Improving Computer Science Learning and Creating Community via MMOG Technology

Jon A Preston
Clayton College & State University
5900 North Lee Street
Morrow, GA 30260
1-770-960-4354
jonpreston@mail.clayton.edu

ABSTRACT
Massively-Multiplayer Online Game (MMOG) interfaces offer potential to foster community-centered interactions for online universities. Additionally, online game engines provide an excellent opportunity to explore computing topics in an engaging environment. Enrollment for online learning and virtual campuses is increasing as universities cope with growing demand for higher education. Current online learning endeavors have focused on delivering content with an emphasis on courses. We propose enhancing the interface of existing online learning systems via virtual social spaces. Our research suggests the model will enhance learning, scale to accommodate any number of students, and reach non-traditional and underrepresented populations of learners.

Categories and Subject Descriptors
K.3.1 [**Computers and Education**]: Computer Uses in Education – *Collaborative learning, Computer-assisted instruction, Distance Learning*.

General Terms
Management, Performance, Design, Human Factors

Keywords
Community, Online Learning, Massively-Multiplayer Online Games (MMOG)

1. INTRODUCTION

Online education has grown considerably in the recent past as universities try new techniques of managing increased enrollment. Course management systems like WebCT, Blackboard, and TopClass offer frameworks in which to place learning units and courses. Digital library initiatives like MERLOT and MIT's OpenCourseWare offer reusable content for educators. But campus life and learning transcends infrastructure and textbooks. The campus space and student-to-student and student-to-professor interactions are paramount to the higher education experience.

Gaming is a very large business; according to the Entertainment and Leisure Software Publishers Association, the demand for home 3D entertainment is likely to reach nearly $18.5 billion worldwide in 2003. Immersive 3D environments are engaging and compelling because they focus on the user's experience and are entertaining [13]. Worldwide, online gamers number in the millions [1].

Thus we ask: how can online education benefit from the interfaces and interactions that game engines provide? Without losing focus on the pedagogy, how can we as educators incorporate the "best practices" of game technology (often on the cutting-edge of computing in many respects) into the learning experience of our students?

We notice that many of our students play games (sometimes during lecture!) and invest many hours in creating virtual characters in virtual worlds, and we posit that educators can capitalize on students' devotion to these virtual environments; if online learning environments could be augmented with immersive, community-oriented online interfaces, student learning may be enhanced. Despite "kill the monster, grab the gold" plot-lines of many commercial game titles, many games offer highly complex problem solving exercises in task decomposition, teamwork, and planning [13].

We propose creating a virtual environment in which online learners can congregate; we believe such an environment will create opportunities for community, afford impromptu peer learning outside the structure of formal online courses, and help foster a more committed, engaged attitude among online students.

2. THE PEDAGOGY OF VIRTUAL WORLDS AND GAMING

Learning, at its best, should be fun; when students are engaged and enjoying the experience, they are more apt to be open to new ideas, remember concepts that were situated in an enjoyable, memorable event, and return to learn more. Games afford an opportunity to achieve this "fun" and engaging atmosphere of learning, and Computer Science is a field that benefits greatly from gaming; note the "Nifty Assignments" sessions led by Parlante et al. at recent SIGCSE conferences (and publications) and other recent work by [7] and others. But not only can learning be improved by material-specific games (as demonstrated by Parlante, Giguette, and others), but learning patterns and problem solving processes can also be enhanced via gaming.

> *The power [of these games] is being able to extend your mind and body into this virtual space, and in that virtual space being able to take on an identity that you can think about in comparison to the real world.*
>
> - James Gee

Gee has received considerable press recently surrounding his assertion that game technology can improve learning and literacy [2, 5, 6], but the concept of capitalizing on the game interface to improve learning is not new. Moser proposed at ITiCSE'97 that a fantasy adventure game could be a useful metaphor to teach introduction to programming, overcoming such issues as boredom, intimidation, and the absence of contextual learning [10]. Additionally, virtual learning environments afford students the opportunity to situate their learning.

Moser argues that the conflict between instructional design and game design may be overcome via a tiered structure wherein students explore more complex material after proving mastery of more basic concepts; the same idea appears in game interfaces where a player must demonstrate competency within a "safe" area of the game world before being allowed to advance to more "dangerous" areas. Just as players explore the virtual world of a game, students explore the subject material over time and become more adept with the subject matter, engaging in a "cycle of expertise" wherein they are presented with simple problems; obtain routine mastery required to overcome these problems; solve similar, more complex problems introducing new elements of the domain; expand their level of mastery; and repeat the cycle at various levels of complexity. Overall, this process results in the expanding of learning and skills [2].

