas, Nussbaum, & Cumsille, 2003). The importance of symbolic interaction is expanded on and moves past the internal mechanisms of the individual towards the social constructs influenced. The socio-cultural value of play provides opportunities for the development of shared meaning from the perspective of Vygotsky (1978), where the symbolic system is the mediating device.

In addition, supporting the socio-cultural development of children’s electronic play is also tied to the Vygotskian theory of the Zone of Proximal Development (ZPD) where tasks are presented to challenge and the player must make cognitive adjustments in order to interact (Gredler, 1996; Ko, 2002; Steinkuehler, 2004). The social structure supports the adjustments, whether coming from an electronic agent within the game or a more knowl-
edgeable other in real life to scaffold the experience. The role of challenge, which is considered a critical characteristic of electronic games, is a consistent theme in all of theories presented and supports the cognitive development of children (Malone, 1981a). The connections made here not only provide a means for understanding the value of electronic games as legitimate play spaces but also provide a context for understanding the psychological influences and interactions that are addressed in the preceding paragraphs (Rieber, Smith, & Noah, 1998). From the active learning proposed by John Dewey to the social-cultural effects addressed by Vygotsky, the critical role of play in children’s development has a strong argument behind it – one that can be used to further understand the role of electronic game play in their lives.

Games vs. simulations. As the line between games and simulations continues to blur, we acknowledge that they are not mutually exclusive; but, to focus our discussion, a clear delineation must be made. Malone (1981a; 1981b), Bowman (1982) and Malone and Lepper (1987) begin to make the distinction in their works, identifying the motivational characteristics of educational computer games. Their work establishes a set of characteristics that are consistently referenced in the gaming literature to define games; these include the use of a non-realistic/fantasy environment, scenarios that engage curiosity, present challenges, and are dependent on the player’s control. In addition, the game environment must be goal-directed, rule-governed and contain elements of competition, whether it is between an individual and the game or another individual (Dempsey, Rasmussen, & Lucassen, 1996; Malone, 1981a).

The definition of simulations, in general, is contentious, but for the purpose of this discussion, we define them as reality-based; they provide an individual with an opportunity to interact with a replication of a social or physical element in reality (Seidner, 1975). Thus, the individual’s interaction with a simulation inherits the rules of reality reducing the level of control an individual has when engaging the environment (Heinich, Molenda, Russell, & Smaldino, 1996). Educational research on non-electronic simulation games focus on the development of appropriate pedagogical strategies to support their use and their effectiveness in producing learning outcomes (Cruickshank & Telfer, 1980).

The framework for this article specifically focuses on electronic games. The distinction between games and simulations is to provide a context for understanding the elements of the frameworks we present.
Elements of the Framework

A framework for understanding educational gaming consists of five key elements: pedagogy, psychology, media effects, genre, and design. These elements are contextualized within the subsections of this article. It should be noted that many of these areas overlap. Researchers in pedagogy are interested in psychological concepts; educators looking at genre can be interested in design. The purpose of this framework is not to divide areas of interest as to excommunicate psychologists from pedagogues and designers from literary theorists. Rather, the purpose is to provide a glimpse of the many aspects of game studies. It is to continue a conversation marking specific concepts within cross-disciplinary studies.

Element 1: Pedagogy

Definition. The content of this section presents research focusing on the teaching practices and strategies used in association with the use of electronic games in classrooms.

Current findings. The use of electronic games to support teaching and learning should be considered in the same ways other technologies (whether it is a PDA or virtual reality); their potential impact on learning is dependent on the pedagogical strategies used to frame their use (Ferdig, 2006). The foremost consideration for instructors when thinking about implementing electronic game technology is the potential benefits in terms of the content, the classroom environment and the needs of the students (Amory, Naicker, Vincent, & Adams, 1999; de Freitas & Oliver, 2005). This requires the teacher to have an elementary understanding of not only the various hardware technologies that could be used for gaming, but also the potential gaming experiences they afford (Egenfeldt-Nielsen, 2004).

Current research areas. A cornerstone for using electronic gaming in the classroom is the selection and implementation of pedagogical strategies that support its integration into the classroom culture (De Castell & Jenson, 2004; Din, 2001; Kirriemuir, 2002; Verenikina, Harris, & Lysaught, 2003). The pedagogical strategies a teacher uses must provide support for students during game play and reinforce opportunities for learning outside of the game. A strategy that has been successful in doing this is to have students engage in collaborative game play, in pairs or small groups. Learning is reinforced outside of the game when the teacher follows up the activity with debriefing sessions and whole group discussions about the experience (Klawe & Phillips, 1995; Oblinger, 2004; Simpson, 2005). The use of
teaching strategies that have students playing games collaboratively has an additional benefit of increasing their enjoyment and motivation, particularly for girls (Inkpen, Booth, Klawe, & Upitis, 1995; Pedersen, 2003). The portability of PDAs and console hardware can support students development of knowledge after they leave the classroom, increasing the time spent engaged in learning experiences (Crocker, 2003; Tomlinson, 2003).

A teacher using an existing game is one important research agenda; students actually creating games is a second critical area. Utilizing game design activities can foster a deeper understanding of the content as well as developing metacognition. These practices include the use of scaffolding devices for design including the presentation of examples and specifications in order to allow concentration to be directed towards a task in terms of the content to be delivered (Kafai, 1998). Having students record the process of design also supports metacognitive thinking as well as providing the teacher opportunities for understanding student thinking (Phillips & Klawe, 1995). Additional resources added to either the game, the game instantiation, or the game development, such as literature and other instructional media, can be used to support the best opportunities for students contextualization of the content knowledge (Squire, 2004; Squire & Jenkins, 2003; Squire, Makinster, Barnett, Barab, & Barab, 2003).

**Implications.** Many factors should be considered when a teacher wants to use electronic games in the classroom. The most important of which are the pedagogical strategies used in conjunction with student game play to provide maximum opportunities for student learning. Those strategies may include simple game play, or it might entail more advanced game development. Additional considerations should be made for the hardware and games selected in relation to the content and student population. After selecting an electronic game, the question of how it will be used must be addressed. A teacher employing methods that provide opportunities for students to re-engage the content when the game play is over can facilitate the deeper understanding of the concepts encountered by making connections to the bigger picture of the content. Utilizing class discussions and collaborative strategies to introduce and integrate electronic games into the classroom reduces the novel effects of its use and can foster student learning.

**Element 2: Psychology**

**Definition.** The content of this section presents research focusing on the mental and cognitive processes engaged during electronic game play. This includes investigations into both the individual and social aspects of electronic game play.
**Current findings.** Research provides evidence that electronic game play impacts and engages mental processes. The cognitive activity supported by electronic game play is a valued attribute of non-electronic environments. The active learning supported by electronic game play is a valued attribute of non-electronic educational environments (de Freitas & Oliver, 2005; Henderson, 2002; Pillay, Brownlee, & Wilss, 1999). Electronic games promote dynamic cognitive activity as a player confronts challenges to be solved and obstacles to overcome that draw upon problem solving, reasoning, and strategizing skills (Dawes & Dumbleton, 2001; de Aguilera & Mendiz 2003; McFarlane, Sparrowhawk, & Heald, 2002). This dynamic process results in the development of higher order processes such as metacognition and justification (Henderson, 2002; Rieber et al., 1998; VanDeventer & White, 2002).

DeLisi & Wolford (2002) and Green & Bavelier (2003) provide evidence that continued game play over time modifies attention processes, as well as perceptual and spatial skills. The maintenance and direction of attention and development of perceptual skills are supported by feelings of immersion. These feelings, produced by a player’s interaction with the environment, engage them in a state of flow where a balance exists between game related information and individual abilities such that homeostasis is achieved (Csikszentmihalyi, 1990; De Castell & Jenson, 2004; Sherry, 2004). This balance is supported by the developed schemas a player uses to direct action and understand the game environment (Douglas & Hargadon, 2001). This role of schema draws attention to potential causes for the inconsistent effects seen when electronic games are used to support learning. An explanation for this is the lack of consideration for the individual differences that can influence the learning potential of electronic game play. The age of the player, prior experience with electronic games in general, and overall cognitive abilities may result in the cognitive concept of interference (Blumberg, 1998; Dempsey et al., 1996). This indicates a need for careful consideration regarding the role of electronic games in any educational environment when the goal is to support learning or develop thinking skills.

**Current research areas.** Aside from the internal mechanisms of the player, the advent of connected gaming technologies that support player to player interaction via the Internet or wireless networks make the social, external processes associated with an object of study as well. Electronic game communities, wireless PDAs and online/console-based multiplayer games have broadened the scope of agent-environment interaction to include a social dimension. Through collaborative play with connected gaming technologies, internal mental processes such as critical and strategic thinking are demonstrated where players’ social interactions provide the foundation for
their use (Facer, Joiner, Stanton, Reidz, Hullz, & Kirk, 2004).

These social interactions in connected collaborative gaming spaces also provide opportunities for the development of personal identities (Bers, 1999; Frasca, 2001). The influence of social interaction is not surprising as they reflect those of the real offline world, where social norms, economic systems, and personal identities are based on interactions of and with an external world (Krotoski, 2005; Turkle, 1995). The exploration of these environments to support the development of social skills and behaviors in children and young adults is just in its beginning stages. Raybourn & Wagner (2004) propose that these spaces can provide a space for children to test out and define appropriate social behaviors that could be transferred to offline communities. The exchange of social, cultural, and game-based knowledge supported by online interactions is highly iterative of the role of schools. The development of affinity groups and mentor relationships could further define classroom communities providing networks of support that go beyond the primary teacher. Welcoming these knowledge communities into classrooms could benefit students and teachers by recontextualizing conceptions of active learning environments (Steinkuehler, 2004; Williamson & Facer, 2004).

**Implications.** Looking at electronic game environments from a psychological perspective provides direction for understanding their potential for supporting student learning. In viewing game environments as a play space where cognitive rehearsals, symbolic interactions, and social structures are utilized, the potential for their educational value comes into focus.

There is a need to develop an understanding related to the interplay of psychology and electronic games in terms of the individual, social and theoretical relationship. The interaction between the individual and an electronic game illustrates the value of the active learning space the environment provides to support the development of important cognitive skills and processes. The social environments that demonstrate the characteristics of the offline social world allow collaborative opportunities that not only provide a space to explore social behaviors but also personal identities.

**Element 3: Media Effects**

**Definition.** The content of this section presents research focusing on the effects and impact of electronic game play on players.

**Current findings.** Investigations that look into the effects of electronic games produce mixed results. Three areas of research, or effects, will be addressed within the context of this section. These effects have significant relevance when thinking about electronic games and learning. A brief over-
view of the medical, gender, and violence effects will assist in understanding the varying nature of this type of research.

**Current research areas.** Physiologically-based effects investigated by the medical community have produced results regarding the use of electronic games as a method for treatment. The effects of electronic game play have been addressed in relation to a disorder that is increasingly prevalent in children – ADD (APA, 1994). The effects revealed are positive, demonstrating that when patients with ADD/ADHD play electronic games, there is a decrease in associated symptoms. After continued game play, patients were able to focus concentration and persist in a task (Houghton, Milner, West, Douglas, Lawrence, Whiting, et al., 2004; Pope, 1996). While the long term benefits of this treatment have not been explored, its potential is supported by results that indicate continued electronic game play alters selective attention and mental rotations skills (Blumberg, 1998; DeLisi & Wolford, 2002; Green & Bavelier, 2003).

The effects of electronic game play on obesity are also a concern within the medical community. Though the correlation between the two is acknowledged, the value of utilizing electronic game play to counteract these effects has also been proposed. The introduction of physically-based games provide a means of reducing levels of obesity through physical activity and present opportunities to develop health related consciousness (Brown, 2006; Dorman, 1997). The effects of electronic game play on the development of conceptual understanding have also been addressed. Another positive outcome occurs when games are used to instruct pediatric patients and parents on informed consent procedures resulting in increased recruitment and retention in clinical trials (Brady, 2004).

Gender effects associated with electronic game play are best illustrated by the existing gap between the numbers of male and female players (Kiesler, Sprouli, & Eccies, 1995). The explanation for this gap in gaming is often attributed to stereotypes identifying a lack of interest by females as the primary influence. This stereotype is being confronted by the identification of game elements that are preferred by female players which have led to the realization that the focus of design towards the male audience is not meeting their interests (Kafai, Franke, Ching, & Shih, 1998; Klawe, 2002).

In addition, the portrayal of electronic game play as a masculine and male-oriented activity in the media results in the intentional concealment of interest by girls in efforts to conform with social norms (Bryce & Rutter, 2002; Walkerdine, Thomas, & Studdert, 2000). Efforts to counteract these effects can come from the classroom environment by encouraging levels of self-efficacy female students have with technology (Hayes, 2005; Inkpen et al., 1995). The influence of stereotypes also affects males, as male pref-
erences for game play are mischaracterized as geared toward violence and action. Marketing that is geared towards male audiences reinforces these stereotypes, neglecting the reality that male preference leans toward games that provide mental challenge and good story lines (Lawry, Upitis, Klawe, Anderson, Inkpen, Ndunda, et al., 1995).

The male stereotype reinforcing the preference for violence in games is one that has influenced investigations into the role of electronic game play on the development of aggressive characteristics. Meta-analyses conducted on violence and aggression and electronic game play have definitely revealed a correlation (Sherry, 2001; Anderson & Bushman, 2001). However, these analyses also reveal a number of important issues that should be addressed when looking at the results. Changing technologies, methodological variance, and documentation of short term effects have provided a motive for weighing this research as inconsistent (Chiu, Lee, & Huang, 2004; Ivory, 2001; Linderoth, Lantz-Andersson, & Lindstrom, 2002). Baldaro, Tuozzi, Codispoti, Montebarocci, Barbagli, Trombini, et al.(2004) provide a physiological account demonstrating the effects of violent electronic games which result in increased arterial pressure and anxiety levels, but not in hostility levels. There is no determination which can be presented that clearly demonstrates a causal argument for a pro or con stance. Acknowledging the violent and stereotypical behaviors in some games within a classroom environment provides opportunities to assist students in developing critical opinions regarding these issues (de Aguilera & Mendiz 2003; Fontana & Beckerman, 2004; Jenkins, 2004; Kadakia, 2005).

Implications. Looking at the outcomes associated with game play from the various perspectives presented illustrates the need to pay them greater consideration in terms of their potential societal impact. The importance of implementing rigorous methodologies to study the effects of game play is evident, as demonstrated by the skewed results of research on violence. How game play impacts conceptions of gender indicate the influential role of media and social mores. A potential means for alleviating gender-based effects is a reconception of the way games are designed and marketed. Knowledge gained from the medical community demonstrate the potential benefits of electronic games on mental and physical states, providing a means for understanding the ultimate value of electronic game play.

Element 4: Genre

Definition. The content of this section presents research focusing on the structural elements that make up electronic game environments, including their style, form, and content.
Current findings. Electronic games serve to engage the player in an experience that fosters feelings of immersion within the environment. The primary origin of establishing these feelings is through the narrative presented through the game. Electronic games present the player with a contextualized environment constructed around a story that requires an interaction with multiple characters in order to achieve a goal. Exhibiting the distinguished elements of characters and setting, electronic games add another dimension to narrative engagement by placing the player in the role of co-constructor as they interact with the pre-defined narrative structure presented through the environment (Eladhari & Lindley, 2004; Wolf, 2002).

Current research areas. The narrative story presented within the environment provides a frame for engaging a state of flow within the player (Fabricatore, Nussbaum, & Rosas, 2002; Sherry, 2004). Through this engagement, the player is able to draw from the narrative environment to reflect on the experience. This is a key point for considering the potential use of electronic games to support students’ construction of meaning (Bizzocchi & Woodbury, 2003; Madej, 2003). The narrative structure of a game has particular implications for online gaming environments such as the Massively-Multiplayer Online Role Playing Games (MMORPGs). In these environments the narrative form functions to enhance feelings of community and assist in the development of personal identity as individuals work together making contributions to the environment in efforts to achieve a goal. The development of identity is supported by the player’s role in these online narratives which present a space that Turkle (1995) labeled as “identity laboratories” providing non-threatening opportunities for self exploration.

In addition to self exploration, the narrative structure of electronic games can provide a space for the construction of meaning (Madej, 2003). A player’s visual and textual literacies are developed in an electronic game environment as they interpret the narrative to understand how relevant knowledge is being communicated and get the maximum benefit out of the information (Pelletier, 2005). A critical eye must also be developed for the media, so the user is able to form parameters that will help them define effective and ineffective communications. The learning principles inherently built into electronic games to support their playability scaffold the construction of meaning, and development of game-based literacies (Gee, 2003). The players’ ability to make meaning from the electronic game environment can be valuable outside of play. The game-based literacy a player develops can be used as a foundation for the formation of associated literacy’s and competencies valued by the field of education (Fromme, 2003).

Implications. The elements that comprise the electronic game environments form its narrative structure and support the player’s transition
into a flow state. Within the flow state, opportunities for game-based interaction increase, allowing the player to have greater control over the action and chances to reflect upon it. In online environments the identification of a common goal fosters the development of community and collaboration where personal investment in the game is influenced by the level of control that is felt from being able to modify the narrative structure. As players engage in a game space and interact with its narrative structure, personal values, opinions, and identities can be explored illustrating a synthesis between player and game. Future work will continue to examine the development of these literacies in and out of schooling.

Element 5: Design

Definition. The content of this section presents research focusing on the strategies of electronic game design that support playability and player enjoyment.

Current findings. The psychological interactions between a player and a game that motivates and sustains play can be attributed to the elements of interaction in which the environment affords. The game-based elements that support a player’s enjoyment and learning are consistent with elements of non-electronic play such as challenge, fantasy, and the engagement of sensory and cognitive curiosity in the pursuit of a goal (Malone, 1981a; Malone & Lepper, 1987; Young, 2004). The game-based design elements that support motivation to preserve play are identified by players as the provision of feedback, embedded competition, a responsive pace, and elements that support learning (Belenich, Sibley, & Orvis, 2004; Wong, 1996). Game-supported learning is directly related to the architecture of the game that balances what is and what is not known about a new environment (Salen & Zimmerman, 2004). Training stages and tutorials are examples of architectural design within games that support learning. Training stages at the start of the games allow players to develop game-based skills that support the use of strategic planning, and, over time, promote the transfer of skills between game play experiences (Fabricatore et al., 2002; Oliver & Pelletier, 2004, 2005). Training levels increase a player’s enjoyment of a game as they provide a contextual frame for navigation through the environment (Desurvire, Caplan, & Toth, 2004; Malone, 1982). Identifying the basic heuristics applied to game design that support the enjoyment and motivation of a player provide the starting point for addressing elements that have particular relevance for learning.
**Current research areas.** A player’s experience with gaming technologies influences his or her expectations of all new game environments encountered. Influenced by this existing schema, as a new game is encountered it is compared to prior experiences which leads to the conclusion that the more consistent a design is with existing schema, the more potential there is for content learning in a game environment (Blumberg & Sokol, 2004; Rosas et al., 2003). The schema developed is a result of the various scaffolding elements built into the game environment. This is consistent with how schema influence learning scenarios that do not implement electronic games. A successful strategy that has translated from traditional learning scenarios into the design of electronic games is the use of directing questions and game-based agents that serve to guide the knowledge developed and scaffold the information presented (Cameron & Dwyer, 2005; Conati & Klawe, 2002; Van Eck & Dempsey, 2002). A critical element of scaffolding is the use of questioning and agent-based feedback that is responsive to the player’s level of knowledge. As knowledge increases, these elements should be adapted by increasing or decreasing the difficulty based on the response (Facer et al., 2004).

Looking at the designed experiences presented through MMORPG environments, additional characteristics can be identified that have particular relevance to pedagogical design. In online multiplayer games, the players are stakeholders where the development of knowledge is rooted within player interaction. As experience is developed and knowledge is shared, skills are refined that support an individual’s reasoning within the environment (Steinkuehler, 2004). In order to develop games that better reflect students’ existing schema and prior experiences, their involvement in the design process to provide end-user feedback has been successfully used. A deeper understanding is developed by those participating regarding how electronic games can be designed that demonstrate effective teaching strategies and the considerations that need to be made in their selection to support learning (Facer & Williamson, 2004).

**Implications.** For a game to be most effective in its delivery of content, it must be consistent with the types of games that students play in order to produce the same types of enjoyment and interest that sustains play. Inclusion of game-based elements that are used in electronic games that do not have educational intentions, such as training levels, assist those students that do not have prior experiences with them. New forms of interaction that reflect effective teaching strategies should be implemented when designing a game with an educational intent, including prompting questions and game-based agents that function as mentors in the environment. It becomes evi-
dent that there is much to be gained from blending the best practices from design with those in education to develop games for learning.

Making an electronic game that is both playable and enjoyable requires an understanding of the psychological, game-based elements and design strategies that interplay during the initial phase of development. A balance must be struck between the challenges presented and the abilities of the player. For the player, when this balance is achieved, it engages them in a flow state, producing feelings of immersion which result in an increased motivation to continue playing. As new technologies emerge to engage players’ senses through pristine graphics and physical responses, existing research outlining the techniques of game design will serve as a foundation for exploring this new level of game-player interaction.

CONCLUSION

It is important to remember that in many instances, research within the field of educational gaming can be associated with multiple categories within the proposed framework. Many research topics in the field of educational gaming converge across multiple content categories. For example, Adams’ (1998) study of SimCity 2000 represents just this challenge by offering evidence that gaming can support learning within specific subject areas, in this case, urban and regional planning. Adams’ study could be categorized as a pedagogical initiative, but it could also be regarded by its psychological focus, as student motivation and pleasure are effectively linked to interactions with the game.

