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Hybrid Reality Games Reframed

Potential Uses in Educational Contexts

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Hybrid reality games (HRGs) employ mobile technologies and GPS devices as tools for transforming physical spaces into interactive game boards. Rather than situating participants in simulated environments, which mimic the physical world, HRGs make use of physical world immersion by merging physical and digital spaces. Online multiuser environments already connect users who do not share contiguous spaces. With mobile devices, players may additionally incorporate interactions with the surrounding physical space. This article is a speculative study about the potential uses of HRGs in education, as activities responsible for taking learning practices outside the closed classroom environment into open, public spaces. Adopting the framework of sociocultural learning theory, the authors analyze design elements of existing HRGs, such as mobility and location awareness, collaboration/sociability, and the configuration of the game space, with the aim of reframing these games into an educational context to foresee how future games might contribute to discovery and learning.

Keywords: *hybrid reality games; hybrid spaces; mobile technologies; urban spaces; problem solving; situated learning; collaboration; educational technology*

> The 1990s were about the virtual. We were fascinated by new virtual spaces made possible by computer technologies. The images of an escape into a virtual space that leaves the physical space useless and of cyberspace—a virtual world that exists in parallel to our world—dominated the decade.
>
> It is quite possible that this decade of the 2000s will turn out to be about the physical.
>
> —Manovich (2002)

Introduction

On February 7 through 9, 2005, a group of children ages 11 to 12 demonstrated their knowledge of Amsterdam's medieval history. Rather than writing essays or

marking multiple choice questions in the traditional paper-based assessment format, students of the Amsterdam Montessori School were actively playing on the city streets using Java-enabled mobile phones equipped with global positioning systems (GPS), solving location-based media assignments on the history of Amsterdam. Using their cell phones as interfaces for immersion in an imaginary narrative taking place in the year 1550 in the medieval city, players were able to communicate with fictitious characters and receive information about the places where they stood in real time, due to their devices' location awareness.

Two groups of children collaborated and competed against each other, simultaneously trying to help a fictitious character find a holy relic by solving location-specific riddles to conquer certain parts of the city. Playing the role of pilgrims while enacting historical scenes from the Amsterdam of the past, students needed to solve location-based assignments to prevail. While part of the group wandered on the streets, the other half was at a remote classroom location. Using an Internet connection, online students sent information and game strategies to students on the street, via their cell phones, guiding them through the city to collect real-world information. A successful collaboration among street players and online players led to efficiency in solving the puzzles and, therefore, conquering parts of the city before the other group. Whoever got the larger part of the city won.

Frequency 1550 (2005) is a hybrid reality game (HRG) that employs mobile technologies to create an imaginary playful layer that lies on top of the physical space, changing the perception of the city and merging the borders between what is reality and what is imagination. As these games are multiplayer, they also promote new types of sociability and interaction among users. HRGs are descendants from multiuser environments, also multiuser domains (MUDs), that originally took place solely online. Virtual communities are traditionally made up of people who gather in the digital space of computer networks, formerly conceptualized as cyberspace. Mobile communication devices, like cell phones, are responsible for bringing these networked communities out to urban spaces. Because HRGs are multiuser games, they are based on collaboration strategies and/or competition among players. HRGs have three main characteristics: (a) They use mobile and location-aware interfaces, (b) they bridge physical and digital spaces, and (c) they transform the city space into the game board, rather than taking place solely in a simulated computer environment.

The bridging of digital and physical spaces can make learning more meaningful by situating the content in actual physical space, rather than in computer-simulated environments, as is the case with most educational MUDs, such as Whyville (1999-2005), River City (2003), Revolution (2004-2006), and Quest Atlantis (1999-2000). By connecting content to its relevant physical locations, these types of games may serve to anchor the information in concrete, physically accessible situations. Therefore, in HRGs, information is distributed in three different sources: physical local spaces, digital spaces, and students' prior knowledge.

Despite these characteristics, there are currently very few HRGs designed specifically for educational purposes. Nonetheless, we believe that as location-based services

become popular, these types of games will become an integral part of learning activities, just like videogames and MUDs have been widely adopted and adapted to foster discovery and learning (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005; Bruckman & Mitchel, 1995; Dede, Ketelhut, Nelson, Clarke, & Bowman, 2004; Jason, Adams, & Bruckman, 2002; Kafai, 2006; Squire, 2002).