Many learners and software programmers describe the state of deepest concentration as "being in the zone" – a state similar to the suspension of disbelief within engaging entertainment and games. The idea of an immersive, virtual world to explore has the powerful potential to improve learning by suspending the disbelief of the user to help him feel a part of a learning environment. Swartout and van Lent, describing "experience-based systems," assert this holds true even for complex subjects:

> *Immersion is a powerful shortcut into users' minds with potential non-game uses. In educational applications, studies have shown that an immersive learning experience "creates a profound sense of motivation and concentration conducive to mastering complex, abstract material."* [15]

3. THE NEED FOR COMMUNITY IN ONLINE LEARNING

Buy-in and motivation are imperative to online learning. If we define motivation as a "learner's willingness to make an extended commitment to engage at a personal level in a new area of learning" [2], then we must ask: How can we foster an environment in which students make such strong commitments? Answers include forming communities and encouraging students to form peer groups, help each other learn, and foster a sense of belonging.

Placing lecture content and assignments online and providing a message board for student posts is not sufficient for online learning, especially in this age of ever-increasing computational power and bandwidth [3]. Media alone is not adequate; guidance and personal engagement of learners is critical [12], and students are more successful in their learning when online courses develop community among the participants [11]. In addition, we must emphasize the student-student (peer) and student-tutor (mentor) interactions as student-instructor interaction declines (due to faculty-student ratio), especially within the context of large-scale and distance education [4, 8].

Geographic distance between learners can create a cognitive and social distance; consequently, online courses run the danger of becoming impersonal. Faculty-approved facilitators can assist students in their online learning, adding a personal touch to an otherwise impersonal experience [12]. As a result, it is vital that learners form communities and peer groups to help keep each other motivated and stimulate learning.

In emerging models of online education, student participation and group discussions are vital to the success of the program. In these new models, student learning is measured less often by tests and quizzes and more often by in-depth discussions about the subject matter. Palloff and Pratt suggest that such collaborative learning increases the "active creation of knowledge and meaning" by participants and empowers them to "become experts in their own

learning." It is also interesting to note that their approach

Figure 1. A community-based MMOG environment

does not depend upon any particular technology [10], so long as the emphasis is on community building and peer learning. Our proposed system has at its core the building of communities through virtual campus environments.

Community can enhance online learning, but the need for community transcends the virtual classroom experience; we must move from a course-centered approach of online education and towards a more holistic model. Student interaction on real world campuses certainly spills over into common campus spaces such as student centers, libraries, and local restaurants. Online campuses need common virtual extra-curricular spaces to help create the community essential to successful online learning. As [9] states:

> *Social communication is an essential component of educational activity. Just as a face-to-face school or campus provides places for students to congregate socially, an online educational environment should provide a space, such as a virtual café, for informal discourse.*

Many students, ourselves included, learn quite a bit outside of the classroom through in-person discussions and in online newsgroups and chat rooms with fellow students. Expanding current online course management systems with these forms of virtual meeting places seems like a logical next progression for virtual universities [4].

With much content available online (MIT, MERLOT, etc.) motivated students can access a wealth of material. Why then do students prefer to attend classes? We believe it is because the college structure offers community.

4. A MMOG EXPERIENCE

Having established a need for increased online courses and virtual universities, the benefits of game-based interfaces to the enjoyment of learning, and the essential nature of building community to online learning, we formulate a model based upon Massively-Multiplayer Online Gaming (MMOG) environments.

Within MMOG systems, users connect to servers that store character information and distribute world updates to connected clients; world updates typically consist of

character/avatar movement, object manipulation (doors opening and closing, etc.), and object transfer (characters obtaining and exchanging items within the world). Since the system transmits only differential updates of the virtual world state to clients, bandwidth consumption is kept minimal – often requiring only a 28.8k modem connection.

In addition, conversations among users are transmitted either as text and displayed in "balloons" (see figure 1) or as compressed audio; one of the captivating aspects of MMOG interfaces is the ability to speak with online friends using text balloons and using Voice-over-IP (VoIP) technology, and our proposed system incorporates both of these depending upon users' preferences.

Figure 1, taken from The Sims Online MMOG, demonstrates an isomorphic view of a virtual world in which users can interact with objects (aquariums, billiard tables, chairs, bookcases, etc.) and other users (conversations, etc.). In this scene, users are studying to develop their avatars' abilities within the virtual world.