Because of the unique complexity offered by research within the educational gaming field, the purpose of this article is to offer the reader the opportunity to consider the multidimensionality and depth offered by this emerging topical area. It is not the intention that a student of game studies would neatly fit within only one of these categories. Figure 1 displays a summary of the areas described in this article; as a summary and a guiding framework, any subheadings were not left out intentionally. We concretely understand that this framework is an evolving framework; future iterations will be based on innovative gaming, initiatives and game projects, and research findings from the various fields and disciplines.
Figure 1. A framework for understanding educational gaming.
Towards a Framework for Understanding Electronic Educational Gaming

There are various underlying categories, themes, and nuances to each of the areas represented in Figure 1. Some of those areas have been discussed in the introduction to this article. For instance, theories of play underscore research in some or all of the research areas. Additionally, research studies in any of these areas will differ based on whether the game is console-, handheld-, or PC-based, whether it is an educational game or a recreational game used for education, multi-player or single-player, student-used vs. student-created, in class or at home, and so forth. Figure 2 highlights some of the underlying themes that are addressed in each of the framework categories.

### Examples of Consistent Themes:

- Games Intent: Recreational vs. Educational Games
- Content: content-free vs. content-driven (e.g. social studies or math)
- Gaming Platform: PC, Mac, Unix, Console, Handheld
- Peripherals: joysticks, dancepads, eyewear
- Audience: Children vs. Adults
- Play Style: Single Player vs. Multiplayer
- Location: in school, at home, at work
- Game Genre: shooter, movie-based, adventure, sports, card or board game
- Gender Stereotypes: Barbie™ games
- Timeframe: one-use vs. extended missions
- The role of culture, background knowledge, and experience

**Figure 2.** Examples of consistent themes in the major areas.

The purpose of Figure 2 is not simply to demonstrate or acknowledge that these underlying themes exist. Rather, it is to enhance an existing call. Electronic educational gaming is a relatively new area; as such, the field lacks a strong research base. We need more research, but this research must be structured and rigorous. It is unwise to make broad claims from two studies using gaming to teach history without further examination of the variables, particularly if one of those studies used MMORPGs on PCs while another used a stand-alone, single-player game on a console. Items such as those listed in Figure 2 become critical components to understand the potential of games for teaching and learning. The bottom line is to develop research programs and studies that are descriptive enough (Geertz, 1973) to be able to delineate between the study of apples and oranges (Salomon & Gardner, 1986). There is also a need to continue to identify these differences that make a difference.
One final concern is the blurring of the line between game and simulation. For purposes of developing this framework, simple definitions were provided and the focus was strictly on electronic gaming. However, current and future innovations often blur the line between these two categories. A strong research agenda will find a place for both while recognizing and celebrating the affordances and constraints both offer.

The future for educational gaming research looks bright, provided we continue to pursue an open-discussion and conversation within multiple fields and disciplines. An evolving and encompassing framework, even if it provides a simplistic view, provides new students to the area with a glimpse of the complexity; it provides existing scholars with a reminder of the multiple perspectives.

References


New Media Resistance: Barriers to Implementation of Computer Video Games in the Classroom

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Computer video games are an emerging instructional medium offering strong degrees of cognitive efficiencies for experiential learning, team building, and greater understanding of abstract concepts. As with other new media adopted for use by instructional technologists for pedagogical purposes, barriers to classroom implementation have manifested in tandem with rising interest in the medium. This article draws upon a broad analysis of current research dealing with the educative impact of computer video games in the classroom, with a focus on these barriers to implementation. This study was a qualitative review of several scholarly papers exploring the use of computer video games in the classroom. Papers were chosen for inclusion in the review based on their focus on educational video game research. Review of the papers led to six major barriers, which are identified and summarized in this article. Barriers included negative perceptions toward video games as educational components; the difficulty of providing state of the art graphics in educational video games; a lack of adequate computing hardware in the classrooms to run advanced video games; a school day divided by short class periods which hindered long term engagement in complex games; a lack of real world affordances; and a lack of alignment to state standards. Implications for each barrier and suggestions for future research round out the findings. [abstract ends]
Introduction

Computer video games are an emerging instructional medium offering strong degrees of cognitive efficiencies for experiential learning, team building, and greater understanding of abstract concepts. As with other new media adopted for use by instructional technologists for pedagogical purposes, barriers to classroom implementation have manifested in tandem with rising interest in the medium. This article draws upon a broad analysis of current research dealing with the educative impact of computer video games in the classroom, with a focus on these barriers to implementation. Several scholarly papers exploring the use of educational video games in classroom settings were subjected to qualitative review. Candidates for inclusion in the review included research dealing with the educative impact of video games within classroom environments. For each paper, barriers to implementation of video games in the classroom were identified and summarized.

Definitions. Gredler (1996) defined educational games as unique opportunities for children to experience activities within a cognitive domain in which new knowledge can be introduced. For the sake of this article, the term computer video game simply extends Gredler’s definition of games to computing environments. Computing environments involve the use of personal computers, and in the case of this article we are concerned with personal computers used specifically within classroom settings.

A wide variety of software exists for multiple platforms designed for home entertainment. Among these multiple platforms, besides computers, include portable gaming devices and home gaming consoles. Most of the articles covered in the analysis outlined in this article tend to eschew gaming consoles. Some researchers have commented on the phenomenon of gaming consoles’ lack of classroom penetration. Some surveys indicate low power computers are commonplace in classrooms and able to handle instructional software of varying degrees in quality (see Becker, Ravitz, & Wong, 1999). Another, more speculative, reason for the paucity of articles covering gaming consoles may be their heretofore lack of customizability. Many computer video games can be modified by educators, developed from scratch by researchers or students, and played on equipment that is pre-existing in many classrooms. However, gaming consoles typically provide pre-made content that cannot easily be altered by end-users, and may be looked upon as pure entertainment devices by stakeholders (whereas the personal computer may be seen as more utilitarian in nature).

Some software in this review, particularly products developed specifically by educational researchers for instructional purposes, might not
be viewed as falling under strict guidelines of traditional video games by those who designed and researched the products. In particular, Dede, Ketelhut, Nelson, Clark, and Bowman (2004) took care to label their product an instructional environment rather than a game. For situations such as these, the papers in question were included in the qualitative review because the instructional products incorporated elements derived from traditional understandings of video games. In these situations, children engaging in the products may have considered them to be video games, or at least have been familiar with the notion of engaging in software that afforded various game-like activities.

**Review Process.** The review process invoked criteria focusing on papers dealing with research surrounding computer video games used for instructional purposes in the classroom. The primary focus of the review process involved identifying elements and/or characteristics of educational video games that hindered their usefulness or otherwise dissuaded stakeholders in adopting the video game elements for classroom implementation.

Subjecting the papers to qualitative review resulted in the following six areas identified as barriers to classroom implementation of educational video games: negative perceptions among stakeholders; graphics quality and other issues surrounding computer graphics; lack of adequate hardware in schools to run newer gaming software; lack of instructional time in school periods to adequately engage in rich, cognitive video games; lack of affordances within artificial environments to adequately represent desired learning objectives; and lack of alignment for objectives within commercial gaming environments to state and local standards. This article will outline the six major identified barriers, discuss the implications of the barriers insofar as using video games in an educational context, and offer suggestions for future avenues of research that hopefully address the needs in overcoming the identified barriers.

**Perceptions Among Educators**

Perceptions hampering acceptance of even the best educational games for classroom use include a lack of understanding concerning the differences between arcade-style games, often the first exposure the general public has to video games, and more complex role-playing, graphically dense, and cognitively viable modern games. These advanced computer gaming products belong in a separately defined category. Virtual interactive environments (VIEs) are derived from several fields, including virtual reality and cogni-
tive science, in order to produce robust and engaging products offering users multiple opportunities for higher order thinking. However, many educators with little or no exposure to modern VIEs may, when asked to consider video games, conjure up mental impressions of lower cognitive arcade titles requiring little or no thought and simplistic gaming properties (Schrader, Zheng & Young, 2006). There also appears to be a general perception in the populace that many video games foster violence, with some research backing up this assertion (cf. Anderson & Bushman, 2001; Sherry, 2001). This may result in reluctance on the part of school personnel to adapt anything using the term video game as an instructional tool for classroom use.

In addition to the negative perceptions surrounding the term itself, actual instruction through video games requires a certain degree of relinquishing control of the classroom. Dede and Ketelhut (2003) noted a strong need for extensive professional development with teachers when implementing their multi-user virtual environment (MUVE). The game-like structure of the MUVE necessitated an approach to classroom management that relies more heavily on technology and constructionist principles, facets with which some teachers may be uncomfortable.

**Implications.** Many text-heavy environments such as the aforementioned MUVE involve the blending of traditional text-based instructional content within the context of a three-dimensional computer graphics environment. This combination of traditional educational elements within what has generally been considered an entertainment medium may ease the divide between traditionalists and early adopters. Some research has indicated that heavy use of scaffolding within VIEs, where students are guided carefully along select paths of instruction while exploring the environment, offers strong cognitive benefits (Warren, 2006).

**Considerations for future research.** Perceptions have a tendency to change over time, and as young teachers replace older ones, biases against digital instruction may simply vanish with successive generations. Nonetheless, several interesting research questions are open for studying the perceptions surrounding educational video games. Do parents and teachers hold different perceptions of instructional VIEs than students? If so, what attributes of the VIEs cause the differing perceptions? What ways could instructional video games be presented that result in more positive impressions among stakeholders? Ultimately, negative perceptions surrounding the use of computer video games for educational purposes may hinge upon a reluctance to meld what has been seen as a mindless waste of time with strong instructional content. For the negative perceptions to diminish, broader understanding of the power the medium of video games offers for instructional purposes will need to be realized in K-20 practice and literature.
Graphics

A team at Georgia Tech created a math game called AquaMOOSE using graduate programmers (Elliot, Adams, & Bruckman, 2002). Upon informing the school-aged experimental group they were going to play a game, the students initially expressed enthusiasm. However, graphics the students were used to from home consoles and traditional computer games proved superior to that of the team’s trial program. Professionally developed games students are used to playing have a high degree of graphical sophistication, and creating educational products from scratch is thus a high barrier.

That barrier may be overcome by modifying existing commercial products which include the advanced graphics favored by players. Such an example was detailed in a paper describing Massachusetts Institute of Technology’s experimental game Revolution, which is a modification of the Neverwinter Nights commercial game (Squire & Jenkins, 2003). Additionally, acceptable graphics quality may be implemented by using an existing three-dimensional environment such as the online Active Worlds, used by Harvard’s River City (Dede, Ketelhut, Nelson, Clark, & Bowman, 2004) and Indiana University’s Quest Atlantis (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2002).

Implications. The graphical barrier looms strongest against researchers and educators wishing to customize instructional content within a gaming environment while also desiring to maintain a high degree of professional quality. Modern video games are akin to movie production, with multiple people and high dollar budgets. As the Georgia Tech team experienced, professional grade gaming environments are costly and time consuming, potentially beyond the will and means of university researchers. The Harvard and Indiana teams found they could work within a commercially available environment, provided they were willing to submit to the restrictions and programming constraints inherent within that environment. Thus, graphical quality may be of increasing concern to researchers in the field, if they desire strong customizability. If researchers are willing to conduct their observations within existing environments, ones in which someone else has spent the time and money programming, graphical quality will be less of an issue in terms of development time.

Considerations for future research. Questions surrounding the graphical aspect of the video game medium might involve its effect on user experience and questions such as: What level of graphical capabilities offered within a gaming environment is acceptable for students to suspend their disbelief? Laurel (1991) asserted the level of quality did not need to be very
high. However, since the time of her writing, computer graphical quality has increased considerably, and young game players have come to expect a certain degree of graphical sophistication that is found in their entertainment products. Could an empirical study point to evidence that top of the line graphics in a game support characteristics that promote higher order thinking? On the other end of the scale, at what point do inferior graphics interfere with instructional content? Can players spoiled by ever increasing graphical quality find a game based on a ten year old graphics engine to be beneath their dignity to play? If a game compensates inferior graphics with quality text and audio, can any limitations in the learning process be overcome? If so, how easily? Ultimately, high quality graphics (and, correspondingly, complex video games) will likely depend on the appropriation of existing products for research purposes. Whether quality graphics or the lack thereof adversely affects learning facilitation remains open for research.

Hardware

An even more significant problem to widespread use of computer video gaming in the classroom may be the lack of machines available for students in many schools. Although 99% of all teachers reportedly have access to computers in schools, one-to-one ratios for students appear to be far from reality (NCES, 2000). Computers that are available for student use traditionally are older and less powerful machines. Some survey authors have suggested lower-level games from the edutainment category, such as those in the Math Blaster series, may likely be placed on school computers because of low processing power requirements (Becker, Ravitz, & Wong, 1999).

Advanced games often require newer hardware and tend to be resource hogs, thus potentially limiting their adoption for classroom use. Innovative educational products created for research purposes, such as those based on the Active Worlds environment, often use fewer resources, making them more likely to be feasible on classroom machines and networks. This idea was a key consideration of Jones and his colleagues when creating software designed for an online three-dimensional classroom. The game-like software was designed to run on older computers, built in 1999 (the year the popular online video game EverQuest debuted) or later (Jones, 2004).

Implications. Strong computer gaming environments are resource intense, placing demands on RAM and hard drives. Educational games, especially those designed with the classroom in mind, may have to be oriented toward lower-end machines if survey data continues to support the notion
that many or most classroom computers are underpowered. A strong educational video game that requires a new computer with robust capabilities may prove to be of limited value within a majority of educational settings. Any educational video game may be limited in its effect if the environment it is implemented in has a shortage of machines available for student use.

Considerations for future research. Older and slower machines may necessitate simpler instructional video games that can adequately perform on dated computers. Researchers may want to consider if opportunities for educational benefits may be limited by older graphics and computing capabilities. Research questions may focus along the lines of such questions as, What are the typical specs on a classroom computer in operation this year? With the progression of technology, how long can a video game hold educational value? Are there detrimental attributes to using dated software with students accustomed to newer software and hardware?

Time Divisions Within the School Day

Squire (2004) noted the time limitations of the bell schedule hampered his efforts to use Civilization III in formal classroom environments. The game is challenging and complex, and users can spend several hours a session playing and learning. Informal learning environments such as after-school and summer programs, and other situations in which the bell schedule is not as critical in dividing learning periods, may prove to be better times for engaging in rich cognitive VIEs. Otherwise, the video games will need to be specifically designed so that learning objectives can be typically achieved within 30-45 minutes. This is a tactic taken by some researchers when designing games for classroom use. Squire and Jenkins (2003) indicated Revolution was designed with time constraints of the typical class period in mind.

Implications. Instructional units are perforce constructed around the school bell. Time spent on complex video games, much as long novels or lengthy movies, will need to be parsed according to the restrictions of the class period. Consequently, researchers desiring to investigate complex VIEs within instructional settings will focus on those with brief components within their broader contexts. For instance, a VIE offering users a large and robust world to explore may have a variety of short learning objectives that can be accomplished in 30 minutes or less. Alternatively, educators and researchers may want to investigate simpler, more narrowly focused video games containing only one or two learning objectives. Conceivably, these
simpler instructional video games may be ideal for the short time slots afforded by school schedules.

**Considerations for future research.** If the bell schedule is a barrier to the use of complex video games in the classroom, researchers may seek to investigate questions surrounding continuing versus short activities. If a student is interrupted while in the process of engaging in a learning objective within the gaming environment, do the interruptions interfere in the student’s learning process? Conversely, can the interruptions of the bell schedule be turned into something advantageous for the learner? Do students who are allowed to engage in complex VIEs over longer periods of time, such as during an after school program, retain more knowledge gleaned from the game than those who engage in it piecemeal?

**Lack of Affordances**

Affordance Theory was proposed by Gibson (1977) as a way to describe the relationship between an entity and its environment. The more affordances offered by an environment, the greater opportunities for interaction become apparent to entities within the environment. Within three-dimensional electronic learning environments, upon which many game-based instructional efforts are based, the current level of software sophistication is insufficient for highly advanced affordances. Dickey (2003) noted that the lack of affordances in some three-dimensional environments to completely simulate real life pedagogy may hinder desired instructional processes. Particularly, she noted limited movements of avatars within the Active Worlds environment resulted in less than realistic experiences among users in synchronous distance learning efforts. Those leading classes, for instance, could not engage in complex gesturing, drawing on a chalkboard to dynamically illustrate points, or other actions easily afforded within real world classrooms.

**Implications.** Virtual worlds are likely to continue to hold some lack of affordances otherwise available in the real world until perhaps technology has advanced considerably from its present point. Conversely, virtual worlds will always allow opportunities for simulated experiences not as easily available in the real world. Simulated science experiments, teamwork over distances, and facilitated communication offer three demonstrable examples of these opportunities. The benefits and disadvantages inherent in the medium will need to be weighed by educators in the course of decision making insofar as instructional content for the classroom.
Considerations for future research. Gibson’s (1977) Affordance Theory offers an intriguing angle for educational video game researchers to explore. Specific components within instructional video games can be analyzed and quantified, with survey research to follow up after the experiment concludes. Participant actions can be gauged as to the number of times an affordance is used within the gaming environment. Survey questions might focus on reasons behind the popularity of certain components within the VIE, or the lack of popularity for other components. Research questions might focus on whether certain affordances within the game facilitate or hinder instruction. A greater understanding of affordances within VIEs that assist in transferring instructional content might assist in the development of more efficient video game based learning environments in the future.

Lack of Alignment to Standards

Squire (2004) noted a need to develop his own curriculum and alignment of standards when implementing Civilization III within classroom environments. Widespread commercial gaming products are designed primarily for entertainment purposes rather than educational purposes, though informal learning may occur through using the products. Teachers wishing to use the games within their classrooms must often develop alignments on their own, a significant hindrance to adoption due to the added time and effort required.

Deubal (2002) indicated that a requirement for any software, including video games, to be successfully used in classrooms is to provide capabilities for dynamic teacher adjustments. Thus, products such as PowerPoint are thoroughly dynamic and find widespread use within classrooms. Products allowing few or no outside adjustments by teachers may find stiffer resistance to adoption. Therefore, if a video game is to find widespread adoption within classrooms as an instructional component, each teacher adopting the game must be able to adapt it to his or her specific state and local standards rather than seeking to adapt the standards to the product.

Implications. State standards are increasingly important for any product adopted for classroom use. Instructional video games will be no exception. Complex video games may be rated by teachers as conducive toward higher order thinking (Rice, 2007). However, whether the higher order thinking induced within VIEs is related to what will be on the students’ state assessments is another matter. It seems a commercial video gaming product pre-aligned to state standards would have an easier time selling itself in
the educational marketplace, relieving early adopter educators from the time consuming need of providing the alignment themselves.

Barring the introduction of such a product, the issue of standards alignment will remain a barrier for individual games in the classroom. One solution might occur in the form of individual teachers posting their alignment work on the Internet. Such public parsing of large projects has been feasible in open source programming, and a form of open source standards alignment may coalesce in the future around such popular products as the Civilization series.

**Considerations for future research.** Is informal learning of merit within formal learning environments? Can learning by doing, within the context of VIEs, transfer to formal assessments that are traditionally text-based by design? These are key issues facing the broader question of viability for educational video games within school settings. The question of transference may never be fully resolved, but will remain an important issue. State assessments are generally text-based; video games are action-oriented. Can engagement in video action lead to higher text-based achievement? Do video games that simply reformat traditional text-based learning within a digital context induce higher engagement and longer amounts of time on task? Can a video game teach students concepts by means other than text that can be transferred to a text-based state assessment?

Conversely, perhaps educational video game research should focus on areas other than achievement on state exams. Are video games best suited as catalysts for increased learning outside the classroom? Should success in implementing video games within the classroom be marked by increased attendance, more time on task, or a higher number of books checked out from the library? These are the sort of questions that will perhaps intrigue researchers in the years to come.

**CONCLUSION**

Wider acceptance of video games as an instructional medium in the classroom is hampered by negative perceptions held by educators. The graphics quality of educational video games needs to be sufficiently advanced to provide strong engagement by the students. While modifying existing products may be a work-around to creating graphical environments from scratch, time and programming skill remain necessary for many implementations. Creators of the more successful educational game-like environments use three-dimensional software that walks a fine line between
graphical sophistication and low resource requirements. This programming compromise will likely continue to be necessary so long as older machines remain common in schools. Newer advanced gaming environments tend to maximize use of computer resources, and consequently will likely remain in entertainment venues rather than quickly finding their way to educational markets. School days remain divided into hour long or less class periods, while advanced VIEs can engage students for hundreds of hours. Finally, many of the best cognitive video games are typically created for mass market consumption, rather than purely educational purposes, resulting in the need for additional efforts by teachers wishing to align them to their curricula.

The training benefits of complex computer games in military and business efforts are well documented (see Prensky, 2001). The pedagogical benefits of educationally appropriate video games, including strong cognitive efficiencies for the grasping of abstract concepts, development of team-building skills in multi-player environments, as well as strong experiential learning, are being researched with promising results (cf. Squire, 2004; Warren, 2006). Facts and details, material usually best covered in dense media at lower learning levels and found in high-stakes tests, remain prime components of older media involving text, lecture, and video. Complex understandings, broad experiences, higher level thinking, and consequential decision making are all approached in many advanced computer games now offered in the marketplace and occasionally co-opted by teachers or created specifically for academic environments. As greater understanding of the pedagogical potential of VIEs increases, acceptance of this new instructional medium is poised to increase as well.

Computer video games promise to be a strong and vibrant medium for interaction and instruction. While this article has focused on barriers to the appropriation of video games in classroom settings as gleaned from the literature, it is by no means certain that these barriers will continue standing. Indeed, each barrier will ideally be overcome by programmers, stakeholders, and researchers, leading to more robust learning environments in the years ahead.

