2011

I am here - are you there? Sense of presence and implications for virtual world design

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I AM HERE–ARE YOU THERE?

SENSE OF PRESENCE AND IMPLICATIONS FOR VIRTUAL WORLD DESIGN

A dissertation submitted in partial satisfaction

of the requirements for the degree of

Doctor of Education in Educational Technology

by

Vicki Suter

March, 2011

Linda Polin, Ph.D. – Dissertation Chairperson

This dissertation, written by

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under the guidance of a Faculty Committee and approved by its members, has been submitted to and accepted by the Graduate Faculty in partial fulfillment of the requirements for the degree of

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DEDICATION

To the friend who inspired the topic for this dissertation, and who was, indeed, always there when it mattered.

To my husband, for his unwavering patience and belief in me, and for the sacrifices he made so that I could make this dream come true, and who has helped me understand the meaning of unconditional love.

To my best friend and sister-of-the-heart, who was generous beyond belief, who was, of all the people in my life, the reason I could complete this journey, and who taught me the deepest truths about love of family.

For my mother and father, who gave me my insatiable curiosity and love of learning.

And most of all, to the blessings and paradoxes of faith and fate.

ACKNOWLEDGMENTS

I will always be grateful to:

- My dissertation chair, Dr. Linda Polin, who asked the best of me and gave the best of herself to me, generously and brilliantly, throughout this life-changing experience.
- My committee members Dr. Bonnie Nardi and Dr. Eric Hamilton, for their significant contributions to the final passage in this amazing journey.
- The students of Dr. Polin's classes, who volunteered hours of their time in support of the experimental study that is the heart of my dissertation.
- My Cadre X mates, who were members of my family through comps, and all of whom still keep in touch as we each finish the different stages of this process.
- The faculty and staff of the Graduate School of Education and Psychology at Pepperdine University, for all their support for this once-in-a-lifetime experience I had dreamed of for over a decade.

VITA

Vicki Suter

EDUCATION

2009 *Doctoral Program in Educational Technology, Pepperdine University*

DOCTORAL CANDIDATE
Dissertation: "*I am here–Are you there? Sense of Presence and Implications for Virtual World Design.*"

1992 *Graduate School of Management, University of California, Davis*

MASTER OF BUSINESS ADMINISTRATION, MIS AND ACCOUNTING

1979 *University of Oklahoma, Norman, Oklahoma*

BACHELOR OF ARTS, ECONOMICS

PROFESSIONAL EXPERIENCE

Director, National Learning Infrastructure Initiative, EDUCAUSE 1999-2005

The National Learning Infrastructure Initiative (NLII) was an initiative of the higher education association, EDUCAUSE (see http://www.educause.edu), based on a vision of higher education that is active and learner-centered, dynamic and lifelong, collaborative, cost-effective, high-quality and accessible.

Accomplishments:

- Defined programmatic goals and recruited volunteer faculty, staff and administrators from NLII-member institutions and partner institutions for applied research to:
    - Elicit new ideas about assessment practices and systems that can transform teaching and learning using technology, and to help institutions of higher education implement effective practices within a framework for new thinking about assessment through institution-wide transformative assessment projects.
    - Develop a practical guide to designing, launching, and growing online communities of practice (based on a three-year project facilitating four virtual communities of practice sponsored by EDUCAUSE).
    - Re-map the learning space based on learner-centered practices for instructional design, applying new research in learning and cognition.
    - Evaluate the potential of electronic portfolios. (Note: the EDUCAUSE-sponsored virtual community of practice that evolved out of this evaluation is now an international organization.)
- Conducted on-line workshops on community of practice topics.

- Designed, developed and implemented six annual NLII conferences (average attendance of 300), restructuring the format from stand-alone presentations to integrated featured sessions and companion concurrent sessions organized by NLII key themes; developed supporting web pages for each set of NLII key themes in advance of conferences; and created and edited new publication, the NLII Annual Review, documenting the results of each conference and setting programmatic goals for following year.
- Developed NLII Fellowship program, and supervised eight Fellows (two per year for four years) as they conducted research on NLII key themes.
- Designed focus session format for three smaller NLII meetings annually, to share and refine results of applied research on key themes such as assessment and learner-centered practices for instructional design.
- Brokered partnerships between NLII and five organizations including the New Media Consortium, MERLOT, AAHE, CNI, IMS to conduct joint applied research projects, develop publications and design and deliver joint conferences.
- Worked with strategic communications planning team, conducting staff management retreats, association member needs assessment, member surveys, focus groups, research on model sites, functional specifications, and design guidelines, resulting in newly-designed EDUCAUSE website.

Project Manager, University of California, Davis (UCD) 1986-2000

Accomplishments:

- Wrote successful grants to Caltrans, CPB/Annenberg, and the Department of Education, to support research on telework, distance learning, e-commerce, and electronic democracy, and to develop a testbed research environment for analyzing wide area networking technologies and the attributes of "smart communities." Served as University of California, Davis principal investigator and project leader on three-year (1993-1996) research contract.
- Created campus-wide faculty support program and coordinated with Teaching Resource Center for faculty development in use of technology for instruction.
- Designed, implemented and managed campus-wide instructional technology training program for UCD faculty, staff and students.
- Served as lead researcher, writer and editor for the Smart Communities Implementation Guide, a 175-page book for a diverse, non-technical audience, translating complex subject: ways in which community members of local government, business, education, healthcare institutions and the general public can form successful alliances to work together to use the potential of information

technology to transform their community in significant and positive ways. (See http://www.smartcommunities.org/guide/index.html)

- Contributed to UCD Accreditation Review Report (December 2002). (See http://wasc.ucdavis.edu/UCDavisFinalReport.pdf)
- Served as staff assistant to the Information Technology Strategic Planning Committee, and contributed to their report– "Information Technology Strategic Plan (1997-2002): Creating a New Information Technology Reality: Strategic Directions for the Campus."
- Co-founded Davis Community Network as a research testbed, and helped pilot it to a successful nonprofit that is still serving the Yolo County region today (See http://www.dcn.org)
- Received numerous Chancellor's Awards for Scientific and Professional Staff.

GRANTS

Doctoral research, Pepperdine University
Member of doctoral advisor's university-funded research team exploring improvement of the educational experience by understanding the design opportunities in virtual play communities that make learning a natural process of developing expertise, supported by tools, artifacts and people in a meaningful environment. Focus of research was on the virtual world Second Life.

California Department of Transportation
Principal investigator for three-year research program at University of California, Davis on the use of telecommunications as transportation, developing as a research testbed the Davis Community Network, (which continues in operation as a self-sustaining nonprofit–see http://www.dcn.orgto evaluate telework, telelearning, telecommerce and electronic democracy, and to study the attributes of "smart communities."

Annenberg/Corporation for Public Broadcasting
Principal investigator for one-year research project on use of a civic network as strategy for building a "smart community," establishing a regional network, and developing online communication tools.

RESEARCH INTERESTS AND EXPERIENCE

Virtual world design (Doctoral research, Pepperdine University)
Developed new construct for the sense of presence and conducted quantitative and qualitative analysis to research the implications for virtual world design. Designed collaborative learning environment and implemented use for class meetings.

Rich, network-based, learning-centered environments
Led applied research team of faculty and staff from wide range of university and colleges for the National Learning Infrastructure Initiative (NLII) exploring the key challenges faced by higher education in moving

from the teacher-centric transfer model of learning to the design of learner-centered environments.

Emerging technologies
Led applied action research teams of faculty and staff from member organizations for the NLII to explore emerging learning technologies such as electronic portfolios, learning objects, gaming and simulation, collaboration/communication software and mobile technologies.

Transformative assessment
Led applied action research team of faculty and staff from member organizations for the NLII to develop tools, practices, methodologies and models that can make assessment and evaluation integral parts of institutional practice and process; infrastructures to help organize assessment data; and approaches for fostering an institutional culture of inquiry and evidence-based decision-making to determine how technology is selected and applied to support teaching and learning.

Communities of Practice
Led applied action research team for the NLII to explore what role communities of practice can play in the transformation of the academy, and in the professional development and support of faculty and staff using educational technologies.

TEACHING EXPERIENCE

Taught a series of two-month online workshops in how to design and implement communities of practice for EDUCAUSE (class sizes of 20-30).
Created curriculum and managed campus-wide staff and faculty development program in use of instructional technology at UC Davis.

PRESENTATIONS AND PUBLICATIONS

Presentation, AERA, 2007, *Learning and the sense of presence in Second Life*.

Presentation, ED-MEDIA, 2007, *Exploring the use of the virtual world, Second Life, for higher education learning.*
McGee, P., Suter, V., & Gurrie, J. (2005). Over the Rainbow: Waking up in Tomorrow's OZ. In P. McGee, C. Carmean, & A. Jafari (Eds.), *Course Management Systems for Learning: Beyond Accidental Pedagogy* (pp. 147–170). Hershey, PA: Information Science Publishing.

Suter, V. and Cambridge, D. (2005). Community of Practice Design Guide: A Step by Step Guide for Designing and Cultivating Communities of Practice in Higher Education. See http://net.educause.edu/ir/library/pdf/NLI0531.pdf.

Suter, V., Alexander, B., & Kaplan, P. (2005). The Future of F2F. *EDUCAUSE Review, 40*. See http://connect.educause.edu/Library/EDUCAUSE+Review/TheFutureofF2F/40527

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Suter, V. (2003). Putting the Learner at the Center: Next-Generation Innovation Emphasizes Enabling Learning in Classrooms and E-Learning Environments. *NLII 2002-2003 Annual Review*. See http://net.educause.edu/ir/library/pdf/NLI0359.pdf

Brown, G., Ehrman, S.C., Suter, V. (2003). Transformative Assessment Conceptual Framework. EDUCAUSE Learning Initiative Report. See http://net.educause.edu/ir/library/pdf/NLI0348.pdf

Suter, V. (2001). Managing Complexity in a Transforming Environment. In C. Barone & P.R. Hagner (Eds.), *Technology-Enhanced Teaching and Learning: Leading and Supporting the Transformation on Your Campus* (pp. 25–34). San Francisco: Jossey-Bass.

Suter, V., (1997). *Implementation Guide for Building Smart Communities: How California's Communities Can Thrive in the Digital Age*. International Center for Communications, San Diego State University. (Lead author and editor). See http://www.smartcommunities.org/guide/index.html

MEMBERSHIPS

American Educational Research Association
Association for Computing Machinery
eLearning Guild
International Society for Technology in Education
American Society for Training and Development

VOLUNTEER

Davis Community Network Co-founder, Executive Board member, and Project team leader for VISTA project (see http://www2.dcn.org/dcn/about/projects/dlit), which was designed to put together a Nonprofit Internet Toolkit, including a variety of tools, resources, classes and support that can improve a nonprofit's effectiveness in serving its mission using the Internet. Presently the web site reflects research on tools that are generally available to nonprofits, describes models for how they are currently used by some nonprofits, and provides best practices in their use.

ABSTRACT

We use the language of presence and place when we interact online: in our instant text messaging windows we often post: “Are you there?” Research indicates the importance of the sense of presence for computer-supported collaborative virtual learning. To realize the potential of virtual worlds such as Second Life, which may have advantages over conventional text-based environments, we need an understanding of design and the emergence of the sense of presence.

A construct was created for the sense of presence, as a collaborative, action-based process (Spagnolli, Varotto, & Mantovani, 2003) with four dimensions (sense of place, social presence, individual agency, and mediated collaborative actions). Nine design principles were mapped against the four dimensions.

The guiding question for the study’s exploration of the sense of presence was: In the virtual world Second Life, what is the effect on the sense of presence in collaborative learning spaces designed according to the sense of presence construct proposed, using two of the nine design principles, wayfinding and annotation? Another question of interest was: What are the relationships, if any, among the four dimensions of presence?

The research utilized both quantitative and qualitative measures. Twenty learners recruited from the Graduate School of Education and Psychology at Pepperdine University carried out three assigned collaborative activities in Second Life under design conditions foregrounding each of the two design conditions, and a combination of the two. Analyses from surveys, Second Life interactions, interviews and a focus group were conducted to investigate how various designed learning environments based in the virtual

world contributed to the sense of presence, and to learners' ability to carry out collaborative learning.

The major research findings were: (a) the construct appears robust, and future research in its application to other virtual worlds may be fruitful; (b) the experience of wayfinding (finding a path through a virtual space) resulted overall in an observed pattern of a slightly stronger sense of place; (c) the experience of annotation (building) resulted overall in an observed pattern of a slightly stronger sense of agency; and (d) there is a positive association between sense of place and sense of agency.

Chapter 1: Introduction

Background and Statement of Problem

From the Socratic perspective, learning environments are based on face-to-face interaction between learners and teachers, assembled in one place, in each other's company. "Presence" is this context meant to be present in a spatial sense and a temporal sense, the present being the current moment in time: what is happening *now in this shared space*.

Changes in the Landscape

With the modern inventions of clocks, calendars and maps, we developed a more abstract relationship to time and space, a process termed "time-space distanciation," where "systems of exchange and knowledge . . . are independent of particular locations in time or space" (Hine, 2000, p. 6). With the invention of the computer and computer networks, we invented new modes of communication and new media that could span time and distance in order to communicate and collaborate, and a new definition of "presence" became necessary. We continue to be endlessly inventive with equipment and software that can make communication with someone on the other side of the world instantaneous, can help us collaborate with large geographically distributed groups, and have allowed us to build simulacra of the world. This has been both beneficial, in allowing us to do new things or do things in a new way across time and distance, and alarming to some, because the full social implications are unclear.

Explosion in higher education distance and blended education. For the most part, use of these new media has been considered second-best to actually being present in the original sense of the word. However, direct presence is not always possible. With the globalization of work, use of computer-supported collaborative work environments has become widespread. With the explosion in distance education and the adoption of hybrid or blended instruction, institutions of higher education have begun to depend much more heavily on virtual learning environments. Some of the causes for this trend include: (a) need to expand access to counter insufficient higher education infrastructure to accommodate enrollments; (b) students' demands for courses that meet their schedules and circumstances; (c) increased competition from for-profit institutions of higher education and resulting change in the institutional landscape; (d) increases in costs (and tuitions) outpacing inflation; (e) increased emphasis on graduation requirements for technological fluency; and (f) improvements in the versatility and usability of technology and its potential to support new learning activities that cannot be offered in a face-to-face environment (e.g., simulations; Howell, Williams, & Lindsay, 2003). An emerging concern is the effect on the quality of education of this increased use of virtual environments. A challenging aspect for the design of online environments for computer-supported collaborative learning is the development and maintenance of the sense of presence (Kirschner, Strijbos, Kreijns, & Beers, 2004; Kreijns, Kirschner, & Jochems, 2002, 2003; Palloff & Pratt, 1999; Picciano, 2002; Rourke, Anderson, Garrison, & Archer, 2001; Whitelock, Romano, Jelfs, & Brna, 2004). Design elements and implementation practices can facilitate or hinder this development.

Next generation learners. A new generation of learners is arriving at these institutions of higher education at the same time as the institutional landscape for higher education is changing. These learners are accustomed to operating in a personalized ubiquitous environment that integrates collaboration, cooperation, communication and the intense use of media-rich networked technologies for multitasking (Prensky, 2001). They expect a similar environment when they arrive at the university, *as they should* (Castronova, 2005) and find instead a deeply text-based culture of educators accustomed to generations of patient, passive listeners.

New genres of virtual environments. Synchronously and perhaps serendipitously, a new genre of virtual environments is emerging and gaining considerable popular recognition and use, in the form of 3D multiuser virtual worlds. These worlds are compelling, engaging online spaces for entertainment, personal expression, commerce and social interaction. These worlds are also the native habitat (mostly as Massively Multiplayer Online Role Playing Games, or MMORPGs) for the new generation of learners. Designers of such commercial worlds have to attract and retain attention and motivation of players. This competitive pressure may account for the effectiveness of commercial designer practices compared to those of learning environment designers in higher education as well as those of virtual reality researchers, “not only in technical aspects such as graphics or networking, but also in how game designers have managed their online worlds as social environments” (B. Brown & Bell, 2006, p. 228).

Virtual worlds such as Second Life which were designed for entertainment may have new features that support formal collaborative learning. Virtual world design features of interest include 3D graphical interfaces, customizable avatars, synchronous and asynchronous communication, support for self-generated social structures such as groups, built-in infrastructures for world-building and creation and distribution of learner-created content (objects, simulations, documents), scripting for programming intelligent objects, customized application development, and integration with external web resources and learning management systems. The result of this wide range of features and the conceptualization of these virtual worlds as places with inhabitants or residents rather than members, users, or login accounts, may have advantages over traditional text-based online learning environments in creating a sense of presence. Earlier text-based virtual environments (Multi-user Dungeon/Dimension/Domain, or MUDs, and MUD Object-Oriented/Multi-user Object Oriented Systems, or MOOs) had many of the same capabilities; however, the influence the wide range of new design features might have on presence is not clear. In addition, the virtual worlds often privilege the sense of sight, allowing different views than are possible in real life, and make possible other manipulations such as "radical changes in the relative sizes of the participant and virtual objects [making it] possible for students to enter an atom . . . At the other extreme it is possible for students to get a sense of the relative sizes of and distances between planets of the solar system by flying from one to the other" (Winn, 1993, p. 9). In a virtual world, a resident can wear a "Heads-Up Display" (HUD) which provides "first person knowledge about objects and events that are accessible to them in the real world only as third-person descriptions" (p. 9).

Design and New Capabilities of Virtual World Technologies

Instructional design is based on an underlying theory of learning and the mind (whether the theory is implicit or explicit), and also on the capabilities of technologies and tools that learning environment designers have available to them. One way to view the range of instructional design approaches is to use the progression from *deterministic*, to *systemic*, to *probabilistic* described by Kirschner et al. (2004).

Deterministic and systemic instructional design. Earlier generations of online learning environments were "deterministic" (supporting traditional instructional design, from a cognitive psychology perspective), in that they focused on "individual learning outcomes by influencing or controlling instructional variables to create a learning environment that supports the acquisition of specific skill" (Kirschner et al., 2004, p. 38). Subsequent development in technologies and constructivist theories of learning led to what Kirschner termed a more "systemic" design view focused on learning *processes* in individuals, where designers attempted to specify complex interdependencies in the learning processes, in advance. This approach shares the problems that arise when knowledge management systems attempt to codify expert tacit knowledge.