Such an environment could be created to simulate (among other spaces) a university "student center," complete with cafeteria, bookstore, computer lab, and other common space typically found on real-world campuses. We envision students congregating in these virtual spaces to form study groups, chat, and learn via osmosis by viewing other students' conversations.

We propose creating a low-bandwidth, MMOG-style graphical interface to the virtual university campus that emphasizes the following key points:

1. Immersive environment to create the "suspension of disbelief" of users
2. Voice-over-IP synchronous communication
3. "Bubble" style text communication
4. Transcription recording of conversations (for asynchronous viewing)
5. Customizable worlds where users can personalize their virtual environment
6. Building peer learning and impromptu learning opportunities

The metaphor of the virtual campus space can also be useful to help learners navigate digital libraries of online learning material (organized by topic, specialization, etc.). Many digital libraries contain vast storehouses of useful information, but locating these items can prove problematic to users; as students navigate the virtual campus, they have spatial and visual cues to help overcome the difficulty of finding the digital items they seek.

Figure 2 depicts the overall MMOG virtual campus system model.

5. ISSUES OF SCALABILITY

Institutions must utilize pedagogically effective and fiscally sound approaches to meet the ever-increasing demand for courses and online learning [4]. Two such models of managing growth effectively include [15]:

1. Emphasize student-to-student interaction and teaming to reduce demand on individual faculty and avoid bottlenecking growth based upon faculty size.
2. Using different kinds of personnel (course assistants, TAs, course managers/coordinators) in addition to faculty members to assist students and help create consistency among course sections.

Our proposed system incorporates both of these techniques. By encouraging students to form intimate learning cohorts among fellow learners in the virtual environment, we promote peer learning among students; the number of such peer groups can grow as needed, with each specialized to the individual students' needs. As in real-world, physical campuses, we expect students to form a core group of peers with whom they gather for course-related and extra-curricular interaction; in addition, students can join multiple cohorts – one for each course or academic domain.

We also utilize tutors and learning assistants that appear in the virtual environment as avatars to help build and assist cohorts and students in navigating the virtual environment. These avatars serve two different purposes: academic and environmental.

Academic avatars represent real-life learning assistants that can help with learning by answering questions, guiding discussions, and posting sample problems to spur learning. These assistants are vital to help guide peer learning groups and provide structure to online conversations among students.

Environmental avatars are agent-based (via artificial intelligence) and serve to answer questions about the virtual environment; just as campus representatives and upperclassmen help new students become oriented to campus life, these assistants exist in the world to help guide students to locations within the environment and better utilize the interface.

Because our model utilizes non-faculty assistants and encourages peer learning, we believe it scalable to meet the future enrollment demands of online and virtual universities. Faculty expertise is best utilized in creating content, managing, improving, and updating learning modules/units, and in overseeing learning assistants.

In addition to improving the learners' experience [3], our model also affords cost savings and improved student learning. Capitalizing on economies of scale, institutions in previous studies using similar techniques yield significant