Programmers should take heed of theory and research found in the literature. Presently, good learning theory seems to be incorporated by commercial programmers, but primarily for the sake of entertainment (Gee, 2003). The combination of good commercial programming with strong instructional content, along with alignment to state standards, should result in promising educational products.

Stakeholders, including parents and teachers, should remain open to innovative means of instruction. Biases concerning the mental acumen needed
to engage in a VIE need to be subordinated to the present reality. These are not games on the level of Pong or Windows Solitaire. Finally, researchers need to continue thinking about and working in this fascinating field and dreaming up many more questions to ask. Computer video games hold the potential for providing phenomenal learning experiences for users. Programmers, educators, and researchers can work together to offer exciting new worlds for children to explore, meet others, and learn.

References


Notes

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Third Generation Educational Use of Computer Games

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This article outlines the characteristics and problems related to edutainment and of the associated research studies demonstrating that learning outcomes look promising. The article suggests that we are moving towards a new generation of educational use of games that is more inclusive. This new generation relies on constructivist learning theories and a deeper understanding of the potential and limitations of computer games in educational praxis. In this approach computer games are just another tool for the teacher which can be dispensed with great success for the right tasks, but have clear limitations and require qualified teachers that can serve as facilitators of learning.

Introduction

Edutainment has since the 1970s used a classic formula for producing educational computer games based on learning theories; unfortunately, many of the underlying assumptions of those games are problematic given our current knowledge of how humans learn. This article outlines the characteristics of edutainment, traces its historical development, and introduces some of the most important research in the area so far.

Finally, it explains what a new approach to educational computer games should include if it wants to avoid the pitfalls found in the current market as well as the research carried out up until now. The article concludes with
a third generation perspective on educational use of computer games. The third generation perspective implies an inclusive triangle of player, culture, and computer games to understand the full spectrum of educational use, taking the educational use of computer games as its starting point. It is not sufficient to look at the player as more motivated, game culture as a collaborative endeavour, or computer games as complex devices that automatically transfer knowledge to any player. We need to look at how each of these elements helps constitute the educational use of computer games.

The Legacy of Edutainment

To this point computer games with educational features have not fared well in the marketplace. The educational content tends to come at the expense of the gameplay and control is taken out of the hands of the player… Game buyers (as opposed to concerned parents) are wary of edutainment. (Leyland, 1996)

Edutainment is a broad term which covers the combination of educational and entertainment use on a variety of media platforms including computer games. Although the brand edutainment is not as attractive anymore (Buckingham & Scanlon, 2002; Konzack, 2003), game companies are still inclined to put games into this category as to strengthen the appeal for parents. Parents appreciate the combination of entertainment and education, preferring play that teaches children something (Sutton-Smith & Kelly-Byrne, 1984). This links well with the common rationalizing of children’s play pursued by adults as argued by Sutton-Smith & Kelly-Byrne (1984). There is a distinct tendency for both educators and parents to cast play in developmental terms. Children should not just play for the sake of playing, but in the process preferably nurture other skills. This wish for rationalizing play is extended to edutainment and used for creating a new market. Although there are theoretically good arguments for using play for learning, they are often glossed over in edutainment (Egenfeldt-Nielsen, 2005).

Edutainment is inspired by behaviourism and, to a lesser degree, cognitivism and socio-cultural theory. It tries to focus on simple computer games and the delivery of straight-forward information to the player. Many early popular educational computer games have a different understanding of learning and do not fit the current label of edutainment (see Egenfeldt-Nielsen, 2005 for an extended history of edutainment and its development).
However, the expression of edutainment slowly becomes narrower extending from a conservative approach to learning. An exploration of edutainment’s nature is important as it will show the characteristics and problems of current edutainment titles, and point forward to new forms of educational use of computer games. In that sense edutainment to some degree serves as the villain in this article rather than a generic term for learning, education and computer games.

On an overall level, edutainment is a subset of educational computer games that is easily recognizable with a clear reward structure in the game separate from the educational experience. In Math Blaster!, the players must shoot down the right answer and on success one’s balloon will move towards a needle. The first player that pops their balloon wins. It is assumed that a constant shooting of the balloons will automatically lead to a conditioned response no matter the learning, context or previous experience. In the recent Math Missions Grades 3-5: The Amazing Arcade Adventure by Scholastic, you earn money for every correct answer. This money can be spent on buying arcades and you even get to run the arcade. Here the rewards are used as a way to push the learning forward without really being related to the learning experience as such. There is not really any connection between the arcade games and the math questions. It is not much different from a mother promising the noisy child an amusement trip if he will be quiet and do his homework.

We should not think of edutainment as a fixed genre but rather as different titles which share some problematic assumptions about motivation, learning theory, learning principles and game design while being produced, marketed and distributed differently than commercial computer games. The characteristics are outlined below based on my earlier work (Egenfeldt-Nielsen, 2005):

- **Little intrinsic motivation**: Edutainment relies more on extrinsic motivation through rewards, rather than intrinsic motivation. Extrinsic motivation is not really related to the game but consist of arbitrary rewards, for example getting points for completing a level. Intrinsic motivation would for example be the feeling of mastery from completing a level.

- **No integrated learning experience**: Usually edutainment lacks integration of the learning experience with playing experience, which leads to the learning becoming subordinated the stronger play experience. The player will concentrate on playing the game rather than learning from the game. One example is the skipping of educational text in a game and going straight for
the mini-games located in the game universe – the split between educational part and games is dominant.

• **Drill-and-practice learning principles:** The learning principles in edutainment are inspired by drill-and-practice thinking rather than understanding. This means that you will constantly get arithmetical problems like 2+2 memorising the results, while not necessarily understanding the underlying rules that make 2+2 = 4. Training rather than understanding is the defining experience.

• **Simple gameplay:** Most edutainment titles are built on a simple gameplay often from classic arcade titles or a simple adventure game with a world you can move around in. There are few innovations in the gameplay used in the genres, although there are of course exceptions.

• **Small budgets:** Edutainment titles are often produced on relatively limited budgets compared to commercial computer games and with less than state-of-the-art technology.

• **No teacher presence:** Edutainment never makes any demands on teachers or parents. Rather, edutainment assumes that students can simply be put in front of the computer with the edutainment title and learn the given content or skills. There is no required teacher or parent guidance, help or involvement.

• **Distribution and marketing:** They are distributed and marketed differently than commercial computer games for example through bookstores, supermarkets, schools and family magazines.

Edutainment games probably do teach children bits of things (see Table 1), but mostly edutainment is simple in its facilitation of learning experiences. Rote learning in relation to spelling and reading for pre-school and early school children may see some gains from edutainment. However, edutainment does not really teach the player about a certain area, but rather lets the player perform mechanic operations. In that sense edutainment is usually more about training than learning. This will lead to memorization of the practiced aspects but probably not a deep understanding of the skill or content – it will be parrot-like responses not really grasped by the student. Although this may work for some limited areas, like spelling and reading, this is a quite limited scope. In general, the parrot-like learning will result in weak transfer and application of the skills as it is not fundamentally understood, but only memorized as a mechanic action in the game environment
(Gee, Lieberman, Raybourn, & Rajeski, 2004; Jonassen, 2001; Schank, 1999). Improvements within the area taught by edutainment titles may show up on assessment, which formulates questions that are very close to the aspect learned, but is more doubtful if the assessment strays away from the specific aspect learned.

There is also common agreement that edutainment fails to integrate the learning with the computer game. Hence, a change of focus in the learning experience from the educational part to the game part. This results in weak learning experiences especially if you consider the time-on-task issue – the player won’t spend a lot of time on educational experiences, but rather gain a lot of game experience (Brody, 1993; Fabricatore, 2000; Facer, Furlong, J., Furlong, R. & Sutherland, 2003; Vandeventer, 1997). In general, the information in edutainment is fed to the player in chunks separated from the games like in the Swedish game *Chefren’s Pyramid*. Here you start with a presentation of Egyptian history and an overwhelming amount of facts that you scroll through and *sometimes* read. Then you start the game, where you walk inside a Pyramid finding different puzzles or small games like *Backgammon* – but these game dynamics have no connection to Egyptian culture, which the game is supposed to teach the player about. Most players will learn to play *Backgammon* though.

Edutainment is also criticized for supporting a superficial and problematic construction of learning in the new generations. As Okan (2003) asks, “Should learning be fun?” This is supported by Healy (1999) and Kafai (2001) who ask whether we, in our eagerness to revolutionize learning, are undermining the very foundation for learning. Students need to be able to endure frustration during learning and stay on track despite problems. This is argued to be rare in edutainment titles and that may be right, but it is certainly not an inherent feature of computer games in general. Frustration and challenge is central in Gee’s (2004) account of the learning qualities of the commercial computer game *Rise of Nations*.

The dynamics found in edutainment are also apparent in the e-learning industry, where low budgets, high amount of mediocre contents and craze for ease of use has led to the lowest denominator. There is little weight on the quality of titles as the market is unable to evaluate the products. The decision-makers buying the e-learning tools are not the ones using them (Aldrich, 2003). This parallels parents choosing the educational titles for their offspring. Although a few parents will sit and play the educational title with their children, they are still quite detached from the playing and most engage superficially with the computer game (Buckingham & Scanlon, 2002).

Overall, the shortcomings of edutainment has let to an overall negative attitude towards edutainment titles. There is, to put it mildly, widespread
scepticism towards almost any aspects of edutainment. The gameplay, learning principles and graphics are all criticized heavily by users, both children and parents, really starting in the early 1990’s (Brody, 1993; Buckingham & Scanlon, 2002; Egenfeldt-Nielsen, 2005; Leyland, 1996).

**Learning Outcome From Educational Use of Computer Games**

Looking at the research into educational use of computer games, one is struck by the quite optimistic tones from most studies; however, one should be cautious. Indeed many of the studies have severe flaws related to researcher bias, short exposure time, no control group and lack of integration with previous research. Overall, this undermines the strength of each study – the incremental learning process within the research field is as of yet still weak.

Table 1 presents an overview of quantitative studies on educational potential of computer games. It should be stressed that most of the studies use computer games as the sole teaching style. The studies examine whether computer games work as a viable supplement primarily during school time. Overall, one must say that the current findings are actually more positive and promising than educational use of non-electronic games (for an overview see Egenfeldt-Nielsen (2005)), but it is hard not to be sceptical as the method flaws are severe. We can certainly say that you learn from computer games but the support for saying something more valuable is weak. The current studies do in most instances not compare computer games with other teaching styles, which is really the ultimate test.

In the following, I will focus on the studies that cover strategy games and have some relation to teaching of social studies, mainly to illustrate the problems with existing research within the area. Both of the studies examine SimCity 2000, which has from its release been emphasized as ripe with learning potential (Becta, 2001; McFarlane, Sparrowhawk, & Heald, 2002; Pahl, 1991; Prensky, 2001).

The most interesting study on the effectiveness of using computer games for teaching is by Betz (1995). It is characterized by operating with a control and experimental group, actually comparing the educational use of computer games with a different teaching style. The participants in the study were freshman students in an engineering technology course with one class assigned as experimental group; another freshman class is the control group. The computer game was presented as a computer simulator and two weeks
### Table 1
An Overview of the Studies Into the Effectiveness of Educational Use of Computer Games

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Year</th>
<th>Genre</th>
<th>N</th>
<th>Subject</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levin</td>
<td>1981</td>
<td>Action</td>
<td>-</td>
<td>Math</td>
<td>Computer games are motivating, engaging and ultimately successful in teaching children the planned math concepts. Computer games may be especially suitable for teaching different ways of approaching math that caters for individual differences.</td>
</tr>
<tr>
<td>Dowey</td>
<td>1987</td>
<td>Puzzle</td>
<td>203</td>
<td>Dental health</td>
<td>Children learn best from a combination of teaching and computer games but although they learn about dental hygiene this does not transfer into change of everyday practice.</td>
</tr>
<tr>
<td>McMullen</td>
<td>1987</td>
<td>-</td>
<td>37</td>
<td>Science</td>
<td>The drill-and-practice computer game was not found to have any effect on the learning, neither short-term nor long-term. However, the students playing the computer game indicated that they thought they had learned more.</td>
</tr>
<tr>
<td>Jolicoeur &amp; Berger</td>
<td>1998a; 1998b</td>
<td>Fractions</td>
<td></td>
<td>Spelling</td>
<td>You learn from computer games, but educational software is more effective.</td>
</tr>
<tr>
<td>Wiebe &amp; Martin</td>
<td>1994</td>
<td>Adventure</td>
<td>109</td>
<td>Geography</td>
<td>They find that there is no difference in learning geography facts and attitudes between computer games and teaching activities not on a computer.</td>
</tr>
<tr>
<td>Sedighian &amp; Sedighian</td>
<td>1996</td>
<td>Strategy</td>
<td>200</td>
<td>Math</td>
<td>The learning outcome is critically affected by teachers’ integration of computer games and traditional teaching, but computer games prove highly effective.</td>
</tr>
<tr>
<td>Betz</td>
<td>1995</td>
<td>Strategy</td>
<td>24</td>
<td>Engineer</td>
<td>Finds that computer games increase motivation and learning.</td>
</tr>
<tr>
<td>Thomas et al.</td>
<td>1997</td>
<td>Adventure</td>
<td>211</td>
<td>Sex education</td>
<td>Students learn from playing the computer game both on specific knowledge items and in self-efficacy.</td>
</tr>
<tr>
<td>Brown et al.</td>
<td>1997</td>
<td>Action</td>
<td>59</td>
<td>Diabetes</td>
<td>The study finds that children can learn about diabetes from computer games changing everyday habits.</td>
</tr>
<tr>
<td>Klawe</td>
<td>1998</td>
<td>Adventure</td>
<td>200</td>
<td>Math</td>
<td>Computer games are effective in teaching students about math.</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Year</td>
<td>Method</td>
<td>Participants</td>
<td>Subject</td>
<td>Findings</td>
</tr>
<tr>
<td>-------------------</td>
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<td>--------------</td>
<td>------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Adams</td>
<td>1998</td>
<td>Strategy</td>
<td>46</td>
<td>Urban geography</td>
<td>Computer games increase motivation and teach students about the role of urban planners (affective learning).</td>
</tr>
<tr>
<td>Noble et al.</td>
<td>2000</td>
<td>Action</td>
<td>101</td>
<td>Drug education</td>
<td>Students taught by the computer games, found the experience motivating and wanted to play the computer game again.</td>
</tr>
<tr>
<td>Turnin et al.</td>
<td>2000</td>
<td>-</td>
<td>2000</td>
<td>Eating habits</td>
<td>Computer games can teach students about eating habits and lead to significant change in everyday habits.</td>
</tr>
<tr>
<td>Feng &amp; Caleo</td>
<td>2000</td>
<td>-</td>
<td>47</td>
<td>Spelling and math</td>
<td>Children that played computer games learned better than peers not using computer games, mostly in spelling.</td>
</tr>
<tr>
<td>Becker</td>
<td>2001</td>
<td>Action</td>
<td>-</td>
<td>Program.</td>
<td>The study testifies to the increased motivation in connection with computer games. Games are found to be more effective and motivating than traditional teaching.</td>
</tr>
<tr>
<td>Lieberman</td>
<td>2001</td>
<td>Action</td>
<td>Asthma, diabetes,</td>
<td>A review of a number of research projects that support that you can learn from computer games.</td>
<td></td>
</tr>
<tr>
<td>Rosas et al.</td>
<td>2003</td>
<td>Action</td>
<td>1274</td>
<td>Reading and maths</td>
<td>Computer games increase motivation, and there is a transfer of competence in technology from using the computer game.</td>
</tr>
<tr>
<td>McFarlane et al.</td>
<td>2002</td>
<td>-</td>
<td>-</td>
<td>All subjects</td>
<td>The study finds that teachers in general are sceptical towards the learning of content with computer games. However the learning of general skills was appreciated.</td>
</tr>
<tr>
<td>Gander</td>
<td>2002</td>
<td>Strategy</td>
<td>29</td>
<td>Program.</td>
<td>The study finds that computer games are effective for especially teaching specific knowledge.</td>
</tr>
<tr>
<td>Squire et al.</td>
<td>2004</td>
<td>Simulation</td>
<td>96</td>
<td>Physics</td>
<td>Students using the simulation game performed better compared to the control group.</td>
</tr>
<tr>
<td>Egenfeldt-Nielsen</td>
<td>2005</td>
<td>Strategy</td>
<td>72</td>
<td>History</td>
<td>Students initially learn the same in history when using video games but have better retention.</td>
</tr>
<tr>
<td>Buch &amp; Egenfeldt-Nielsen</td>
<td>2006</td>
<td>RPG</td>
<td>72</td>
<td>Social studies</td>
<td>60% students on self-assessment found they learned more with Global Conflicts: Palestine than a traditional course. Almost 40% that it was around the same.</td>
</tr>
</tbody>
</table>
before the reading assignments the experimental group received a head start to ensure they played the computer game. Both of the groups received the same reading and test after the study. The correlation was tested with the Mann-Whitney test, and showed that the experimental group did better in the test (p< 0.05). The survey results from the experimental test were also quite positive as most students preferred the computer simulator, used it more than the reading, enjoyed it more, tended to discuss it with friends, thought the computer game was less hard than reading and found that the computer game helped them understand the reading. Overall the positive aspects of the experience were overwhelming and support educational use of computer games.

The study, however, does have some methodological flaws on closer examination that seriously challenge the validity, reliability and generalization of the results to commercial computer games in general. First of all, the manual for the computer game is quite dense on the topic of urban planning. It actually points to relevant reading, which hardly can be said for most commercial computer games. The extra material points to the game designer Will Wright’s special interest in providing an educational experience. The random sampling is problematic as it consists of classes, which are not normally considered acceptable as a random sampling (Coolican, 1994). A class may have different established dynamics or other hidden variables which influence the results. These problems are aggravated in Betz’s study as little effort is done to examine if there exists basic differences between the classes, especially a pre-test exam to establish the academic level would have been critical to raise the scientific quality. This is, however, often hard in an educational setting and a pre-test could also steer the students in a particular direction, challenging the validity of the study.

The most serious flaw is, however, that the results don’t really measure computer games compared to other teaching, but rather as an extra supplement. The experimental group and control group get the same reading, but the experimental group also plays the computer games. It is hardly surprising that extra time-on-task within a somewhat related area that also sparks discussion and interest, increases learning. On the other hand, it is of course interesting that you can get students to spend more time on a subject through computer games. Still, the real question is whether the time used on the computer game is sufficiently legitimized by increased learning, compared to other teaching methods. In other words, the study does not show us how big the impact of the computer games is and it fails to show if the same result could have been obtained by reading an extra hour instead of playing. Of course the extra hour provided by the computer games would perhaps never emerge with traditional teaching material.
In another study of *SimCity 2000*, Adams (1998) also found support for using computer games within the subject urban planning. Adams takes a more structured approach to teaching, with the computer giving the students different experiments to carry out in the game. The outcome of the study was evaluated through essays and the student’s preference. The course was voted a favourite project by 48% of the students, outperforming the eight closest projects significantly. The study, however, lacked more systematized evaluation of learning with a control group or pretest-posttest set-up. All the problems in Betz’s study reported above, also holds true for this study. Although the study finds the students do learn from computer games, it is quite unclear what the exact effect is and how it compares to traditional teaching forms.

Overall, the 20 studies in Table 1 overwhelmingly support that you learn from computer games, and that most students appreciate games in education. However, the studies in general do not ask the hard questions concerning educational use of computer games. None of the studies actually compare computer games to other teaching methods or activities, to examine whether computer games are worth the initial efforts in learning the interface, setting up computers and other practical problems (Egenfeldt-Nielsen, 2004). Most of the studies are one-shot studies with a lack of knowledge of the characteristics of computer games and with weak connections to earlier research. We need to raise the bar for educational use of computer games – asking under what circumstances do we learn and how do computer games compare with other learning experiences. It is hardly enough to establish that we learn from computer games as this is essentially true for any activity we engage in. The real question is what computer games offer that set them aside from existing educational practice whether this be the use of commercial entertainment games, edutainment titles or a mix of the two.

**Learning Theories Across the Different Areas**

Figure 1 identifies different views on educational use of games, which entails the positioning of different learning theories, the historical progression evident in learning theories, and the connection with educational computer games’ use (Figure 1).
Figure 1. The model shows the different generations characteristics, and how they emphasis different learning theories.

The starting point is a focus on learning through changing the behaviour of students. Behaviourism is interested in directly observable actions split into a stimuli and a response. The theory claims that you learn by practicing skills and contents through reinforcements and conditioning. There is little initial interest in differences between learners, settings and material learned. Through practice you will learn the correct response to a certain stimuli. The 1st generation perspective corresponds with the dominating expression of edutainment, which assumes that learning occurs when you unreflectively practice a skill enough times. Some edutainment titles try to differentiate between learners, and take into account different ways of learning, which points towards 2nd generation educational games. Research from a behaviourist perspective within educational use of computer games tend to focus on extrinsic motivation opposed to intrinsic motivation. In extrinsic motivation you get a reward for engaging in an activity, and are not motivated by the activity by itself. The actual research from a strictly behaviourist perspective is somewhat limited, but the approach is rampant in dominating edutainment titles (Brown, 1997; Lieberman, 1997; Lieberman, 2001; Prensky, 2001, 2004).
In the cognitivist approach, the learner becomes the centre of attention. The cognitivist approach criticizes the automatic relation presented in behaviourism between stimuli and response. They see the focus on behaviour as skewed, neglecting other important variables, namely the cognitive structures underlying the responses, which are crucial for gaining intrinsic motivation and meaningful learning. People have underlying schemas that represent what have been learned. When students approach a new task you need to take into account that they have different schemas. These schemas make up limits and options for each learner that can be addressed through scaffolding information, chunking information, multimedia information, and present material in ways that correspond with cognitive abilities. There are limits to the information you can process, better ways to solve problems and different ways of perceiving information.