Virtual worlds and probabilistic design. The new genre of open-ended, socially-oriented virtual worlds such as Active Worlds Educational Universe (AWEDU) and Second Life gives learners and learning designers "world-building" power by offering features that make the worlds into open design spaces. Learning designers (and learners) have control over the environment and the objects within it and thus can operate with a "probabilistic" design view, where complex interdependencies are "treated as unknowns and are not specified" (Kirschner et al., 2004, p. 48). In the probabilistic design approach, the emphasis is on interaction as well as learning processes, and the emergent, collective nature of learning is embraced.

The limit of the deterministic and systemic views is an implicit assumption that learner behavior will remain the same. The probabilistic approach accommodates change in user behavior and interaction (which occurs, one hopes, when they are learning). Kirschner et al. (2004) note: "The question is not what outcomes specific educational techniques and collaborative work forms cause, but rather what activities they actually afford" (p. 49).

Failure to capitalize on capabilities of virtual worlds. The full extent of the potential of the new generation of virtual is explored by few, as existing practice is maintained in the new environment resulting in little or no advantage over use of earlier technologies, a common response to emerging technologies. For example, in Second Life, it is the common practice of learning environment designers to design virtual copies of brick and mortar campuses and buildings without any particular learning design goal. When you can build just about anything you can imagine, why build real life replicas, use the environment for highly decorated chat or for "the simple transference of content from sequential media, [which] makes little sense" (Sherman & Craig, 2003, p. 419)? These applications don't leverage the capabilities of the environment.

Creative uses of virtual worlds. According to Sherman and Craig (2003), uses that leverage the capabilities of 3D virtual worlds are those that involve: (a) manipulating objects in a three-dimensional environment for "architectural walkthroughs, design spaces, virtual prototyping, scientific visualization, and medical research, training, and procedures" (p. 414); (b) using the extra dimensionality for representations of data over an x-y-z plot; (c) designing scenarios for "which the goal is to explore or familiarize oneself with a physical place" (p. 416). Further capabilities include a focus on:

1. Problems that cannot be tackled in the physical world (e.g., witnessing the birth of the universe).
2. Problems that cannot be studied safely (e.g., witnessing the turmoil within the funnel of a tornado).

3. Problems that cannot be experimented with due to cost constraints (e.g., let every student practice docking a billion dollar submarine).
4. Problems in “what if?” studies (where virtual exploration could lead to better understanding). (Sherman & Craig, 2003, p. 417)

Study environment. The sense of presence construct developed by the researcher is independent of any particular virtual world. For the purposes of the study, Second Life was chosen because of its nature: (a) as a 3D multiuser open-ended socially-oriented virtual world with a wide range of features and possibilities; (b) high level of accessibility, including use of an open source model for applications; (c) a business model that encourages content creation; and (d) the high level of adoption for development of learning environments for higher education use and the active community of practice maintained by these faculty and staff. Second Life has been variously described as a tool for social networking, for holding three-dimensional visual conversations, and for programming intelligent objects (Brogden, 2007). Most importantly for this study, it is, like Active Worlds Educational Universe (see http://www.activeworlds.com/edu/index.asp), one of a few “platform service[s] for the *development* [italics added] of shared three-dimensional environments that supports multiple users with real-time communication capabilities through both text and voice” (Rodriguez, 2006, p. 79).

Second Life is “resident-driven and self-evolving” (v3image, 2007, p. 10), in contrast to World of Warcraft, which is a virtual world fantasy game with a pre-established “back story” (that is, an integrated fantasy world, with built-in quests, internal plots and characters).

Second Life residents have unique representations (“avatars”) and can (a) create their own characters, surroundings, and objects; (b) have complete control over the appearance, clothing, behavior of their avatar; (c) make or acquire their own unique clothing; and (d) develop scripts for or acquire animations for avatar gestures and behavior. Ninety-nine percent of content is user-created (Ondrejka, 2004a) using the 3D modeling tool and a scripting language, Linden Scripting Language (LSL), to add behavior to objects. Content creation by residents is the basic world model. An open economy provides for sale and trade of content and resale of land, with a market that determines the value of the creations and real estate, and an exchange process that can convert Linden dollars, the currency of Second Life, into US dollars. The only back story for the world is that open economy. The intellectual property of “in-world” creations is owned expressly by the creator (even if exported elsewhere). The creation and sale of objects is a primary activity in the world.

The virtual world supports basic physics, although residents do have the magical power to fly, and imitates the physical world with sky, sun, moon, water, and land with highly varied terrain and, through animated objects, weather. Virtual land is divided into regions, which are “both geographical and administrative units” (Rymaszewski, Au, Wallace, Winters, Ondrejika, & Batstone-Cunninghma, 2007, p. 8). Landowners own part or all of a region. Groups of avatars can own land jointly. In the case of Pepperdine University, the Graduate School of Education and Psychology has purchased a private island for exploration and experimentation.

A large community of practice for Second Life educators (SLED) is very active and it (a) is supportive of teachers new to the environment; (b) offers free tutorials, workshops, seminars and regular in-world meetings; (c) sponsors a successful open source environment that results in many free educational objects and applications; and (d) maintains a web site and an electronic list. According to the web site maintained by the community, over one hundred universities, schools and colleges are using Second Life (see "Learning and teaching," n.d.).

Design challenges inherent to open-ended, socially-oriented virtual worlds. In addition to the opportunities provided by 3D open-ended socially-oriented virtual worlds, new design issues are introduced, such as: (a) the lack of a back story and the challenge of providing an imperative to action in such an open-ended environment; (b) the confusion engendered by multiple user interfaces with arrays of buttons, menus, and heads-up displays; (c) the chaos and lack of structure which is introduced by the very flexibility and freedom to create that is a strength of such environments; and finally, (d) the learning curve to acquire mastery of such a robust environment, and of the scripting language necessary to develop new objects or interactive sites. The greatest disadvantage is that such environments may be more demanding of the learning designer, who, for effective design, may need to create the scaffolding and structure (or design activities by which the learners do so), and to design open-ended activities that include individual reflection and group dialogue about the experience.

Summary of the Problems to be Addressed by this Study

The changes in the landscape of higher education, increase in online offerings, nature of next generation learners and advancements in technology have converged to elevate the importance of the design of online learning environments for collaborative learning in higher education. Simultaneously, a new genre of virtual environments has emerged, designed for entertainment, personal expression, commerce and social interaction. Open-ended socially-oriented virtual worlds offer a wide range of new capabilities, balanced against the challenges that use of such worlds bring. Research indicates the importance of the sense of presence for computer-supported collaborative learning. To realize the potential of virtual worlds for learning, we need to understand the implications of design on the emergence of the sense of presence. Although adoption of the use of virtual worlds is increasing in higher education, absent a theory-based set of guidelines, most learning environment designers are not capitalizing effectively on the potential of these new virtual worlds. As one commentator noted, “We are like gods without a manual in Second Life” (J. B. Rhoads, personal communication, June 4, 2007).

Previous Studies

A significant body of research exists on computer supported collaborative learning (Anderson, Rourke, Garrison, & Archer, 2001; Dede, 1995; Dillenbourg & Traum, 1999; Dimitracopoulou, 2005; Garrison, 2003; Garrison, Anderson, & Archer, 2000; Janssen, Erkens, & Kanselaar, 2007; Jonassen & Rohrer-Murphy, 1999; Kirschner et al., 2004; Kreijns & Kirschner, 2001; Kreijns et al., 2002, 2003; Kreijns, Kirschner, Jochems, & Buuren, 2004; Reeves, Herrington, & Oliver, 2004; Riva, 1999; D. A. Smith, Kay, Raab, & Reed, 2003). A separate body of theory and research is available on the development of the sense of presence (Bailenson, Blascovich, Beall, & Loomis, 2003; Baños, Botella, Garcia-Palacios, Villa, Perpina, & Alcaniz, 2000; Biocca, 1997; Biocca & Levy, 1995; Botella, Baños, & Alcañiz, 2003; Bystrom, Barfield, & Hendrix, 1999; DeGreef & IJsselsteijn, 2000; Durlach & Slater, 2000; Gunawardena, 1995; Heeter, 1992; IJsselsteijn, 2002; IJsselsteijn, Lombard, & Freeman, 2001; IJsselsteijn, Ridder, Freeman, & Avons, 2000; Lessiter, Freeman, Keogh, & Davidoff, 2001; Lombard & Ditton, 1997; Lombard et al., 2000; Lombard & Jones, 2007; Mantovani & Riva, 1999; Markardian & Hwang, 2003; Riva, Davide, & Ijsselsteijn, 2003; Schroeder, 2006; Slater, Usoh, & Steed, 1994; Steuer, 1992; Thie & Wijk, 1998; Vinayagamoorthy, Brogni, Gillies, Slater, & Steed, 2004; Whitelock et al., 2004; Witmer & Singer, 1998; Youngblut, 2003; Zahorik & Jenison, 1998). Yet a third body of research exists on virtual worlds (including text-based MOOs and MUDs; Alexander, 2005; Bartle, 1997, 2004; Bruckman, 2001; Bruckman & Resnick, 1995; Burka, 1993; Crump, 2001; Ducheneaut & Moore, 2005; Erickson, 1993; Fabri, Moore, & Hobbs, 2004; Fanderclai, 1995; Grigar & Barber, 2001; Haynes & Holmevik, 2001; Kolko, 2001; Koster, 2002, 2005; Murray, 1997; Taylor, 2006).

In addition, human-computer interaction (HCI) design related to computer-supported collaborative learning has been explored (Kirschner et al., 2004; Nardi, 2001b), and work has been done on developing an activity theoretic framework for HCI and computer-supported collaborative learning.

Limitations of Prior Research

Most presence research is based on a conceptualization of the sense of presence as an attribute of media or property of human experience, and only a relatively limited number of the prior studies have addressed the narrowing of focus from online collaboration to the development of the sense of presence as an action-based process, to the sense of presences as a *collaborative* action-based process, as follows: (a) online collaboration (Axelsson, Abelin, Heldal, Schroeder, & Wideström, 2001; Casanueva & Blake, 2000; Jackson, Taylor, & Winn, 1999; Mortensen et al., 2002; Schroeder et al., 2001); (b) the development of the sense of presence as an action-based process (B. Brown & Bell, 2006; Gamberini & Spagnolli, 2003; Gifford & Enyedy, 1999; Greenhalgh, 1999; Jakobsson, 2006); and (c) the development of the sense of presence as a *collaborative* action-based process (Baker, Hansen, Joiner, & Traum, 1999; Carroll, 1991; Carroll, Neale, Isenhour, Rosson, & McCrickard, 2003; Carroll, Rosson, Convertino, & Ganoe, 2006; Cottone & Mantovani, 2003; Gifford & Enyedy, 1999; Spagnolli et al., 2003).

Research on the development of the sense of presence as a collaborative action-based process in 3D multiuser virtual worlds is sparse indeed (Hobbs, Gordon, & Brown, 2006; Kirschner, 2001; Kreijns & Kirschner, 2001). Even fewer studies exist concerning commercial environments such as Second Life (Ondrejka, 2007; Strepparava, Harb, Russo, Zorzi, & Rizzi, 2007; Terdiman, 2005), Croquet (Smith et al., 2003) and Active Worlds for Education (Rodriguez, 2006), where learning environment designers are given the capability of creating customized environments using a basic virtual world platform.

Another limitation of most existing studies is that they focus on text-based environments or, at the other extreme, high-tech virtual reality environments (where, as the name implies, presence is most often defined in terms of fidelity to reality). In addition, the focus of studies of the sense of presence in text-based environments has been almost entirely on asynchronous communications, such as discussion boards. The new virtual worlds emphasize synchronous (real-time) interaction. In addition, they appear to have “good-enough 3D virtual reality” (Castronova, 2005), as compared to virtual reality environments which are expensive and have limited availability. As noted earlier, the new genre of virtual worlds is more accessible, and has many new capabilities and features that previous environments lacked; these may have implications for the development of the sense of presence.

The new virtual worlds are also a re-emerging focus for educational researchers interested in harvesting the design principles and capabilities that make them such compelling, engaging spaces for entertainment, personal expression, and social interaction. Most of this current research is focused on an assumption that educators would use these principles in creating specialized "educational games." Much less is known about the potential for direct use or adaptation of these commercially-available 3D virtual worlds to support collaborative learning.

Researchers have noted that previous studies of human-computer interaction design have not been helpful in improving the quality of design or adaptation of 3D virtual worlds to educational uses. Indeed, human-computer interaction researchers using participatory design methods already suffer from lack of a common vocabulary for describing activity even with earlier genres of virtual environments:

> As we move toward ethnographic and participatory design methods to discover and describe real everyday activity, we run into the problem that has bedeviled anthropology for so long: every account is an ad hoc description cast in situationally specific terms. Abstraction, generalization, and comparison become problematic. (Nardi, 2001a, p. 10)

Design studies that are theory-based, using a common theoretical framework, allow for comparability and lines of inquiry that are currently difficult to sustain.

Although a number of attempts have been made, including a three-year international project (October 2002-September 2005) funded through the EU's

Information Society Technologies Future and Emerging Technologies Omnibus Presence Technology Assessment and Measurement Groups (OMNIPRES, n.d.), no coherent, multilevel reference model for the sense of presence has yet emerged. (Note that the final formal deliverable of this project, the Presence Research Handbook, is in press.)

Most importantly as to application of previous studies to interaction design based on learning experience, most of the studies are not founded in any explicit theory of the mind, learning, and practice. To realize the potential of these kinds of virtual worlds as platforms for customized collaborative learning environments–that is, as open, world-building design spaces–we need to understand how they might invite the emergence of the sense of presence, and the intent of this study is to use a theory-based approach to extend the existing research.

Sense of Presence as a Multidimensional Construct

For the purposes of this study (understanding the sense of presence in virtual worlds used for formal collaborative learning environments in higher education), the sense of presence is defined as an *collaborative action-based process* (Spagnolli et al., 2003).

Previous research on the development of presence can generally be divided into four camps:

1. The sense of presence is developed through the sense of place (Bruckman, 2001; Crump, 2001; Eladhari & Lindley, 2004; Harrison & Dourish, 1996; IJsselsteijn, Harper, & Group, 2001; Ketterer & Marsh, 2006; Lefebvre, 1991; Lomas, 2007; Ondrejka, 2004b; Steinkuehler & Williams, 2006; Turner & Turner, 2006; Wellman, 1979, 2001).

2. The sense of presence is developed through social interaction (social presence; Biocca, 1997; Biocca, Burgoon, Harms, & Stoner, 2001; Biocca & Harms, 2002; Biocca, Harms, & Burgoon, 2003; Biocca, Harms, & Gregg, 2001; Bregman & Haythornthwaite, 2003; Garrison, 2003; Garrison et al., 2000; Garrison, Anderson, & Archer, 2001; Gunawardena, 1995; Heeter, 1992; IJsselsteijn et al., 2000; Kirschner et al., 2004; Kreijns et al., 2003; Kreijns et al., 2004; Rourke & Anderson, 2002; Rourke et al., 2001; Thie & Wijk, 1998).
3. The sense of presence is determined by what we can and cannot do (individual agency; Herrera, Jordan, & Vera, 2006; Murray, 1997; Nowak & Biocca, 2003; Penny, 2004; Slater, Sadagic, Usoh, & Schroeder, 2000; Szulborski, 2005; Zahorik & Jenison, 1998).
4. The sense of presence is determined by the extent to which collaboration with others is successful (Axelsson et al., 2001; Biocca & Levy, 1995; Bowers, Pycock, & O'Brien, 1996; Bowman, Kruijff, LaViola, & Poupyerv, 2005; Bullock, 2004; Carroll et al., 2003; Casanueva & Blake, 2000; Farshchian, 2003; Fitzpatrick, Kaplan, & Mansfield, 1996; Grabinger, 2004; Greenhalgh, 1999; Jackson et al., 1999; Kreijns et al., 2003; Kreijns et al., 2004; Mortensen et al., 2002; Palmer, 1995; Quan-Haase, Cothrel, & Wellman, 2005; Riva & Mantovani, 2000; Rourke & Anderson, 2002; Schroeder et al., 2001; Slater et al., 2000; Snowdon, Churchill, & Frécon, 2004; Whitelock et al., 2004).

Youngblut (2003) identified 100 experimental studies of various issues regarding the sense of presence (with nearly 70 different measures of presence involved). She notes that “most researchers believe an ultimate measure of presence will be an aggregate of different components, for example, subjective and observed behavioral measures, and, depending on the application, may address multiple types of presence” (p. 5). In addition, “problems of stability and bias associated with simple rating scales [may be due to use of] . . . unidimensional presence ratings, when it is in fact multidimensional. Thus, a measure that takes account of the potential multidimensional structure of presence may prove to be more robust” (Lessiter et al., 2001, p. 285).

This study suggests we might learn something significant about the sense of presence and collaborative learning in virtual worlds if we include all four dimensions (sense of place, social presence, individual agency, and mediation of collaboration) in a multidimensional construct of the sense of presence, beginning with an assumption that each dimension is separate and logically orthogonal to the other.

To further operationalize the construct, a Presence/Collaborative Learning in Virtual Worlds Matrix was constructed by the researcher for use as a framework for exploring computer-supported collaborative learning and the development of presence in the virtual world, Second Life. The matrix has four columns, one each for the four broad dimensions of presence developed for the purposes of this study: sense of place, social presence, individual agency, and mediation of collaboration. The four columns are mapped against nine rows, each describing principles and guidelines for use of an open-ended, socially-oriented virtual world to create customized collaborative learning environments that invite the emergence of the sense of presence, as higher education students engage in formal collaborative learning activities in Second Life.