This article is a speculative study about the potential uses of HRGs in education, as activities responsible for taking learning practices outside the closed classroom environment into open, public spaces. Adopting the sociocultural learning theory as our framework (Lave & Wenger, 1991; Vygotsky, 1978), we analyze design elements of existing HRGs, such as mobility and location awareness, collaboration/sociability, and the configuration of the game space (bridging physical and digital spaces), with the aim of reframing these games into an educational context to foresee how future games might contribute to specific ways of learning. Namely, our analysis emphasizes elements of HRGs that build off the notions that students construct meaning while participating in a social context (Brown & Campione, 1994; Vygotsky, 1978), through action and active reflection (Dewey, 1938; Kolb, 1984), and when the learning activities are contextualized (Gredler, 2001; National Research Council, 2005; Rosas et al., 2003). The article addresses three central research questions: What are the affordances[1] of HRGs for potential uses in educational contexts? Why are learning technologies shifting from fixed interfaces, such as desktop computers, to mobile ones, such as Palmtops, iPods, and mobile phones? How can HRGs benefit discovery and learning differently from traditional videogames and multiuser virtual environments (MUVEs)?

To answer these questions, and to conceptualize these new types of games, four perspectives are addressed. First, we define HRGs, focusing on specific design elements that might be potentially beneficial for education. Second, we analyze how mobile technologies might represent a powerful interface for game play, especially in educational contexts, taking over the ubiquity of personal computers (PCs) during the last decade of the 20th century. Third, we give a brief overview of some past pedagogical projects on simulations, MUDs and MUDs Object-Oriented (MOOs), and augmented reality gaming, emphasizing their similarities to and differences from HRGs. Last, we use existing HRGs as examples of how some of their design elements could be potentially beneficial to education via social, experiential, and situated means.

This article contributes to the ongoing explorations of the relationships between mobile technologies, location-based gaming, society, and education through examining three significant arenas: (a) the shift of computer-mediated educational practices from virtual spaces, such as MUDs and MOOs, to physical hybrid spaces, (b) the conceptualization of hybrid reality gaming as a ludic practice that goes beyond mobile games played on the cell phone screen, and as networked games that take place on urban spaces, and (c) the affordances of mobile interfaces in promoting education by grounding discovery and learning in three different spaces: physical space, digital space, and student's prior knowledge.

Defining Hybrid Reality Games Within an Educational Framework

HRGs have three main design elements. First, they are mobile and location-based activities. Second, they are multiuser games and, therefore, social activities. Finally, they expand the game environment outside the traditional game space (the board or the screen) into the physical space, thereby creating new spatial perceptions, by merging physical and digital spaces, and new possibilities for social networks in both spaces. Each of these characteristics is suitable for making HRGs relevant media for aiding education, by following three learning principles: social, experiential, and situated learning via a new relationship to space.

Social learning is possible because these games are multiuser activities in which the players create the content of the game and do so via communication and collaboration. Lave and Wenger (1991) emphasize the importance of discourse as a means of learning because talk fulfills various functions such as encouraging engagement, focusing and shifting attention, and helping communicating individuals begin to coordinate ideas. These functions facilitate the meaning-making process for learners, but it is a collaborative effort in which all participants are active. Therefore, meaning is negotiated as a product of interaction in which the material being discussed is actively processed. Game players are working together through the ideas in the game to come to some shared understanding that enables them to move ahead. The learning takes place as game players communicate with each other, bringing to the game their own knowledge and perceptions, rather than transmitting a body of facts to one another.

Experiential learning is possible because the game requires active participation of all game players. The concrete experiences of the game provide opportunities for action and subsequent reflection of that action to come to richer understanding (Dewey, 1938; Kolb, 1984). For instance, by being actively involved in the activities drawn from Amsterdam's medieval history in the HRG Frequency 1550, the students potentially learn more by engaging multiple senses and intelligences rather than just reading about it (Gardner & Hatch, 1989).

Situated learning is made possible by the mobility of users and the use of location-aware interfaces emphasizing the notion that learning occurs as a function of its context. By bringing the activity back into relevant physical locations, the game players' activities are situated in their actual contexts, making the learning activity more meaningful. Students often have difficulty in a formal school environment because the disciplines of mathematics, reading, and science are traditionally taught in a manner abstracted from any context associated with their experience (Lave & Wenger, 1991). Therefore, educators and researchers have pushed to situate learning in real-world contexts to concretize the knowledge through experience (Gredler, 2001; National Research Council, 2005; Rosas et al., 2003). By taking advantage of the users' mobility and making use of location-aware interfaces, learning activities can be situated in actual, relevant contexts.

The next section provides a brief definition of HRGs that will define a framework for connecting them to educational contexts. The framework is constructed by the three interrelated characteristics delineated above: (a) social learning, (b) experiential learning, and (c) situated learning.