I call this the 2nd generation approach, using computer games for educational purposes. Here you will try to build educational computer games that present information in ways that are appropriate to this specific learner, and open up different ways of approaching the same topic. The multimedia experience is central for providing these different ways to a topic, and multimedia also supports the player’s progression at his own speed and ability. Scaffolding information becomes even more central than in the previous generation. The 2nd generation also differentiates itself from the 1st generation through its interest in meta-skill: problem-solving, analysing, perceiving, and spatial ability. The trend was apparent from the mid-1980’s to the mid-1990’s where hand-eye coordination, problem-solving and other cognitive skills were heavily researched. It is still found in many educational computer games and educators’ preferences for the problem-solving abilities that can be harvested from playing computer games (Klawe, 1998; Klawe & Phillips, 1995; Malone, 1980; Malone & Lepper, 1987a; Malone & Lepper, 1987b; McFarlane et al., 2002; Whitebread, 1997).

Constructionism is the bridge between 2nd and 3rd generation games with a strong focus on the learner while involving the setting. For constructionists, the artifacts in the environment can be used to mirror the learning processes from the outside. At the same time, the artifacts provide a platform for exploring new material, mostly from an individual perspective, but also in collaboration. This is further stressed in situated learning and the socio-cultural approach, where the learning process is seen as mediated in a social context. In a social context physical artifacts (or tools) are a good facilitator for learning new concepts, as they give a shared starting point and potentially show the student new ways to proceed (Wenger, 1999; Wertsch, 1991, 1998).
The construction of knowledge, as meaningful through your orientation in a social context, becomes paramount in 3rd generation games. Instead of conceiving content, skills and attitudes as residing with the user, knowledge is transferred to culture, tools and communities. Wenger (1999) talks about the interplay between participation and reification, where participants will continuously construct a community through the negotiation of meaning. To support this negotiation reifications are constructed like school culture, agendas, conception of computer games, and hi-score tables. You learn new things by participating in these communities and appreciating and negotiating what counts as knowledge, skills and attitudes. It is worth stressing, that in this perspective the educational use of computer games ties much closer to the surrounding culture. When you use computer games in schools, the students will draw on a variety of cultural capital to make this experience meaningful. This process is also reciprocal, as the renegotiation of computer games in schools will also lead to new cultural capital being generated, which is useful outside of school.

The 3rd generation approach doesn’t exclusively focus on the specific computer game, but looks at the broader process of educational use of computer games. It stresses the key role of providing a social context that facilitates asking the right questions and going the right places. Here, the teacher becomes central as facilitator for balancing the educational computer game experience as connected to school, other practices and drawing on other practices to expand the scope of the computer game from just playing to learning. The third generation is less interested in the actual content in computer games, but focus more on the students’ engagement with the computer game (Egenfeldt-Nielsen, 2005; Gee, 2003; Squire, 2004).

The discussion above highlights the need for a broad learning approach to computer games consisting of several layers. We need to appreciate, how content, skills and attitudes are not just transferable, and neither merely a question of interaction between player and computer game. On the other hand this interaction may very well be severely limited by the concrete implementation of the computer game and its contents. An active, interested and strong community that thinks of computer games as its preferred way to learn history, will not get very far if the computer game does not scaffold information, has a problematic interface, assumes existing knowledge nowhere easily found and bombards the students with overwhelming amounts of information. It will certainly also play a role with the basic reward structure, habituation and connecting experience in time. Students will be steered in directions by being awarded points, getting a hi-score and beating other players. They will learn that *sword* refers to the object sword every time they
pick up a sword object with text below it. And they will slowly be less impressed by what this specific educational computer game has to offer them. The strong audiovisual universe will also serve to create a stronger learning experience.

It should be stressed, that each generation is carried forward to the next, but de-emphasised. The learning mechanisms in behaviourism are still at play in next-generation use and so are the ones from cognitivism but they are conceived in a broader overall frame. Hopefully, a more inclusive understanding of educational use of computer games will bring us beyond the current lack of innovation in the market – letting research inform a new generation of strong educational game products.

**CONCLUSION**

There are positive research results on the benefits of educational use of computer games, but it still seems that the real breakthrough is some years away, when it comes to the majority of teachers using computer games in an educational setting.

Unfortunately many publishers and developers within the area are stuck in the early generation of games that provide much low hanging fruit, but also have a lot of limitations as described above. This does far from imply that these games do not work, but rather that there is much room for further improvement. The first generations of educational use neglect the importance of the teacher and ignore many of the challenges an educational setting sets. A third generation educational use of games demands more of the teachers as the teacher becomes crucial for the facilitation of the learning experience and the debriefing following the game sessions. In third generation, computer games serve much more as small and condensed micro-universes that provides rich and compelling experiences that can be explored further with a variety of teaching methods.

From a commercial perspective, third generation is a hard sell, because it punctures some of the widespread fantasies about games as the magic wand that can be swung to solve all problems in education. Furthermore, in a third generation perspective, games actually need to be tailored much closer to the actual learning content – it is not enough the wrap some arbitrary content in a trivia game framework. And perhaps the hardest challenge is that third generation challenges the teacher to revisit and rethink teaching and learning assumptions, because the games hook into other teaching practices and fit with recent research on how people actually learn. A third
generation computer game is not content to be sitting on a computer in a distant lab (like much existing edutainment), but wants to mingle with other curriculum and practice. From an educational perspective this should make us want more games, and indeed voices are increasingly heard.

For educational use of computer games to really mature, I believe we have to learn one important lesson from the games industry – computer games are global and expensive merchandise. To make it a viable business that attracts entrepreneurs we have to find ways for educational computer games to become global without just being about spelling and math. This is the only way to really set the right level of ambition that makes it realistic to harness the power of computer games – a power we see demonstrated every-day when people spent hours in game worlds alone or with other. We do not have to see the same quality as commercial computer games but we have to get considerable closer than today. This challenge requires a true alliance between researchers, policy-makers and developers to identify the best starting points for such endeavors².

References


Notes

1 This chapter focuses specifically on the research on educational use of computer games, and does not engage with the relevant adjoining area of educational use of simulations and games. This area does have a number of reviews that can serve as a solid starting point (Bredemeier & Greenblat, 1981; Clegg, 1991; Dorn, 1989; Randel et al., 1992; Van Sickle, 1986).

2 A good example of such an alliance is “Global Conflicts: Palestine,” a research project that started almost 3 years ago and is now a commercial product (http://www.globalconflicts.eu/).
First Steps and Beyond: Serious Games as Preparation for Future Learning

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Electronic game technologies can prepare novice learners for future learning of complex concepts. This article describes the underlying instructional design, learning science, cognitive science, and game theory. A structural, or syntactic mapping (structure mapping), approach to game design can produce a game world relationally isomorphic to a targeted complex concept. Such a game world should provide experiential and reflective gameplay to help learners form a preconceptual mental model of the targeted concept. A preparation for future learning (PFL) approach would follow gameplay with direct instruction.

Introduction

Winning an electronic game is performance-based evidence that a player has mastered aspects of a game world. The player has learned navigation, culture (rules), skills, and knowledge necessary to succeed within an unfamiliar landscape. In this sense people learn through gameplay, and electronic games foster learning (Gee, 2003). As sales and usage data attest (Interactive Digital Software Association, 2002; Woodcock, 2006), successful electronic games are very good at motivating people to play them. This is because gameplay can induce the state of intense concentration, control, and engagement known as flow (Csikszentmihalyi & Larson, 1980; Fullerton, Swain, & Hoffman, 2004; Salen & Zimmerman, 2004), and flow is intrinsically rewarding.
Can education leverage the mechanics that are so successful in fostering flow in electronic games designed for entertainment? A formalism for designing educational environments that incorporates gaming technologies will enhance the ability to engineer flow experiences connected to academic learning outcomes. Learning outcomes are categorized into psychomotor skills, cognitive strategies, attitudes, procedural knowledge (learning how), or conceptual knowledge (learning what) (Anderson & Lebiere, 1998; Gagné, Briggs, & Wager, 1992). The Selenology Exploration – Ludic Environments – Networked Education (SELENE) group at Wheeling Jesuit University’s Center for Educational Technologies® has developed an approach to the design of domain-specific games that prepare novices for future learning of complex concepts. Complex concepts are systems of subconcepts, objects, attributes, and inter/intraconcept relations. These concepts are defined rather than directly experienced. Complex concepts are key components of meaningful learning. Unfortunately, expert review of typical commercial, off-the-shelf electronic games indicated that their gameplay is more likely to support learning outcomes involving procedural knowledge or relational rules than complex conceptual knowledge (Reese, 2006). This suggests a need for educational games that support conceptual learning and a methodology through which to design them. The SELENE approach addresses this need by preparing students for the “what” of learning. It is based upon a framework drawn from three strands: flow and adaptive expertise, structure mapping, and preparation for future learning. These are introduced briefly within this section and then reviewed within later sections in more detail.

**Flow and adaptive expertise.** Within this discussion the concepts of flow and adaptive expertise (Schwartz, Bransford, & Sears, 2005) are used (a) to explain how typical gameplay flow states support growth in players’ skill in executing procedures and relational rules and (b) to suggest the characteristics and role of reflective tools (Norman, 1995) that enable learners to construct flexible conceptual knowledge by testing hypotheses (concepts-in-use, see Jonassen, 2006). Reflective tools support a second type of flow state produced through thinking that requires effort and reflection.

**Structure mapping and the SELENE approach.** Cognitive structure underlying human analogical reasoning (Gentner, 1983) is analogous to the structure underlying a game world (Fullerton, Swain, & Hoffman, 2004). In both cases goal structures motivate the way humans perceive and react toward that underlying relational structure (for goal structure and analogical reasoning, see Holyoak, Gentner, & Kokinov, 2001; Holyoak & Thagard, 1989; Spellman & Holyoak, 1996; for goal structures and games, see Fullerton et al., 2004). This explains why structure mapping theory of ana-
logical reasoning works for designing educational game worlds that model the relational structure of targeted learning outcomes – especially those of complex concepts. Complex concepts are especially challenging for novice learners (e.g., Gabel, 1999; Hestenes, Wells, & Swackhamer, 1992; Lawson, Alkhoury, Benford, Clark, & Falconer, 2000). Gameplay experience in an appropriately engineered game world could provide just the right prior knowledge to help learners construct viable, robust, and coherent knowledge for complex science concepts (e.g., force, mass, heredity, density, or mass-mass/mass-mole relationships).

**Preparation for Future Learning (PFL) and the Double Transfer Design.** The transfer literature provides a relatively new experimental design and paradigm that can be applied toward studying game-based learning environments for equipping learners with solid, grounded, relevant prior knowledge. Developed by Bransford, Schwartz, and their colleagues (Bransford & Schwartz, 1999; Schwartz & Bransford, 1998; Schwartz et al., 2005; Schwartz & Martin, 2004), the double transfer design enables researchers to study instructional interventions that prepare students for learning from instruction that follows. That is, the interventions provide learners with experiences that serve as prior knowledge and enable meaningful engagement with direct instruction. They call this type of intervention preparation for future learning (PFL).

**The Preparation for Future Learning Model**

The PFL paradigm was formalized by Bransford and Schwartz (e.g., Bransford & Schwartz, 1999; Schwartz & Bransford, 1998; Schwartz et al., 2005; Schwartz & Martin, 2004). They were interested in a methodology that would improve assessment sensitivity for measuring transfer in learning. Their research demonstrated that typical assessment paradigms, such as asking learners to solve problems, often lack the sensitivity to measure knowledge gains due to educational interventions because they sequester learners away from external resources. They suggested following educational interventions with a learning resource and then assessing subjects who had access to the resource. The learning resource is some form of direct instruction. A video lesson or a lecture by a teacher might serve as a learning resource. Bransford, Schwartz, and their colleagues repeatedly find that subjects who receive PFL interventions and the learning resource outperform those who have not. The PFL method is specific to instructional interventions that prepare learners with prior knowledge, what Hatano and Inagaki
Reese (1986) identified as a preconceptual mental model. The method serves as an anchor for learners who use it to connect new knowledge to existing cognitive structure.

**A place for direct instruction.** Bransford, Schwartz, and Brown and their colleagues (Bransford, Brown, & Cocking, 2000; Schwartz & Martin, 2004) stressed that direct instruction has a role within pedagogical approaches that support constructivism. This is because constructivism is a theory of knowing rather than a theory of pedagogy. Von Glasersfeld’s (1995) theory of radical constructivism recognizes an objective reality but warns that an individual’s knowledge is not the same as objective reality. However, an individual’s knowledge can be viable. Viable knowledge is “actions, concepts, and conceptual operations” that “fit the purposive or descriptive contexts in which we use them” (p. 14). The approach described herein aligns with this orientation.

**Mental models and formal education.** A mental model is an individual’s private and personal cognitive representation (Gilbert, 2005). A mental model of a conceptual domain would represent a system of objects, the relations that connect them, and their attributes (Gentner, 1983). Learning involves knowledge construction, which entails construction of mental models. A viable mental model empowers an individual to successfully interpret and interact with the external world (von Glasersfeld, 1995). In formal education a learner must construct a viable mental model of the targeted knowledge. A viable mental model is robust, coherent, and normative (Linn, Eylon, & Davis, 2004). Formal education targets disciplines and aligned learning goals. A viable mental model enables an individual to successfully interpret and transact within a targeted discipline.

**Adaptive Expertise and Reflective Tools**

Hatano and Inagaki (1986) defined routine expertise as efficient performance of procedural knowledge (decision rules and executive strategies) along with skills for applying that knowledge. Expertise has traditionally been transmitted “without undue difficulty through direct observation, verbal instruction, corrective feedback, and/or supervision” (Hatano & Inagaki, 1986, p. 263). Hatano and Inagaki distinguished between routine expertise and adaptive expertise. Routine expertise concerns procedural knowledge and skills. In addition to these, adaptive expertise requires that the individual possess an apt mental model (understanding) of the targeted domain. One indicator of understanding is when the individual can judge “not only the
conventional version of the skill, but its variations as appropriate or inappro-
appropriate and/or can modify it according to the changes in the constraints”
(Greeno, 1980, as cited on p. 263). Constructing an apt mental model re-
quires (a) each individual to collect “data or empirical knowledge” (p. 264)
over varying conditions that reveal the relationships between domain vari-
ables, and (b) prior knowledge, which Hatano and Inagaki labeled precon-
ceptual knowledge. In alignment with the SELENE approach, Hatano and
Inagaki wrote:

A model may be obtained primarily through perception, as a
somewhat vague “image” of the object – what it is like. It may also
be derived indirectly, especially when mechanisms are invisible, on
the basis of its functions or reactions to external stimulation. In the
latter it is often borrowed from another domain through analogy.
Prior knowledge of constituent parts, if available, is also used in
this derivation (p. 264).

Thus, conceptual knowledge is essential to adaptive expertise, and peo-
ple often construct preconceptual knowledge through analogical reasoning.
Adaptive expertise grows as an optimal balance of routine expertise and in-
novation. Flow grows as an optimal balance of skills and challenge (Csik-
szentmihalyi, 1997). Mapping between adaptive expertise and flow suggests
the two are analogous experiences (Reese, 2006).

Donald Norman (1995) recognized two types of flow experience. While
both involve focused attention, people are most likely to experience flow
when “the experience is driven by the events” (p. 29). This is experiential
flow. Norman described the “powers of the experiential mode: The mind is
externally driven, captured by the constant arrival of a barrage of sensory
information” (p. 33). The second type of flow experience requires self-con-
trol and reflection. It is self-paced. This allows the learner time to compare
and contrast concepts and information. It supports reflective learning. Re-
flexive learning requires structure and organization, but the naïve learner
lacks the conceptual or preconceptual model to direct structuring or organi-
zation. A metaphor-enhanced game world can provide that structure. Game
worlds can provide reflective tools that scaffold the player’s ability to orga-
nize, compare, and contrast domain objects and subconcepts. For example, a
game introducing lunar geology (selenology) and the concept of differentia-
tion might involve player transactions with a reflective tool that supported
comparison of how high and low density materials in a molten state respond
to gravity. When reflective tools are incorporated into an educational game,
they must be designed as integral and motivated components. Gameplay in-
volving the reflective tool must advance the player toward the game goal
(which should be an analog of the targeted learning goal).
The SELENE Approach: An Application of Structure Mapping Theory

SELENE has applied structure mapping theory (Gentner, 1983) to the design of game-based learning environments targeting introductory complex concepts. Domain specification requires identification of key subconcepts and objects and their intra- and interrelations. In a process similar to typical task analysis for conceptual learning outcomes, a team consisting of the instructional designer (a metaphor specialist) and content area experts must come to consensus about a specification of the target domain’s relational structure. They are joined by the game designers for the next stage, during which they specify the analog domain. This is a nontrivial task. Specification of one chemistry domain consisting of eight subconcepts and one analog took more than 150 hours. The specification steps are described elsewhere (Reese, 2003, in press; Reese & Coffield, 2005).

Instructional environments must activate learners’ prior knowledge (Gagné et al., 1992). Learners require adequate and pertinent prior knowledge to construct a viable mental model of a targeted concept. When the concept is concrete, the instructional environment can provide concrete transactions that support the learner in forming and refining hypotheses to (a) discriminate instances of the concept and (b) apply it. When complex, defined concepts are the targeted learning goal, the real world often does not and cannot provide embodied experience analogous to the targeted domain. When people use prior knowledge to build their mental models of complex and unfamiliar concepts, they are often engaging in the cognitive process of analogical reasoning. When prior knowledge is not available, the learning environment must provide experiences that ground new learning (Merrill, 2002). In other words, the learning environment must provide preparation for future learning. Game-based environments designed and developed as target domain analogs may provide a solution.

Metaphors are a good solution because analogical reasoning is ubiquitous in human cognition and the basis for most complex thought (Hummel & Holyoak, 1997, p. 427). People construct primary metaphors from their embodied experiences (Lakoff & Johnson, 1980, 1999), using perceptions of transactions with the concrete world to make sense of subjective, abstract, and unfamiliar domains. This suggests that people should be able to construct metaphors from virtually embodied transactions within a game world.

Analogy is a mechanism for transfer. People transfer the relational structure of the source domain onto the target domain (Holyoak & Thagard, 1989). People naturally use analogical reasoning to support mental model construction for concepts. Through the application of the principles of ana-
logical reasoning (i.e., structure mapping theory, see Gentner, 1983; Gentner & Markman, 1997), virtual environments can be designed to provide virtually embodied experiences that are analogous to the targeted domain’s relational structure.

Mapping is a process of putting the target domain into one-to-one correspondence with the source domain (Gentner, 1983). If one were to draw a diagram that illustrated a source domain A, it would indicate domain objects, their properties, and the relations that connect them within the system (see Figure 1, note that the diagram does not illustrate properties). Objects are often represented by ovals labeled by an object name. The relations that join objects are indicated by arcs (directional arrows), which are labeled with a phrase to represent the relation. During the mapping process people project the relational structure of the source domain onto the target domain. People infer that the target domain is structured just like the source domain. If you were to draw a target domain B structure resultant from a mapping from domain A, it would indicate domain objects and the relations that connect them within the system. Using the notation system described above, objects are labeled ovals, and relations are labeled arcs. With the exception of the names labeling the objects within the ovals, the representations of the target B and source A domain would look identical.

![Figure 1. Concept map representation of a hypothetical source domain A and its isomorphic target domain B.](image_url)
Four other principles of analogical reasoning are essential to the SE-LENE approach: (a) goals, (b) highlighting, (c) parallel connectivity, and (d) systematicity. These principles determine procedures for domain specification and source-to-target mappings.

**Goals.** Analogical reasoning is a pragmatic process (Gentner, 1989; Gentner & Holyoak, 1997; Holyoak & Thagard, 1989, 1997). That is, the selection of an analog along with the mapped structure is constrained by the goal structure that has motivated the mapping. Game designers use goal structures to motivate gameplay. Educational games require goals that support source-target mappings.

**Highlighting.** Pragmatic constraints determine that the analogizer will highlight pertinent areas of a source domain and map only those areas onto the target (Gentner & Markman, 1997; Kurtz, Miao, & Gentner, 2001; Lakoff & Johnson, 1980). Source and target domains are never completely identical. If they were, they would be identities rather than metaphors. Designers can apply highlighting to game world design by selecting those components of the source domain that are salient to the targeted learning.

**Parallel connectivity.** Isomorphism constrains mapping such that one and only one object from the source domain is mapped onto the target domain object. It is helpful to picture the source and target domains each as a tree with branches. For example, concept 5 in Figure 1 has three branches (leading to nodes 6, 7, and 8). A branch in the target domain is constrained to having as many sub-branches as its source domain analog: a condition of three branches in the source requires three branches in the target. Three branches from the source do not map as two branches in the target. They don’t map as one branch in the target. In fact, an analogizer faced with three source domain branches and only two target domain branches would infer a third, isomorphic target branch. This inferential process is the source of many scientific discoveries (e.g., black body radiation, see Hawking, 1992). A *theory constitutive metaphor* is one that provokes scientific discovery (Boyd, 1993). An instructional metaphor is one that promotes an individual’s ability to infer viable relational structure of a targeted domain.

**Systematicity.** A domain with deeper relational structure (a tree with deeper layers of dense sub-branching) has more systematicity. People prefer to map domains with deep relational structure. The deeper the relational correspondence between source and target domain, the more likely people will construct a mapping between the two (Gentner, 1983, 1993). People also prefer to play electronic games with deep relational structure. Top game designers advise that games should be simple (accessible), hot (flow-inducing), and deep (Hawkins, 2000). Thus, systematicity aligns with both game
design and analogical reasoning. This suggests that game worlds can be rich analogs of targeted complex concepts. Metaphor-enhanced game worlds should support the richness of deep play in that they allow learners to think deeper and deeper about the relational structure of the to-be-learned content.