Significance of the Study

This study is significant, given: (a) the context of new social spaces with the potential for being harnessed as learning spaces; (b) the historical work that demonstrates the worth and nature of the sense of presence; (c) the gaps in theory-based design practice; (d) the limited implementations of online environments designed for learning as a social practice; and (e) the limitations of unidimensional definitions of presence. In response, the researcher has developed a new construct for the sense of presence with four dimensions (sense of place, social presence, individual agency, and mediated collaborative action chains), where presence is defined as the ongoing result of a collaborative action-based process, in terms of contextualized human experience.

The researcher has also developed nine design principles, drawn from research on computer-supported collaborative learning, human-computer interaction design and work on the design of virtual worlds for education or entertainment. The construct has been operationalized both with respect to the four dimensions of the construct and with respect to the nine guidelines, in the Presence/Collaborative Learning in Virtual worlds matrix.

Purpose of the Study

For the purposes of this study, the researcher has applied two of the nine design guidelines to explore the development of the sense of presence across all four dimensions of presence. The study utilized activities that have been used in other research on presence and collaboration, and was carried out under three conditions to compare two design guidelines, as follows: (a) where wayfinding is foregrounded, (b) where annotation is foregrounded, and (c) where both wayfinding and annotation are implemented together to control for order effects. The study explored to what extent the subjective report of the experience of presence aligns with the hypothesized effect of designed-presence.

The guiding question for inquiry was: What is the effect on the sense of presence in collaborative learning spaces designed according to the sense of presence construct proposed, under three design conditions (wayfinding, annotation, and wayfinding and annotation together) in the 3D open-ended, socially-oriented virtual world, Second Life? Another question of interest: what are the relationships (if any) among the four dimensions of presence described by the construct?

It is hoped that the research can begin to bridge the gap between abstract theory and practice, by providing a theory-based and validated set of guidelines for virtual world design to create customized collaborative learning environments (for higher education students) that invite the emergence of the sense of presence. To the extent the construct has been validated, the design principles based upon it will be useful to learning environment designers for leveraging the capabilities of Second Life, and for addressing the issues and challenges that this new platform for designing learning environments introduces.

Research Methods and Design of Study

Multiple sources for data informed measurement for the proposed construct. Analyses from Second Life interactions was conducted to validate the construct and two principles from the set of theory-based design guidelines based upon it. Twenty learners recruited from the Graduate School of Education and Psychology at Pepperdine University carried out assigned collaborative activities under three conditions: where wayfinding was foregrounded, where annotation was foregrounded, and where both wayfinding and annotation were foregrounded.

Experienced-Presence Online Surveys

After each learning activity, learners completed an online survey concerning their subjective experience of presence during the activity. The survey is a combination of three experienced-presence questionnaires developed by other researchers, to test sense of place (Slater et al., 1994; Usoh, Catena, Arman & Slater, 2000), social presence (Biocca, Harms, et al., 2001), and individual agency (Witmer & Singer, 1998). The surveys were elected on the basis of (a) match to the definitions being used in this study for the first three dimensions of presence, (b) on the extent of the surveys use in prior studies, and (c) on external reviews by other researchers as to the validity, reliability, and sensitivity of the instruments. The research examined the means and standard deviations obtained concerning the survey questions, created and evaluated summary statistics, and evaluated the quantitative results for correlations across the dimensions of presence.

Qualitative Data Analysis

General questions of an exploratory nature were also be pursued through: (a) researcher and trained second rater’s open-ended observations of learners carrying out the assigned collaborative tasks under the three design conditions, (b) clarifying and confirmatory interviews with a sample of learners after completion of the collaborative learning activities, and (c) a focus session with expert group of faculty and staff using Second Life for teaching and learning.

Content validation of the construct was established through a semi-structured focus group session with a three-person group of experienced, exemplar members of the

Second Life Educators community of practice. Focus group members were asked for feedback on the clarity, utility, and theoretical soundness on the design principles of the Presence/Collaborative Learning in Virtual Worlds model.

An adaptation of Mwanza's "Eight-Step Process" in her Activity-Oriented Design Model (Mwanza, 2002) was used as the organizing framework for data analysis of the fourth independent variable, mediated collaborative actions/operations chains. A prospective mapping of the nodes of a collaborative learning activity system was performed prior to the experiments to prepare for data collection, and then was revisited given the action and operation chains actually observed during the learning activities.

Mwanza's "Activity Notation" (Mwanza, 2002), was used to decompose the situation's activity system into "manageable constitutive units or sub-activity systems…linked together through the shared object of the main activity system" (p. 191).

Interaction analysis was conducted on the qualitative data collected during the collaborative learning activities (observation notes, chat transcripts) to discover occurrences of or references to the phenomena of interest (collaboration and the sense of presence). These were coded according to the Presence/Collaborative Learning in Virtual Worlds matrix, identifying design attributes or tools that supported the phenomenon (whether as designed or in new ways), or for gaps and unmet needs (additional features that might address problems observed in supporting sense of presence in the environment).

Organization of the Study

The following chapter, Chapter 2, includes a review of pertinent literature, organized around theories of the mind, learning and practice, related understanding of collaborative learning, design of computer-supported collaborative learning environments, human-computer interaction design, and prior research on the sense of presence. The conceptual framework, activity theory, is reviewed, and the four-dimensional construct for the sense of presence and associated nine design guidelines is described in the Presence/Collaborative Learning in Virtual Worlds matrix. The chapter includes a review of research methods used in prior studies. Chapter 3 describes the research methods and study design.

Chapter 2: Literature Review

Introduction and Organization of Section

The study is concerned with human-computer interaction design and the emergence of the sense of presence in the 3D multiuser virtual world, Second Life, as it is used as a formal collaborative learning environment by higher education learners. Three bodies of research informed the conceptual framework: (a) the well-developed body of research on computer-supported collaborative learning, informed by a sociocultural perspective on cognition and learning and including a substantial effort regarding multiuser text-based environments such as MUDs and MOOs); (b) existing research on the development of the sense of presence in virtual environments; and (c) research and practice in the design of virtual worlds for education and entertainment. To create a coherent model for analysis of human-computer interaction in the study, the concepts of computer-supported collaborative learning, presence, and human-computer interaction (HCI) design in virtual worlds were aligned through use of activity theory as an analytic tool. Activity theory studies which bridge HCI, computer-supported collaborative learning and the sense of presence were also explored.

Theories of the mind, learning and practice which are both explicit and implicit in existing work can be broadly categorized either as cognitivist conceptualizations of collaboration and learning or as post-cognitivist conceptualizations of collaboration and learning, and this categorization is a major theme of the literature review because of implications for the conceptualization of the sense of presence to be used in the study. The implications of each perspective on theories of computer-supported collaborative learning, conceptualizations of the sense of presence and approaches to HCI design was explored throughout the literature review.

Since an important aspect of the research is to understand how human-computer interaction design influences the sense of presence and to use a theory-based approach in doing so, the literature review then reviewed theoretical bases for HCI from cognitivist and sociocultural perspectives.

The body of literature concerning collaborative learning and issues around computer-supported collaborative learning in particular is described in depth. Theoretical work and design practice regarding human-computer interaction design for virtual worlds is also surveyed.

The literature review then turns to the heart of the research, the sense of presence in virtual environments, and suggested three categories for the existing research according to three conceptualizations of presence: (a) presence as an attribute of media; (b) presence as a property of an individual's experience; and (c) presence as an collaborative action-based process that includes individual experience within an activity system. A multidisciplinary approach is applied in reviewing different treatments of presence.

The final section of the literature review identified the sociocultural and cultural-historical perspective as the underlying theory of the mind, learning and practice to be used in the study. A new conceptualization of presence developed for the purpose of the study included: (a) a definition of presence as a collaborative action-based process with four dimensions (sense of place, social presence, individual agency, and mediated collaborative action and operation chains); and (b) a matrix based on this construct, suggesting nine design principles mapped against the four dimensions of presence. Other important terms were defined in this section.

Prior Research on Computer-Supported Collaborative Learning

An important body of research already exists about collaborative learning in virtual worlds, developed through studies of learning and social interaction in multiuser text-based virtual environments that emerged from what were originally online role-playing games, Multi-User-Dungeons, which evolved into Multi-User Domains (MUDs) when they were appropriated as social worlds, and MUD Object-Oriented (MOOs). These were used for academic conferences, as discourse-based and collaborative learning virtual environments for academic classes, for virtual communities (Bruckman & Resnick, 1995), online dissertation defenses (Grigar & Barber, 2001), and of course, research. Although text-only, MUDs and MOOs had had a similar set of capabilities as the new 3D multiuser virtual worlds, including: (a) the ability to customize avatars, (b) support for social structures at very fine-grained and user-controlled levels, (c) multiple representations of knowledge and information and support for a wide range of media, (d) specific engineering for world-building and user-created content, (e) scripting for programming intelligent objects, (f) customized application development, (g) integration with web resources and external learning management systems, and (h) open source extensions and commitment to open source.

The issues that computer-supported collaborative learning researchers were exploring are almost identical to the topics du jour in this decade, including: (a) identity and identity formation in virtual worlds (Bruckman, 1992; Kolko, 2001; Turkle, 1997); (b) sense of place (Bruckman, 2001; Crump, 2001); (c) whether or not the virtual world should be designed to mimic the physical world, with campuses and classrooms, or if the use of virtual worlds might be an opportunity for experimentation (B. Brown & Bell, 2006; Fanderclai, 1995); and (d) whether virtual worlds are really “serious enough” environments, since they are also being used for games.

Underlying Theories of the Mind, Learning and Practice

Theories of the mind, learning, and practice are based on one of two major theoretical perspectives. These perspectives are cognitivist and post-cognitivist theories.

Cognitivist Perspectives

From a cognitivist perspective on mind, learning and practice, learning is a process that occurs in individual minds and the focus of attention is on helping individuals gain knowledge or skills at using knowledge. From this perspective, knowledge is external and learned (and grounded in a reality that is “out there”). Systems and practices that are based on this perspective emphasize dissemination of information, organization of content, and mental models: “clearly transmitted information leads to successful learning” (Grabinger, 2004, p. 53). From this perspective, collaboration depends on successfully sharing knowledge between collaborating individuals.

Because cognitivism is based in objective realism, learning design based upon it is “deterministic in that it tends to focus on individual learning outcomes by influencing or controlling instructional variables to create a learning environment that supports the acquisition of specific skill” (Kirschner et al., 2004, p. 48). Support of collaborative learning is problematic because it introduces variability of the individual and group learning processes “such that it is nearly impossible to predefine conditions of learning or instruction to control interaction and skill acquisition” (p. 48).

Many approaches to knowledge management are based on the cognitivist perspective, as well as most human-computer interaction design and most systems theory as it is applied to design. Important cognitivist strategies include representation of knowledge, metaphors, pattern recognition, conceptual frameworks and mental maps.

The movement in the 1990s toward design of multimedia learning environments was built on a cognitivist view that multiple, varied and sensorily rich channels for knowledge transmission to an individual would improve learning. As Kreijns et al. (2003) noted, support for social interaction was taken for granted in these environments and was often either missing or an after-thought that was handled by instructor intervention. Another pitfall was the tendency to restrict social interaction to cognitive processes (Kreijns et al.). For one study that systematically evaluated the findings of 17 original research studies in terms of technologies, teaching strategies, presence, and learning, the addition of a “social” dimension of presence was limited to individuals’ reciprocal perception of and interaction with other mediated people, places and things (Markardian & Hwang, 2003). Learning was conceived in terms of cognitively-based lower-level objectives (memorization) to higher-level objectives such as “manipulation of facts into cognitive ideas and concepts, such as analyzing and synthesizing” (Markardian & Hwang, p. 514).

Post-Cognitivist Theories of Learning

Major post-cognitive, sociocultural theories of learning include constructivism, situated cognition, distributed cognition, actor-network theory, phenomenology, and the theoretical framework for this paper, activity theory (also known as cultural-historical activity theory). What is common to each is that the theories are based on a subjective view of reality, and a conceptualization of the sociocultural nature of learning as a process of enculturation through authentic experience. Community is central and learning is seen as a social practice involving doing and being (identity), instead of an individual process of knowing. Knowledge from a sociocultural perspective is “a functional stance on interaction—not a truth” (Barab & Duffy, 1998, p. 3).

Each of these theories conceptualizes the human mind and consciousness as extending beyond the individual human being, rejects duality and emphasizes the whole, and can be useful as an analytical tool as well as a theoretical framework in understanding the important role of technology and other tools in human life (Kaptelinin & Nardi, 2006).

Constructivism as a sociocultural perspective on the mind, learning, and practice. From a strongly sociocultural perspective, constructivism builds upon the human need to make sense of the world, to understand and resolve uncertainty through action, and is based on a theory of learning as the reciprocal social and cultural construction of meaning and identity where “knowledge is situated and progressively developed through activity” (Barab & Duffy, 1998, p. 109).

Although constructivism is grounded in subjective knowledge and sense-making rather than objective transmission of information, the actual implementation of it has often had a strong cognitivist aspect: “To develop competence in an area of inquiry, students must: (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organized knowledge in ways that facilitate retrieval and application” (Bransford, Brown, & Cocking, 2000, p. 16).

The extent to which implementation of constructivism as the cognitive, individual aspects of learning foregrounded depends on whether the social nature of learning is limited to “a small aura of socialness supporting input for individual acquisition and internalization of the cultural given” (Lave & Wenger, 1991, p. 48), or is based on Lave and Wenger’s (1991) view of learning as a social *practice*, where “learning, thinking and knowing are relations among people in activity in, with and arising from the socially and culturally structured worlds” (p. 51).

Learning and human-computer interaction design based on constructivism is a more “systemic” design view focused on learning processes, where designers attempt to specify complex interdependencies in advance (Kirschner et al., 2004). Learners may or may not set the goals; this can compromise the authenticity of the learning experience and the extent to which the students feel a sense of ownership.

Another constructivist model of computer-supported collaborative learning is a process of critical inquiry through asynchronous critical discourse, which was introduced in the community of inquiry model (Anderson et al., 2001; Duffy & Kirkley, 2004b; Garrison, 2003; Garrison et al., 2001; Grabinger, 2004; McKlin, Harmon, Evans, & Jones, 2005; Rourke et al., 2001; Shea, Fredericksen, Pickett, & Pelz, 2004), which involves the dimensions of cognitive presence, teaching presence, and social presence. The model is based on an understanding of learning at a macro level, as a social process by which meaning is constructed through discourse and practical inquiry; and at the micro or private level, the value of reflection for individual learning. Cognitive presence is defined as “the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse in a critical community of inquiry” (Garrison et al., p. 5). Social presence is defined to be “the ability of participants in a community of inquiry to project themselves socially and emotionally, as ‘real’ people (i.e., their full personality), through the medium of communication being used” (Garrison et al., 2000, p. 94). Teaching presence in the community of inquiry model involves specific roles. The role of the teacher is to design, facilitate and direct the process, and to provide resources for learners’ use. However, it is not clear why teaching presence would differ from the presence of any other participant, except for the hierarchical division of labor and faculty’s traditional role. Systems which have a built-in hierarchy of privileges, such as course management systems, would provide barriers to online collaborative learning. Note that the application of the term “presence” in the community of inquiry model is in a substantially different context than its treatment in presence research, which is discussed in a later section.

Situated learning and communities of practice model as a sociocultural perspective. In the acknowledgement section of *Situated learning: Legitimate peripheral participation,* Lave and Wenger’s seminal work (1991), the authors noted that their concept of legitimate peripheral participation was presented to “a reading group on activity theory, critical psychology, and learning in the workplace” (p. 5). Lave and Wenger indicated that the group, which included among its membership activity theorists Cole and Engeström, “served as a wonderful source of ideas and discussion” (p. 5), perhaps accounting for the resonance between the two analytical viewpoints, situated learning theory and cultural-historical activity theory. As the authors noted, they considered their original purpose was to translate the understanding of learning as “an integral part of generative social practice in the lived-in world” into a “specific analytic approach to learning" (p. 35). Situated learning theory is rooted in the understanding of knowledge as an activity in a social context; communities of practice represent a situated learning approach. The learner is a "person-in-the-world, as a member of a sociocultural community . . . [and] knowing is an activity by a specific person in specific circumstances" (Lave & Wenger, p. 52). Further, learning is identity work, across a life-long trajectory of participation, with "evolving and continuously renewed set of relations" (p. 49) in different communities, "activity in, with, and arising from the socially and culturally structured world" (p. 51).

An important aspect of situated learning is its reciprocal nature. As learners participate in communities of practice in different domains and acquire expertise in practice in that domain, they both reproduce and transform the communities of practice:

As the authors explored different approaches to "situatedness," they came to realize that

> [their concept of situated activity] took on the proportions of a general theoretical perspective, the basis of claims about the relational character of knowledge and learning, about the negotiated character of meaning, and about the concerned (engaged, dilemma-driven) nature of learning activity for the people involved. That perspective meant that there is no activity that is not situated [and] implied emphasis on comprehensive understanding involving the whole person rather than "receiving" a body of faculty knowledge about the world; on activity in and with the world; and on the view that agent, activity, and the world mutually constitute each other. (Lave & Wenger, 1991, p. 33)

Lave and Wenger (1991) experienced a shift in perspective that ultimately led to the analytic viewpoint on learning that they labeled “legitimate peripheral participation,” when they began to understand situated learning as “a transitory concept, a bridge, between a view according to which cognitive processes (and thus learning) are primary, and a view to which social practice is the primary, generative phenomenon, and learning is one of its characteristics” (p. 34).

From this perspective, “people share activities and not merely concepts” (Carroll et al., 2006, p. 21). Carroll et al. argue that communities of practice (one of the steps in their prescribed progression of collaboration) do not develop for learners in formal learning environments. While Barab and Duffy (1998) agree with this assessment that collaborative communities of learners do not communities of practice make, efforts to design strong connections between student practice fields and society, “giving students a legitimate role (task) in society through community participation/membership,” may provide some of the benefits of communities of practice (p. 25). Collaborative technologies can facilitate this participation.

Distributed cognition as a theory of the mind, learning and practice. Distributed cognition has been defined as the distribution of intellectual processes and products among individuals, between individuals and mediating artifacts, across environments both physical and symbolic, and across time. Pea (1993), a major contributor to the development of distributed intelligence and learning concepts, argues that they actually represent more of a heuristic framework than a theory of mind, learning and practice.