Mobility and Location Awareness: Categorizing Mobile Games

HRGs are not necessarily pervasive games but are always location based. Location-based mobile games (LBMG) employ mobile technologies equipped with GPS or cellular positioning as interfaces to the game story space. Pervasive games, in turn, are conceptualized as activities that happen all the time, everywhere, in which the game play[2] is no longer restricted to a specific time frame. Pervasive games merge with daily activities and blur the borders between the game play and serious life. In this type of game, whatever the player is doing, he or she might be immersed in the game. Pervasive games might be location based, such as the Swedish game Botfighters (2000-2006) and the Japanese Mogi Mogi (2003-2006), but are not necessarily so, as was the case of Electronic Arts's Majestic (2001).[3] Conversely, LBMG might be pervasive but can also have a specific game play, that is, the time period dedicated to play the game, as is the case with Frequency 1550 (2005) and Blast Theory's performance I Like Frank (2004), which will be discussed later in this article. However, only mobility in urban spaces is not enough to create a HRG. Urban games such as The Go Game (2003-2006), Conqwest (2004),[4] and Tracking Agama (Ruston, Stein, Newman, Carter, & Millican, 2004) use mobile phones for short message service (SMS), voice, and pictures but do not include location awareness. Moreover, these games take place primarily in physical spaces and therefore do not include collaboration among players in noncontiguous spaces. HRGs include the merging of immediate and distant contexts, connecting players who are simultaneously in physical and digital spaces. By doing that, they create an imaginary playful layer over the city space, changing players' perception of spaces and merging borders between the game and spaces usually associated with day-to-day life.

Hybrid Reality Games as Multiuser Games

HRGs are massively multiplayer role-playing games without the screen. Massively multiplayer online role-playing games (MMORPG) are descendants from MUDs, which have been extensively studied as social spaces in which users/players meet to play out identities, construct spaces, and interact with each other (Dibbell, 1999; Donath, 1997; Kim, 2000; Rheingold, 2000; Smith & Kollock, 2000; Turkle, 1995). MUDs have become popular with the development of the Internet and can be defined as (a) social places (spaces used for communication), (b) places that allow communication among people who are not in the same physical place, (c) places that allow people to meet in digital spaces, and (d) places that let people inhabit the same (digital)

space even if they are not actually talking to each other. In summary, MUDs are role-playing games (RPGs) enacted in digital spaces.

Peirce (2004) points out that "the central play mechanic of the MMORPG is . . . social storytelling, or collaborative fiction" (p. 148). Therefore, the story emerges as a direct result of social interaction. Apart from traditional discussions between ludologists and narratologists on whether games can be considered narratives (Wardrip-Fruin & Harrigan, 2004, p. 35), most game scholars to date agree that MUDs are intrinsically narrative spaces (Aarseth, 1997; Mäyrä, 2004; Montfort, 2004; Peirce, 2004). In addition, they are mostly emergent narratives, constructed in real time by social collaboration among its users.

HRGs bring the concept of a MUD into hybrid spaces, because the "story" is no longer solely created on the computer screen but actually takes place in a hybrid environment that mixes physical and digital worlds. However, HRGs are still RPGs, in which users create identities and interact with each other. HRGs include characteristics from both traditional and online RPGs. Traditional RPGs are also played outside the screen. Like online MUDs, HRGs connect people who do not share the same contiguous space. Like both traditional and online experiences, HRGs use quite a bit of players' imagination, because most of the story takes place in the players' minds. However, unlike traditional RPGs, HRGs happen while players are in motion, which relates to the first characteristic of HRGs as mobile games. Players need to be moving around to play, a characteristic that is different from most videogames, board games, and traditional mobile games.

Bridging Physical and Digital Spaces: Expanding the Game Environment

Because HRGs use the physical space as part of the game scenario, they may also include some kind of unpredictability, which is not restricted to the game rules and belongs to everyday life situations. Lehtonen and Mäenpää (1997) call this *street sociability* (p. 156). Street sociability is "the particular public form of sociality, of being at once both interested and yet indifferent and anonymous." While in the city, one cannot foresee whom one is going to meet or what is going to happen. It is exactly this unpredictability that creates exciting playful experiences.[5] "It is a question of a similar anticipatory expectation as in games of chance: something might happen" (p. 159). Merging real (serious life) spaces with imaginary game spaces, HRGs also challenge a common characteristic of traditional games: Games generally have another status when compared to reality. According to Järvinen, Heliö, and Mäyrä (2002), "The events in the game do not affect the states of things outside the game" (p. 14). However, the most relevant feature of HRGs is situating the game inside traditional daily-life spaces, therefore blurring the borders between real space and the game space.

Criticizing most ludologists who seek for a definition of games apart from narratology, literature, or film (Aarseth, 2004; Eskelinen, 2001, 2004; Frasca, 2004), Henry

Jenkins (2004a) argues for an understanding of game designers as narrative architects (p. 121). By emphasizing the importance of the construction of space as an element of game design, Jenkins (2004a) points out that RPGs, which have traditionally been studied as modes of collaborative storytelling, are in fact centered around the players' movement through space (p. 121). The game space might be represented physically, as is the case of board games, graphically, as is the case of MMORPGs, or textually, as is the case of textual MUDs such as LambdaMOO. However, in all of the above-mentioned examples, players navigate the game spaces also in their imagination. In the case of HRGs, the relationship to space is even more complex, because HRGs take place simultaneously in three spaces: physical urban space, digital space, and the players' imagination. In the case of educational HRGs, the players' imagination is mediated by the students' prior knowledge.