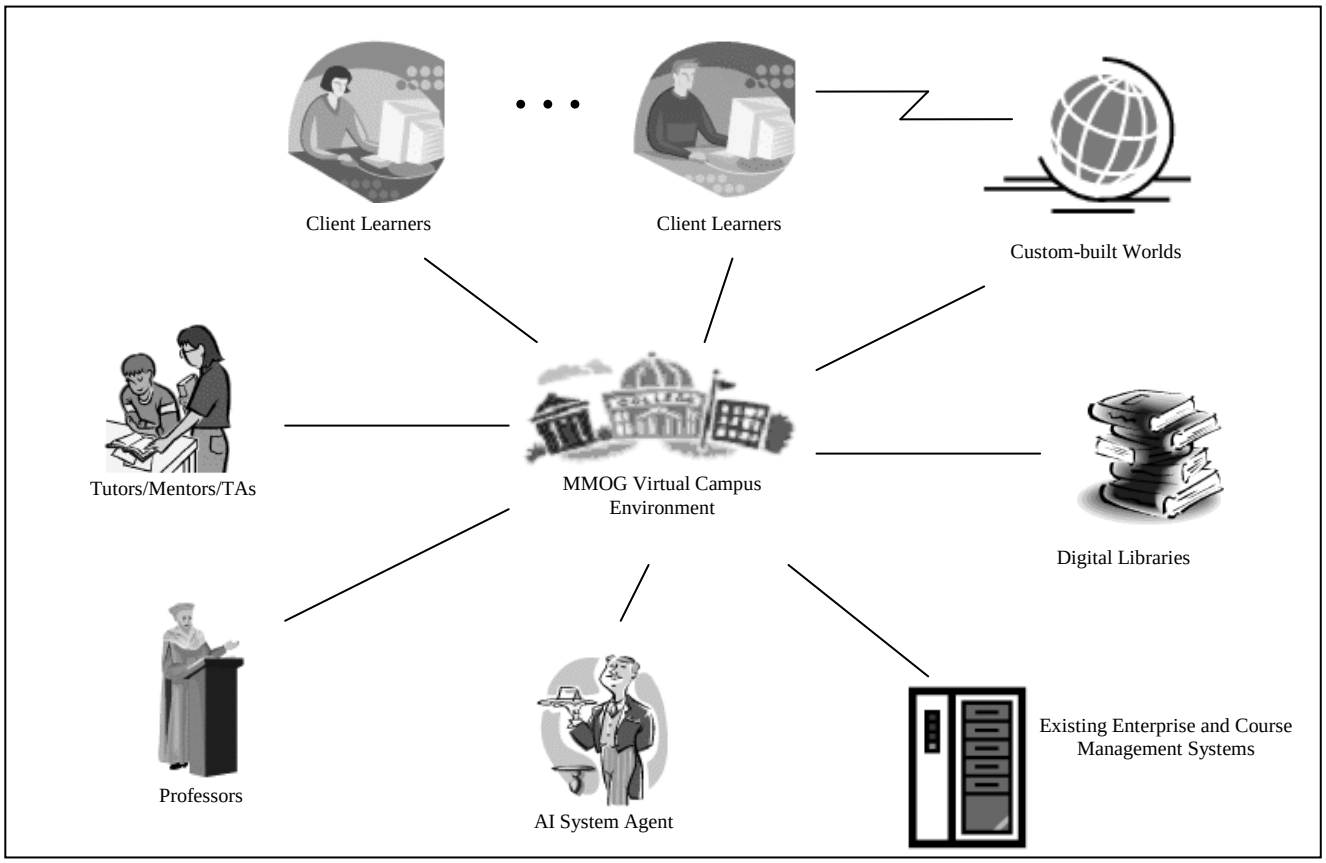

Figure 2. A MMOG Virtual Campus Model

savings (using fewer faculty to reach more students) while maintaining or improving learning outcomes [15].

6. APPLICATIONS IN CS COURSES

Several opportunities emerge when applying MMOG interfaces to computer science education:

- Modern online game environments are object-oriented, and students can explore OO principles as they interact with objects and build their own worlds (see figure 3)
- The toolkits used to build customized worlds make use of inheritance, polymorphism, reflection and serialization; thus students can explore these topics in an already-defined, easy to manipulate environment and see immediate results of their work
- Scripting and language theory/design issues can be explored by students, as modern online game engines incorporate sophisticated, custom languages to trigger events and control avatars
- Students can experience artificial intelligence and agent-based computing through the in-game non-player characters (NPCs); goal and path planning algorithms may be implemented in these online game worlds
- Because modern online worlds are 3D, these interfaces allow for the exploration of graphic algorithms and graphic modeling without the overhead of managing low-level data structures; thus it is an intuitive and manageable introduction to 3-dimensional graphics
- Students experience shortest path and connectedness graph algorithms as they interact with the environment
- Platform-independent online game engines currently exist for MAC, Windows, and Linux; thus choice of OS is not a prohibiting factor in our model

Based upon our initial research, we are excited about the possibilities of incorporating online game worlds into our computing courses. Not only may the interfaces themselves lead to more conversational and community-oriented