In its purest form, distributed cognition is based on a construct of a network of people and artifacts, with each treated as the same type of node on the network, for the purpose of converging on a shared representation. The emphasis on representation and symmetry between human and non-human nodes distinguishes this perspective from activity theory (Kaptelinin & Nardi, 2006), and also reveals an orientation of learning toward systems, rather than activities “at different levels of coordination, cooperation, and co-construction” (p. 222).

The most successful approaches based upon distributed cognition are those undertaken with large organizations that have well-defined structures where stability is important, for example operations aboard a military vessel (Kaptelinin & Nardi, 2006). Distributed cognition emphasizes coordination, where individuals essentially work separately, with the results of their work tracked and integrated at key (more or less predictable) milestones. As such, it is less successful in situations that are highly dynamic, emergent, and evolving.

A virtual world designed to support collaborative learning and distributed cognition would include tools for the development of representations. The support for strategies such as online conversational turn-taking and representational tools in a “shared concept space” (Haythornthwaite, 2005) would be emphasized, as would the ability of the “external regulator” (Dillenbourg, 1999, p. 6) to set up initial conditions carefully and to monitor learners’ interactions. Strategies based on distributed cognition include mechanisms to support self-explanation, induction, and attend to cognitive load.

A perspective on distributed cognition (intelligence, consciousness, and learning) that is closer to the sociocultural perspective than the traditional cognitivist perspective is proposed by Salomon (1993):

> The social and artifactual surrounds, alleged to be "outside" the individuals' heads, not only are sources of stimulation and guidance, but are actually *vehicles of thought*. Moreover, the arrangements, functions and structures of these surrounds change in the process to become genuine *parts of the learning* that results from the cognitive partnership with them. In other words, it is not just the "person-solo" who learns, but the "person-plus," the whole system of inter-related factors . . . And if intellectual processes and products can be seen as being distributed among individuals or between individuals and culturally provided implements, may it not also be the case that intelligence is an emerging quality rather than a possession? (pp. xiii-xiv)

Activity theory as a theory of the mind, learning and practice. Activity theory—because of its conceptualization of computer technology as a mediating tool or artifact—offers both a conceptual framework and an analytic tool for exploring the effects of the human-computer interaction and design on a sense of presence in 3D virtual learning environments. Cultural-historical activity theory introduced the idea of human psychological functions mediated through tools, rules, roles and community. That is, "the human mind emerges, exists, and can only be understood within the context of human interaction with the world; and…this interaction, that is, *activity*, is socially and culturally determined" (Kaptelinin, Nardi, & Macaulay, 1999, p.28).

The cultural-historical model provides a "conceptual map to the major loci among which human cognition is distributed" (Cole & Engestrom, 1993, p. 8). Cole and Engeström explain the different points on the model most frequently used to illustrate cultural-historical activity theory:

> [T]he fact that individuals ("subject") are constituted in communities is indicated by the point labeled "community"…relations between subject and community are mediated, on the one hand, by the group's full collection of "mediating artifacts," and on the other hand, by "rules" (the norms and sanctions that specify and regulate the expected correct procedures and acceptable interactions among the participants). Communities, in turn, imply a "division of labor," the continuously negotiated distribution of tasks, powers, responsibilities among the participants of the activity system. (1993, p. 7)

The unit of analysis for an activity system is an activity. Cognitive actions (remembering, decision-making, and learning) are distributed among the artifacts, the rules, the community, and the division of labor.

Activity theory foregrounds development, which differentiates it from other sociocultural theories (Engeström, 2000). Activity theory offers an approach for understanding, over time, the dynamics of individuals and their context as learning occurs: the fluid *and* reciprocal movement between the intra-psychological and inter-psychological as learners are "constructing, testing, implementing and revising this zone of proximal development for their activity" (p. 307). That is, although the subject's motivation and intent to produce an effect or achieve an object is critical, the center of attention in construction of knowledge moves beyond the self, to include "a temporal and developmental perspective" and a "systemic and collective perspective" through a systematic focus on the activity and the activity system itself (Engeström, p. 307).

Human-Computer Interaction Design

This study is a study of human-computer interaction (HCI) design associated with collaborative learning in the virtual world, Second Life, in order to explore the emergence of the sense of presence. For that reason, a brief review of the literature on HCI is important, as is a discussion of the implications of cognitive and post-cognitive frameworks, again to make the underlying theory explicit for the study.

Cognitivist Perspective of HCI Design

The contrast of a cognitive perspective of HCI design to the activity theory perspective is helpful because cognitive scientists did much of the original work on HCI, developed the conceptual models for that work, and as such still have a strong influence on HCI today. In particular, Norman (1993), a cognitive scientist whose research has been extensively applied to HCI design, used a construct he called “cognitive artifacts,” which were physical artifacts such as paper, and mental artifacts such as language, computer technologies, and digital information media. He has been critical of the design of digitally-based artifacts because in his view they didn’t support natural mapping, natural principles of operation, or meaningful and accessible representation.

One of Norman’s (1993) contributions to HCI design was his adaptation of the idea of affordance to technologies: that is, technologies have affordances. Norman (1999) refined the concept further in a later article, where he reiterated his explanation from *The Psychology of Everyday Things* (Norman, 1988) that the way humans manage in a world of thousands of novel objects, if properly designed, is that “the required information was in the world: the appearance of the device could provide critical clues required for its proper operation” (Norman, 1999, p. 39). He also noted that “understanding how to operate a novel device had three major dimensions: conceptual models, constraints, and affordances" (p. 39). In the later article, he emphasized that in the context of design, especially human-computer interaction design, affordances are *perceived* affordances. While the computer system has built-in physical affordances such as a mouse or keyboard, what appears on the display–an icon or a cursor–is not an affordance, but "visual feedback that advertise the affordances: they are the perceived affordances" (p. 40).

This distinction is important because, as Norman (1999) argued, these are design elements that can be manipulated independently of one another. For example,

> Perceived affordances are sometimes useful even if the system does not support the real affordance. Real affordances do not always have to have a visible presence (and in some cases it is best to hide the real affordance)…A graphical depiction [that] suggests to the user that a certain action is possible…is not affordance, either real or perceived. Honest, it isn't. It is a symbolic communication, one that works only if it follows a convention understood by the user (p. 40).

Aside from affordances and cognitive artifacts, Norman emphasized the very useful ideas of conceptual models and constraints. He noted that the most important (and most difficult) aspect of a successful design is developing the underlying explicit and perceivable conceptual model and assuring internal consistency. With regard to behavioral constraints, Norman (1999) introduced three categories: (a) physical constraints, which are closely related to real affordances; (b) logical constraints, such as a scroll bar for moving down to see the bottom of a page, which make "the fundamental design model visible, [enabling] users to readily (logically) deduce what actions are required. Logical constraints go hand in hand with a good conceptual model" (p. 40); and (c) cultural constraints, which are conventions shared by a community of practice, that have evolved over time. Again, Norman emphasized that "symbols and constraints are not affordances, but examples of the use of a shared and visible conceptual model, appropriate feedback, and shared, cultural conventions" (p. 41). The design constraints based on conceptual model(s), constraints, conventions and intended affordances as designed by developers, and as experienced or perceived by inhabitants who are experimenting with a virtual world as a shared learning space, can provide a helpful language for describing human-computer interaction design issues.

Activity Theory Perspective of HCI

Nardi (2001a) describes the fundamental difference between activity theory and cognitive science:

> Activity theory proposes that activity cannot be understood without understanding the role of artifacts in everyday existence, especially the way artifacts are integrated into social practice (which thus contrasts with Gibson's notion of affordances). Cognitive science has concentrated on *information,* its representation and propagation; activity theory is concerned with *practice*, that is, *doing* and *activity*. (p. 14)

The implications of activity theory as a conceptual grounding for this study call into question the traditional HCI concepts of representation, metaphor, and mapping, which come from cognitive science, and which are still subtly pervasive in actual learning environment design even when a sociocultural orientation is claimed. It is not that these design concepts are completely unhelpful, it is that they are not enough to take us from the notion of the "solitary intelligence, decontextualized from its uses beyond the educational," (Pea, 1993, p. 49), into environments that support learning as *people-in-action*, and the *activity of representing* over representations of knowledge (Wartofsky, 1979). For example, although Roschelle (1992) refers to social constructivist theory and situated action as the basis for his theory of collaborative learning as "convergent conceptual change" (p. 238), his implementation of it appears to be limited to a "small aura of socialness" (Lave & Wenger, 1991, p.48) and in fact "shares with contemporary cognitive theory the emphasis on students' construction of deep-featured situations and their restructuring of commonsense metaphors" (Roschelle, p. 238). Roschelle's approach involves constructing shared meanings for concepts through an iterative process: learners collaborate by displaying their meaning to each other, confirming meanings, and refining shared meanings in interactive cycles of conversational turn-taking. The desired outcome is for a deep new conception of an idea through convergent conceptual change. However, the process as he describes it is ultimately based on a theory of the mind and learning that involves representations: that is, mental maps, metaphors, and shared conceptions of a problem and knowledge. The dynamic of development is a black box where the activity is (apparently) limited to discussion, and the learner's intent is not addressed, unless it is assumed to be comprehension of text, where the desired outcome is to practice engaged, critical reading and to attain the ability to engage in discourse about it (which may be no small matter, if the intention is to teach the learner how to "do school"). However, collaboration limited to dialogue is still "talking about" a domain and field of practice, and not "talking within," (Lave & Wenger, 1991, p. 109) which is necessary for the change in identity and ultimately, membership in the community of practice (Polin, 2004). Pedagogy completely designed around discourse not anchored in practical activity is missing that critical second dimension.

Humans' activities are directed toward other humans and things with material and sociocultural properties, to produce an effect according to biological or cultural needs and intentions (Kaptelinin & Nardi, 2006, p. 241). The human acting to achieve an effect is, in activity theory, the subject, and the focus of their activity is the object. Activity theory is based on a hierarchical understanding of the human interaction, from: (a) activities undertaken in order to fulfill the subject's needs and desires (motivations); (b) actions (tasks in human-computer interaction literature) carried out as part of the activity; to (c) operations, where actions become so routine that they are unconscious, unless there is a breakdown in the process. An example would be the action associated with typing. Many individuals, because of experience using a computer keyboard and with the ability to type rapidly, can type almost as fast as they can think, with little awareness of the operation – unless a key on the keyboard is broken, as the "u" recently was on the researcher's computer.

Indeed, a construct from activity theory discussed by Kaptelinin (2001), the "functional organ" (Leont'ev, 1981), may be interpreted in the context of sense of presence. A computer tool that has been functionally integrated is experienced as a property of the individual (the tool becomes a part of the person, inside of the mind boundary, and the human-tool separation disappears). Kaptelinin suggested that the notion of a functional organ would help resolve the issue that designers face in addressing two interfaces: human to computer, and human and computer to external world. One of the applications of activity theory in this study is at the intersection between activity theory and HCI: its use in determining how HCI design can promote functional integration of computer tools; in other words, convert them to functional organs. In this sense, as a computer tool becomes a functional organ, the mediating artifact “disappears” from the learner’s perception of their experience; this is equivalent to the perceptual illusion of non-mediation, which is the commonly-accepted definition of the sense of presence (Lombard & Ditton, 1997).

As a practical interpretation of the usefulness of activity theory for the design process itself, Redmiles (2002) contended that:

> Activity theory provides a framework for describing phenomena at various levels. First, it answers software requirements questions at the most basic level, i.e., the tasks and activities the software is part of. Second, it focuses on the social organization of key players in an activity, such as stakeholders in a problem, communities of users, roles and other social forms. (p. 1)

Finally, there is precedent in the considerable previous work in HCI and computer-supported collaborative learning which has used activity theory as a conceptual framework and analytic tool (Baker et al., 1999; Bellamy, 2001; Bødker, 1989; Greenhalgh, 1999; Kaptelinin & Nardi, 2006; Kuutti, 2001; Nardi, 2001a; Robins, 2002).

In general terms, an activity system analysis of a collaborative attempt to build a particular object, as part of a learning activity in a virtual world, would use the activity as the unit of analysis, and would include: (a) the subject(s) and their intentions, (b) the object, (c) the perception of a mediating artifact or complex of mediating artifacts, (d) the community in which the activity is situated, (e) the rules/protocols that govern behavior in that community, and (e) the division of labor that determines responsibility. From a more sophisticated perspective, activity theory used both as a conceptual tool and an analytical tool in exploring human-computer interaction in a virtual world integrates the following key aspects: object-orientedness, hierarchy of human interaction (activity-action-operation), internalization/externalization, mediation, and development (Kaptelinin & Nardi, 2006).

Collaborative Learning

The term, “collaborative learning,” like presence has multiple definitions based on the underlying theory of the mind, learning and practice. The nature and benefits of collaborative learning, its role and importance in distance learning, and the relationship between collaborative learning and social interaction can also be interpreted from cognitivist and post-cognitivist perspections.

Nature of Collaborative Learning

As is logical, research on collaborative learning has evolved along the same cognitivist to post-cognitivist path over the past decade, as can be seen from the changing unit of analysis. Originally, research focused on the individual, functioning in a group (Dillenbourg, Baker, Blaye, & O'Malley, 1996). The unit of analysis then became the group itself and intra-group dynamics. The focus from this perspective, collaboration was a “process of shared creation: two or more individuals with complementary skills interacting to create a shared understanding” (Schrage, 1991, p. 40).

Finally, collaborative learning began to be conceptualized from a sociocultural perspective, with the focus moving from cognition to individuals’ relations to community, from learners as students to potential members of communities of practice, and from a unit of analysis as situated activity to the individual, in community (Barab & Duffy, 1998).

Dillenbourg, a researcher who has explored collaborative learning over the past decade, primarily from a cognitivist perspective, describes an naive definition of collaboration: “A situation is termed ‘collaborative’ if peers are more or less at the same level, can perform the same actions, have a common goal, and work together” (Dillenbourg, 1999, p. 7).

The shift from a cognitive conceptualization of collaborative learning to a sociocultural conceptualization of collaborative learning is a shift from acquisition (of knowledge) to participation, and this shift “changes the focus from the individual as ‘person-to-be-changed’ to how to facilitate emergent practices of learners working collaboratively, with particular emphasis on learners’ reasons for carrying out the activities and the context in which they are nested” (Barab, Hay, Barnett, & Squire, 2001, p. 2).

When, as is suggested for this study, collaborative learning is seen both as an individual experience and as a sociocultural activity, the use of activity theory is helpful. Because an activity involves a subject or subjects operating in community, with relations mediated by roles and rules, Carroll et al. (2006) argue that effective collaboration may depend on mental models, but these must be extended to include “how knowledge and beliefs in common are identified and used to coordinate group activities (e.g. through consensus formation), how complementary knowledge and skills are deployed and developed in roles and other divisions of labor in team performance, and how social, cultural and physical concepts and entities are incorporated to support team cognition and performance” (p. 24). Indeed, as was suggested earlier, the representing process is at least as important as the representations or products of representation, if not more.

Learning “involves collaborative social processes intended to stimulate the meaning-making capabilities of learners” (Cottone & Mantovani, 2003, p. 249), and occurs best as a natural process of engaging in activities and shared experiences in a richly-contextualized, authentic environment rather than thinly-contextualized content delivered in a classroom to effect knowledge acquisition.

In a broader sense, if collaborative learning is modeled after collaboration among scientists, it can be defined as “human behavior that facilitates the sharing of meaning and completion of tasks with respect to a mutually shared . . . goal, and which takes place in social settings” (Sonnenwald, 2006, p. 63).

Dillenbourg (1999) notes that “symmetry of knowledge (skills or development)” is rare in any group, and that “[with] real people engaged in real life situations, one cannot simply assume that partners have completely shared goals, even if some external agent fixes this goal” (p. 8). From a sociocultural perspective on learning, this asymmetry of knowledge is actually more beneficial than symmetry, and differences in subjects’ intentions are a given.

Benefits of Collaborative Learning

From a constructivist perspective, the benefits of collaborative learning include its ability to provide “scaffolding of the critical thinking and inquiry process . . . challenging perspectives . . . and a support environment” (Duffy & Kirkley, 2004a, p. 114). Advantages of collaborative learning include: (a) the development of critical thinking skills and deeper level thinking through discourse in a community of inquiry (Garrison et al., 2001); (b) experience with collaborative work practices expected in the workplace; (c) development on two planes, the inter-psychological, and the intra-psychological; and (d) “reduction of feelings of isolation, increased satisfaction with the course, and increased motivation” (Hughes, Wickersham, Ryan-Jones, & Smith, 2002, p. 86).

The beneficial characteristics of collaborative learning as described by (Kreijns et al., 2003) are:

1. Learning is active;
2. The teacher is usually more a facilitator than a ‘sage on the stage.’
3. Teaching and learning are shared experiences.
4. Students participate in small-group activities.
5. Students must take responsibility for learning.
6. Students are stimulated to reflect on their own assumptions and thought processes.
7. Social and team skills are developed through the give-and-take of consensus-building. (p. 337)

Role and Importance of Collaborative Learning in Distance Learning

For the distance student, the creation of community through collaboration is even more critical. Interaction with peers in community is central to the effective distance learning environment, otherwise, “there is uncertainty how to proceed, of how well the concepts are understood, of what is required, and how much work is expected” (Duffy & Kirkley, 2004a, p. 117). In addition, the “pull” of community provides motivation for persisting and prioritizing academic requirements in the face of more “present” concerns (Duffy & Kirkley).