This bridging of spaces is made possible by the use of mobile technologies as interfaces for game play. In America, cell phones are still mostly associated with voice communication and many studies on cell phones suggest that they withdraw users from the physical spaces in which they are (Gergen, 2002; Plant, 2002; Puro, 2002). Conversely, the use of cell phones as game devices, equipped with location awareness and an Internet connection, strengthens the users' connections to both physical and digital spaces.

Defining the Relevance of the Mobile Interface as a Learning Technology: Community Formation, Affordability, and Game Interface

Mobile Phones as Collective Technologies

Following a trend that is developing cell phone use beyond its original function as a mobile telephone used for two-way voice communication (Licoppe & Guillot, 2006; Licoppe & Inada, 2006; Matsuda, 2005; Rheingold, 2002), we have reasons to believe that cell phones are becoming even more popular as interfaces to be used as game-playing devices in educational contexts.

This idea is especially evident when examining how mobile phones are culturally used in other countries rather than in America. Scandinavian countries and Asian countries like Japan and Korea use mobile phones no longer merely for verbal communication but as collective multiuser technologies. The Tokyo Thumb Tribes, for example, are Japanese teenagers who exchange a huge number of text messages a day (about 80) and barely use cell phones for voice communication (Rheingold, 2002, p. 6). Similarly, cell phones have been used as tools for macro-coordination, as seen in the case of President Estrada in Manilla, whose downfall was caused by protestors organizing themselves via SMS (p. 160). Macro-coordination actions are also represented by a social phenomenon called Flash Mobs (Walker, 2003), observed in San

Francisco, London, and Berlin, made up of "dozens or even hundreds of people with cell phones who gather suddenly, perform some specific but innocuous act, and then promptly scatter" (p. 2). Mobile phones have also been studied as producers of group relationships via SMS use in Finland (Kasesniemi & Rautiainen, 2002) and Sweden (Weilenmann & Larsson, 2001). Such studies and examples show us that although cell phones are still mostly conceptualized as two-way voice communication technologies, they are increasingly becoming multiuser interfaces suitable for macro-coordination, social gatherings, and multiuser game play (Benford et al., 2003; Licoppe & Inada, 2006). In most of these activities, the voice is the least used feature of the cell phone.

Mobile Phones as Affordable Technologies

The increasing popularity of videogames in the past 20 years not only developed new computer technology but also focused academic attention on the study of how games, as pervasive activities in young people's lives, influence contemporary culture and communication (Jenkins, 2004b). Games on cell phones are likely to exceed in popularity their use on PCs, because mobile phones are always with the user and are thus much more ubiquitous interfaces. Whereas PCs are accessed only from specific places (except for laptops), mobile phones can be used anywhere (where there is a signal). Furthermore, cell phones are much less expensive than laptops and handheld computers and therefore affordable for a larger number of users. A general belief is that mobile phones, not personal computers, are the technologies that will help to bridge the digital divide in developing countries (LaFraniere, 2005; Markoff, 2006). Mobile phones are combining in more affordable ways functions that have previously been performed by both fixed telephones and desktop PCs. Recently, Microsoft announced what they consider a less expensive alternative to a laptop: A cellular phone that is transformed into a computer by connecting it to a TV and a keyboard (Markoff, 2006). As a result, it is easy to foresee that mobile phones will be a more affordable option for schools to allow students to connect to the Internet.

Mobile Phones as a Game Interface

Besides being affordable and ubiquitous, cell phones can also be regarded as built-in platforms for game playing. They include a screen and a set of keys that can be used as different commands to conduct the game. Many would not buy a Playstation to specifically play games, but if games are embedded in cell phones, they can become part of other activities and a means of using the device "in between" other actions. However, simply transferring complex PC-based games to mobile handsets without taking advantage of the specific affordances of the new interface will not work (Norman, 2002). Although it is possible to play 3D games on a cell phone, the graphic quality and Internet connection speed are still inferior to a PC. A report from the European Commission Directorate-General Information Society (2002) suggests that

"the most popular [mobile] games will most likely be based on game play rather than on graphics. They will also incorporate the true nature of the mobile phones: communication and location" (p. 179). HRGs are designed to use the city space as the game board, as opposed to using only a premodeled digital space. Moreover, they rely on features that are unique to the mobile interface: mobility and location awareness. And because mobile phones are primarily communication devices, multiuser games are a natural option for mobile technologies. Understanding the interface capabilities is critical to foresee the future and create content and new uses for this new medium.

Cell phones move along with the users, therefore connecting players with each other and with the game space. Besides competition against other players, as happens in Botfighter (2000-2006), HRG players may also be involved in collaboration strategies and problem-solving issues, as evident in Mogi Mogi (2003-2006) and Frequency 1550 (2005), respectively.