People construct a mental model of a concept by building and refining hypotheses while using the concept (concepts-in-use, see Jonassen, 2006). Initially, this is a preconceptual mental model. People test this model by applying it to the targeted situation and refining it through iterative cycles. People are usually unaware of this ubiquitous process. The hypothesis testing that occurs within game world possibility spaces appears to mirror this real world experience. Thus, game worlds could provide an instructional environment through which players construct mental models of targeted concepts as concepts-in-use.

**Complex concepts and analogical reasoning.** People are embodied entities. That is, they interact with a physical world through and using their bodies. Understanding, learning, and the human ability to manipulate the environment derive from the ability to group objects, events, and symbols together based upon common characteristics (Merrill, Tennyson, & Posey, 1992). These groupings are concepts. People conduct embodied interactions with concrete concepts. A chair is a concrete concept. People can see chairs, paint chairs, sit on chairs, and lift chairs.

Concepts are mental models. The mental models of science are expressed, scientific, and often quite abstract. The abstract concepts concern properties, interactions, and systems that are too large, small, complex, subtle, or distributed in space or time for embodied interactions through human perceptual systems. In some disciplines, such as Newtonian physics, a human’s embodied, everyday experiences lead to commonsense mental models that are incompatible with science concepts. One example is the geocentric perspective that reinforces misconceptions about the causes of the phases of the moon (Gazit, Yair, & Chen, 2006). Commonsense inferences derived from everyday experience lead to mental models that conflict with Newtonian mechanics: “Students find Newton’s Third Law unreasonable, and they prefer some version of the dominance principle: In a conflict the ‘more forceful’ exerts the greater force” (Hestenes et al., 1992, pp. 143-144). Even great scientists such as Newton and Galileo have held some of the most important Newtonian physics misconceptions (Hestenes et al., 1992). These researchers and others (Lakoff & Johnson, 1980, 1999; Lakoff & Núñez, 2000) have found that people form conceptual metaphors based upon their embodied experiences. Those metaphors can act as prior knowledge, forming the foundation for new mental models of targeted scientific concepts.
The Game World: A Possibility Space for Learning

A digital game world is a system composed of virtual objects and relations among and within them (Fullerton et al., 2004). A game world affords player transactions with game objects that are controlled by the game system. Digital game design concerns the creation of gameplay experiences (Fullerton et al., 2004; LeBlanc, 2004). Gameplay and the game interface must introduce each player to a game world and enable the player to construct a viable mental representation of it (Wright, 2004). Thus, gameplay consists of interactions between the player and game objects that are directed and constrained by the relational structure between and the properties within game objects.

Each player forms a personal mental representation of the game world that is idiosyncratic. This is consistent with a constructivist orientation (von Glasersfeld, 1995). The representation consists of game world objects, relations, properties, and their response to player actions. This is the player’s mental model of the game world. A mental model is a “personal and private cognitive representation” (Gilbert, Boulter, & Elmer, 2000, p. 12). The player constructs a mental model by testing and refining hypotheses about the game world. Initial hypotheses are largely directed by a top-down mechanism, first impressions based upon prior experience and prior knowledge. The player refines those expectations because of bottom-up mechanisms based upon perceptions of game world transactions. A well-designed game provides feedback that reinforces a player’s construction of an increasingly viable mental model that enables the player to successfully interact with the game world (Wright, 2003, 2004).

When game worlds are clones of existing and well-known game genres, it is a relatively trivial matter for players to transfer knowledge from previous gameplay experiences to a new one. Modifications to the mental model are minor. Although all mental model construction results from hypothesis testing and successive approximations, novel games require a greater degree of mental model construction. Will Wright has called such explorative gameplay an instantiation of the scientific method (Sheffield, 2006). The simulation game type Wright invented provided a new genre with novel gameplay. Wright (2003) designed each of his simulation games (e.g., The Sims™, SimCity™, SPORE™) by selecting one or more overarching concepts. He provides gameplay that supports the targeted concepts by manipulating dynamics, topologies, and paradigms. He designs gameplay to support (scaffold) players to construct an initial mental model of gameplay and successively modify it to bring the players’ mental model into alignment with suc-
cessful gameplay (Wright, 2004). Wright conceptualizes a game world as *possibility space* sculpted by the game designer. His players learn the game world by forming successively more appropriate metaphors of gameplay and the game world that lead to viable mental models (Wright, 2006).

**Game Worlds and Gameplay as Preparation for Future Learning**

Squire (2006) argued that gameplay is designed experience: “Players’ understandings are developed through cycles of performance within the game worlds, which instantiate particular theories of the world (ideological worlds)” (p. 19). His description is analogous to Jonassen’s. To summarize, game worlds are apt environments for learning through analogical reasoning because:

- Game worlds are systems of objects and attributes and the relations that connect them.
- Gameplay within a game world simulates embodied experience within the real world.
- Gameplay engages flow states through reinforcement of goal structures.
- Game worlds can be designed over deep relational structure. They can have deep systematicity. They can support deep play.
- Players learn game worlds and gameplay through building and refining hypotheses.

Five cognitive requirements map from the real world analogical reasoning toward its application within instructional environments for concept learning. Table 1 lists them and the game world-real world analogs.

<table>
<thead>
<tr>
<th>Cognitive Requirement</th>
<th>Real World</th>
<th>Game World</th>
</tr>
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<tbody>
<tr>
<td>Embodied experience</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>System of objects, attributes, and their relations</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Concepts in use</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Deep systematicity</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Pragmatic motivation</td>
<td>X</td>
<td>X</td>
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Examination of human cognitive processes led the founding father of instructional design, Robert M. Gagné, to propose a sequence of instructional events that supports the way people learn. He suggested nine events of instruction. The third is to stimulate recall of prerequisite learning, which is relevant prior knowledge (Gagné et al., 1992, p. 190). Subsequent theorists have modified Gagné’s events (see, for example, Smith & Ragan, 1993), and others have proposed alternative models. Even in the latter, such as those for problem-centered learning environments (Merrill, 2002), the theorists identify activation of prior experience as a primary event of instruction. Activation of prior knowledge is a preliminary step across most instructional design methodologies.

Electronic games have the potential to support many aspects of the instructional environment. The place of an electronic game within instruction may well be a function of the type of learning outcome supported by the game. When the learning outcome is an introductory complex concept for which normal, lived, embodied experience does not provide viable prior knowledge, a virtual world analogous to the relational structure of the targeted conceptual domain and designed with game-based affordances can provide prior experience that prepares the learner for learning. Within a PFL approach the game does not carry the entire load of instruction. Level one gameplay must be followed by direct instruction (see Figure 2). Level two gameplay can be structured as a transfer environment of assessment of learning.

**Figure 2.** The double transfer paradigm as applied to design and assessment of learning in PFL educational games targeting complex concept learning outcomes.
Electronic games are powerful technology tools. When game worlds are inadequately specified, players will learn the targeted concept, but they will learn it wrong. SELENE has proposed a formalism for the design of digital learning environments enhanced by structure mapping theory and game-based technologies. Circumscribed by the complex concept learning objective, SELENE has identified an alignment among PFL, analogical reasoning, and flow and used it to develop a theoretical framework. The framework supports a research agenda for design and assessment when educational games prepare students for future learning of abstract concepts. The SELENE approach provides one way to optimize an embodied reality. This discussion suggests:

- A structure mapping approach will increase the systematicity of game world analogs and the viability of the mental models learners construct during gameplay.
- Educational game worlds should support both experiential and reflective cognition.
- Metaphor-enhanced game worlds can prepare learners with apt preconceptual knowledge.
- Game designers advocate for the player. Subject-matter experts advocate for the content. Instructional game specialists must advocate for the learner.

The success of Will Wright’s games suggests that game worlds can influence people. SELENE technologies seek to inspire people as well, creating the next generation of not only scientists, but thinkers. To accomplish that, SELENE will use metaphor-enhanced, game-based environments to motivate people to make productive life choices while providing them a knowledge base to succeed at those choices. Csikszentmihaly and Larson (1980) wrote:

The main goal of a truly civilized education is, in fact, to teach children to experience flow in settings that are not harmful to self and others. Again this is the goal Plato established for his own educational system: to train youth in how to find pleasure in action which strengthens the bonds of human solidarity rather than set them against each other. (p. 186)

The SELENE approach connects flow with enhanced preparation for future learning through educational gameplay. Additionally, SELENE exploits
the connection between flow and adaptive expertise. Thus, SELENE gameplay supports players’ steps toward using the best knowledge of the past and present to “discover a better way of being in the future” (Csikszentmihalyi, 1997, p. 77). SELENE’s ultimate accomplishment may be to contribute to a truly civilized education by teaching children to experience flow in settings that not only help them in the present, but eventually let them use their newly learned skills and knowledge to benefit society.

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Notes

1 This research was supported by NASA-sponsored Classroom of the Future grant NNX06AB09G and NASA Explorer Schools Evaluation Framework: Classroom of the Future Educational Gaming and Technology Effectiveness Studies grant NAG5-13782.

2 A relation is the natural or logical association between two concepts. Two concepts and their relation form a proposition (Gentner, 1983; Gentner & Kurtz, 2006).

3 SELENE refers to the cognitive process as analogical reasoning and a specific instantiation of that process as a metaphor.
People normally map relational structure from the source domain to the target (the top arrow, mapping from left to right). Designers of instructional metaphors must specify the target domain and use it to constrain the source domain by mapping relational structure from the target to the source (the bottom arrow, mapping from target to source). In the concept maps within the figure, concepts are represented by labeled ovals and the relations that join them are represented by labeled arcs. The lowercase letters represent the arc relation labels. Domains A and B are relationally isomorphic, so the same relations appear in both domains.
Gaming Literacies: A Game Design Study in Action

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Educators and education advocates have recently acknowledged that the ability to think systemically is one of the necessary skills for success in the 21st century. Game-making is especially well-suited to encouraging meta-level reflection on the skills and processes that designer-players use in building such systems. Membership in a community of game producers means sharing thoughts and experiences with fellow players. This ability to gain fluency in specialist language and to translate thinking and talking about games into making and critiquing them (and vice versa) suggests that games not only teach literacy skills but support their ongoing use. Rather than imagining that education can be transformed by bringing games into the classroom, researchers should consider not only the effects of the thinking engendered by those who play, but also by those who design the play. This article offers an overview of the pedagogy and development process of Gamestar Mechanic, an RPG (Role Playing Game) style online game designed to teach players the fundamentals of game design. It will discuss some of the early results of the project, with an emphasis on the conceptual framework guiding the work, as well as the kinds of literacies and knowledge structures it is intended to support.

Introduction

When someone reflects-in-action, he becomes a researcher in the practice context. He is not dependent on the categories of established theory and
technique, but constructs a new theory of the unique case. His inquiry is not limited to a deliberation about means which depends on a prior agreement about ends. He does not keep means and ends separate, but defines them interactively as he frames a problematic situation. He does not separate thinking from doing, ratiocinating his way to a decision which he must later convert to action. Because his experimenting is a kind of action, implementation is built into his inquiry. (Schön, 1983)

Gamers are nothing if not reflective in action and, according to Schön (1983), operate as researchers in the practice context. No move is made without consideration of what the move means — both to an ability to make future moves and to the current state of the game. As a result, constant experimentation with the theories one builds through play defines the *modus operandi* of gamers. Game designers, too, share an affinity to reflection-in-action, as they deploy a reflective design process involving an iterative sequence of modifications to the rules and to the behaviors of game components. Game designers follow a cycle of design: playtest, evaluate, modify, playtest, evaluate, and modify. Not surprisingly, this sequence looks much like the process of play.

None of this is new. We know that play is iterative and that game design is a model rooted in reflection in action (Salen & Zimmerman, 2004, 2005). We also know that digital games and gaming practices have done much to shape our understanding and misunderstanding of the post-Nintendo generation and hold a key place in the minds of those looking to empower educators and learners. Beyond their value as entertainment media, games and game modification are currently key entry points for many young people into digital literacy, social communities, and tech-savvy identities. So what does this all mean for the dialogue around games and education?

For several months now, I have served as lead designer on *Gamestar Mechanic*¹, a game about game design funded through the MacArthur Foundation’s new initiative in Digital Media and Learning (http://www.digitallearning.macfound.org/) and developed through a collaboration with Gamelab (http://www.gamelab.com/), a New York City-based game development company and the Games, Learning, and Society (GLS) group at the University of Wisconsin-Madison (http://website.education.wisc.edu/gls/). In *Gamestar Mechanic*, an RPG-style online game, middle and high school age players learn the fundamentals of game design by playing stylish ‘mechanics’ charged with the making and modding of games. This article will offer an overview of the pedagogy and development process of *Gamestar Mechanic*, with an emphasis on the conceptual framework guiding the work, as well as the kinds of literacies and knowledge structures we intend it to
support. The first section outlines the situating context for the project, the discourses and ideas it engages, and presents a model for thinking about the intersection between game design, gaming, and epistemic learning. The second section documents initial testing with an extremely rough prototype of the core game experience and reflects on strengths and weaknesses of the current design. The third section offers an overview of the project and defines the key criteria and learning principles we are working to embed within the experience of play.

**Design As Learning**

*Gamestar Mechanic* began with a belief that the practice and production of game design enables a type of reflection in action that supports good learning. This approach has been mirrored over the years in the development of products like Mindstorms® and open-source tools and programming languages like Logo®, Squeak®, Scratch®, and Alice® designed to teach procedural thinking, problem solving, and logic, by learning to program. Seymour Papert and Michel Resnick pioneered thinking about how the acquisition of a programming language empowers a person to model knowledge and to see the world as a system of interconnected parts. *Gamestar Mechanic* shares in this approach not by teaching the language of programming but the language of *game design*.

This distinction is quite important for several reasons. First, many excellent game-making software products exist already and have been used, in limited cases, by teachers in K-12 and university contexts. These tools include Game Maker®, RPG Maker®, 3D Game Maker®, Zillions of Games®, Toontalk®, Klik and Play®, and Adventure Game Studio® to name but a few, with many more products currently in development. These tools have a proven track record of facilitating game production and have opened up the context of game making to those who are not professional game designers. Yet while each of these tools *enable* game design, they don’t explicitly embed the practice or thinking of game design within the experience and often focus on game programming as the primary pedagogy. Within these tools, games emerge out of a set of programming procedures: make the ball bounce against a wall – *Make a wall sprite and a ball sprite*; manipulate the ball – *Add Event > Event Selector > Mouse > Left button*.

*Gamestar Mechanic* contrasts this approach by situating the making of games within a larger game world, where the making and modding of games is not only the primary play mechanic or mode of interaction, but also the
means by which game design thinking and practice are modeled and performed. Players take on the role of mechanics, brought into a steam-punk inspired world to repair and contribute games to the economy on which the now broken-down world runs. Every element in the world constitutes a game component – embodied as creatures – that can be used to design and repair games. Through a series of carefully scaffolded challenges, players are introduced to the rules governing the behaviors and relationships between creatures and earn the ability to access the creature’s DNA to modify basic parameters like speed, movement pattern, intelligence, health, loops, and conditionals (if this, then that). Players enter and play through the game from the point of view of design. So while they emerge from the experience understanding aspects of game programming, it is not the dominant paradigm.

Clearly, this is not a superior approach to the programming-as-design strategy taken up by other tools, but simply a different one. The approach is unproven, experimental, and will undergo revision as the project is developed and tested with kids. This cannot be overemphasized: the state of our current thinking is primarily speculative, and a design spec does not a game make. The real work begins when the game gets in the hands of the players. While much of what I share here sounds reasonable, we will only know for sure how well the theory translates into practice once players, educators, and researchers have given it a go and observed what transpires. I will discuss the design model in the third section, but first want to expand on the thinking that brought the project into being.

Thinking Like a Game Designer

The initial proposal made some claims that seven months later still hold true. Gamestar Mechanic allows young people to design digital games – to be game designers – not in order to train them for game industry jobs, but to give them a platform on which to build technical, technological, artistic, cognitive, social, and linguistic skills suitable for our current and future world. This approach to learning is one that the GLS group refers to as epistemic games or professional practice simulations (Beckett & Shaffer, in press; Shaffer 2004, 2005; Shaffer, Halverson, Squire, & Gee 2004; Gee 2005a). Gamestar Mechanic is an epistemic game or professional practice simulation that speaks quite directly to the issues of being tech-savvy in the modern world and displaying media literacy in both old and new forms of reading and writing. Rather than approaching the discussion of reading
and writing in terms of games as multimodal texts we are instead exploring game design itself as a form of procedurally-based, multimodal literacy, which allows for the reading and writing of symbolic systems but does so through the qualities and characteristics of the medium itself as activated through play.

Game design as a domain of professional practice involves a rich array of knowledge and skills. Knowing how to put together a successful game involves system-based thinking, iterative critical problem solving, art and aesthetics, writing and storytelling, interactive design, game logic and rules, and programming skills. The designer must also be a socio-technical engineer, thinking about how people will interact with the game and how the game will shape both competitive and collaborative social interaction. Designers must use complex technical linguistic and symbolic elements from a variety of domains, at a variety of different levels, and for a variety of different purposes. They must explicate and defend design ideas, describe design issues and player interactions at a meta-level, create and test hypotheses, and reflect on the impact of their games as a distinctive form of media in relation to other media. And each of these involves a melding of technological, social, communicational, and artistic concerns, in the framework of a form of scientific thinking in the broad sense of the term (e.g., hypothesis and theory testing, reflection and revision based on evidence, etc.). Designers are making and thinking about complex interactive systems, a characteristic activity in both the media and in science today.

Connected to an embodiment of practices undertaken by a game designer in the real world are the practices taken up and enacted by players, who are equal stakeholders in the Gamestar Mechanic experience. In the same way that reflection-in-action requires an integration of thinking and doing, Gamestar Mechanic combines playing with making, connected activities situated in a social world. While players have the run of their own Factory, they must connect with other players in the Gamestar Mechanic community, both to share expertise and to play together via the games they build. Situating learning within a community of learners is critical, as members of the New London Group (2000) wrote in regard to the concept of multiliteracies: “...if one of our pedagogical goals is a degree of mastery in practice, then immersion in a community of learners engaged in authentic versions of such practice is necessary” (p. 84). This immersion is important not only in making the experience an engaging one, but in expressing the absolute connection between kinds of literacies and learning that take place in and around the play experience itself. It is the mobilization of these forms of learning that are at the heart of our exploration, and have led me to consider further
how we might talk about the concept of gaming literacies, both in relation to
the *Gamestar Mechanic* project, and to the field of games and learning more
generally. Game design may be a way to rethink approaches to other media
and the literacies that run across them.

**Assessment goals.** *Gamestar Mechanic* is governed by a set of assess-
ment goals, which point to specific outcomes we hope to see. These goals
are critical to the project, as they guide the design and inform the claims we
eventually will make about its successes and failures. On a general level, we
want to provide opportunities delivered as part of the game experience for
players/learners to constructively critique what they are learning, creatively
extend and apply it, and eventually innovate on their own within old com-
munities and in new ones (New London Group, 2000). We must be able to
demonstrate what children are learning through the game, including special-
list language. After playing the game, are children talking like game design-
ers, using terms like *core mechanic*, *rules*, and *goals*?

Several assessment goals were established at the onset of the project.
One goal defines the need to characterize the ways of thinking, valuing, and
acting that are built into the game. We will need to argue that what is built
into the game is a good and accurate portrayal of how game designers think,
value, and act. This helps to construct validity. Next, the assessment out-
comes must argue convincingly that the ways of thinking, valuing, and act-
ing built into the game – ways that set up certain forms of problem solving
– are good for something society and its policy-makers care about and are
fair in how they work for different populations. This is related to consequen-
tial validity. We will need to show that the players actually learned to solve
the kinds of problems the game presents them with and that players set up
various degrees of transfer. That is, they can solve similar problems outside
of a game format, as well as less similar ones and even dissimilar ones (*far
transfer*), including school-based problems. And we must make sure this
learning lasts. As Jim Gee noted (2003), it would be particularly nice if we
could show the game encouraged innovation in the sense that players could
offer innovative solutions to problems outside the game (for example, show
they can “break set” in approaching a problem). Last we must be able to as-
sess whether the game works – when kids are doing it together and as part
of a learning system – to develop academic forms of language, the sorts of
language associated with school and success in school. This is a tall order
and one of the reasons that throughout this article I will continually qualify
the work as in-progress. We have lots of ideas but not a lot of evidence, yet.

**Gaming literacies.** Justin Hall, a recent participant in a set of online
dialogues on the subject of kids, games, and learning wrote, “I continue
to believe that literacy, language, and personal expression, will stem from increasing exposure to flexible rule sets and iterative systems for solving small problems.” Like Hall, the team behind Gamestar Mechanic shares in the belief that exposure to the flexible rule sets and iterative play embodied in both design and gaming practices are critical for thinking about literacy in the 21st century. More specifically, we are exploring the idea of literacies specific to gaming and domains of media produced by games and supported through attitudes brought to bear on their play.

Gaming literacies emerge from what I call a gaming attitude, which Jay Lemke (2006) refers to as a “stance of playfulness,” an attitude tied directly to the creative, improvisational, and subversive qualities of play. I intentionally use the term gaming literacies and not game literacies as my interest is not simply in how digital games work (formally, socially, culturally, ideologically) but in how they support a performative and often transgressive learning stance based in play, which in turn, owes much of its specific character to the status of games as dynamic, rule-based systems. 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.