Collaborative Learning and Social Interaction

Many educational researchers believe that “social interaction is a key element in group learning” (Kreijns et al., 2003, p. 338). The necessary condition to successful online collaboration is social interaction. As Kreijns et al. note, “If there is collaboration then social interaction can be found in it, and vice versa, if there is no social interaction then there is also no real collaboration” (p. 338). In a review of the online collaboration literature, Hughes et al. (2002) found that

> for online collaboration to be most effective, participants must: (1) see the value of expending the (considerable) effort required, (2) be comfortable with and trust the medium, (3) be comfortable with and trust their instructor (or facilitator) and fellow collaborators, and (4) feel as though they are immersed in a rich, engaging, and rewarding social experience. (p. 86)

Design Issues in Computer-Supported Collaborative Learning

The phases of the evolution of instructional design (and design of computer-supported collaborative learning environments) from cognitivist to socioculturally grounded, can be seen as moving from deterministic, to systemic, to probabilistic (Kirschner et al., 2004). Design of a learning environment can be based on: a) a traditional instructional design, from a cognitive psychology perspective, and “deterministic in that it tends to focus on individual learning outcomes by influencing or controlling instructional variables to create a learning environment that supports the acquisition of specific skill”; b) a “systemic” design view focused on learning processes in individuals, where designers attempt to specify complex interdependencies in advance–an approach that is essentially constructivist in nature; and (c) a “probabilistic” design view, where complex interdependencies are “treated as unknowns and are not specified” (p. 48). In the probabilistic view, the emphasis is on learning and interaction processes, and the emergent, collective nature of learning is embraced. The limits of the first two views are their implicit assumptions that learner behavior will remain the same. The probabilistic approach accommodates change in learner behavior and interaction (which occurs, one hopes, when they are learning). Kirschner et al. (2004) note: “The question is not what outcomes specific educational techniques and collaborative work forms cause, but rather what activities they actually afford” (p. 49). From this sociocultural perspective, individual and social phenomena are mutually constitutive, and, for the purposes of this study, the differing hierarchies of action (goals of individuals, and goals of collective actions) are played out in the virtual world (Kaptelinin & Cole, 1997).

Issues related to design of computer-supported collaborative learning environments based on a sociocultural approach include the need to support: (a) informal sociability, visibility and availability; (b) socio-emotional communication channels; (c) awareness for collaborative work (social, action, activity and situation); and (d) group identity, accountability and social capital. The importance of social interaction in computer-supported collaborative learning was emphasized earlier in the paper: “Social interaction is important for establishing a social space in which a structure can be found that encompasses social relationships, group cohesion, trust and belonging, all of which contribute to open communication, critical thinking, supportive interaction, and social negotiation” (Kreijns et al., 2002, p. 10).

In the online collaborative environment, visibility is serious issue because learners aren't co-located or even co-temporaneous, so other affordances must provide information about availability for social interaction. To increase sociability, the environment must provide a means for determining the presence of other community members and initiating spontaneous informal interactions (typically casual conversation, not task-based interactions) through "lightweight, easily accessible and easy to use mechanisms" (Farshchian, 2003, p. 212). The success of instant messaging, with its cues about the current state of participants with regard to interaction, and previous interactions supports this argument (Hughes et al., 2002; Quan-Haase et al., 2005).

Bregman and Haythornthwaite (2003) also identify visibility as a critical aspect of collaborative learning in an online environment, and include in their treatment of visibility the need for a way for learners to provide representation of self, as well as the range of methods and media available for self-expression.

An example of an environment designed almost completely for sociability is *There*, which is "a persistent world with objects which can be manipulated, customizable avatars representing each user, and various facilities for interactions between avatars, and between avatars and objects. Rather than as a competitive game as such, *There* is marketed as a 'virtual getaway'–a world where social interaction and play are the main activities. There is no overall goal to *There*" (Brown & Bell, 2006, p. 228). Note, however, that an activity theoretic perspective is relevant even for this environment: Brown argues that the importance of the sociability is on "the shared activity together–such as chat, or interaction around objects, where we perform our friendships" (p. 233).

The environment is open-ended, in the sense that "new uses and applications can be discovered by users" (p. 240).

To summarize, these are a set of key design considerations in creating "*sociable* CSCL environments aimed at providing non-task contexts that allow social, off-task communication (e.g., casual communication) and that facilitate and increase the number of impromptu encounters in task and non-task contexts through the inclusion of persistent presence and awareness through time and space of the other members" (Kreijns et al., 2003, p. 349).

Human development. Through collaborative team members' participation in community, they learn and expand their abilities and understanding. In addition, one of the basic tenets of Activity Theory is that contradictions and conflicts represent opportunities to learn; that is, opportunities for human development, transformation, and innovation.

Human-Computer Interface Design for Virtual Worlds

Basic "Hard-Wired" Virtual World Architecture

As designers begin building basic virtual world infrastructures, there are decisions that will become "hard-wired" into the world's architecture. These design decisions will: (a) set the development course for the world's ethos, tone and underlying conceptual model; (b) determine the balance between player and designer control in the world and its contents; (c) facilitate (or not) sociability and community-building; (d) set the rate of change and the level of persistence; and (e) create (or not) a unity of intention or imperative to action.

This study did not deal with those decisions regarding technical infrastructure issues such as load balancing and grid or client streaming architecture, or the equations and models used to simulate the world, except as they may affect the learner's experience. The study also did not examine the effects of intelligent agents (non-human agents) in virtual environments.

For the purposes of this discussion, the terms "resident" or "learner" were used in place of "player." Other aspects of virtual world design that aren't "hard-wired," but that may be flexible for customized world design are discussed in a later section on presence research.

Persistence/Change Continuum and Ownership of the Virtual World

A primary decision is the placement of the world on the persistence/change continuum. Will the world be an open-ended, socially oriented world, a platform for building other worlds or is it to be a fixed world with pre-defined storyline and content? Bartle (2004) argues that the following are key decision decisions: First of all, who decides? Who "owns" the world and its contents, the residents or the designers? Does the world belong to designers through their control of the map of the world and the characters in it (high persistence/low change)? Or do the designers "create the core and means by which it can be extended; thereafter they hand it over to the players to do as they wish" (p. 59). This decision determines whether content creation will be the responsibility of designers, an opportunity for collaborative self-expression by residents, or some combination of the two.

For example, the underlying model for Second Life is that of an open-ended socially-oriented world serving as a platform for building customized virtual worlds or “sims.” Content is created by residents based on an open economy for sale and trade of content and a market that determines the value of the creations. Ondrejka, one of the founders of Second Life, noted that the desire of people to express themselves can result in “an amazing amount of content. At the end of May 2004, users had created more than one million objects, over 300,000 objects with scripted behaviors, and over 300,000 pieces of clothing. Well over 99% of the objects [were] user created . . . Forty-two percent of Second Life users create objects from scratch, and more than 44% have successfully sold an object to another user” (Ondrejka, 2004a, pp. 10-11).

In a fixed world with a pre-defined storyline and content controlled primarily by designers, there is a “designed narrative potential” (Eladhari & Lindley, 2004, p. 4) built into the world’s back story, “metastory” or conceptual model, through material constraints. The advantage of the narrative back story or metastory is that it provides a built-in unifying framework for actions and an imperative for action. In the absence of this unifying framework, the visitor has the experience of “many things to do, objects to fiddle with . . . [but no] sense of why any one action would be preferable to another” (Mateas & Stern, 2006, p. 654), and will quickly lose interest. For example, the Disney design team for *Aladdin’s Magic Carpet Ride* found that “people only tolerate undirected wandering in an environment for up to about two minutes” (Sherman & Craig, 2003, p. 429).

For the World of Warcraft, a world with an “impositional form of narrative” (Eladhari & Lindley, 2004, p. 4), the metastory is very well-developed, resulting in low change/high persistence. For the open-ended world at the high change/high persistence end of the continuum (for example, Second Life), where the metastory is almost absent or controlled by residents, the plasticity of the world as a learning design space allows: (a) the learning designer to develop customized learning environments and tools, (b) the learner to create and adapt tools and change their learning environment, and (c) for both to create or adapt artifacts and tools to accomplish actions as part of a learning activity.

The trade-off for a high change/high persistence condition is that a greater burden is put on the learner in a world that did “not come with a fixed set of objectives for its inhabitants, but rather provided a broad palette of possibilities from which the players could choose, driven by their own internal inclinations” (Farmer & Morningstar, 2006, p. 741). This condition also challenges the designer, who must find that balance between creating a sufficient unifying framework and imperative to action for learners without reducing individual agency unduly or working in opposition to their motivations and intentions.

World’s Logic and Physics

In order to maintain the virtual world’s reality, the logic of the world (conceptual model), physics, and substance must be self-evident, established early, and maintained persuasively through detail. The amount of detail required and the extent of its similarity to the real world environment is a matter of some debate, depending on the application and the audience, and given the trade-offs between realism and amount of computational effort dedicated to rendering objects. However, there is now some agreement that high fidelity to real life is not necessary, as long as the design and adherence to the world’s logic is maintained, consistency is more important than realism (unless the learner chooses to experiment with another “reality setting”). This is discussed in more detail in the section on conceptualizations of presence (see “Immersion”). One facet of the world’s internal logic that must be addressed is the treatment of day and night, and the passage of time in the virtual world (absolute and relative).

With regard to the role of the world's physics in its conceptual model, the designer can choose to have: (a) no physics effect in the world; (b) use physics that mimic Newtonian physics, which provides the closest approximation to the physical world; (c) Aristotelian physics, which provides the closest approximation to the way people normally understand physics; (d) other world physics; or (e) resident-controlled physics (Sherman & Craig, 2003). Bartle (2004) suggests establishing "just enough" physics for the world and for "the level of detail at which it operates" (p. 319), and he suggests mimicking learners' naïve sense of "how the real world works" (p. 320) to reinforce what he terms immersion, in other words, Aristotelian physics.

For use of the virtual world as a computer-supported collaborative learning environment, the ability to choose the physics would allow learners to interact with the world, modify the laws and observe the results.

Closely related to level of detail is the "point of view" available for learners' use (Sherman & Craig, 2003). The term, point of view, comes from the literary device of: (a) first-person narrative, where the perspective is looking out through one's own eyes; (b) second-person, looking at one's representation or avatar from outside as though through another's eyes or from another vantage point, such as a camera view from above, below or behind one's shoulder; and (c) third-person, where the representation of self is not present.

Substance

Substance is also an important aspect of a consistent conceptual model for the world. Sherman divides “the substance of the world into four primary categories: (a) world geography, (b) objects, (c) agents, and (d) user interface elements” (Sherman & Craig, 2003, p. 408).

A consistent geography of the world must be determined as part of the basic architecture, as well as the system of representation to be used–nodes, coordinates (tiles) or coordinates (polygons)–and how boundaries are to be represented (physical boundary, invisible walls, etc.; Bartle, 2004). How terrain is to be handled is also important.

The content of the world is usually in the form of objects, and these can be provided by the designers as completely rendered, or a basic set of shapes (polygons) that can be manipulated by residents. Objects can have different compositions, and can be intelligent (or not) depending on whether scripts or behaviors can be associated with the objects. Another important aspect of objects is the extent to which “transference of object permanence” (Sherman & Craig, 2003, p. 385) is implemented in the world. That is, is the object and its behavior realistic (e.g., Doppler effect when one approaches or leaves the object’s vicinity)? Also, as this relates to persistence, does the object “exist” even if we don’t see it (e.g., if our avatar leaves the world). Is it there where we left it? Persistence is discussed in more detail in the section on the conceptualization of presence. Agents are often an “advanced form of an object,” but they exhibit lifelike, autonomous behavior, even thought they don’t represent a human as an avatar does (Sherman & Craig, 2003).

User interface elements are those virtual controls that manifest in the world: for example, menus. The challenge in design is to minimize the extent to which user interface elements "break" the virtual world conceptual model, as they are not typically present in real life. The other challenge is dealing with the default (start-up) mode of the world. If command mode is the default, "the message that the world is sending them is that this is a place where you can *do* things: it emphasizes freedom to act on the world" (Bartle, 2004, p. 116). For conversation (chat) mode as the original default, "the message is that this is a place where you can *communicate*. It emphasizes freedom to interact with other players" (p. 116).

Presence Research

Conceptualizations of Presence

The original meaning of "presence" is revealed in its Latin roots, "esse." The Latin phrase, "in esse," exemplifies the meaning: "in actual as opposed to potential being" (Partridge, 1959, p. 187). Philosophically speaking, "experiencing your own presence in virtual reality is like the process of discerning and validating the existence of self in the natural world (which humans have engaged in since birth)" (Heeter, 1992, p. 262). This is of course, self with other humans: presence in that case being present together with others in a spatial sense; and in a temporal sense, the present being the current moment in time: what is "now" happening in this shared space.

When humans began to extend their faculties with various media, questions began to emerge about the quality of mediated experiences in comparison to direct presence. Anything other than direct presence has been considered second best for collaborative learning (with some important exceptions), but with globalization and the increasing dependence on computer-mediated communication, supporting direct presence is becoming less possible. Institutions of higher education increasingly depend on online learning environments. Reeves et al. (2004) note in their research development agenda the general failure to “design and implement truly innovative interactive collaborative learning environments in postsecondary education” (p. 54), and note that one cause of this failure is the use of commercial course management systems for most online courses, which “tend to promote thinking of online course design as a process of replicating traditional classroom instructional practices” (p. 54).

Anderson suggests “at this stage in the development of online collaborative learning environments, there is a clear need to further the understanding of the more effective and successful approaches and their relationships with underpinning theoretical principles and technological affordances” (Anderson, 2003, p. 58). The same lack of understanding persists in the adoption of new technologies such as virtual worlds, even as their use is adopted by colleges and universities as collaborative learning environments.

One especially important and challenging aspect for the design of online environments for computer-supported collaborative learning is the development and maintenance of the sense of presence in online environments (Kirschner et al., 2004; Kreijns et al., 2002, 2003; Palloff & Pratt, 1999; Picciano, 2002; Rourke et al., 2001; Whitelock et al., 2004).

A large body of research exists on the sense of presence in virtual environments. For example, an entire Massachusetts Institute of Technology journal, *Presence: Teleoperators and Virtual Environments*, has been devoted to the subject for the past eight years. International researchers from disciplines with markedly different semiotic domains have tried to capture the slippery, complex phenomenon. These include but are not limited to education, game design and theory, computer-supported collaborative learning, computer-mediated communication, computer-supported collaborative work, human-computer interaction and design, virtual reality, philosophy, phenomenology, communications, rhetoric and communication, psychology and social psychology, anthropology, group and social dynamics, cognitive neuroscience, media studies, arts (visual, written and performance), design, visualization, urban planning and design, human geography, computer science, haptics, telecommunication engineering, and artificial intelligence.

Perhaps the result of this diverse group of disciplines is the size of the more than fifty definitions, related terms, factors, and models collected during this researcher's open coding effort, conducted during the literature review and development of the construct for the sense of presence to be used in the study. Lombard and Ditton (1997) reviewed literature from across many of the disciplines exploring presence, identified six conceptualizations of presence, and developed a definition which appears to have been commonly adopted:

> Presence is the perceptual illusion of non-mediation. The term "perceptual" indicates that this phenomenon involves continuous (real time) responses of the human sensory, cognitive, and affective processing systems to objects and entities in the person's environment. An "illusion of nonmediation" occurs when a person fails to perceive or acknowledge the existence of a medium in his/her communication environment and responds as he/she would if the medium was not there. Although in one sense all of our experiences are mediated by our

> intrapersonal sensory and perceptual systems, "nonmediated" here is defined as "experienced without human-made technology." (p. 9)

The above definition can be used across many different disciplines, but becomes less useful when one attempts to operationalize it for a specific use (e.g., computer-supported collaborative learning), especially using an activity theory perspective. The underlying theory of the mind, practice or learning associated with this definition of presence is not explicit. In earlier stages of the literature review, the following definition of presence seemed more useful:

> Very elaborated definitions that try to capture the "essence" of what is presence could be premature at this moment and can prejudice us more than help us. As a first approach we state that presence is a human experience, a mental representation of a space (space-temporary context) where the self is placed. Presence is a multidimensional construct and, thereby, many factors need to be studied (referred to the media, to the context, to the task and the virtual environment, to the person that is using the system, and to the external world). Presence will be the result of the interaction between all these factors. (Botella et al., 2003, p. 3)

There is no larger sociocultural or collective environment in this definition. This absence reinforces the authors' explicit identification of their psychological approach to presence.

Suggested Categories for Conceptualizations of Presence

For the purposes of the study, the fifty terms associated with various conceptualizations of presence discovered during the literature review have been clustered into three broad categories: (a) presence conceptualized as an attribute of media; (b) presence conceptualized in terms of a private experience of an individual in a moment in time (a property of the individual); and (c) presence as a dynamic collaborative action-based process occurring in the context of an activity that includes the individual, the artifacts associated with the process, the object of the process, and others involved in the activity.

Presence as an Attribute of Media

Presence as an attribute of media was an early analytic focus of presence research, because the disciplines most involved at the time were media and social studies, and virtual reality research. From this perspective, media characteristics are seen as determinants of presence, and a critical constituent aspect of presence in media is sensory realism, the extent to which the virtual medium matches the "real" thing with regard to human perceptions (Lombard & Ditton, 1997). The extreme version of this is the traditional virtual reality environment, where the user wears the reality simulation engine (head-mounted display, headphones, gloves, etc.) as the interface to the virtual environment.

Dimensions and measures of presence as an attribute of media include objective measures and subjective measures. Examples of objective measures include: (a) fidelity in image quality, size and viewing distance, aural presentation characteristics and kinetic feedback; (b) speed with which the medium responds to user inputs (Lombard & Ditton, 1997); (c) engagement of sensory and motor channels (Biocca, 1997); and (d) interactivity, where variables of interactivity are measured in terms of number of inputs medium will accept, level of control afforded to the user, degree of mapping between input device and medium response (Lombard & Ditton).

Examples of subjective measures of presence as an attribute of media include: (a) the relative “ability of a communication medium to make the interlocutors available to each other” (Spagnolli et al., 2003, p. 798); (b) perceptual immersivity, the extent to which the medium provides an immersive experience through realism and also filters out the external world; and (c) a construct called “social richness” of the media, defined as “the extent to which the medium is perceived as sociable, warm, sensitive, personal or intimate when it is used to interact with other people”(Lombard & Ditton, 1997, p. 4).

Presence as a Property of an Individual’s Experience

Another conceptualization of presence focuses on an individual’s sense of presence in the virtual world, at a particular point in time, under particular conditions. Most of the more current literature on presence falls into this category. Under this state of “personal presence,” the individual is aware of their existence “as a separate entity from a virtual world that also exists” (Heeter, 1992, p. 262).