Effects of social transformation as a result of widespread mobile technology use have also permeated our school environments. In Japan, children use cell phones as part of their daily lives, even in classrooms. As a consequence, "Japanese schools are developing policies to block cheating by SMS" (Alexander, 2004, p. 5). Furthermore, students also use their laptops and personal digital assistants (PDAs) to gather information on lectures and classes. Instead of blocking cell phone use, however, educators should take advantage of a technology that is extremely embedded in children's lives.

Teachers should explore the ways in which mobile devices can enhance, rather than distract from, the learning process. Some examples of the educational use of mobile technologies in regular classroom activities are (a) the Duke Digital Initiative,[6] which fosters the use of handheld GPS units, Palm PDAs, and iPods in curricular development and among everyday student use, (b) The Education Arcade and MIT Teacher Education Program's augmented reality simulation projects,[7] which aim at engaging students in simulation games that combine real-world experiences with additional information supplied to students by handheld computers. Some games developed at the project are Environmental Detectives (2003), Mystery @ The Museum (2003), Charles River City (2004), Outbreak @ MIT (2004), Virus (2004; Klopfler, Yoon, & Rivas, 2004), and Live Long And Prosper (2004; Klopfler et al., 2004).

Students do work differently with mobile devices than they do with tethered desktop computers. A large monitor is semipublic; every passerby can see what's on it. Mobile devices tend to be more private; they are held closer to the body. Such machines become prosthetics for information, memory, and creativity. Although cell phones can be very powerful immersive devices, excluding the surroundings while users play a game on the tiny screen or talk to somebody in a remote space (Plant, 2002), they are also collective communication tools, that is, technologies that promote integration among groups of people as well as with the physical space that surrounds the user. From this perspective, cell phones take the focus off of the screen and place

it in the physical world. HRGs, therefore, have a distinguishable characteristic from MUDs, MOOs, and MUVEs when it comes to educational settings: They take advantage of users' mobility in the physical world, instead of placing the user inside a simulated digital environment.

Simulations and Games in Education: What Do They Have in Common With Hybrid Reality Games?

As games were already embedded in children's daily lives, educators started developing ludic activities as playful ways to improve instruction (Barab et al., 2005; Bruckman & Mitchel, 1995; Dede et al., 2004; Jason et al., 2002; Kafai, 2006; Squire, 2002). Whereas homework assignments often failed to capture students' attention, their rapt and almost mesmerized engagement in games led educators to consider how they could capitalize on these intrinsic motivators (Malone, 1980). Yet, the application of computer games in education initially suffered the same fate that plagues the initial use of technology in instructional settings. Rather than changing pedagogical practices to take advantage of the affordances made available by the technology, many instructors simply incorporated into existing curricula without altering traditional teaching practices and delivery.

Congruent with traditional didactic instruction that tends to promote rote memorization and regurgitation of basic facts and skills, videogames such as Math Blaster™ (2005) were used for drill and practice to help master basic arithmetic and spelling skills (Perkins, 1985; Rosas et al., 2003). When games are only used for mastery of these basic skills, however, no qualitative value is added to what currently exists beyond cost-effective efficiency. This is strongly evidenced by multimedia comparison studies in which pedagogical practices were held constant and the medium was the intervention (e.g., computer versus paper; Baker & O'Neil, 2003; Clark, 1983; Fletcher, Hawley, & Piele, 1990).

Fortunately, educators and educational researchers are looking to work *with* the changes in technology, games, and society as evidenced by new research, both in instruction and assessment. There is a progression of moving beyond didactic instruction to creating more meaningful learning experiences as well as developing assessments that can measure the sort of higher order processes that are involved in these types of activities (Goldman, Pellegrino, & Bransford, 1994; Linn, Baker, & Dunbar, 1991).

The following examples include existing educational simulations, MUDs, and augmented reality games, which we believe share some of the design elements with HRGs we consider relevant for promoting meaningful learning. We analyze these design elements in each type of activity, evidencing its benefits to education that will be applied to HRGs in the next section. Equally, we point out how these activities lack some of the design elements that are unique to HRGs, leading us to believe that HRGs might provide a better learning experience in some educational contexts.

Interactive computer simulations have often been used for curricula that require process active inquiry and modeling (Barab, Hay, Barnett, & Keating, 2000; Fretz, Wu, Zhang, Davis, & Krajcik, 2002; Reiser et al., 2001; Vahey, Enyedy, & Gifford, 2000; White & Fredericksen, 1998). Like HRGs, the learning activities of many of these simulations are experiential and situated, attempting to promote deeper understanding by giving students inquiry-based problem-solving tasks that are linked to real-world situations or phenomena. Moreover, simulations such as Probability Inquiry Environment (Vahey et al., 2000) and Knowledge Integration Enviornment (Linn, Bell, & His, 1998) take advantage of the social context of learning by forcing students to make their thinking visible to promote thoughtful evaluation and critique about argumentation and evidence. However, these simulations differ from HRGs in that the experience is still very much linked to the desktop computer. Therefore, the problem contexts are explored in simulated environments on the screen, rather than in contexts out in the physical space.