Learning to read a game system in order to play with it points toward a specific kind of literacy connected, in part, to the ability of a player to understand how systems operate, and how they can be transformed. Modding and world-building, which form the basis for much of the play of Massive Multiplayer Online (MMO) games and virtual worlds, for example, might be one such literacy, while learning how to navigate a complex system of out-of-game resources, from game guides, FAQs, walkthroughs, and forums to peer-to-peer learning, might represent another. A third literacy might be seen in the learning that takes place in negotiating the variable demands of fair play: players must become literate in the social norms of a specific gaming community learning what degree of transgression is acceptable and when a player has crossed the line. A fourth in learning how to collaborate within a multiplayer space, where knowledge is distributed and action is most often collective.

For those of us that design digital games, understanding the ways in which the structure of the medium itself elicits particular attitudes toward action and interaction with the medium is endlessly beneficial. This interest is heightened when the desire for understanding is cast into the context of learning and games. Because games are already robust learning systems, we must begin to tease out the intrinsic qualities and characteristics that guide the types of learning gaming and games advance. Some of this work is being
done by the GLS group around *Gamestar Mechanic*, but there are a number of researchers worldwide engaged in similar work, many of who appear in this volume. Yet what is of even more interest is to discover how these attitudes and modes of interaction are being transcribed or enacted elsewhere – beyond games – if we can make that claim at all. Does game design translate into a way of thinking about the world and if so, in what contexts does this form of thinking apply? If we see evidence, perhaps, we will have a more clear idea of what forms of learning and modes of literacy are general and specific to games and be able to take advantage of this understanding in the creation of both new games and learning environments.

**Player as Producer.** While *Gamestar Mechanic* takes on the issue of gaming literacies modeled in other game experiences – supporting activities like reading game systems in order to act within them or operating within the complex information networks which define many player communities – one literacy has been intentionally foregrounded for many of the reasons mentioned above. *Gamestar Mechanic* explicitly supports a literacy of production: players design games, write game reviews, mod game components, and produce knowledge around the games they create. As Mizuko Ito has noted, “The promises and pitfalls of certain technological forms are realized only through active and ongoing struggle over their creation, uptake, and revision” (2005, p. 2). Gaming as a production-oriented literacy moves to the forefront within this discourse, with several styles of participation in evidence. In what ways are we seeing youth empowered through their participation in the creative production, uptake, and revision of games? What roles do gamers take on through game production and to what extent do they experience a mixing of specialized roles, which may or may not occur outside a gaming context? In what specific ways can a game turn players into game producers?

This emphasis on production may be misleading within a larger conversation around gaming literacies, as it might seem to present the argument that players can only be truly considered literate in relation to games if they manipulate and produce their own. This is one criticism I myself hold in regard to some recent writing that has been done around the concept of participatory culture: it can seem as if there is an implicit assumption that to be a full participant, one must also produce. If we follow this argument, only gamers-who-mod would be considered full members of the current culture of participation. This is simply not true. While a good percentage of teens, for example, produce some sort of online content – a recent report indicates 57% of online teens create content for the internet⁵ – the production of game artifacts (skins, levels, fan fiction, etc.), is just one of the many ways that
players participate in the robust knowledge networks that constitute the ecology of games. So while Gamestar Mechanic relies on production as a primary basis for play, it simultaneously supports other literacies as well, including reading and writing, critical thinking, problem solving, negotiation of complex social and material economies, and technology-associated literacies like computer programming. Production is therefore not the only mode of participation, but just one of many ways in which players engage.

Engagement is, first and foremost, a way into learning, as the many champions of games and education are quick to remind us. But beyond developing Gamestar Mechanic as an experience engaging young people in the practice of game design, we are also keenly aware of the need to use game design itself as a potential strategy for young people to meet their own social objectives. If we argue that production can be empowering (and there is a lot of data suggesting this to be the case) then we most certainly need to try and explore the specific ways in which Gamestar Mechanic can support not only game production but also the production of knowledge, attitudes, relationships, and skills. It is paramount to ask how the deployment of what is produced, be it a game or game artifact, supports what is learned and gained more generally. Sometimes the making of the game itself is of less importance than the deployment and use of that game by others (Pelletier, 2006). Here is where the idea of situated learning again comes in, for the uptake and revision of what is made by a community of players is part of the kinds of literacies we hope to produce. Situated learning is

“...constituted by immersion in meaningful practices within a community of learners who are capable of playing multiple and different roles based on their backgrounds and experiences. The community must include experts, that is people who have mastered certain practices. Minimally, it must include expert novices, that is people who are experts at learning new domains in some depth. Such experts can guide learners, serving as mentors and designers of their learning processes.” (New London Group, 2000, p. 33)

By embedding game making activities within a robust social community Gamestar Mechanic hopes to leverage the expertise not only of the game designers who have imprinted their knowledge on the design of the experience itself, but that of other players. Much of the play of the game takes place in the exchange and critique of games by the community of players. Players advance toward membership in the Council of Master Mechanics by earning better than average ratings on the games they make. Games are reviewed both by other players and by members of the Council itself. The narrative conceit of the Council allows teachers who may be working with
the players to act as mentors within the learning space, reviewing games and giving feedback through a fictional avatar integrated into the overall narrative of the world. Professional game designers can also be invited in to take on a role as a master mechanic, for a short or extended period of time. In this way, *Gamestar Mechanic* allows players to assume different roles within a community of learners and invites in expertise across a range of channels.

**Prototype Testing**

Testing with an early prototype took place over two days on December 1 and 2nd, 2006, in the GLS labs at the University of Wisconsin-Madison. Sixteen kids participated in the workshop, ranging in age from 6th to 8th grade. Slightly more boys than girls participated, all had played games before, and at least half considered themselves gamers. Only one or two had made a game before – board games made as part of a school assignment. Several of the kids knew each other and arrived in small groups. We were interested in whether the kids wanted to make games alone or with their friends, and to what extent they wanted to share what they made: with their friends, with their parents, and with other kids in the workshop. We were similarly interested to see if there were distinct differences in how girls and boys approached the design of games, and if these differences translated into different attitudes about why they wanted to make games in the first place. Last, and most importantly, we wanted to learn if we had created something that interested them. If they turned their noses up at what we had built, we would need to rethink our whole approach.

We used two different formats during the workshop. In the first, two or three kids worked with me directly designing games on two computers. During the session, I tried to simulate the kind of in-game prompts and dialogues that will be present in the final version of the game, and the kids worked both with structured challenges and in open play where they could design games from scratch. In the second format, kids were given a quick introduction to the game, were shown the editor, and were then allowed to work on their own in a shared lab, sometimes with one kid to a computer and other times with two kids per computer. We were curious how quickly they could pick up the fundamental idea of the tool when left to their own devices, and how they might teach others about things being discovered as they made their games. We also wanted to know how long they would remain engaged and at what point they might wander off to play *Guitar Hero*.
or any of the other console games present in the game lab next door. Members of the GLS team observed through a one-way mirror in the first scenario and came in and out of the open lab in the second. All sessions were videotaped and recorded.

The results of the tests were very encouraging. While there is not space to document everything we discovered, I can offer some general observations. Please note that while future testing will include quantitative analysis with test groups of a much larger size the results presented here are primarily qualitative. Further, these early notes should be read as preliminary observations rather than actual research findings.

- The kids were deeply engaged in game making; when given the option to play a mini-game that came with the software or to build a game of their own, every child chose to build their own game.
- When given the choice to mod a game in progress or begin with a blank screen, approximately 90% of the kids opted to start from scratch. Players quickly learned that they could erase all of the elements of a partially built game; once this feature was discovered they moved immediately to erase all elements from the play area in order to create a new game 100% of their own design.
- An average session lasted 90 minutes and only ended when we needed to change groups. The kids did not lose interest during this time, and worked on their games throughout the entire session without stopping. Approximately 80% of them asked if they could keep working on their games; this group continued to make games in the computer lab, without an adult facilitator. When we gathered all the participants together at the end of the testing session, this group was eager to share their new games with the others.
- A small percentage of the kids who continued making games at the close of their official session chose to build levels for the game they had completed. Because there was no formal way to link levels in the prototype, players who decided to make levels had to come up with the idea on their own. They tended to name their games as a series (e.g., Incredible 1, Incredible 2, Incredible 3), and indicated on the game labels they prepared for each game that the games were part of a single, larger game.
- There were significant differences in how the boys and girls designed their games. In general, the girls were initially more thoughtful in their designs and spoke at the beginning of a session (as well as throughout) about what they wanted to happen in
their game. The boys shied away (at least initially) from describing their game concept at the outset and almost always immediately filled the play area with enemies. They also tended to build games that were less strategic and simpler than those of the girls. This is not to say that the boys were not thoughtful, but that it took them a bit longer to settle in to thinking about the kinds of games they could make. Once the boys filled their games with enemies and recognized that they hadn’t made a very good game, in every case they erased what they had done and explored other approaches. In the end, the boys and girls made equally interesting games from a game design perspective, and we perceived no qualitative differences in the games they designed.

- There were other gender differences as well. For example, one group of three girls all built games without a shooting avatar. When asked why, they said that it made the game “too easy if you can shoot the enemies.” Several of the girls also took advantage of the paint feature of the tool – the mouse could be used to paint tiles in the play area – and created game spaces that looked like an image of something. For example, two 8th grade girls created images of a teddy bear face and a spiral as the basis of their game board. We will need to find ways to allow kids to build play spaces with meaning; complex spaces that look like something, for example, whether these are “detailed spaces with ghosts,” as was requested, or spaces with representational appeal.

- The kids tended to spend up to 15 minutes building their game before pressing Play to test it, even when prompted several times to do so. If we want to teach the principle of iterative design, and we do, we will need to build in a content structure that addresses this initial behavior. Because the software makes it incredibly easy to toggle between Edit and Play mode, we recognize that this behavior is closely connected to the way a kid thinks about the game design process. Kids clearly have some model in their mind as to the kind of process needed to create a game. For these game design novices, a game can’t be played until it is nearly complete.

- One extremely effective challenge was to ask kids to design a game for their friend. This request seemed to focus them in a different way (the boys made really, really hard games for each other; the girls thought about the kind of game their friend might like). It appeared that the kids enjoyed playing each other’s games, and continually chatted to each other while playing their friend’s game,
comparing designs, talking about new game ideas, and speculating on what the next level or version of the game might look like. This type of challenge caused the social groups to mix, with boys and girls playing each other’s games, and broke down the distinctions between those that knew each other prior to the workshop and those that didn’t.

- There were no distinct differences in how quickly the kids picked up the skills to use the editor, between the facilitated and non-facilitated sessions, and the kids in the non-facilitated session were quick to turn into teachers for one another, yelling out things within minutes to starting that they were discovering and moving between computers to help each other out.

- About half of the kids preferred to build a game alone and the other half liked to build it together with a friend. There were no differences in gender here, with boys and girls equally split on how they wanted to design games. All, however, wanted their friends to play their games and every kid asked if they could continue to work with the game once they left the workshop. We are allowing the kids to do so, as we want to track how long they remain interested, and how the kinds of game they make either change or remain the same over time. If we want kids to use the game long-term, we must discover what new behaviors and needs emerge with ongoing use. This is an exciting aspect to consider and will require us to leverage the community and social dimensions of the experience.

This first small test demonstrated that kids are interested in the kind of game making Gamestar Mechanic offers. While there is still much to be done to translate many of the things observed into the game’s design and associated curriculum, we feel that the basic project assumptions are solid, and we can move forward in refining our approach. We will hold a rigorous series of playtests with kids over the course of the next year, and look forward to learning more about what it is that kids are learning through design.

**Design from Mini to Meta**

Before digging into the specifics of the design principles governing Gamestar Mechanic and its associated pedagogy, it is useful to briefly explore the concept of design, and the fundamental principles of game design on which the project is predicated. We must remember that Gamestar Me-
Salen does not model game design generally, nor embody the game design process of all game designers. Like any game, it is an artificial system that models a specific ideological perspective, in this case, a perspective on how games work, and what it might mean to design them. More than anything else, *Gamestar Mechanic* models the way some game designers think – it models the way other members of my team and I think. While this might be seen as a weakness, it is hopefully a strength. If we want to show that a game can teach a particular way of thinking, it is better to begin with a specific perspective rather than an overly generalized one. So how does one think about design?

Donald Schön regards design as a material conversation with the forms, substances, and concepts of a design problem as they are being used. His design approach is both *process-driven* and *reflective*, emphasizing the iterative qualities of design. “In a good process of design, this conversation is reflective…the designer reflects-in-action on the construction of the problem, the strategies of action, or the model of the phenomena, which have been implicit in his moves” (1983, p. 79). Design historian Clive Dilnot, on the other hand, suggests that design *transforms* by exploring the tension between the existing and the potential.

What design, as a mode of transformative action, allows us to see is how we negotiate the limits of what we understand, at any moment, as the actual. In design, in other words, we begin to see the processes whereby the limits of the actual are continually formed and re-formed. (1998, p. 69)

Consider a game of Tag. *Without* design we would have a field of players scampering about, randomly touching each other, screaming, and then running in the other direction. *With* design we have a carefully crafted experience guided by rules, which make certain forms of interaction explicitly meaningful. *With* design, a touch becomes meaningful as a “tag” and whoever is “it” becomes the one to avoid. The same is true of digital games as well. As game designer Doug Church has said, “The design is the game; without it you would have a CD full of data, but no experience” (2000, p. 3). In some sense, *Gamestar Mechanic* embraces each of these definitions, as it is structured around the concept of iteration. From a learning perspective, it is designed to enable a deep understanding of how a system of rules, behaviors, and relationships guide the design of an interactive experience, activated through play.

**Embedding knowledge in practice: Principles, practices, roles.** *Gamestar Mechanic* embodies a particular set of ideas, roles, and practices associated with game production. This is a way that as designers we embed
knowledge in practice, capitalizing on the kinds of reflection-in-action that will undoubtedly take place. *Gamestar Mechanic* aims to teach basic game design fundamentals, as well as model basic practices of a game designer. Because designing games is a complex, multilayered design activity, the process of design is scaffolded through game design challenges, with game modification being the primary way players are introduced to both the elements of a game, and game design core principles.

In determining the knowledge base that forms the basis of the experience, we considered not only the core design principles to be taught, but also the range of activities players would need to experience if we were correctly modeling the practice of a game designer. In addition, we thought about the kinds of game design roles a player would need to take on during the experience, in order to fully embody the multiple roles a game designer assumes in their field. Taken together, this list of fundamental principles, best practices, and roles provide a blueprint for the *Gamestar Mechanic* experience, giving specific guidance to the testing and assessment components. Since we know the nature of the specific practices and concepts that define the kind of thinking we want to reproduce, we can work to embody these as best we can within the structure of the game itself. We can also test directly for evidence that players are taking on these roles: are they learning to speak, act, and think like game designers? Reproduction of these principles by players will help us to measure to what degree our design is working to teach.

**Core game design principles to be taught.** Game design is a complex, multilayered design activity, whereby systems of meaning (games) are created through the design of rule sets resulting in play. As products of human culture, games fulfill a range of needs, desires, pleasures, and uses. As products of design culture, games reflect a host of technological, social, material, formal, and economic concerns. Because rules, when enacted by players, are embodied as the experience of play, game design can be considered a second-order design problem. A game designer only indirectly designs the player’s experience by directly designing the rules of play.

The real domain of game design is the aesthetics of interactive systems. As dynamic systems, games produce contexts for interaction with strategic and quantifiable outcomes. This interaction is often digitally mediated (videogames are played on computers, consoles, or other digital platforms) but not always, as much of the knowledge basic to the practice of game design applies to the design of non-digital games as well. Long before computers existed, designing games meant creating dynamic systems for players to inhabit. All games, from Chess or Go to *The Sims* and beyond, are spaces of possibility for players to explore. Designing this space is the focus of game
design. Game designers construct gameplay, conceiving and designing systems of rules that result in meaningful experiences for players.

While it is very challenging to describe the fundamental principles of game design, an abbreviated list can help establish the groundwork for an understanding of this highly interdisciplinary practice. Fundamentals include understanding design, systems, and interactivity, as well as player choice, action, and outcome. They include complexity and emergence, game experience, procedural systems, and social game interaction. Finally, they include the powerful connection between the rules of a game and the player the rules create, the pleasures games invoke, the ideologies they embody, and the stories they tell.

Rules are a fundamental part of any game. Defining the rules of a game and the myriad ways the rules fit together is a key part of a game designer’s practice. When rules are combined in specific ways, they create forms of activity for players, called play. Play is an emergent property of rules: rules combine to create behaviors that are more complex than their individual parts.

Because games are dynamic systems, they respond and change in response to decisions made by players. The design of the rules that guide how, when, and why a player interacts with the system, as well as the kinds of relationships that exist between its parts, forms the basis of a game design practice.

Game design is the design of systems of meaning. Objects within games derive meaning from the system of which they are part. Like letters in the alphabet, objects and actions within a game gain meaning through rules that determine how all of the parts relate. A game designer is responsible for designing the rules that gives these objects meaning.

There is a connection between the form and content of a game. Games are made up of game components, which include all of the objects that make up a game world. Components include game characters or markers, the play area, the scoring system, and other objects defined as part of the game system. Game designers must choose which components make up the game and assign behaviors and relationships to each of these components. Behaviors are simply kinds of rules that describe how an object can act. A game character might be able to run or jump – two different kinds of behavior. A door might be assigned an invisible behavior, which means that it cannot be seen on screen.

Game design – when done well – results in the design of meaningful play. Meaningful play in a game emerges from the relationship between player action and system outcome; it is the process by which a player takes action within the designed system of a game and the system responds to the
action. The meaning of an action in a game resides in the relationship between action and outcome. The relationship between actions and outcomes in a game are both discernable and integrated into the larger context of the game. Discernability means that a player can perceive the immediate outcome of an action. Integration means that the outcome of an action is woven into the game system as a whole.

Players want to feel like the choices they make in the game are strategic and integrated. Game designers must design the rules of a game in such a way that each decision a player makes feels connected to previous decisions, as well as to future decisions encountered in the course of play. Degrees of randomness and chance are two tools that a game designer has at his or her disposal to balance the amount of strategic choice a player has in a game. Choice is related to the goal of a game, which is often composed of smaller sub-goals a player must meet to win the game. All games have a win or loss condition, which indicates what must be achieved in order to end the game. Because all games must have some kind of quantifiable outcome to be considered a game by traditional definitions, defining the win and loss states for a game is critical feature of a game’s design.

Game design models player interaction on several levels: human-to-human interaction, human-to-technology interaction, human-to-game interaction.

- The core mechanics are the experiential building blocks of player interactivity, which represent the essential moment-to-moment activity of the player, something that is repeated over and over throughout the game. During a game, the core mechanic creates patterns of behavior, and is the mechanism through which players make meaningful choices. Mechanics include activities like trading, shooting, running, collecting, talking, capturing territory, etc. Game design relies on the design of compelling, interactive core mechanics.
- Interaction between the player and an input device allows the player to control elements within the game space. Design of the input device is connected to the design of the game interface, which organizes information and allows a player to play the game. A game interface can be simple or complex, but should always provide a player with access to the elements and activities of the game.
- Interaction between different game components is defined by rules that describe what happens when these components interact. Does the ball (component) bounce (rule) off the wall (component) or smash (rule) a hole (object) in it?
Game design uses an iterative design process: a game is designed through an iterative sequence of modifications to the rules and to the behaviors of game components. Game design follows a cycle of design: playtest, evaluate, modify, playtest, evaluate and modify. It is through iteration that game designers achieve the right balance between challenge, choice, and fun.

Game designers tune or balance their game, so that it is not too easy or too hard for players to play, and work to create just the right amount of challenge. All games are made up of challenges or obstacles a player must overcome in order to reach the goals set forth by the game rules.

Game design involves the design of resources, or game components used by players during the game. Resources can include things like money, health, land, items, knowledge, or ammunition, for example. In some games, resources are parts of systems known as game economies, which determine how resources are managed and circulated, and how many of each resource might exist within a game. In defining economies, game designers must consider both the formal make-up of the economy and how players interact with it.

Games reward players in many different ways, which is one way that a game communicates, or gives feedback, to a player about their performance. Game designers have to make decisions about the kinds of rewards they want in their game on both a moment-to-moment level (did the player know that they killed the monster?) and on a game level (did the player know they won? Or that they raced faster than the last time they played?).

A highly interdisciplinary endeavor, game design involves collaboration between experts in graphic design (visual design, interface design, information architecture), product design (input and output devices), programming, animation, interactive design (human computer interaction), writing, and audio design, as well as experts in content areas specific to a game. Game designers must know how to speak the “language” of each of these fields in order to see the possibilities and constraints of their design. The intersection of constraints from each area with the rules of play shapes the game in innumerable ways and drive the design process forward.

CONCLUSION

When kids learn to design games they not only learn how to explore the possibility space of a set of rules but also learn to understand and evaluate a game’s meaning as the product of relationships between elements in a
dynamic system. In the rudimentary testing we did with the initial *Gamestar Mechanic* prototype, we observed kids thinking and speaking as designers of systems. We saw them able to articulate a set of rules that gave their system meaning and we watched as they shared their knowledge of this system by successfully playing and reviewing each other’s games. Perhaps most importantly we witnessed their coming to an understanding of a design system and instantiating this understanding through the creation of fun, playable, and inventive games.

Educators and education advocates have recently acknowledged that the ability to think systemically is one of the necessary skills for success in the 21st century. We believe that game-making is especially well-suited to encouraging meta-level reflection on the skills and processes that designer-players use in building such systems, be they games or communities of practice. Membership in a community of game producers means sharing your thoughts and experiences with your fellow players. This ability to gain fluency in specialist language and to translate thinking and talking about games into making and critiquing them (and vice versa) suggests that games not only teach literacy skills but support their ongoing use. Rather than imagining that education can be transformed by bringing games into the classroom, researchers should consider not only the effects of the thinking engendered by those who play, but also by those who design the play.