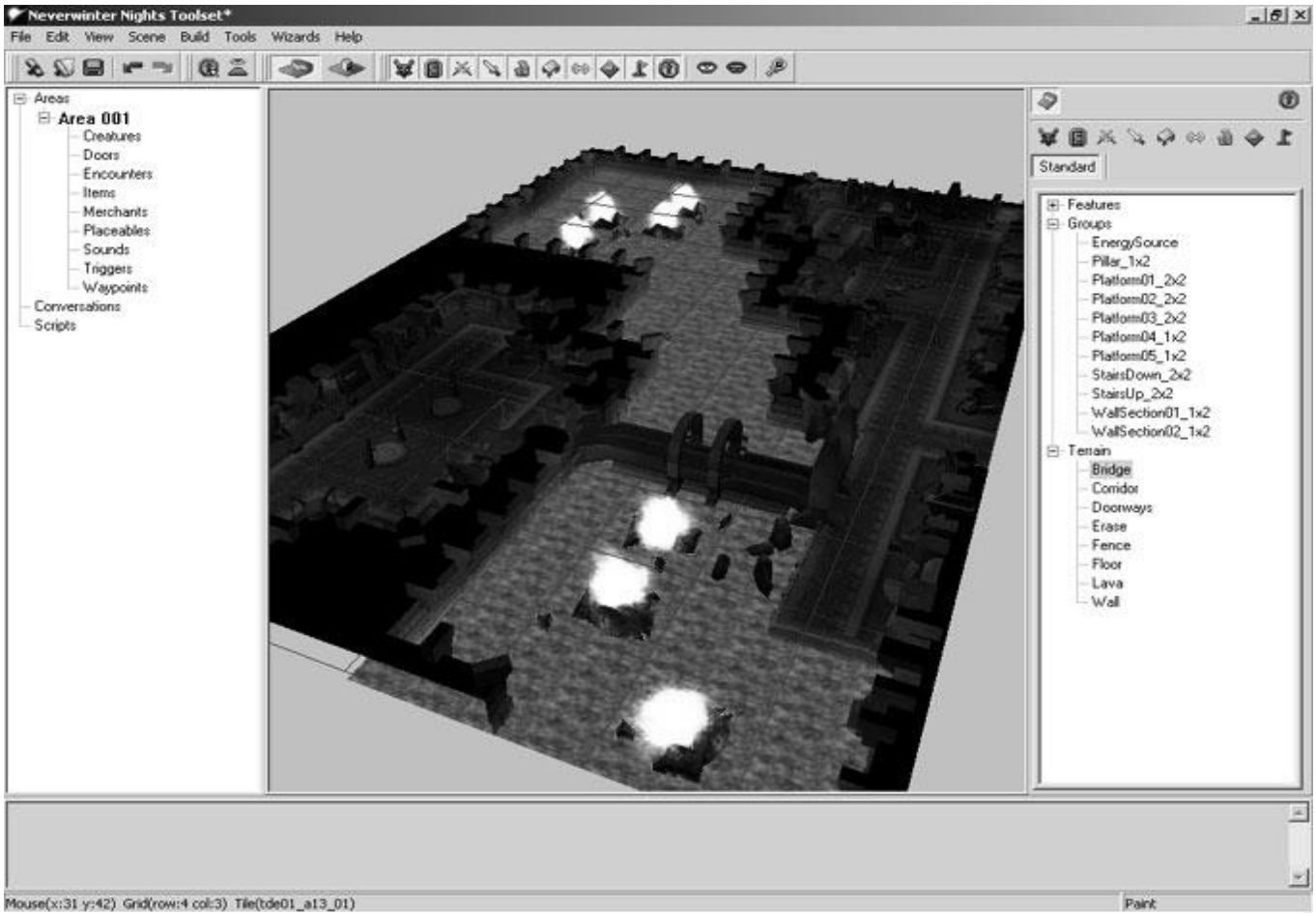

Figure 3. Object-Oriented World Building Toolset

interactions among students, but the world creation toolkits themselves allow for exploration of fundamental computer science topics while encouraging students to learn by doing and exploring.

7. CURRENT WORK

In the fall of 2003, we researched the pedagogy of online worlds and distance education and designed the model to incorporate MMOG technology into CS education and set up the server; we selected the "Aurora Toolkit" and the "Neverwinter Knights" engine because of commercial availability, power, flexibility, and cost (PIII 800mHz, 2GB HD, 128MB ram specifications for the server, and only $30 per client license).

In the spring of 2005, we will create the campus model and "bootstrap" it: populating it with points of interest for students and encouraging students to enter the space. Student assistants will create customized worlds and explore the computing concepts listed previously in section 6 via existing world building toolkits in pilot studies of the online environment.

In the near future, we will incorporate the virtual world into existing courses and present preliminary results and student reaction accompanying this paper at future conferences. As more students adopt the use of the virtual environment, the students' experiences will become enriched, and we plan to study the impact of using the environment on learning in CS.