As mentioned earlier in this article, HRGs are descendants from multiuser digital environments. MUDs and MMORPGs have been extensively adapted to educational contexts, because these types of playful activities share with HRGs some of the characteristics we defined as advantageous for learning, such as being multiuser (social) and actively immersing players in life-like situations (experiential and situated). Some examples are Whyville (1999-2005), River City (2003), Revolution (2004-2006), and Quest Atlantis (1999-2000). Identity becomes an important aspect of learning in these environments, emerging from learning that is social, experiential, and situated. These games become communities of practices that are designed to incorporate the very social, economic, and political life issues that are relevant to that particular community (Lave & Wenger, 1991). Therefore, as game players, their experience of these issues can affect their identities as they become more actively involved in that community (Squire & Jenkins, 2003).

However, in simulations, MUDs, and MUVEs, the environments are simulated worlds, essentially regarded as disconnected from the physical space. Although students might be in noncontiguous physical spaces, they inhabit the same digital environment. Thus, the real-world context is situated only in a simulated environment, making the student's actual physical location irrelevant to the task. Because experiential learning emphasizes the notion that learning involves a direct encounter with the phenomenon being studied (Kolb, 1984), we believe that HRGs can take advantage of this emphasis by situating the game in the physical space. For instance, in Frequency 1550 (2005), students are roaming the city streets and exploring the spaces where historical buildings actually stood. It is possible that their physical presence at these spots may promote more thoughtful consideration about the meaning and relevance of these spaces to the content they are studying.

Augmented reality games are more similar to HRGs because they bring learning closer to its actual context by making the physical location key to the task. This very notion is evident in the work of Eric Klopfer and Kurt Squire (2004), who investigate

games using mobile technologies in educational contexts. By taking advantage of the affordances of handhelds such as portability, social interactivity, context sensitivity, connectivity, and individuality, they study how augmented reality can transform the way students learn about environmental science. In Environmental Detectives (Klopfer & Squire, 2003), students walk around the campus with their PDAs taking digital readings of contaminants in the soil or access and examine relevant digital information (Squire & Jenkins, 2003). The game required that students decide what kinds of data should be collected (e.g., hard scientific data about the concentrations of the contaminants or additional information gathered by experts), all within a limited time frame. Like augmented reality games, HRGs are an ideal way of concretizing experiential learning by locating them in physical spaces related to the task.

However, although collaboration may be a component of augmented reality, it is not a necessity. Students can play the game without having to cooperate or communicate with another student. Moreover, the physical world is clearly identified as the primary game space. That is, students generally inhabit the same contiguous space with overlaid/enfolded digital data. Squire and Jenkins (2003) envision augmented reality games "set around popular vacation attractions such as the Boston Freedom Trail, where players investigate mysteries, trade information, or post clues to the internet" (p. 26). It is this merging of social spaces, this "hybrid reality" that emerges from the use of mobile interfaces and location awareness, that affords us new possibilities for educational purposes, discussed in the next section.

Deconstructing Hybrid Reality Games for Use in Education

The most critical elements that HRGs can bring to education, which differ from the types of games we have discussed thus far, are (a) the mobility of users connected to location awareness, (b) the way players socialize/communicate with each other, and (c) the way they inhabit differentiated spaces/representations. Because players inhabit both physical and digital worlds in HRGs, the primary space is not clearly defined. Therefore, not only are collaboration and mobility essential components of hybrid reality gaming, but they also differ from MUDs and augmented reality games by not privileging one space over another (physical or digital).

At this point, it is worth analyzing existing experiences in HRGs to fully understand how these games can be advantageous for learning. We will focus on HRGs like Can You See Me Now? (2001-2006) and I Like Frank (2004), from the Blast Theory and Mixed Reality Lab, focusing on the specific design elements that might benefit education. Likewise, we will give examples of how existing augmented reality games and urban games could possibly be transformed into educational HRGs.

Blast Theory's games have been developed for artistic purposes but contain the elements of HRGs that can facilitate the principles of learning we have discussed.

Blast Theory is an artistic British group that works in conjunction with the Mixed Reality Lab in the University of Nottingham, England. Their work focuses on developing games that happen simultaneously in physical and digital spaces, integrating and forming communities between players who walk on the street and online players. Blast Theory's performances differ from other location-based games mentioned in the Mobility and Location Awareness section above, such as Mogi Mogi (2003-2006), and Botfighters (2000-2006), in two ways: They are not pervasive, nor can the primary game environment be defined. In Blast Theory's games, an action in the physical space might influence a decision in digital space and vice versa. Their first two HRGs, Can You See Me Now? (2001-2006) and Uncle Roy All Around You (2003), used handheld computers equipped with GPS as the game interface. With the increasing availability of 3G phones, Blast Theory started using cell phones as their primary game interface, as seen in I Like Frank (2004).