There are additional implications as well. As a learning system, *Gamestar Mechanic* encourages risk-taking and learning in a low-risk setting. Learners can dive in first and learn through critical experimentation, developing hypotheses about how things work and testing out these theories within an iterative framework. They don’t have to “play for keeps” until they are ready, and can rely a little or a lot on the expertise of peers within the community of developers. Each kid in our test group went about their design a bit differently, yet all saved and shared their games with immense pride and almost no prompting to do so. Such an attitude should mean a great deal to those invested in shaping the future of education. Agency and a sense of affiliation are most certainly two of those most difficult things to achieve, with or without the lure of games.

In closing, I am reminded of something the writer Jonathan Letham (2007) wrote in regard to the discovery of ideas and the importance of finding originality and creativity through building on existing knowledge. He talks about the idea of “undiscovered public knowledge,” coined by Don Swanson, a library scientist at the University of Chicago. Swanson showed that standing problems in medical research might be significantly addressed, perhaps even solved, simply by systematically surveying the scientific litera-
tured. Left to its own devices, research tends to become more specialized and abstracted from the real-world problems that motivated it and to which it remains relevant. This suggests that such a problem may be effectively tackled not by commissioning more research, but by assuming that most or all of the solution can already be found in various scientific journals, waiting to be assembled by someone willing to read across specialties. While the production of new projects like *Gamestar Mechanic* are critical in our quest to better understand what it means to bring games and gaming literacies into any thinking about the future of education, it is equally important to continue to reassess what it is we already know and to bring our different disciplinary expertise to bear on our object of study. In doing so we can begin to develop hybrid frameworks that tie together theories developed for the study of text to theories developed for the study of habits, practice, and activity. I’d like to see this happen sooner rather than later and look to all those engaged in this debate as primary players in this endeavor.

REFERENCES


Notes

1 Gamestar Mechanic Project Team: Design: Kyron Ramsey, Katie Salen, Eric Socolofsky, Greg Trefry, Muon Van, Phil Weber, Bobby Wylie, Amar Ibrahim; Assessment: Alex Games, Jim Gee, Betty Hayes, Robert Torres

2 There are several different initiatives taking place worldwide focused on teaching kids to make games. Some include work with the software GameMaker® (www.gamemaker.nl), including work I have done with university level students (retroredux.parsons.edu; dt.parsons.edu/mobilegamemosh), the Game Making in Education project in Australia (http://www.groups.edna.edu.au/course/view.php?id=81), as well as the Summer Game maker competition, run by Education World (http://www.education-world.com/At_Home/student/student029.shtml). The Making Games project, run out of the Centre for the Study of Children, Youth and Media by Caroline Pelletier, Dr. Andrew Burn, Professor David Buckingham, used a piece of custom designed game making software. (www.lkl.ac.uk/research/pelletier.html)
Other precedents for the project include games based on level editing like Line Rider© (2006), Bridge Builder© (1998), Junkbot© (2002), Block Action© (2006); games where design is the basis of play: Okami® (2006), Magic Pengel: The Quest for Color® (2003); software experiences based on user-customizable parameters: Polly’s World© (2000), Sodaplay© (2001); and games about game design: the Game Game© (2005).


Game Literacy in Theory and Practice

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This article addresses the notion of teaching about games as a cultural medium in their own right. This includes critical analyses of existing texts but also involves enabling students to create their own. Implications of this approach are discussed and concrete, research-based examples are provided. A more theoretical discussion of the notion of game literacy and the principles on which this approach is based is also included. The article concludes with implications for policy and practice.

“If you want to use television to teach somebody, you must first teach them how to use television” (Umberto Eco, 1979). Umberto Eco’s argument about the educational use of television can equally be applied to newer media. As he implies, media should not be regarded merely as teaching aids or tools for learning. Education about the media should be seen as an indispensable prerequisite for education with or through the media. Likewise, if we want to use computer games or the internet or other digital media to teach, we need to equip students to understand and to critique these media: we cannot regard them simply as neutral means of delivering information, and we should not use them in a merely functional or instrumental way.

In this article, we consider the implications of this approach specifically for computer games. Our interest here is not in using games as a means of delivering a particular curriculum or of re-engaging disaffected learners – a role in which games are often cast (cf. Kirriemuir & McFarlane, 2004). Nor
are we concerned with the learning principles that might be derived from analysing play with computer games, and then perhaps applied to the learning of traditional subjects in schools (cf. Gee, 2003). On the contrary, our primary focus is on how we might teach about games as a cultural medium in their own right, just as we teach about film or television or literature. As in those other areas, we believe that this should not be confined to the critical analysis of existing texts but should also involve enabling students to create their own. In later sections of the article, we provide some concrete instances of the approach, drawn from our own research in UK schools. We begin, however, with a more theoretical discussion of the notion of game literacy and the principles on which our approach is based.

**Defining Game Literacy**

Over the past twenty years, there have been many attempts to extend the notion of literacy beyond its original application to the medium of writing. As long ago as 1986, one of the leading British researchers in the field, Margaret Spencer, introduced the notion of ‘emergent literacies’ in describing young children’s media-related play (Spencer, 1986); and the call for attention to new or multiple literacies has been made by many authors over subsequent years (Bazalgette, 1988; Buckingham, 1993a; Cope & Kalantzis, 2000; Tyner, 1998; and many others). We have seen extended discussions of visual literacy (e.g. Moore & Dwyer, 1994), television literacy (Buckingham, 1993b), cine-literacy (British Film Institute, 2000), moving image literacy (Burn, 2007a), information literacy (Bruce, 1997) and digital literacy (Gilster, 1997). Proponents of the so-called New Literacy Studies have developed the notion of multiliteracies, referring both to the social diversity of contemporary forms of literacy, and to the fact that new media of communication require new forms of cultural and communicative competence (Cope & Kalantzis, 2000).

This proliferation of literacies may be fashionable, but it raises some significant questions. Popular discussions of economic literacy, emotional literacy and even spiritual literacy seem to extend the application of the term to the point where any analogy to its original meaning (that is, in relation to written language) has been lost. Literacy comes to be used merely as a vague synonym for competence or skill. The term literacy clearly carries a degree of social status; and to use it in connection with other, lower status, forms such as television or computer games is thus to make an implicit claim for the latter’s validity as objects of study. Yet as uses of the term
multiply, the polemical value of such a claim – and its power to convince - is bound to decline. Thus, while recognising the significance of visual and audio-visual media, some scholars challenge this extension of the term, arguing that literacy should continue to be confined to the realm of writing (Barton, 1994; Kress, 1997); while others effectively dispute the idea that visual media require a process of learning analogous to the learning of print (Messaris, 1994). Furthermore, while the analogy between writing and visual or audio-visual media such as television or film may be useful at a general level, it often falls down when we look more closely: it is possible to analyse broad categories such as narrative and representation across all these media, but it is much harder to sustain more specific analogies, for example between the film shot and the word or the film sequence and the sentence (Buckingham, 1989).

So what are the possibilities and limitations of the notion of game literacy? Is it just an elaborate way of talking about how people learn to play games, or is it something broader than that? Indeed, do we really need another literacy? In exploring this issue in this article, we will inevitably have to address some fundamental questions. To make the analogy between games and writing presumes that there are some significant elements that are shared between those media (and, by extension, by a range of other media as well). It implies that games can be analysed in terms of a kind of language – that they make meanings in ways that are similar, at least in some respects, to written language. It also implies that there is a competency in using that language which is gradually acquired – a competency that can, perhaps, be explicitly taught, and that can be transferred across to other media or forms of communication. Yet the notion of game literacy also implies that there is something specific about this medium that distinguishes it from others – that we positively need game literacy as distinct from print literacy or television literacy, or even a broader notion like media literacy. Pursuing the analogy, therefore, requires us to address some difficult questions about how we define the characteristics of games as a cultural form, about how we differentiate them from other media, about how they create (or make possible) meaning and pleasure, about how users (players) make sense of them and learn about them, and so on. We do not intend to answer all of these questions in this article, but we do intend to pursue some of the issues, not least in the hope of achieving a greater degree of precision in the use of this term.
Games as Representations and Games as Games

There are clearly many elements that games share with other representational or signifying systems. On one level, this is a well-known symptom of the convergence that increasingly characterises contemporary media: games draw upon books and movies, and vice-versa, to the point where the identity of the original text is often obscure. Users (players, readers, viewers) must transfer some of their understandings across and between these media, and to this extent it makes obvious sense to talk about literacies that operate – and are developed – across media (Mackey, 2002; Burn, 2004).

More fundamentally, computer games are almost invariably multi-modal texts (Kress and van Leewen, 2001) – which is to say that they often combine different communicative modes, such as still and moving images, sounds and music, speech and writing, and so on. Different games (or genres of games) will use and combine these modes to different degrees and in different ways; and this will vary according to the functions the different modes perform (or, in multimodal parlance, the functional load the modes will carry). These elements can be, and are, studied at a micro level, in ways that are at least analogous to the study of written language. Zach Whalen’s (2004) analysis of music in computer games is a recent case in point; another example would be Diane Carr’s (2003) account of space in the games Silent Hill and Planescape Torment. We would argue that there is scope here for much more detailed analysis of the visual style of games and the ways in which different representational conventions make different claims about their relation to reality (or what semioticians would call their modality claims).

More broadly – and controversially, at least for some games scholars – there is the fact that games also employ broader elements that are similar to, or analogous with, other media. Thus, many games have characters; and it is possible to analyse these characters, for example in terms of fairly conventional literary criteria (such as the distinction between flat and rounded characters that derives from E.M. Forster, 1927; cf. Ryan, 2001) or in terms of structuralist paradigms such as the functions of hero, donor, helper and so on identified by Vladimir Propp (1928/1968), which we employ below in relation to children’s game designs. The narrative functions of such characters suggest that many games also have, or use, narratives; and it is possible to analyse these narratives, for example in terms of semiotic distinctions between hypotactic and paratactic narrative (drawn from Hodge & Tripp, 1986) or in terms of notions such as the implied reader, the implied author, the addressee, and so on (drawn from the work of Gerard Genette, 1980).
We apply several of these approaches elsewhere in our analysis of role-playing and action-adventure games (Carr, Buckingham, Burn, & Schott, 2006).

Nevertheless, these kinds of parallels are anathema to many game theorists. Many academics in game studies, and indeed some game designers, have effectively dismissed such elements as merely trivial or peripheral. Markku Eskelinen (2001), for instance, dismisses stories within games as uninteresting ornaments or gift-wrapping and argues that paying them any attention is just a waste of time and energy; while the designer Chris Crawford (2002) sweeps aside elements such as characterisation and narrative as merely cosmetic. Yet while some theorists might seek to marginalize such elements, even a cursory look at the fan culture surrounding games would suggest that they are absolutely crucial to their appeal.

Thankfully, the debate on games and narrative has generally drawn back from these rather absolutist positions (see, for instance, Frasca, 2003); but the point remains that analysing games simply in terms of their representational dimensions produces at best a partial account. For example, characters in games function both in the traditional way as representations of human (or indeed non-human) types and as points of access to the action; but the crucial difference is that they can be manipulated, and in some instances positively changed, by the player (Burn & Schott, 2004). Likewise, many games contain and depend upon narratives to provide motivation and engagement; and yet narratives can also be developed by players, albeit in different ways in different circumstances. Even a more specific semiotic analysis would suggest that games function in linguistic terms both through the indicative mood (that is, showing us the world) but also in the imperative mood (that is, urging us to take action upon that world).

In other words, we need to account for the fact that games are played; and any analysis of game literacy also needs to address the ludic (or playable) dimensions of games. There is a growing literature, both in the field of game design and in academic Game Studies, that seeks to identify basic generative and classificatory principles in this respect. For example, Aki Jarvinen (2003) provides a systematic taxonomy of different types of game rules; Markku Eskelinen and Ragnhild Tronstad (2003) describe the different types of gaps that provoke ergodic work on the part of the player; while Wolf (2002) distinguishes between different types of objects or assets in games. The most extended example of this kind of analysis to date – and one that looks well beyond computer games – is Katie Salen and Eric Zimmerman’s *Rules of Play* (2004), which considers (among other things) the logical or mathematical principles on which games design is based.

Even so, it does not make sense to see the ludic and representational elements of games as necessarily separate or opposed; and we will see later
how they can be connected both through explicit teaching and in children’s
design practices. The distinction may reflect a certain division of labour
within the games industry (between programmers on the one hand and art-
ists/designers on the other). But in the analysis of games themselves, and of
players’ engagements with them, it makes very little sense to see this issue
in either/or terms (see Carr et al., 2006). Similarly, we would argue that any
account of game literacy needs to address both the elements that games have
in common with other media and the elements that are specific to games
(whether or not they are played on a computer). These might to some extent
be identified with the representational and the ludic dimensions of games re-
spectively; although we need to recognise that games also have specific rep-
resentational conventions that may not in fact be shared with other media.

**Literacy as Critical Social Practice**

Research on print literacy clearly shows that literacy should not be seen
as a set of disembodied cognitive skills, but as a set of social practices (e.g.
Heath, 1983; Street, 1995). Literacy practices are embedded in social con-
texts and social relationships; and they involve forms of social action that
have social purposes and consequences. This view of literacy thus implies
that individuals do not create meanings in isolation, but through their in-
volvement in social networks, or interpretive communities, which promote
and value particular forms of literacy. It also means recognising how dif-
ferent social groups have different kinds of access to literacy, and how ac-
cess and distribution are related to broader inequalities within society (Luke,
2000).

Likewise, any analysis of game literacy needs to take account of the so-
cial dimensions of gaming and not merely the textual or formal aspects of
games per se. This involves understanding how the social activity of play is
defined and carried out, and how players are socially located; and this then
leads into broader questions about how social relations and identities them-
selves are constructed. It also entails an understanding of the institutional
and economic factors that shape the production, distribution and circulation
of games. In the case of game literacy, therefore, this approach suggests that
we cannot regard – or indeed, teach – this literacy as a set of cognitive abili-
ties that individuals somehow come to possess once and for all. We would
need to begin by acknowledging the ways in which the activity of gaming
is part of the texture of people’s daily lives and social relationships; and we
would also need to address the broader social, economic and even political
forces that constitute the wider game culture. In our view, these questions are not peripheral to the analysis of literacy, but central.

In the context of education, discussions of print literacy typically distinguish between functional literacy and critical literacy (Cope & Kalantzis, 2000). This is a distinction that we believe can also be applied to the medium of games. Functional literacy in relation to games might include such basic hardware skills as the ability to operate the relevant technology, to load and save a game, and to use the controls efficiently; but it might also include software-related skills such as the ability to navigate around the game space, to utilise menus and options, to customise assets to one’s requirements, and so on. To say this much is to imply that game literacy is essentially about playing well: the more literate you are, the higher your score will be. Of course, this is a reductive definition; although it is hard to see how these aspects of game-play could be completely dispensed with. Can somebody who is simply hopeless at game-playing be considered game literate?

Nevertheless, the notion of literacy – particularly in an educational context - generally implies a more reflexive approach. Literacy in this sense involves analysis, evaluation and critical reflection. It entails the acquisition of a meta-language – that is, a means of describing the forms and structures of a particular mode of communication; and it involves a broader understanding of the social, economic and institutional contexts of communication, and how these affect people’s experiences and practices (Luke, 2000). According to advocates of the multiliteracies approach (Cope & Kalantzis, 2000), literacy education cannot be confined simply to the acquisition of skills, or the mastery of particular practices; it must also entail a form of critical framing that enables learners to distance themselves from what they have learned, to account for its social and cultural location, and to critique and extend it.

This notion of critical literacy is by no means unproblematic, as the ongoing debates about so-called critical pedagogy clearly show (Buckingham, 1998). There seems to be little place in some conceptions of critical literacy for aspects of pleasure, sensuality and irrationality that are arguably central to most people’s experience of media and of culture more broadly. An emphasis on critical distance fits awkwardly with the emphasis on immersion and spontaneous flow – and even the pleasure of addiction - that is frequently seen as fundamental to the experience of gaming. As such, we would wish to caution against a narrowly rationalistic conception of critical literacy – a conception that is arguably quite at odds with how the majority of players behave or might wish to behave.

In this respect, it is also important to emphasise that literacy is not merely critical but also creative – it is a matter of writing as well as read-
ing. Accounts of media literacy have only recently turned their attention to the question of how people learn to produce – or otherwise actively engage with – media (Buckingham, 2003). Yet to some extent, games problematize any straightforward distinction between consumption and production. There is clearly a continuum within game play between genres that are primarily about reaction (first person shooters, or Tetris, for that matter) and those that allow space for strategising and reflection. There are also some genres (most obviously Role Playing Games (RPGs), and especially Massive Multiplayer Online Role Playing Games (MMORPGs)) that permit the player a greater degree of choice, for example in the customising of game characters or aspects of the game world, and even defining the overall objectives of the game, than others. From there we can move on to consider “modding” and level editing, some of which may be explicitly made possible by the inclusion of facilities within the game package itself (as in the case of Timesplitters 2). Then there are game design tools, which vary from the relatively constrained packages designed for home use (such as Stagecast Creator or 3D Gamemaker) to the modification of open source game engines and the use of professional software used within the games industry. Finally, the ‘fan cultures’ that surround gaming may be characterised by quite complex levels of creative participation, as well as critical engagement and debate (Jenkins, 2006). Machinima, for example, is an emergent media form in which game players render, record and edit sequences from games as short animated films (see www.machinima.com).

In the discussion that follows, we consider these cultural, critical and creative dimensions of game literacy in the context of games designed by school students. We draw on a recently completed research project, Making Games, in which we worked with an educational software company, Immersive Education Ltd., to create a software tool that would enable children to make their own 3D computer games. While there has been some previous research in this area, it has mostly focused on the potential of game-making in terms of developing logical or mathematical thinking (e.g., Kafai, 1996). Many of the games that have been produced in these studies bear little relationship to the kinds of games that students are likely to be playing outside the classroom. By contrast, our interest here is in the potential of game-making both as a form of creative cultural expression in its own right and as a means of developing students’ critical understanding of the medium. The project ran from 2003 to 2006, and involved partnerships with two secondary schools, one mixed comprehensive in Cambridge (with a largely middle-class white intake) and one girls’ comprehensive in Lambeth, South London (with a largely black African-Caribbean intake). We researched the work of
approximately 100 young people, 14 of whom stayed with the project over the three years. The ages of the students ranged from 12 to 15, though those referred to in this article are 12-13, Year 8 in the UK school system. In the account that follows, we focus particularly on the work undertaken in the Cambridge school.

Making Games

In recent years, media education has placed a growing emphasis on the importance of student production (Buckingham, 2003). This builds upon a longstanding set of rationales for the value of production work, both as a creative and as a critical practice (Buckingham, Grahame, & Sefton-Green, 1995). However, it also reflects the rapid growth of accessible digital authoring tools for use in schools. These software packages have allowed for the widespread exploration of digital video editing (Burn, 2007a), while digital music editing, website authoring, desktop publishing and graphic design have also begun to appear in media education programmes. However, the creative production of games has proven more problematic. No commercial software yet exists which will allow students detailed control over the design process, while also enabling them to produce a complete, satisfying game.

The students we describe in this article participated in a media education course in which they made their own games using prototype versions of the authoring tool developed by the Making Games project, currently named Missionmaker. The research involved the development of the software through a process of iterative design, informed by interviews and activities with the students, and a study of game design processes in media lessons, after-school clubs, and homes. The methods used included semi-structured interviews, videotaped observation, and analysis of the students’ games, drawings and writings. The analysis of these data employed theoretical frameworks derived from earlier models of media literacy, as outlined above, as well as social semiotic and multimodal theories of textual design, and play, game and narrative theory.

One research objective, which will be the focus here, was to develop a model of game literacy based on researching the students’ existing experience of games and their creative authoring practices. The following account, accordingly, will consider the cultural experiences students brought to their game designs, the forms of critical awareness they already possessed as well as those developed through the design process and other aspects of the programme, and the nature of the creative production process itself.
The Cultural Experience of Games

The children we worked with had varying experience of games. A minority did not play games or particularly like them; although some who claimed they did not play (especially girls) later revealed more knowledge and experience than they at first implied. There were widely varying tastes and loyalties to specific genres: some liked first-person shooters, some liked *The Sims*, some enjoyed strategy games, and so on. There were some patterns here which, although we cannot claim that they are in any way representative, are worth noting.

To begin with, there were predictable gender differences. At first glance, it seemed that boys preferred action games, including shoot-em-ups, while girls preferred peaceful constructive games. However, it later transpired that these claims may have had as much to do with children’s own construction of themselves through stereotypical images and expectations of gender as with any real preferences (Pelletier, 2005). In fact, some girls did want to play and make “violent” games, while some boys did play and make “peaceful” games. This is in accordance with other research into gendered gaming. For example, a study of an Australian High School found that girls enjoyed a much wider variety of game genres than they at first admitted (Mackereth & Anderson, 2000); while advocates of “grrl gaming” have proposed that girls can gain pleasure from fantasy roles in games which allow some escape from stereotypical expectations of gendered roles in everyday life (Cassell & Jenkins, 1998). Nevertheless, this aspect of game-play and design also provided valuable opportunities to open up discussion of gender representation with students.