One way to distinguish an analytic focus on presence as a property of an individual’s experience in a virtual environment from a focus on presence as an attribute of media is to evaluate the relative importance given to considerations of psychology and physics. For issues of virtual environment design based on presence as an attribute of media, simulation of physical reality is emphasized. For presence as a property of an individual’s experience, the way the mind perceives physical reality and the self is paramount (Biocca, 2003), and verisimilitude in the virtual world may even interfere with the individual’s sense of presence.

Measures of presence as an individual private experience “can be studied either by asking people directly or by collecting its effects in the behavior…captured as a static snapshot by the measuring apparatus” (Spagnolli et al., 2003, p. 799). Dimensions of presence as the property of an individual might be organized around issues such as: (a) the depth of immersion, (b) level of engagement, (c) adequacy of the sense of embodiment and individuals’ personal control over their avatars (Cuddihy & Walters, 2000), (d) support for development of identity and identification, (e) strength of motivation, (f) extent of awareness, (g) participation in community, or (h) state of flow. Many conceptualizations of these terms come from virtual world design and game design.

Terms in this list are variously classified as conditions of presence, mutually constitutive states related to presence, effects of presence, causes of presence and the same term might be classified as each of these by different researchers. There are inter-relationships among these, depending on foregrounding, sequencing and dependencies defined by the researcher.

One reason for this tangle of terms may be that conceptualizations of presence seen in terms of individual experience are especially sensitive to the underlying (often implicit) theory of the mind, learning, and practice. For example, depending on the underlying theory of the mind, one often-identified dimension of presence, immersion, may be seen as: (a) a progressive process associated with identification with one’s avatar (Bartle, 2005); (b) dependent upon agency and development of identity, a conceptualization of presence from the perspective of media studies (Murray, 1997); or

(c) as an allocation of attentional resources (Witmer & Singer, 1998), which is a cognitive conceptualization of presence.

The thorough evaluation and classification of each of these dimensions of presence conceptualized as individual experience is beyond the scope of this study. However, identifying through the literature the dimensions that appear most relevant to virtual world design is likely to be helpful to an understanding of design issues, and to provide the background for the conceptualization ultimately chosen. A consistent decision criteria for choosing terms for this list of aspects of presence as a property of an individual’s experience is that they are of a phenomenological nature: that is, experiences perceived by the individual.

Sense of place. Associated with virtual worlds is the idea of space or place, and this is an important aspect of this study. As mentioned earlier, many virtual world designers conceive of virtual worlds as places, including Bartle (2004):

> There is a distinction between space and place. A space is an abstraction that groups objects of a particular type under a set of fixed rules; a place is a region (under adjacency rules) of some space. For example, matter operating under the laws of physics gives us the 3D space we call reality; Athens is a place in this space. (p. 478)

Erikson (1993) identified “the need to understand the properties of space which are entwined with human interaction…and that enable them to serve as frameworks for communication, cooperative work, and social interaction” (p. 2). In the computer-supported collaborative work community, there is a debate about how support for social interaction is best provided: by a conceptual model based on space, that is, “independent movement within a shared coordinate system, combined with the representation of others' positions through avatars"), or a conceptual model based on place and the argument that "social behavior is engendered by other important aspects of an environment beyond the provision of a shared coordinate system…more generalized abstractions that suggest conventions of conduct or that support ease of navigation" (Benford, Greenhalgh, Rodden, & Pycock, 2001, p. 84).

One definition is that "place equals space plus meaning" (Harrison & Dourish, 1996). That is, the sense of place is ultimately a unique, individual human experience that arises out of (a) an individual's reaction to the physical or aesthetic characteristics of the environment, (b) their memories of experiences in that place and the feelings associated with those memories, and (c) their interactions in the space and their feelings associated with prior interactions with people there.

The practices of designers of virtual worlds for game play offer some suggestions for design of virtual worlds for computer-supported collaborative learning that are related to development of a sense of place. The first is the need to reinforce exploration, in the case of games throughout the first thirty hours of game play, by embedding hidden rewards for visiting and exploring, and creating the space "in such a way as to maximize the appearance of spaciousness" (Rogers, 2005b, p. 26). Another design suggestion relating to spatial navigation is to allow residents to "experience pleasures specific to intentional navigation: orienting ourselves by landmarks, mapping a space mentally to match our experience, and admiring the juxtaposition and changes in perspective that derive from moving through an intricate environment" (Murray, 1997, p. 129).

Designers also suggest that a consistent, explicit conceptual model is required for navigation. Well-designed navigation intensifies the sense of place. Rogers contends that the first thirty minutes of a visit to a virtual world should involve a smooth introduction to the environment, and a good design practice is to ensure “complexity unfolds through simplicity;” that is, controls are revealed only when they are needed (Rogers, 2005b, p. 20).

One of the affordances regarding the sense of space that is available in virtual worlds and not available in real life is the ability to support “multilateral perspectives”, the ability to adopt the visual point of view not one’s own through camera views, zooming one’s view above, below, and behind an object or landscape feature.

Immersion. Immersion is strongly associated with presence and other experiential dimensions of virtual worlds. Early virtual reality researchers saw immersion as the extent of fidelity to physical reality, thus leading to an experience of the sense of presence.

One respected virtual world designer and theorist, Bartle (2005), defines immersion as “one of the several forms that presence can take” (p. 10), related to extent to which the player identifies with their avatar, progressing from separate object to persona. Douglas and Hargadon (2004) suggested a different experiential progression of immersion into engagement into flow, but acknowledge that neither of the pairs “maps all that tidily onto most definitions of interaction” (p. 203).

While similarity to real world environment means that a player doesn’t have to work to learn the virtual world’s logic, such similarity isn’t required for immersion. As long as the logic is established as that world’s reality and maintained persuasively, the player can remain immersed until their experience in the world doesn't match that world's established reality, a condition called "breaking the immersion" (Bartle, 2004). The design and adherence to the world's logic might be termed "immersivity," although this term has been used by traditional virtual reality researchers to refer to the degree to which the technology isolates the user from other stimuli, or an objective description of physically-oriented or sensate aspects of the system (e.g., "field of view"; Schuemie, Straaten, Krijn, & Mast, 2001).

Researchers from disciplines that are sensitive to the root meanings of words resist appropriation of the terms such as immersion for other meanings. For example, a researcher out of the humanities calls attention to the prefixes of immersion and presence:

> Immersion insists on being inside a mass substance, presence on being in front of a well-delineated entity. Immersion thus describes the [virtual] world as a living space and sustaining environment for the embodied subject, while presence confronts the perceiving subject with the individual object. But we could not feel immersed in a world without a sense of the presence of the objects that furnish it, and objects could not be present to us if they weren't part of the same space as our bodies (Ryan, 2001).

Another researcher might draw the meaning of immersion from the metaphor of "the physical experience of being submerged in water" (Murray, 1997, p. 98), with a definition of immersion as "a psychological state characterized by perceiving oneself to be enveloped by, included in, or interacting with an environment that provides a *continuous stream* of stimuli and experiences" (Witmer & Singer, 1998, p. 227). Others term this the "immersive fallacy," and argue that one might be immersed in meaning, rather than environmental stimuli (Salen & Zimmerman, 2004, p. 452).

Agency. Agency involves the use of power, either directly or through the involvement of another person or thing, to achieve a desired end. Murray defines it as “the satisfying power to take meaningful action and see the results of our decisions and choices” (Murray, 1997, p. 126).

The definition of agency as it used within activity theory is very similar: “the ability and need to act” where acting equals “producing an effect according an intention…[which encompasses] both *biological needs* and *cultural needs*” (Kaptelinin & Nardi, 2006, p. 241). This conceptualization of agency is one of the pivotal notions in activity theory as it closely tied to another that differentiates activity theory from other sociocultural theories: intentionality, the subject’s motivation or cultural need to act (Kaptelinin & Nardi). From an activity theoretic perspective, objects essentially define the activity system: change the object and a new activity system is required to describe the relationship. This is because the subject’s ability or power to act is changed: “Producing effects, acting, and realizing intentions, while potentialities of certain kinds of agents, vary within the enactment of a specific activity” (p. 247).

So far the discussion has addressed human agency: do non-human things have agency? In activity theory, they do. By virtue of the mediating role a tool or artifact plays as a realization of a human intention through design, creation or appropriation of the tool, it is capable of producing an effect. However, humans have a complex set of motivations that they bring to and take from any particular activity system, they reflect on and make sense of (intra-psychological) the collective activity (inter-psychological), and they have emotions and values that affect interactions within the activity system (Kaptelinin &

Nardi, 2006). All of these differences are the critical ones where learning is the focus as a social practice.

A theory-based understanding of agency in a virtual world describes an individual's ability to interact with a virtual environment, to manipulate objects and the environment with tools (that they can either appropriate, or develop) or with the help of others, to produce an effect according to a desired or needed end (motivation and intention).

Identity. From the sociocultural perspective, learning can be seen as a continuous negotiation of identity developed through experience in communities and their practices; that is, learning how to be (Brown, 2006), which makes identity a critical dimension of presence for the purposes of this study.

Concerning the topic of identity development and management in online worlds, Turkle's (1997) seminal work is on most reference lists about the topic. As has been suggested by virtual world designers and theorists who have explored the development, management and experimentation with identity in virtual worlds, one of the compelling opportunities that virtual worlds provide is to support the learner's individual discourse of developing identity (Gee, 2003; Shaffer, Squire, Halverson, & Gee, 2004; Taylor, 2006). This can be based in an expressive architecture such as Second Life, or alternatively with architecture that has "designed narrative potential" (Eladhari & Lindley, 2004, p. 4), such as World of Warcraft. That is, in Pearce's terms, while both have a story system, the metastory is almost absent in the first (expressive), and very well-developed in the second (narrative; Pearce, 2004).

As noted by Bailenson, Blascovich, Beall and Loomis (2003), "Extending one's sense of self in the form of abstract representation is one of our most fundamental expressions of humanity" (p. 1). Avatars in virtual worlds can be seen as abstract representations of the self. In virtual worlds based on game play, the process of choosing an avatar also involves creating and developing a character in a role appropriate to the game world's back story.

From the perspective of a successful virtual game designer, Rogers (2005a) emphasized the importance of the avatar and increased identification with it as the critical point for first engaging the player and then sustaining their interest. He notes that "[The avatar] is the social window onto the game world…the primary object of gameplay and reward…. the primary object of achievement…and represents the aspired persona for the player" (p. 21).

Social presence and co-presence. As studies on presence continued into the 1990s, researchers began to move beyond the question of physical presence and fidelity to physical reality, to the question of social presence. In the presence literature, social presence has been defined as a dimension of co-presence, and co-presence as a dimension of social presence. As might be expected, these terms have various definitions in the presence literature. Social presence has been defined as (a) "the feeling of being together, of social interaction with a virtual or remotely located communication partner" (IJsselsteijn & Riva, 2003, p. 7); (b) social richness (warmth, personal, intimate) of media (Lombard & Ditton, 1997); (c) a "network of social relationships amongst group members embedded in group structures of norms and values, rules and roles, beliefs and ideals" (Kreijns et al., 2004, p. 608); (d) "ability of learners to project themselves socially and emotionally as ‘real’ people into a community of learners” (Garrison et al., 2000, p. 17); (e) degree to which media is “judged warm, personal, sensitive and sociable” (DeGreef & IJsselsteijn, 2000, p. 3); (f) result of instructor interaction skills that affect “student perceptions of the social and human qualities of the medium” (Gunawardena, 1995, p. 164); (g) as perceptual stimuli regarding existence of others and interaction with them where the degree of social presence depends on the strength of the tie at a particular moment (Heeter, 1992); and (h) “Mediated social presence is the moment-by-moment awareness of the co-presence of another sentient being accompanied by a sense of engagement with the other (human, animate or artificial being)…and is an outcome of the other’s cognitive, emotional, and behavioral dispositions” (Biocca, Harms, et al., 2001, p. 2).

A large body of research exists on aspects of social presence, including computer-mediated communication (CMC) research (Bregman & Haythornthwaite, 2003; Haythornthwaite, 2005; Sacau, Gouveia, Ribeiro, Gouveia, & Biocca, 2003; Wellman, 2001) and with regard to group interaction in computer-supported collaborative work.

A thought-provoking context is treatment of a virtual world as a “as a medium of interpersonal communication in the same way all media have been evaluated” (Palmer, 1995, p. 292), and linking social presence, culture and communication (Riva & Mantovani, 2000). A similar view is a “relational perspective, [which] suggests that functional and social factors should both be examined” (Gunawardena, 1995, p. 164). Of relevance here would be learners’ perception of interaction, and with social performance. Social performance is socio-emotional interaction (unlike learning performance which is task-driven interaction) and “encompasses variables like the degree of established social space, sense of community, and degree of trust" (Kreijns et al., 2004, p. 608). (Note that social performance and learning performance "cross-reinforce" each other.) Social performance has an effect over time, as communicators develop "individuating impressions of others through accumulated CMC messages" (Gunawardena, p. 154).

The related term "co-presence" also has various definitions: (a) "the subjective sense of being together or being co-located with another person in a computer-generated environment" (Axelsson et al., 2001, p. 282); (b) "the feeling that one is in the same place as the other participants, and that one is collaborating with real people" (Casanueva & Blake, 2001, p. v);" (c) the factor on which social presence varies, from superficial to deep sense of co-presence, "the degree to which the observer believes he/she is not alone and secluded, their level of peripherally or focally awareness of the other, and their sense of the degree to which the other is peripherally or focally aware of them" (Biocca, Harms, et al., 2001, p. 2).

A major problem with most operational definitions of co-presence is that they conflate sense of place and sense of co-presence. The sense of place is "logically orthogonal" to the sense of co-presence–we can be talking on the phone, and feel a strong sense of co-presence (being together), without feeling a sense of place (Slater et al., 2000). Our language often reflects this fuzzy thinking, because we use sense of place terms in instant messaging (IM) windows. For example, the source for this dissertation's title, "I am here–Are you there?" arises from the common use of that phrase in IM; however, the experience of a sense of place is not shared by but everyone using IM.

Interactivity. Disagreement about immersion is echoed by a lack of consensus about the nature of interactivity. Interactivity is tied by virtual world designers to agency, who see interactivity as participation between a person (interpreted through a social perspective. psychological, emotional, and intellectual) and a system (e.g., functional, structural interactions with the system). Their focus is on the game designer's management of player choice (Salen & Zimmerman, 2004).

Community building. This aspect of presence ties directly to the study's conceptual grounding in cultural-historical activity theory. Researchers assert that development of community in virtual environments has the same developmental path as for "real life" (M. A. Smith & Kollock, 1999; Wenger, McDermott, & Snyder, 2002).

Collaborators "learn, share, and refine core goals, values and practices" (Carroll et al., 2006, p. 26), and if their membership is "constitutive of [their] identity as a person, professional relationships and values, family and community roles, etc" (p. 25), then teams can begin to form and act within a community of practice. Although the authors don't predict such results from "randomly-selected college students performing contrived exercises….collaborating merely for course credit" (p. 25), a multi-year cohort of graduate students can serve as a community of inquiry.

Designers of virtual worlds have learned that community is what keeps players coming back (Ondrejka, 2004b; Rogers, 2005b); and research into MMORPGs and other virtual worlds is "demonstrating the central role of game communities as virtual Communities of Practice in using multiplayer role-playing games for nurturing and mobilizing learning" (Papargyris & Poulymenakou, 2005, p. 42). The same can be said of non-gaming virtual worlds. For example, Second Life designers and community managers have observed the high level of volunteerism and a commitment to help newcomers: "users…run classes and events to ensure that new residents understand how to create and customize within Second Life. Twenty-five percent of Second Life users are in-world more than 30 hours per week; many of those hours are spent interacting and educating newcomers" (Ondrejka, 2004a, p. 10). This researcher has experienced this personally - she is a member of two very active communities of practice (CoPs), one for educators, and the other a "graduate students' researcher colony" (see http://www.simteach.com), and these two CoPs have carried out a number of ongoing projects, including developing and carrying out workshops and presentations for an "educators' track" at the 2006, 2007 and 2008 Second Life Community Conferences.

Engagement and flow. Salen and Zimmerman (2004) discuss design for engagement and pleasure, and its relationship to the concept of the *flow state*, and suggest that "being in flow represents a rich and meaningful engagement with the activity at hand" (p. 339). Dividing Csikszentmihalyi's (1990) eight components of flow into two sets of four–those that are the effects of the flow state, and those that are prerequisites to the flow state–they suggest that design for this component of presence focus on the prerequisites: "a challenging activity, clear goals, clear feedback, and the paradox of having control in an uncertain situation" (p. 338).

Presence as a Collaborative Action-based Process

Another conceptualization of presence recognizes that "presence is an ambitious concept referring to the user's experience in the virtual environment, which is complex, contextualized, and dynamic. It stresses the reciprocal contribution of both the environment and its inhabitants in configuring each other and the central role of local action in shaping presence" (Spagnolli et al., 2003, p. 800).

This approach goes beyond properties of individual experience or media attributes to encompass the entire context of the activity as described in activity theory: subject, object, mediating artifacts, community, rules and norms, and division of labor. Individual experience is part of this context, but the unit of analysis is the activity, not the individual's experience at a moment in time. This is a "cultural concept of presence as a social construction" (Mantovani & Riva, 1999) with three elements: a cultural framework, the possibility of negotiation (both of actions and of their meaning), and the possibility of action (Mantovani & Riva; Riva & Mantovani, 2000).

With this conceptualization, presence is a publicly accessible phenomenon, not a "private, intimate state" (Spagnolli et al., 2003, p. 800). Presence is also emergent—its configuration depends on the learners' goals (objects) and intentions and on the resources available to be appropriated for the action, rather than on a rigid, static definition unrelated to context. The focus is on "the process through which presence is constituted and changed…and the relationship between the user and the physical and social environment…" (p. 800).

In addition to the points of reference defined by activity theory, the following addition is suggested because it relates to agency and to collective processes in addition to individual experiences and attributes of media.