Can You See Me Now? (2001-2006) is a type of hybrid space Pac-Man and was enacted in the cities of Sheffield (United Kingdom, 2001), Rotterdam (The Netherlands, 2003), Köln (Germany, 2004), Tokyo (Japan, 2005), and Cambridge (United Kingdom, 2005). Two groups of people play against each other. Online players inhabit a 3D model of the city, while street players, equipped with handheld computers, GPS, and walkie-talkies, try to catch online players in the physical city. Street players track down online players via a 2D map of the city represented on their handheld computers. If a street player is within 5 meters of an online player, the online player is "caught" and therefore has to leave the game. Street players take pictures of the places where they "see" the online players—which are, of course, empty spaces, because the online player is not physically there. As shown above, the main difference from a traditional Pac-Man game is that Blast Theory's game takes place simultaneously in physical and digital spaces. Therefore, the game cannot happen without the real-time interaction of players in both spaces.

Similarly, I Like Frank, played in 2004 in Adelaide, Australia, sets online players alongside players on the streets. Street players are walking in the city, equipped with cell phones with GPS devices. Street players can see online players exploring the same area of the city on a 2D interactive map on their cell phones' screens. The game drops online players at their desktop computers into a 3D digital model of the same city. Street players appear in the digital city as black figures in a column of orange light. Other online players appear as white figures. A postcard is hidden somewhere on the streets of the physical city, containing a clue to Frank's location. Using the arrow keys to navigate the 3D model, online players must search through the digital city to find the postcard and then transmit its specific spot to a player on the street. Street players and online players communicate via text messaging. Each pair of online and street players must work together, and they have 60 minutes to find Frank.

During the game play, online players see a different representation of the game space from the one that is inhabited by street players. Not only do they inhabit a different representation (a digital space), but this space also contains information not

available on the city streets. Examples are "black holes" that provide additional clues to find Frank. On the other hand, only street players have direct access to the postcard that contains the invitation to see Frank. Therefore, it is clear that to accomplish the game's mission, both players must work together by sharing information that is space specific. Uncle Roy All Around You (2003) is similar to I Like Frank (2004), but it uses PDAs as the game interface, instead of cell phones.

Underlying our theoretical framework is that knowledge is not simply a body of facts looking to be acquired but rather is constructed between individuals as they negotiate meaning, primarily through the means of discourse (Lave & Wenger, 1991). The notion of street sociability (Lehtonen & Mäenpää, 1997), mentioned earlier, highlights the unpredictability of being in the city streets and creates exciting playful experiences one cannot foresee, such as whom one is going to meet or what is going to happen. But because the primary game space is not defined, this element of unpredictability extends to the digital space as well. Learning becomes a function of the coconstruction of knowledge (Brown & Campione, 1994) that emerges as game players (students) who inhabit both spaces share the space-specific information to play the game. Blast Theory's game design holds both street players and online players accountable in the process of learning because each has unique access to information that the other needs. Therefore, meaning can only be constructed through the communication between individuals.

In both Can You See Me Now? (2001-2006) and I Like Frank (2004), the narrative in the game and the use of mobile interfaces require players to be mobile in both physical and digital spaces, making the physical location central to the task. The game design was centered around the very artifacts located in the city streets (e.g., phone booths, buildings, or cars sitting by the curb). This feature is also evident in the HRG Frequency 1550 (2005), mentioned in the beginning of this article. To win the game, location-specific riddles were about specific areas of Amsterdam, which could only be solved by using information provided virtually from the remote game player and information obtained from the actual historical buildings.

Let us take these experiences described in Can You See Me Now? (2001-2006) and I Like Frank (2004) and apply them to a potential educational game situated around the Boston Freedom Trail, following the concept suggested by Squire and Jenkins (2003). Squire and Jenkins propose a potential augmented reality game in which students investigate mysteries and post clues to the Internet. However, as an augmented reality game, game players would only be in the physical space and would thus have to be at the Boston Freedom Trail to share the experience.

Now consider turning this game into a HRG. Students physically present in front of the Old North Church on the trail can communicate and collaborate with students in California, who navigate through a digital representation of the same trail. One part of the game would be that the players must share information that is space specific. For example, the student physically at the Old North Church can determine whether the lanterns are lit to signal that the British troops are arriving (which could lead to a clue in the mystery). Meanwhile, the student inhabiting the digital representation

can access information about where the British troops are along the trail. Because the primary game space is not clearly defined, both students can act as full participants in the game.