In addition, there were widely varying experiences of games that can be related, on the one hand, to age or maturity, and on the other hand to regulation and censorship. Some children’s experience was of games often associated with their age group or even with younger children: *The Sims*, *Crash Bandicoot*, and *Harry Potter*. However, a minority had played games more often associated with adult audiences, such as the horror games *Silent Hill* and *Resident Evil*, or the controversial *Manhunt*, mentioned by one boy. Two implications follow from this. Firstly, it seems important to recognise that some children have more adult tastes than others: in a discussion with one group of 12/13-year-olds about the pleasure of games, for instance, two boys made a series of sophisticated points about the nature of suspense in *Silent Hill*, during a discussion that had begun with *Harry Potter*. Secondly, controversies about violent content and regulation (for instance, *Manhunt* is rated by the British Board of Film Classification as only suitable for view-
ers aged over 18), are clearly productive topics for discussion or simulation work as part of a consideration of media institutions and audiences. Age is of course a concern here; but as with other forms of violent content, the pedagogic stance here is to recognise that young people have interests in such content before regulatory authorities permit them to view it legally (and indeed, sometimes precisely because of such regulation). The logic is to prepare them for such experiences, rather than somehow to pretend they do not exist.

Many children had experience of games which had been developed as part of cross-media franchises, such as *James Bond*, *Lord of the Rings*, *Harry Potter*, *Spiderman* and *Star Wars*. One girl played game spin-offs of film and TV with her father:

> When I’m with my dad I play like…usually *Lord of the Rings* and *Harry Potter* and sort of known games, like, not sort of…games that have like got books as well or films or TV programmes that I sort of know.

In some cases, children played the game because of a passionate commitment to the overarching idea, character or narrative, as in the case of a group of five ardent Harry Potter fans. There are interesting implications here for how narratives are experienced across literature, film and game, and how they are differently constructed across these media; and this can be exploited in the context of literacy work in English or media studies, as the work of Catherine Beavis (2001) has shown. There are also many questions about the nature of the media industries, and how they organise such franchises, that can be posed in the context of media education. Finally, this kind of cross-media loyalty among fans raises questions about the nature of fandom as an intense form of audience behaviour, again a topic of particular interest to media education.

Finally, various forms of critical engagement with games were demonstrated in the interviews. In some cases, these were forms of appreciation, and expressions of individual taste: there were children who particularly liked the Harry Potter games, or enjoyed skateboarding games because of the excitement and satisfaction they provided, or enjoyed social aspects of gaming (there were examples of children playing with friends, brothers and sisters, fathers and mothers, and even a grandfather in one case). In other cases, there were very specific kinds of critical comment: on the differences between PC-based and console-based games; on boring aspects of games which were too slow or repetitious; and in one case, a series of critical remarks specifically about the second Harry Potter game. In some respects,
then, children and young people can be seen to develop quite sophisticated forms of critical discourse through their everyday engagements with games, which can be further explored in the classroom.

**Critical Literacy**

However, one key dimension of critical awareness is to do with the conceptual grasp of the semiotic structures of the text. As we have indicated above, these can be seen in terms of the representational and the ludic aspects of games. While the former was a very common dimension of the students’ understandings, the latter was more strongly developed among those who were already game enthusiasts. For example, a very small proportion of our participants (four boys) had some experience of what might be called proto-design, through using the level editor in the commercial game *Timesplitters 2*. Briefly, this provides an editing interface in which players can create their own level of the game, building their own 3-D space and locating objects, assets and characters. More crucially, they have the ability to construct the conditionality of the game: they can, for instance, determine that when the player enters a designated space, an enemy character will begin shooting at them. These boys had a conception, then, of what they called game logic, since this was the name of the relevant menu in the level editor.

For most students, however, this kind of concept was completely new. They generally had a good informal grasp of the more obvious components of games which are visible to the player: missions, end-of-level bosses, obstacles, rewards, challenges, and combat. But the notion of games as rule-based systems (see Juul, 2003; Frasca, 1999; Salen & Zimmerman, 2003) was not something they had learned from their experience of play. As well as this concept of rules, our teaching also focused on the idea of economies – the quantified resources determined by the designer, for strategic use by the player (such as health, hunger, point scores, weight, time, vulnerability, ammunition). The course we developed with the teachers who were partners in the project set out to develop a critical understanding of such concepts in two ways – by exploring how they related to games in general in the students’ own experience; and by focusing explicitly on such concepts in the process of game design with the software.

The general exploration of the concepts in class discussion produced thoughtful results from many students, although at this stage their grasp of the ideas was not always completely secure. Students were encouraged to think of examples of rules across many kinds of game. One student, Jack, came up with this list:
Call of duty – you mustn’t shoot your ally
Tennis – the ball mustn’t leave the court
Pool – the white ball must not go down any of the pockets
Cards (pontoon) – you must not score more than 21 to win
Cricket – you can’t touch the wickets with your bat

Like many other students, Jack used examples both from computer games (Call of Duty is a first-person action game based in a World War II narrative) as well as from other kinds of game. He also wrote at length about why rules were important, for a homework following a class discussion:

The reason games have to have rules is because if there wasn’t rules in a game you couldn’t have challenges and boundries (sic), limits too, and that would spoil the fun and cause you not to have anything to complete. Rules are needed for objectives because they are almost the same thing because they are both telling you to do or not to do something.

This account recognises that rules make a game a specific kind of text, one largely constructed in the imperative mood - which, rather than simply presenting you with a story, continuously demands that you act within that story.

The discussion also considered the paradox of why we enjoy following rules, which in contexts other than games and play can be oppressive. Again, Jack continues this discussion with himself:

People enjoy following rules because it creates suspense of trying not to lose the game by breaking the rule, and a lot of people like difficult challenges. For example, on a computer game, trying not to be seen and to sneak somewhere where you are rewarded with a prize.

Jack’s recognition that game rules are related to affective qualities such as suspense, and also to the challenge and level of difficulty posed by the game, is a sophisticated insight that prepares the way for his own game design. The notion that constraint is related to the pleasures of play can be understood in terms of theories of rule-governed, structured play, such as Frasca’s (1999) use of Caillois’ notion of ludus (1979), where a strict rule-system is structurally associated with victory or defeat - as it is in Jack’s definition. This is distinct from Caillois’ paideia, in which less defined rules generate pleasurable play that is not necessarily oriented towards an outcome of quantified gain or loss. The distinction between game and play is
an important debate in play and game theory, and one which students in schools can usefully pick up. For example, football is obviously a game with clearly-defined rules. What about paintballing? What about young children’s clapping and skipping games? What about “I’m the King of the Castle?” Clearly, some kinds of play are also games with firm rule-systems, while others are less well-defined, more open, more improvisatory.

The other key concept related to the ludic structures of games that we introduced was the idea of economies: that is, quantifiable resources within games, such as health, hunger, power, currency, ammunition, food, healing potions. We began by discussing the common sense notion of economy as a monetary resource. In their written homework, students again developed this idea for themselves, rooting it in their own knowledge of the world, and their experience of games. Fiona used the examples of Ibiza’s tourist industry and The Sims:

Ideas of economy in a game (e.g., The Sims) is money as without it your ‘sim’ will not have a good life and you will find the gameplay much harder and less enjoyable as the sims get mad as they can’t have many possessions and sometimes they don’t have any food so they are really depressed.

This work shows that children are often familiar with ludic aspects of the text which are explicitly discussed in popular discourses (in game manuals, magazines, websites, fan sites, or within the games themselves), such as non-player character (NPC), or end-of-level boss, or first person shooter. However, they do not generally know unfamiliar terms and concepts which may underlie the ludic structure. The concepts of rule and economy, then, amplify their existing understanding of how games work, make explicit what was previously implicit knowledge, and prepare the way for the use of the tools in the authoring software which allow for the construction of rules and economies. However, this also shows that these concepts are by no means purely abstract: they need to be related back to students’ wider cultural knowledge both of games and of other relevant experiences which serve as examples and analogies.

In terms of narrative, two approaches were used. One involved discussion of how stories and games had features in common, asking, for instance, if students could think of stories which had rules or economies. One girl produced the example of Hansel and Gretel, arguing that the breadcrumbs left as a trail by the children through the forest were an economy, since they could run out, and also a rule: if the trail is visible, you can find your way home.

Our other strategy here involved introducing Propp’s character functions (1928/1968), commonly employed in teaching about narrative in media edu-
cation, and asking students to design a selection of these into their games. Within the software, the protagonist is also the player character, with specific properties which can be managed and designed by the students, such as levels of health, hunger, and so on. All the other characters are NPCs who have to be designed and programmed to behave or speak in particular ways. Enemies may be inflected as game-characters such as end-of-level bosses - especially powerful NPCs who have to be defeated to complete a level (in much the same way as Shelob the spider or Grendel are defeated by Sam Gamgee or Beowulf, respectively). Figure 1 shows an end-of-level boss being attacked by the player in one student’s level design. The use of ammunition as an economy has been designed here in relation to the vulnerability of the boss character, which has been set high for difficulty. In terms of Propp’s narrative theory, this is the antagonist, of course.

![Figure 1. Boss character in level 6 of *Jimmy DeMora and the Dying World.*](image)

As we have argued above, critical game literacy does not only involve a conceptual grasp of the languages or semiotic properties of games. It also entails some understanding of the wider cultural and social meanings sur-
rounding them and the circumstances of their production and consumption. In the case of this project, these aspects were addressed by simulating the work of a game development company and the processes of review and evaluation in games magazines accompanying the release of a new title. The following example of a press release written by students gives some idea of this kind of work:


Kids Make Their Own Game!

Students in Year 8 at Parkside Community College in Cambridge have formed a games company named PIG productions, in order to create a spectacular adventure game with an impeccable plot.

PIG is an acronym for Parkside Interactive Games, and PIG’s first game is currently in the making, by the name of Jimmy DeMora and the Dying World. Using Mission-Maker and just under 30 creative minds, students work in one of the English rooms at their school to design and make the game. …

The game is scheduled for release at all good game stores from May 2006, as the final touches are currently being made to the game. Lucky people who have had the opportunity to preview the game have never given it less than 4 stars, mainly for the plot.

The game follows secret agent Jimmy DeMora, who is living in a world that is deteriorating thanks to global warming, and is suddenly faced with the kidnapping of his daughter and sister. He has to rescue many prisoners, including much of his family, and seek a holy artefact for renewable energy. Some say the game is a cry for attention to the melting polar ice-caps, some say it’s an exaggerated joke.

Whatever is said, we can’t wait to see how the final release is seen by the gaming world!

While there is no space here to develop a detailed analysis of this area of the project, we can remark in passing that the writing reveals an emerging consciousness of the work of games developers, of specific practices such as genre-labelling, and of conventions of game evaluations such as star-ratings. In addition, we can see that the development of this kind of aware-
ness is easily related to the meanings the children invested in their game, in its treatment of the theme of global warming, but also to the pleasure of production, suggested in the final sentence and in the brief reference to the humour which offsets the serious message of the game.

**Creative Production: Ludic and Narrative Design**

To begin planning their class game, students were asked to write individual proposals for homework: short pitches for a game, which had to include Proppian character types and examples of the rules and economies explored in class. The teacher then synthesised as many of these ideas as possible into a single plan. Thus, one girl had suggested a game based on the melting of the polar icecaps due to global warming, as a result of which the protagonist lost his family and had to find and save them. Several others had thriller, assassin or secret agent themes. One girl had subverted the stereotypically feminine activity of shopping that features in many games by proposing a shoplifting game; and so on.

These ideas all became part of the final game, *Jimmy DeMora and the Dying World* (a title proposed by one of the students). In the game, secret agent Jimmy DeMora has to find the evil corporation that is causing global flooding through its unscrupulous production of environmentally unfriendly fuels, stopping off for some shopping and saving members of his family along the way. A crucial part of the teacher’s role here was mediating the students’ proposals, partly through class discussion which opened up contradictions, differences, advantages and disadvantages; and partly by encouraging a consensus which would produce a whole-class design which would be coherent, and to which, as far as possible, everyone in the class had contributed.

Clearly, this game has a central narrative. It also has game structures: levels, obstacles, rewards, and clearly-defined win-lose states. The player character was named Jimmy DeMora after a proposal by one of the class, who had suggested a gangster-themed game with an assassin as the central character (possibly influenced by games such as *Hitman 2: Silent Assassin*). However, as the class game design amalgamated elements from proposals by many members of the class, the character was modified in terms of his mission and narrative background. He was equipped with a gun, albeit not to assassinate anyone but to rescue members of his family and to save the world which was threatened by global warming and evil corporations. If Jimmy was the Proppian hero, other characters proposed by students ful-
filled other functions: his kidnapped daughter was the princess; the evil corporation was the villain; various other characters in other levels helped, donated, misled, and so on.

The overall game design was then divided up by the teacher into 15 levels, one for each pair of students in the class. This allowed each pair to work on their own small game, with its own structure and sense of beginning and end. However, each pair had to constantly negotiate with its adjacent pairs to see how the levels would connect with each other and with other pairs to achieve other kinds of coherence; for instance, to make sure that NPCs appearing in their level would look, behave and speak in the same way as the same character appearing in another level later or earlier in the game.

A closer look at one of the levels will give some idea of the design processes involved, and how the two students who made this level have considered ludic and representational elements in their section of the game.

Figure 2. The mission pop-up in Sara and Louise’s level of Jimmy DeMora.

Figure 2 is taken from level 8, which was made by two girls, Sara and Louise. Here the player, as Jimmy DeMora, has to rescue his sister who is held captive by the evil corporation. The image shows a pop-up inserted by the girls at the beginning of the level: to specify the mission for the level,
they instruct the player to “Find my sister and send her home please!” This simple instruction embodies both representational and ludic design: it continues the narrative events, characters, unresolved conflicts and episodic trajectory, while also issuing a ludic imperative which provides the challenge for the level. Interestingly, there is an error of person: the structure of the whole class plan would produce “Find your sister.” Sara and Louise seem to be imagining that the protagonist is an invisible presence in the game; while the player, by implication, becomes something more like the helper character of Propp’s typology. These distinctions, however, are obviously not clear to the girls – this is an aspect of narrative they are addressing through production but not yet conceptualising clearly.

Figure 3 shows the design of their gameworld. This is the designer interface of the software, in which the large panel with the grid is the tile editor, a generic feature of game design software (the Timesplitters 2 level editor has a similar feature, as does the inexpensive commercial package 3-D Gamemaker).

![Figure 3. Sara and Louise’s gameworld design.](image)

On the tile editor can be seen a large area of rock and two lakes, which is the chamber where the game starts. From this leads a corridor below, end-
ing in a chamber where various resources can be found, but which is otherwise a dead-end. Above, another two corridors join up to form a simple maze which eventually leads to a large sci-fi styled chamber, where the player meets various enemies, and from there to another corridor ending in a prison cell where the sister is found, ending the level.

The parallel and connected trajectories of game and narrative are very clear here. The player has to find the sister, and she appears as a character in the narrative world, appropriately imprisoned in a small cell. The journey to find her involves repeated combat with enemy stormtroopers and the exploration of confusing, alien spaces such as sewage conduits, alien laboratories and cells. This sequence has all the elements we could reasonably expect of a brief narrative sequence: conflict, resolution, and three Proppian character types – protagonist (and possibly helper), antagonist and princess.

Meanwhile, the ludic elements include mission, challenge, reward, and clearly-defined win-lose states. There are three of these: the player can lose by not finding the sister (one door is programmed to close irretrievably if the player makes the wrong move); by being killed by an enemy stormtrooper; or by running out of time. Economies are clearly designed into the game. The player can find enough ammunition at the beginning of the game to kill two or three stormtroopers, but then needs to find the various refills distributed through the gameworld, which are guarded by more stormtroopers. The time is set at five minutes, and is therefore very tight - although this can be boosted by successful entry to one of the chambers.

To examine how the girls managed the idea of rule, we will look more closely at one rule they have constructed. Figure 4 shows the designer’s perspective on the start chamber.

At the bottom of the screen can be seen the rule editor. This is a function the research and design team built into the software to make the process of rule design explicit and transparent. It involves creating the conditions for events in the game by selecting an event, the action that will trigger it, and the activator that will set off the trigger. In terms of game literacy, this involves learning how to create a rule, a fundamental component of the principle of conditionality in game design, and also a basic element of high-level programming.

Here, Sara and Louise want to provide the player with ammunition for the gun which is lying elsewhere in the chamber (concealed behind a treasure chest). However, they want to make it difficult for the player to get the ammo, so they have placed it in the lake (it can just be seen below the foliage). In order to obtain it, the player has to manoeuvre themselves to the edge of the rock without falling over – once in the lake, it is impossible to
climb out. This is difficult, but achievable with practice. However, the girls have made life even more difficult. To the left of the image can be seen a transparent shape, in front of a barred door, behind which is an enemy stormtrooper. The shape is a trigger volume – a defined space which is invisible to the player, but which will trigger events if entered. The rule the girls have created, which is in the rule editor at the bottom of the screen, is: If Player / enters Cylinder Trigger 11 / Female Stormtrooper seeks and destroys Player.

Figure 4. Sara and Louise’s rule design.

This example shows that rules have two dimensions: a programmed rule, aspects of which the player will be ignorant (in this case, the trigger volume), but which operate the machinery, so to speak; and a rule determining conditional action on the game from the player’s point of view. In this case, this is realised by the player as something like, “If I get too close to the stormtrooper, she will shoot me.” This functions as a ludic rule, in the same kind of way as placing a pawn in the wrong square will result in it being taken by a knight in chess. However, it also makes narrative sense – if the protagonist arouses the suspicions of the enemy guards, they will open fire.

The design of this small sequence gives a good idea of at least part of what we mean by the creative aspect of game literacy. In one sense, this
level is entirely original – it is a new creation. In another sense, however, it involves the use of what Vygotsky (1978) calls semiotic tools and cultural resources. Here, these can be seen in three ways: the assets provided by the software (the game-world, characters and rule-editor); the resources devised by the class (another student had invented the Jimmy DeMora character); and the concepts applied in the design, in this case narrative functions and rule, learned in earlier lessons.

However, there is more going on here. The design reveals a sophisticated sense of how a challenge can be constructed in a game – how a careful articulation of the 3-D environment, the pick-up object and the programmed trigger creates a difficult and interesting ludic experience for the player. This can involve cautiously approaching the verge, the experience of teetering dangerously on the edge, the shock of coming under fire by accidentally triggering the stormtrooper, and the need to rehearse and repeat the manouevres several times in order to succeed. In short, this sequence has all the elements of a miniature game within it: a mission, obstacles, a reward and a defined win-lose state. However, it also creates, within the orderly deployment of rule-systems and programmed logic, an affective experience for the player which is fundamental to the complexity of play. In Caillois’ schema, the rule-governed nature of ludus can be used to describe some aspects of Sara and Louise’s level; but the more fluid, chaotic nature of his paideia is also appropriate for the complex set of events they have designed. Even more specifically, the dangerous vertiginous experience of play he called Ilinx is created by the juxtaposition of the enemy and the cliff-edge. In short, they have designed not only an effective game, but a wider experience of play.

Thus, creativity here means more than using received templates, procedures and resources. It involves the critical feature of transformation, which for Vygotsky (1931/1998) is a defining element of creativity. It involves the memory of earlier experiences of games and the creative combination of different resources to provide a rich realisation of the principle of ludic conditionality on the one hand, and narrative suspense on the other. According to Vygotsky, the imaginative activity of young children can transform physical resources into fictional entities through acts of symbolic substitution; but creativity is only fully realised when children combine such imaginative acts with conceptual thinking. In the case of Sara and Louise’s level, we can argue that concepts of narrative and game, and specifically of rule and economy, have combined with the imaginative transformation of space and dramatic movement to create a new player experience in their game. In addition, we can see how such work is informed by their own experiences of games and gaming cultures.
CONCLUSION: GAME LITERACY AND EDUCATIONAL PRACTICE

Our aim in this article has not been to offer a definitive theory of game literacy: to do so would be, to say the least, premature. However, we have tried to offer some account of what we believe a theory of game literacy might entail, and the kinds of functions it might be expected to serve. To sum up: we have argued for a theory that addresses both the representational and the ludic dimensions of games; that incorporates a critical as well as a functional dimension; that addresses the textual dimensions of games, while also recognising the social contexts and social processes through which literacy is manifested and developed; and that entails a focus on the creative writing dimensions as well as on reading or consumption.

But do we really need such a theory – and if so, why? Our answer is a tentative “yes.” As we hope to have shown, game literacy has some potential, not simply as a fashionable metaphor but also as a means of provoking a more sustained discussion of games and gaming culture, and how they are to be studied. Polemically, it might help to draw attention to aspects of games that need to be addressed more carefully. In this respect, it is worth noting specific implications of our project for the policy domain, and for research practices. In respect of the first, some of the project dissemination has targeted key players in UK educational policy, and the government’s Department for Education and Skills (DfES), the Qualifications and Curriculum Agency, and the British Educational Communications Technology Agency have been represented on the advisory committee. The DfES has been strongly supportive, funding a stand at the Los Angeles E3 exhibition. In respect of the second, our research suggests the value of combining social semiotic approaches to how young people make meaning with media authoring tools with cultural studies perspectives exploring the cultural experiences and practices which inform such creative work. The methodological questions raised here are presented in a forthcoming handbook of research in new literacies (Burn, 2007b).

Practically, game-literacy might also provide a useful basis for educational initiatives in this field. For example, the software produced by the project, and, importantly, the accompanying pedagogic framework based on the notion of game-literacy presented in this article, is being used by over 100 early-adopter educational sites, even before the full commercial release of the software. The variety of curriculum contexts – media, English, art, ICT – suggests how such subjects might expand their notions of creative work, cultural context, and methods of assessment to accommodate game-literacy. Apart from anything else, it demonstrates that games are a signifi-
cant part of children’s cultural capital, and a potential expressive form which they can develop in the classroom. For many schools, however, this remains invisible, in Bourdieu’s sense that to see (voir) one has to know (savoir): “a work of art has meaning only for someone who possesses the cultural competence, that is, the code into which it is encoded” (1984, p. 2). By contrast, we would argue that the forms of expertise and critical understanding displayed by many of these young game designers represent exactly the kind of cultural competence that should be more extensively valued and developed within education.

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**Notes**

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