Design, learner-created content and world-building. At first glance, design, learner-created content, and world-building do not appear to have a relationship to presence. However, this relationship is closely interwoven with the concept of agency: the power of the individual to act, where acting is defined to be producing an effect according to an intention and need (Kaptelinin & Nardi, 2006).

In one case, the agency of interest is that of the learning environment designer, and their ability to tailor the virtual world to the appropriate context, and in the virtual world's flexibility to support a high variety of learning activities. The definition of design used here is a modification of Salen and Zimmerman (2004) and is applied to the activities of an instructional designer in designing a learning environment and a learning activity both: "Design is the process by which a *designer* creates a context to be encountered by a participant, from which meaning emerges" (p. 41). The adaptation, based on activity theory, is: Design is the process by which the designer creates initial context and opportunity for collaborative learning activities (directed toward learning outcomes as objects) to be experienced by learners who, through collective activity, appropriate different aspects of the context (especially the artifacts available). The plasticity of the virtual world determines the constraints within which the learning designer must operate.

The learners may also be constrained or empowered to collaboratively create the content and transform context through constraints on or opportunities for "world-building" and creative design. The greater the plasticity, the wider the range for modifying or creating artifacts and transforming the context by the learners themselves: thus, the term, world-building.

A related perspective on virtual worlds (specifically in video games) is one suggested by Gee (2003): "They situate meaning in a multimodal space through embodied experiences to solve problems and reflect on the intricacies of the design of imagined worlds and the design of both real and imagined social relationships and identities in the modern world" (p. 48).

Virtual world designers (Ondrejka, 2004a) identify the power for world-building as a key decision that is fundamental to the conceptual model of a virtual world, wrapped up in the questions of motivation, agency, locus of control and power to create. The fundamental question is, “Who has the power to build the world and objects within it” (Ondrejka, 2004b, p. 1)? How is the division of labor, the rules and allocation of power to create and “world-build” handled? In hierarchically constituted virtual worlds, where most of the inhabitants are “users,” developers (and faculty) are responsible for creating most of the content. Another approach is to allow “residents to control nearly every aspect of their world” (Ondrejka, 2004b, p. 1), and to provide built-in tools and tools to build other tools, designed to be used collaboratively in real-time for the purpose.

Experienced virtual world designers recognize the danger of the extremes at either end of the continuum. While part of agency is the ability to produce an effect through an action, another necessary aspect is that the action is being taken toward a high-level intention. Mateas and Stern (2006) give the example of the puzzle-based adventure, *Zork Grand Inquisitor,* which offers “a rich world to navigate and many objects to collect and manipulate. Yet, since there is no unity of action, there is no way to relate current actions to the eventual goal. . .This leaves the player in the position of randomly wandering about trying strange juxtapositions of objects” (p. 654). That is, one part of agency is the ability to produce an effect through an action, “having many things to do (places to go, objects to fiddle with)”; however the second key characteristic is action toward a high-level intention, a “sense of why any one action would be preferable to another” (p. 654). Lack of what the authors call “unity of intention,” which is developed through formal constraints, detracts from agency. In narrative theory for interactive drama, the formal constraint is provided by the plot. From the perspective of the learning designer in a virtual world, this emerges as the issue of whether there is a world-wide back story or not, how much scaffolding and structure is built into the world, and how much the designer can or will have to build.

Shaffer has a domain-centric view of the importance of structure from the learning designer: Learning by doing in a virtual environment does not mean "just doing any old thing, wandering around in a rich computer environment to learn without any guidance…Learners are novices. Leaving them to float in rich experiences with no guidance only triggers the very real human penchant for finding creative but spurious patterns and generalizations. The fruitful patterns or generalizations in any domain are the ones that are best recognized by those who already know how to look at [a] domain and know how complex variables in the domain interrelate with each other" (Shaffer, 2006, p. 10). From the learners' point of view in computer-supported collaborative learning, the formal constraint(s) may come from constraints imposed by the virtual world design and/or from the design of the learning activity.

Conceptualization of Sense of Presence

Among the conceptualizations suggested for the sense of presence—an attribute of media, a property of individual experience, and an ethnographic, action-based approach—this study was based on an adaptation of the ethnographic, action-based approach to studying presence (Spagnolli et al., 2003). That is, presence was conceptualized as a dynamic process associated with an action in an activity system, occurring in a socio-cultural context over time. The advantage of this approach is that it allows a holistic approach without moving completely into the subjective (because actions can be observed), it highlights the role of artifacts *in context* (which is the role technology plays in an activity system).

This approach to presence "problematizes the configuration of the virtual body, the boundaries of the VE [virtual environment], the objects recognized in the simulation" (Spagnolli et al., 2003, p. 800). Individual experience and the physical and social aspects of the environment during the action can be captured through observation.

Dimensions of the Sense of Presence

For the purposes of this study, four dimensions of the sense of presence have been identified, based on the presence research, the aligning theoretical framework (activity theory), and the conceptualization of the development of the sense of presence in the virtual world as the ongoing result of an collaborative action-based process, in terms of contextualized human experience of collaborative learning activity. The dimensions are (a) sense of place, (b) social presence, (c) individual agency, and (d) mediation of collaboration.

Sense of Place

For the purposes of this study, the sense of place is that which is referred to in the literature as physical presence or spatial presence: *There is a "there," there*. It "remains as *an emergent property* of interaction between an individual and the environment, and while there are some shared elements, the experience of the place is fundamentally unique to each of us" (Turner & Turner, 2006, p. 207). Attributes of media which lead to the development of a sense of place are affordances for "the subjective experience of being in one place or environment, even when one is physically situated in another" (Witmer & Singer, 1998, p. 225). They identify sensory factors such as: (a) the environmental richness (visual characteristics of the environment, its vividness); (b) multiple sensory channels (other sensory features such as sound); (c) consistency of multimodal presentation; (d) degree of self-movement perception; and (e) ability to modify point of view. Ultimately there is no sense of place until we give a "space" meaning through connections to previous places or feelings that the attributes of the space invoke in us; that is, place=space+meaning (Harrison & Dourish, 1996).

Some researchers include sense of place, social presence, and individual agency in their definition of the sense of place; however, in the more narrow definition to be used for this study, the sense of place does not include the sense that anyone else is there, nor that there is a wide scope of actions one can take, nor of the possibility of collaborative activity.

An example of the sense of presence limited to the dimension of sense of place would be a virtual environment for a one-person one-way simulation, such as a bot-guided virtual tour of a botanical garden. An example from Second Life is a beautifully rendered virtual Harlem.

Social Presence

In previous research, social presence has been seen as: (a) the sense of engagement with another (Lessiter et al., 2001), (b) "social richness" of the environment (Gunawardena, 1995; Rice, 1992; Short, 1976), (c) the ability to project socially and emotionally as a real person with other real people (Garrison et al., 2000), (d) the extent to which others appear to exist and react as real people do (Heeter, 1992), or (e) avatar realism (Bailenson et al., 2005). The sense of place and social presence are often merged (Axelsson et al., 2001; Schroeder et al., 2001), or this merger is termed "co-presence"

(IJsselsteijn & Riva, 2003). On the other hand, co-presence is also used by others as a synonym for social presence (Casanueva & Blake, 2000; Lombard & Ditton, 1997).

For the purpose of this study, the sense of social presence is defined as: *We are together with others, with the ability to communicate and interact socially.* That is, social presence is the sense of being together with other people, with opportunities for interacting and communicating synchronously and asynchronously, with some degree of mutual awareness and attention (Biocca, Harms, et al., 2001).

This study is based on the assumption that we can feel a strong sense of being socially present without a sense of co-location in a shared place; for example, a phone conversation can convey a sense of social presence without a sense of place (Slater et al., 2000).

Individual Agency

In the definition to be used by this study, "presence is tied to action in the environment" (Zahorik & Jenison, 1998), and is based on individual agency, as is defined by Kaptelinin and Nardi (2006): "*the ability to act…to produce an effect according to an intention…or need*" (p. 242).

Witmer and Singer (1998) merge sense of place, individual agency and sense of presence in their Immersive Tendencies and Presence Questionnaire (ITQ-PQ). However, they do identify a set of "control factors," determining the extent to which a person experiences control over the task environment: (a) degree of control, (b) immediacy, (c) mode, (d) anticipation of control, and (e) physical environment modifiability. These control factors were treated as components of individual agency for the purpose of this study.

The basic question for individual agency is, to what extent do we have the power to carry out actions toward an end we desire or need, in the virtual world? A minimalist example of individual agency would be found in an interactive simulation, where, for example, the aspects of an ecological niche could be manipulated, and the results seen (e.g., environmental changes leading to changes in predator and prey populations).

Mediation of Collaboration

The focus of this study is the development of the sense of presence in virtual worlds used for (formal) collaborative learning in higher education.

Using activity theory to frame a collaborative learning activity as an activity system, such a system would include:

1. A collaborative group (group subject).
2. An object which is shared by the collaborative group in order to carry out the assignment successfully (note that the subjects will ultimately define the object).
3. A social context of a cultural framework–what are the rules of this assignment, what are the expectations of how we should go about this work, what are the norms of this community?
4. Negotiation of meaning and action–what is the goal, how will we achieve it, and how will we divide up the work?
5. The real possibility of group action (Riva & Mantovani, 2000).
6. Tools for carrying out actions and operations that constitute the collaborative work (adapted from those available in the world, or created by the learners using other tools).

For the purpose of the study, terms *activity*, *subject*, *object*, *action*, *operation* and *tools* have a specific technical definition based in a hierarchical understanding of human interaction from activity theory. As described by Jonassen and Rohrer-Murphy (1999), activities are complex, and involve “the *production* of some object . . in which the activity is accomplished” (p. 62); “the subject of any activity is the individual or group of actors engaged in the activity” (p. 63). Activities are made up of chains of actions (tasks) that are conscious and goal-directed. Actions are made up of chains of operations, which are so routine as to be unconscious–unless, for example, there is a breakdown in a tool that is used to carry out the operation, in which case it becomes an action (Jonassen & Rohrer-Murphy; Kaptelinin & Nardi, 2006). An example would be the action associated with typing this paper. Because of many years using this kind of keyboard and a fast typing speed, I can type almost as fast as I can think, and I seldom think about that operation – unless the “u” key is broken, as it recently was. Finally, a tool can be anything from a shared language, to a model, to an actual computer tool; each is culturally framed (culture-specific), and both transforms and is transformed in the activity in which it is used (Nardi, 2001a).

Within the conceptual framework described above, the fourth dimension of the sense of presence, mediation of collaboration, is defined as: “*We (a group subject, members of a collaborative group) can use tools to collaborate to carry out action/operation chains toward a shared object(ive) that relates to a formal learning activity (system).*”

The advantage of having identified this as a dimension of the sense of presence is that it allows an approach to human experience that does not move completely into the subjective (because actions can be observed), and it highlights the role of artifacts and objects (tools) as perceived and used.

Understanding the sense of presence as the ongoing result of a collaborative action-based process means thinking of presence as it evolves dynamically over time, in a sociocultural context. The more conventional perspectives of presence limited to presence as an attribute of media or as a property of private individual experience are helpful, but these perspectives don't tell the whole story. These perspectives are limited, much like a photograph of a panel of the AIDS Memorial Quilt (The Names Project, n.d.). While compelling, a single photograph can't really express or reveal: (a) the places in which the quilt's panels were made; (b) the threads, embroideries and other materials from which the panels are composed; (c) the quilters' motivation(s); (d) the frames on which the quilting was done, the devices used as tools in each panel's construction or the tools which were created to do the work; (e) the constraints imposed by the nature of materials and how the panels were to be displayed; (f) the way the work was divided up; (g) the communities from which the quilters came (and the communities created as a consequence of the work); and (h) the cultural traditions and practices influencing the panel makers or the specialized language they used to communicate with others who worked on the quilt. On the other hand, using activity theory to understand the activity systems involved in the creation of the quilt would involve: (a) viewing a series of photographs of panels, (b) observing the process of creating the quilt over time, (c) viewing videotapes of the construction of many panels, (d) viewing videotapes of quilt displays, (e) interviewing individual panel makers, and (f) interviewing groups of panel makers. Together, these would give us a way to explore the activity; in the same way, activity theory would give us a way to explore the sense of presence in a virtual world.

Study Environment

Second Life is a 3D multiuser virtual world that has been variously described as a tool for social networking, for holding three-dimensional visual conversations, and for programming intelligent objects (Brogden, 2007). More than a virtual world, it is, like Active Worlds Educational Universe (Active Worlds, n.d.), one of a few “platform service[s] for the development of shared three-dimensional environments that supports multiple users with real-time communication capabilities through both text and voice” (Rodriguez, 2006, p. 79).

History of the World

Second Life was conceived by Philip Rosedale, developed (and maintained) by Linden Research, Inc., and opened to the public on June 23, 2003 (Rymaszewski et al., 2007). Unlike MMORPG’s such as World of Warcraft, which is a virtual world fantasy game with a pre-established “back story” (that is, an integrated fantasy world, with built-in quests, internal plots and characters), Second Life is an open-ended, socially-oriented virtual world which is “resident-driven and self-evolving” (v3image, 2007, p. 10). By December 2003, an in-community grassroots social movement forced a change to the design and business model for Linden Labs, from a business model that depended on a tax on content to a tax system based on land ownership (Rymaszewski et al.). There is no monthly charge for residents to use Second Life–the monthly charge is based on ownership of land. However, land purchase or rent is necessary for those who wish to create a fully-customized word and a more extended presence and to build permanent objects to trade or sell (the world provides sand boxes for temporary “builds”).

Residents create their own characters, surroundings, and objects. In fact, 99% of content is user-created (Ondrejka, 2004a), using the 3D modeling tool and (if needed), a scripting language, Linden Scripting Language (LSL), to add behavior to objects. Content creation by residents is the basic world model. An open economy provides for sale and trade of content and resale of land, with a market that determines the value of the creations and real estate, and an exchange process that can convert Linden dollars (the currency of Second Life) into US dollars. The only back story for the world is that open economy. The intellectual property of “in-world” creations is owned expressly by the creator (even if exported elsewhere): An example of this is *Tringo*, which was a game developed in Second Life, and which is now offered on a number of gaming and mobile platforms. The creation and sale of objects is a primary activity in the world. Residents run virtual businesses, and a few make all or part of their real life income from their Second Life businesses or occupations, which range from party and wedding planner to musician to machinima set designer.

Residents are represented in the world by unique avatars and have complete control over the appearance, clothing, behavior of their avatar (and can make or acquire their own unique clothing and write or acquire animations for avatar gestures and behavior).

The virtual world supports naïve physics, although residents do have the magical power to fly, and imitates the physical world with sky, sun, moon, water, and land with highly varied terrain (and, through animated objects, weather). Virtual land is divided into regions, which are “both geographical and administrative units” (Rymaszewski et al., 2007, p. 8). Landowners own part or all of a region. Groups of avatars can own land jointly. In the case of Pepperdine University, the Graduate School of Education and Psychology has purchased a private island for exploration and experimentation.

A large community of practice for Second Life educators (SLED) is very active and supportive of teachers new to the environment, with free tutorials, workshops, seminars and regular in-world meetings, and is also a sponsor of a successful open source environment that results in many free educational objects and applications. An electronic mailing list and web site are maintained by the community. According to the web site maintained by the community, over one hundred universities, schools and colleges are using Second Life (SimTeach Wiki. n.d.).

Capabilities and Uses of Second Life

Designers (and learners) using Second Life’s capabilities can: (a) create and manipulate intelligent objects and control their attributes, such as transparency, color, light reflectance, sound qualities, flexibility, mass, growth rate, and interactive behavior (through scripts); (b) link objects together to create a setting that recreates an historical or archaeological site, supports role playing, or is otherwise responsive to and interacts with learners; (c) make movies of interactions between avatars; (d) animate avatars; (e) simulate perceptions through a particular point of view (e.g., virtual hallucinations of schizophrenia); (f) simulate natural complex systems like ecosystems; (g) incorporate other media (graphics, sound, audiocasting, videocasting, podcasting); (h) express complex ideas visually; and (i) integrate with other Internet resources (web pages, wikis, open source course management systems). These capabilities are all available in Second

Life, and if the learner (or learning designer) doesn't want to create resources themselves, many are already available ready-to-use and for free in the educational community in the virtual world.

Learning designers from educational institutions experimenting with Second Life have developed a number of imaginative and appropriate examples of its use. Examples include:

1. Classes on film, radio, and television production: drama/screenwriting; sound design; screen composition; set/environment/interactive design; cinematography and digital media; use of machinima for role playing, improvisation, script and story; "merged media entertainment" (productions simultaneously presented in and out of world); new media arts; and screenings and festivals of real and virtual films (Australia Film, TV, Radio School, 2008).
2. A campus environment designed with deliberate branding goals, intended to serve as "an attractive and engaging metaphor" for a traditional campus, with: a set of general purpose online teaching aids; and games repurposed for the virtual world environment, such as the "Groupthink Exercise" (originally developed at MIT (Ernst, 2006)
3. A simulation developed at the UC Davis Medical Center reproduces the hallucinatory experience of individuals with schizophrenia: "Computer simulations of the perceptual phenomena of psychiatric illness are feasible with existing personal computer technology. Integration of the evaluation survey into the environment itself was possible. The use of Internet-connected

graphics environments holds promise for public education about mental illness (Yellowlees & Cook, 2006).

4. A model (“Really Engaging Accounting”) that “allows students to visualize the equality of Assets, Liabilities and Equity. Students can interact with the model directly via chat or by writing a transaction on a notecard which is read by the accounting model. As each part of a transaction is entered the model provides feedback by saying whether the debit/credit is increasing/decreasing a particular account category. When chatting with the model only one part of the transaction can be entered at a time, thus reinforcing the notion of dual-entry accounting. As transactions are entered into the 3-D model, floating text of the accounting equation is updated so students can see how the debits/credits are effecting the model both numerically and visually” (Hornik, n.d.).
5. Multimedia “mixed-reality” events such as National Public Radio’s Science Friday, which is simulcast live every Friday at 11 AM PST on the radio, and audio-streamed inside of Second Life. The host, Ira Flatow, is present as an avatar in Second Life, and questions are taken from the SL audience as well as the traditional audience via phone). The advantage of the simulcast is twofold: (a) during the broadcast, the audience can interact about the broadcast in chat back-channels; and (b) after the broadcast, the podcast is integrated with videos, models, and other resources related to the topic (Science Friday, n.d.).
6. Historical re-enactments such as those provided on Renaissance Island, which supports re-enactment and role playing by recreating the entire 16th century

period (Elizabethan England, throughout the Renaissance, Tudor period, and Medieval ages) with objects such as period clothing, locations of the period such as the Globe Theatre, and sponsored events, “to allow visitors to interact and feel how life would have been” in 16th century England (Netsquared, n.d.).