8. NON-TRADITIONAL AND UNDERREPRESENTED LEARNERS

There is a significant population that is involved in massively-multiplayer online gaming. Current statistics place the number of users at nearly 4 million worldwide within the top seven online games (Lineage, Everquest, Ultima Online, Sims Online, etc.) [1]. These are users who have personal computers and/or console gaming devices (PS2, Xbox, etc.) and either a modem or broadband

connection; this population represents a potential, untapped resource for online higher education as they already have the minimum technology requirements and contain enough computational and graphical ability.

The demographics of these online worlds can be refreshingly surprising. In particular, the Sims Online is a breakthrough product that appeals to a mass market, not just teenagers and men. Almost all players are adults, and half are women [1]. In a time when we are trying to make computer science more accessible to female and second-career learners, we would be well served to consider why online games such as The Sims Online appeals to populations that are typically underrepresented in computing.

By utilizing existing computing and networking infrastructure and creating more community-based environments for learning, our proposed model for virtual environment-based online education has the potential to reach new populations of learners.

9. CONCLUSION

Current and emerging massively-multiplayer online game technology and existing supportive computational and network infrastructure offer new opportunities to enhance learning in Computer Science and other fields. The community-centered, peer-learning environments will improve students' experience inside and outside of the virtual classroom, resulting in better student motivation, learning, retention, and graduation rates.

Our proposed system moves beyond using games in the classroom to enhance learning. We propose to immerse students in a virtual world akin to massively-multiplayer game systems where community, communication, group dynamics, and cooperative task completion are central to the learning environment. We propose modeling the in-class and out-of-class experience for students using customizable student avatars and mentor and artificial-intelligent (system-level agent) avatars.

We believe that the compelling and engaging nature of these online worlds will involve students more in their learning and augment current online learning systems to more accurately capture the campus environment and improve learning.

MMOG technologies afford opportunities beyond creating community for online and distance education. Concepts in object-oriented design and programming, graph algorithms, language design, artificial intelligence, and graphics present themselves in a student-friendly environment that offer benefits to CS students. We will present our findings accompanying this paper.

10. REFERENCES

[1] Dial M for Multiplayer. gameSTATE (Sum 2003). 15-18.

[2] Carlson, Scott (moderator) and Gee, James. Video Games in the Classroom (Colloquy Live). The Chronicle of Higher Education. Wednesday, August 27, 2003. http://chronicle.com/colloquylive/2003/08/video/

[3] Chastine, J. and Preston, J. Designing Effective Communication Tools for Online Computer Science Courses. 32nd University System Annual Computing Conference. http://www.usg.edu/oiit/re/re03

[4] Daniel, John S. Mega-Universities and Knowledge Media. Kogan Page, London. 1996.

[5] Gee, James Paul. Turning Games into Learning Machines. Game Developer (September 2003), 55-56.

[6] Gee, James Paul. What Video Games Have to Teach Us About Learning and Literacy. Palgrave Macmillan, New York NY, May 2003.

[7] Giguette, R. Pre-Games: Games Designed to Introduce CS1 and CS2 Programming Assignments. Proceedings of the 34th SIGCSE Technical Symposium (Reno NV, February 2003), ACM Press, 288-292.

[8] Hamalainen, M. et al. Electronic Markets for Learning: Education Brokerages on the Internet. Communications of the ACM, 39, 6 (June 1996). 51-58

[9] Harasim, L., Hiltz, S., Teles, L., and Turoff, M. Learning Networks. MIT Press, Cambridge MA. 1996. pg 137.

[10] Moser, Robert. A fantasy adventure game as a learning environment: Why learning to program is so difficult and what can be done about it. Proceedings of ITiCSE '97 (Uppsala Sweden, June 1997), ACM Press, 114-116.

[11] Palloff, Rena M and Pratt, Keith. Building Learning Communities in Cyberspace. Jossey-Bass Publishers, San Francisco CA. 1999.

[12] Riffee, William H. Putting a Faculty Face on Distance Education Programs. Syllabus, vol. 16, no. 7 (February 2003), 10-13.

[13] Rosenbloom, Andrew. A Game Experience in Every Application. Communications of the ACM, 46, 7 (July 2003). 28-31.

[14] Swartout, William and van Lent, Michael. Making a Game of System Design. Communications of the ACM. 46, 7 (July 2003). 32-39.

[15] Twigg, Carol A. Expanding Access to Learning: The Role of Virtual Universities. Center for Academic Transformation at Rensselaer Polytechnic Institute. Troy, NY. 2003.