A similar outcome might be accomplished with games like Tracking Agama (2004), an urban game created by Scott Ruston, Jennifer Stein, Brad Newman, William Carter, and Tripp Millican at the USC Interactive Media Division. Tracking Agama is played with a cell phone, a blog, text messages, and a voice mail system, using downtown Los Angeles as the game board. Players' ultimate goal is to find the fictitious character Agama by exploring clues hidden in the city landscape. The online blog is the starting point of the game, where players can learn about Agama's story and get the first tip on where to start the game in the city. From there, players collect clues embedded in city landmarks and call the voice mail system from their cell phones to provide information and get directions to the next location. Agama may also contact players via SMS. Tracking Agama (2004) is an excellent example of how a game using simple technology might allow players to have a different relationship to a city they thought they were familiar with, by embedding a fictitious narrative over the city of Los Angeles and by requiring players to actually walk in an urban space in which most inhabitants drive by car.

Now, let's take some of the design elements previously analyzed in Blast Theory's performances and in Frequency 1550 (2005) to imagine turning this game into an educational HRG. First, instead of being configured as a single-player game, groups of players could collaborate with each other to find Agama. This would require an online map of Los Angeles, in which online players would have an avatar, see the position of street players, and have access to some of the clues that might lead to eventually finding Agama. As a result, the game would (a) become a multiplayer game and (b) take place in both physical and digital spaces, rather than having the physical downtown Los Angeles as the primary game space. Second, following Frequency 1550's design, a game like this could easily be used to teach site-specific history to students, if the clues to find Agama included historical content about Los Angeles's landmarks, monuments, and buildings. To succeed and to get to the next location, students would need to solve riddles related to the history of the city.

Besides accomplishing similar goals as educational MUDs and augmented reality games, HRGs have additional characteristics that can benefit education, namely,

1. creating an environment where collaboration is necessary to achieve the goal by giving each player space-specific information. Collaboration is a means of learning because peer-to-peer interaction can encourage engagement, help to focus and reorient attention, and assist individuals to coordinate ideas through discourse. In these ways, collaboration can facilitate the meaning-making process for learners (Brown & Campione, 1994; Lave & Wenger, 1991).
2. bridging players in different spaces via mobile technologies (in this case, mobile phones). This will enable students in various locations around the globe to participate

in the game and act as full participants of the community (Lave & Wenger, 1991) because the game is not primarily defined in the physical or digital space.

Conclusion

Computers are often viewed as cultural artifacts that can mediate learning through their information-handling capacity (Salomon & Perkins, 1998). The Internet can be used as a means to bridge people and information without a restriction of space or time. Games can serve as another tool to mediate learning through their intrinsic motivational properties: challenge, fantasy, and curiosity (Malone, 1980). The affordances of all three aspects (information-handling capacity, somewhat unrestricted access to people and information, and intrinsic motivational properties) are also inherent in cell phones, mobile Internet, and HRGs. However, what HRGs can bring to education is what is missing from MUDs and MUVEESs (making physical locations more relevant to the task) and from augmented reality games (necessary collaboration and the bridging of spaces).

HRGs' intrinsic motivational properties transform an otherwise dry curriculum into something entertaining and fun, using affordable and ubiquitous technology. However, these types of games are more than a new snazzy delivery vehicle for the existing content. HRGs force players to look at familiar spaces from unfamiliar perspectives and at content learned in the classroom from a different viewpoint, using learning principles such as elements of social, experiential, and situated learning.

Furthermore, to function successfully in society, higher order skills such as collaboration and problem solving are emphasized in today's classrooms. The very nature of HRGs fosters these skills by making them a crucial part of the task. It has long been argued that what occurs in the classroom is too far removed from outside contexts. Education should embrace and incorporate the changes that result from advancements in technology rather than simply adapt the technology to maintain the status quo. We hope that other researchers and game developers start to explore the educational benefits of HRGs, which will bring us one step closer to meeting this challenge.

Notes

1. *Affordance* is a term from psychology redefined by Donald Norman (2002) in a design context that "refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used" (p. 9).

2. Järvinen, Heliö, and Mäyrä (2002) use the term *game play* when referring to "the time period during which a game imposes its rules and its environment on the player" (p. 17).

3. Majestic was a frustrated attempt from Electronic Arts developed in 2001 to create a pervasive game that would access the player at all times, via different communication media, such as e-mail, telephone, fax, and Web pages.

4. An extensive list of mobile location-based games and pervasive games can be found at http://www.in-duce.net/archives/locationbased_mobile_phone_games.php.

5. Lehtonen and Mäenpää (1997) also suggest that "even though we emphasize unpredictability as the key to playful street sociability, it is important to note that this entertainment aspect of uncertainty relies on mutual trust between the 'players.' . . . If the implicit rules of street sociability are not followed, the aleatory elements, the feeling that 'something unexpected might happen,' starts [*sic*] to generate fear" (p. 161).

6. For more information, go to http://www.duke.edu/ddi/.

7. For more information, go to http://education.mit.edu/ar/.

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