7. A site featuring astronomy, aeronautics and the history of space flight, which is jointly sponsored by the International Space Museum, National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), California Institute of Technology, and the Jet Propulsion Lab on Explorer Island in Second Life (National Aeronautics and Space Administration, n.d.). During any NASA launch (for example, a Mars mission), there is a launch event in Second Life.
8. Alternative representations of computing artifacts: Aesthetic Computing Island designed by Fishwick, Oliverio & Ditto of University of Florida to explore “the potential for collaboration, immersion, aesthetics, creativity, social interaction” (University of Florida, 2007). Examples of student projects include “Simple Arithmetic Machines, Finite State Machines, A Perceptron, a Turing Machine, and Cellular Automata.”
9. Live performances and recitals by concert pianists, graduate students, violinists, flutists, with streaming audio on Music Island in the Sea Turtle Island sim(ulation) in Second Life (Miranda, 2008).

Implications of the Sense of Presence in the Design of Virtual Worlds

The Presence/Collaborative Learning in Virtual Worlds Matrix was constructed for use as an initial framework for exploring computer-supported collaborative learning and the development of presence in the virtual world, Second Life. In the Presence/Collaborative Learning in Virtual Worlds Matrix, the design principles are mapped against the four broad dimensions of presence developed for the purposes of this study: sense of place, social presence/co-presence, individual (subject) agency; and mediation of collaboration.

The four dimensions of the sense of presence constitute four of the five columns of the matrix. The first column represents nine design principles for 3D multiuser virtual worlds for computer-supported collaborative learning activity, and the column-row intersections operationalize the design principles associated with each dimension of presence. The nine design principles proposed are as follows:

1. Maximize usability of travel interaction techniques.
2. Facilitate wayfinding.
3. Support developmental progression of avatar and identity.
4. Provide socio-emotional context and communication channels.
5. Encourage group formation and identity development.
6. Situate learner in environment with authentic imperative for action.
7. Integrate object creation and manipulation with collaboration and leverage 3D nature of virtual world to support personal and group annotation.
8. Use notification systems to stimulate chance encounters and group awareness.

9. Use notification systems to support grounding and collaborative awareness (situation, action, and activity awareness).

These principles are drawn from computer-supported collaborative learning literature, from research on design of virtual reality for the sense of presence, and from work on design of virtual worlds for gaming.

The design principles are described in detail below. Some specific examples for Second Life are also included below. One goal of the study is to identify examples for each design principle.

Maximize Usability of Travel Interaction Techniques

Travel interaction is one aspect of navigation (wayfinding, described next, is the other). Travel is defined to be “the task of performing the actions that move use from our current location to a new target location or in the desired direction” (Bowman et al., 2005, p. 183). Because travel is easily the most common and universal task in 3D interfaces, and travel (navigation in general) often supports another task rather than being an end into itself, an important design principle is to maximize the usability of travel interaction techniques.

Travel has been covered intensively in virtual reality research, which is the source for the design principles to be used in this study are:

1. “Provide multiple travel techniques to support different travel tasks in the same application”, with minimum of effort for most common travel (Bowman et al., 2005). These may include teleportation or other passive modes, or completely self-controlled locomotion (walking, flying, riding, driving), depending on the purpose of the task (Sherman & Craig, 2003).

2. Make simple travel tasks easier by using target-based techniques for goal-oriented travel and steering techniques for exploration and search (Bowman et al.); for example, teleportation for the first type, and steered locomotion such as a guided tour for the second.
3. Provide clear and consistent visual cues for different tasks and associated travel techniques (e.g., a teleportation chamber similar to the structure on Star Trek).
4. Organize entry areas as “public zones” for the simplest forms of travel for naïve users.
5. “Use graceful transition motions if overall environment context is important…Only in cases where knowledge of the surrounding environment is irrelevant should teleportation be used” (Bowman et al.).

For examples of the implementation of these principles in Second Life, Weber, Rufer-Bach and Platel (2008) use the theme park as a model:

> When you enter a real-life theme park, you’re going to see–or even be handed–a map. Information booths and other important locations are obviously marked. It’s easy to follow broad, obvious pathways. But there’s usually also some sort of transportation, like a train, that you can jump on for a quick tour around the entire place, usually with a recorded tour guide. (p. 210)

Other suggestions for design of navigable space from Weber et al. (2008) include: (a) providing guided travel through a programmed Heads-Up Display (HUD), without limiting avatar’s control over their view of world; (b) setting destination landmarks to the entrances of buildings and spaces; (c) building easy-to-find entrances to structures or set roofs to phantom, that is, objects through which one can pass; (d) supporting the airborne avatar with direct flight options for easy landing perches and entry to each floor of multi-storied buildings, rather than forcing teleportation; (e) designing path widths sufficient that even inexperienced avatars can navigate; (f) attending to Second Life camera's dislocation from an avatar, for which the default view is from slightly above and behind the avatar, such that the view is incorporated in functional building design for travel; (g) limiting degree of enclosure to that appropriate to building function; (h) providing windows in tight spaces so avatars can orient during in-building travel; (i) using ramps on stairs so avatars don't have to struggle to use them; and (j) providing navigation cues from real-life structures (e.g., doors). Note that Oberg, an experienced Second Life designer, comments that use of various real-life navigation cues "such that people feel a sense of familiarity" is important, but that it is also important "to extend and transform the design to take advantage of the unique social, cultural and climatic conditions of Second Life" (Weber et al., p. 225).

Facilitate Wayfinding

Studies of wayfinding by virtual reality researchers are highly relevant to the design of learning environments in virtual world. Wayfinding is defined to be how the resident or learner defines pathways through an environment to an intended destination, "using and acquiring spatial knowledge, aided by both natural and artificial cues" (Bowman et al., 2005, p. 227) in order to navigate in the world. Wayfinding supports navigational awareness; it is defined and is Bowman describes three types of spatial knowledge: (a) landmark knowledge of "visual characteristics of the environment;" (b) procedural knowledge ("sequence of actions required to follow a certain path," like how to get to a destination using public transportation (e.g., “take the number 5 bus from Fifth and Main, and get off at the third stop”); (c) and survey knowledge, a topological knowledge of the environment and directional compass orientation, which takes the longest to construct (Bowman et al., 2005).

The four categories of the purposes of wayfinding are: exploration (no particular destination in mind); search (to find something at the target which may be at a known, or unknown location); maneuvering (very specific target to reach through “many small-scale movements”); and specified trajectory movement (e.g, the learner is moved through the environment automatically through use of a “bot” or some other device). This last category does not allow the user to move along their own path, but does usually allow avatar control over view or perspective (Bowman et al., 2005, p. 231).

Bowman et al. (2005) propose the use of legibility techniques, real-world design principles, naturalistic cues, and artificial cues as the bases for virtual world design relating to wayfinding. All of these emerged from real world human “place” design (urban design, architectural design, urban planning). Lynch introduced many of the structural rules used for urban planning in his seminal work, *The Image of the City* (Bowman et al., p. 143).

While Sherman and Craig (2003) argue for a more cognitivist theory of wayfinding, where the learner builds a mental model of the space for reference during travel, the collection of wayfinding aids they have identified is a useful one and includes: well-marked paths, maps, landmarks, memorable placenames, compass, instrument guidance, exocentric view (ability to switch from egocentric view to bird’s-eye view), display of position coordinates, and constrained travel (ride-alongs).

Many of these aids are built-into the basic world-building platform of different virtual worlds, but others drawn from game design for virtual worlds have to do with encouraging exploration and return visits to the world by ensuring that the learner experience pleasures specific to intentional navigation, by embedding and hiding rewards for exploring, and thus creating individual reference points and paths (Rogers, 2005b). Salen and Zimmerman (2006) point out the opportunity inherent in virtual worlds as “representational systems with spatialized dimensions” which give learners a “chance to build meaning through spatialized interaction” (p. 65).

The implementation of the principle, “facilitate wayfinding,” would include the following actions:

1. Provide a variety of aids, cues and techniques to support the learner’s process of defining a path. Such aids would include, for example, landmarks, place names, instrument guidance, and orthogonal grid structure (Sherman & Craig, 2003).
2. Divide the large-scale world into distinct small parts, preserving a sense of “place” (Darken & Sibert, 1996).
3. Organize the small parts under a simple and unified organizational principle, provide and show all parts on the map (Darken & Sibert).
4. Partition the world to support smaller clusters of people (Bartle, 2004).
5. Provide frequent directional cues, with the map always showing observer’s position, and the upward direction of the map, if turned perpendicular to the floor, showing what is in front of the viewer (Darken & Sibert).

6. "Superimpose grid on map, which allows for effective use of landmarks and predominant reference points for distance and direction" (Darken & Sibert, p. 143).
7. Locate landmarks at the intersections or crossroads of major paths, for socially-oriented functions and formal meeting spaces (Bowman et al., 2005).
8. Use a combination of open and closed spaces (Bowman et al.).
9. Provide early experiences for development of "landmark knowledge," "procedural knowledge," and "survey knowledge" (Bowman et al., p. 232).
10. Provide cues to ground avatar's orientation, perspective, and geocentric position (Darken & Sibert).
11. Support collaborative tasks including exploration, naïve search, primed search, maneuvering, and specified trajectory movement (Bowman et al.).
12. Consistently provide information as to location of group members.

In a discussion of good design in Second Life, Weber et al. (2008) continue their metaphor of a theme park:

> For a leisurely and fun way to get from one area to another in Second Life, you can include a big-dramatic, eye-catching thing to lure visitors to a specific attraction–theme-park designers call this a *wiene.* Walt Disney coined to term to describe leading theme-part guests with an eye-catching landmark as if they were being lured with a hot dog (or like a horse with a carrot). (p. 210)

Other examples from Weber et al. (2008) for wayfinding support in Second Life include using wide, visually enticing pathways throughout the world; building visually unique structures and spaces; simplifying and opening up spaces; using roofs of buildings as gathering places; and

> using the architecture as the guiding piece of wayfinding [such that[there is an improved connection with the build and the content and putting the landing point in the middle of the program for the various areas [so that] the visitor is confronted with multiple easy options for circulation through the space, each leading to differing processing through the build, giving a variety of subtly different experiences. (p. 217)

Support Developmental Progression of Avatar and Identity

The virtual world may have representations for each resident, known as avatars, which convey identity, location, movement, and activities to others (Benford et al., 2001). World designers determine the extent to which avatars are customizable with regard to appearance and other personal attributes. In adventure-based worlds, avatars are developed as characters, which have advancement paths for skill development. Rogers (2005b) termed a player's avatar their "social window onto the game world . . . primary object of achievement . . . and aspired persona" (p. 21); the avatar is equally important in social (non-game) virtual worlds.

Benford et al. (2001) define avatars to be "graphic embodiments" (p. 79). Presence researchers often use the term "embodiment" when describing the importance of the avatar and the development of a relationship to it. Using a notion of the body as the "first interface," Biocca (1997) has explored this idea in terms of: (a) the development of virtual reality interfaces; (b) the corresponding progressive embodiment, or tighter coupling, of the body to the interface; and (c) the resulting technological extension of our bodies into virtual space (1997). Biocca uses the term in the context of designing a spatial environment, and a representation of the body and its expressiveness in that environment. Research about avatars is also concerned about realistic control and coordination of body movement (Bowers et al., 1996).

Many virtual worlds support customization of the appearance of their avatar. An individual's potential identification with their avatar is perhaps signaled by the care with which they choose a name for the avatar (anonymity is preserved in many virtual worlds) and how they clothe and accessorize their avatar.

The level of player control over their avatar influences identification with it, including such aspects as avatar appearance or synchronous, direct control of avatar movements. Studies have been done of virtual worlds such as *The Sims Online,* where "lack of synchronous avatar control generated a series of dissociations between the players and their avatars" (Steen, Davies, Tynes, & Greenfield, 2006, p. 256).

Bartle (2004) describes a desirable developmental progression of identification with one's avatar as: (a) initially regarding the avatar as an object that one can create and control as their representative in the virtual world; (b) coming to recognize their avatar as their representation, or extension of themselves within the virtual world; and (c) if the relationship progresses, the avatar becomes a persona or actual identity in the world. He notes that if individuals "consider it [to be] them in the virtual world . . . [this delivers an] affirmation of identity" (Bartle, 2005, p. 11).

The avatar and the individual's initial identification with it might be considered the first of what James Gee termed the "tri-partite play of identities:" the virtual identity (Gee, 2003, p. 58). He termed the further development of avatar and identity as projective identity. In a game, the “conflation between the player and his or her virtual persona as they jointly enact a trajectory of experience within the game space creates not only a sense of ‘being there,’ [but also] a sense of being (first person embodiment in the world)” (Lim & Chee, 2007, p. 247). Lim and Chee suggest the use of different modes of experiential opportunity that include scenario mode (role-playing in given scenario) and simulation mode (control of environment at macro level), to move the development of identity along this trajectory of identity.

Aspects of the design principle of supporting the developmental progression of avatar and identity include:

1. Maximize the extent of avatar customization available and encouraged in the virtual world, including ability to control name of avatar, appearance, and, gestures.
2. Provide and encourage use of unique avatar-related tangibles real for the virtual world, that can be changed, shared, exchanged (clothing, accessories).
3. Encourage avatars to develop their profiles as public annotations of the self (statements about themselves, including preferences, self-described personality characteristics, favorite places; Bartle, 2004).
4. In the formal learning setting, use avatar labels with real names.
5. Encourage avatars to make personal notes regarding observations and judgments of others, and personal history with them (Bartle, 2004).
6. Provide personal space, where avatar can express their identities in customization and decoration.

7. Minimize lag and scale structures appropriately, so that perception of spatial location and locomotion of the avatar is natural and closely reflects avatar's actions in the virtual world (Bowers et al., 1996).
8. Provide different modes of collaborative experiential opportunities for the development of identity (e.g., scenario, role-playing, personal experience through pre-designed simulation, design of simulations; Lim & Chee), and encourage development of electronic portfolio documenting achievements and activities.

Examples of the support of the developmental progression of avatar and identity in Second Life include: (a) building structures and furniture at slightly larger scale to accommodate various sizes of avatars without anomalous results (e.g., teleporting and getting stuck in the ceiling); (b) for the same reasons (to keep the avatar from getting stuck in walls) making sure furniture is set away from the walls (Weber et al., 2008); (c) limiting lag through efficient builds; (d) allowing students to choose their own names (using special avatar-controlled labels for displaying real life names in the classroom); (e) encouraging avatars to experiment with different appearances, clothing and accessories (and providing private spaces for "changing" these to overcome the Second Life design problem of the "naked" avatar that can appear during this process; (f) providing role play areas for avatars to change appearance and accessories for role-playing (choose entirely different forms for their avatars for different characters in a role-play; Mayrath, Sanchez, Traphagan, Heikes, & Trivedi, 2007); (g) providing personal areas that can be customized; and (h) creating experiential opportunities for participating in mini-scenarios and short pre-designed simulations.

Provide Socio-Emotional Context and Communication Channels

One of the limitations of a virtual environment is the flat affect of communication, in absence of all the non-verbal cues available face-to-face. This affect is the result of the lack of emotional context and the inability of avatars to express a range of emotional states. Fabri et al. (2004) argue that collaborative virtual learning environments in particular require channels for socio-emotional context and communication, through emotionally and physically expressive avatars.

To accomplish this, it is necessary to: (a) “support higher order activities than mere movement; actions of social significance such as approaches, exchange of glance, turning to, turning from and other basic expressive actions” (Slater et al., 2000, p. 26); (b) to capture the “passions that imbue human activity,” which include tension, tension release, enthusiasm, solidarity, agreement, disagreement and empathy” (B. Brown & Bell, 2006, p. 67); and (c) to support the expressive, “bumptious nature of object construction and instantiation” for alignment of motives (Kaptelinin & Nardi, 2006, p. 158). Social context successfully signaled in bodily behaviors of the avatar may, as Penny (2004) argues for the success of a simulation, depend on the extent to which “bodily behavior is intertwined with the formation of representations” to the precision necessary to the same task in the real world (p. 83).

Another method of providing social context is through physical design: “A collaborative virtual environment should provide adequate cues” for appropriate social behavior; that is, formal discussion or a virtual place for “related and informal gatherings” (Chen & Börner, 2005, p. 83).

To summarize, the design principle of providing multiple channels for setting and communication socio-emotional context is implemented by:

1. Designing cues for appropriate social behavior in the architecture of buildings and structures.
2. Making available numerous customizable gestures, animations, poses, postures, and movements for appropriation by avatars.
3. Creating culturally-appropriate visual indicators (confusion, agreement, disagreement, questioning) for all avatars to share in common.
4. Give avatars “voice” by allowing (but not requiring) audio.
5. Ensure support of socio-emotional channels (including bodily behavior of the avatar) is integrated with tools for carrying out tasks.

Examples of designing for socio-emotional content and communication channels in Second Life include: programming/offering multiple poses and animations for avatars, to create more natural avatars with wide range of gestures and physical expressiveness; providing intelligent objects (through scripting) for expression of emotion, agreement, disagreement; tailoring architecture to appropriate social behavior (e.g., coffeehouse for relaxed, informal setting; formal building for more structured setting); and supporting VoIP for audio channel of communication.

Encourage Group Formation and Identity Development

As virtual worlds are “social beasts,” an essential imperative is the ability to form groups, and for residents to participate in multiple groups (Bartle, 2004, p. 391). In the design of computer-supported collaborative learning environments, a key part of the infrastructure is to facilitate the projection of shared group identity in the virtual world. In work settings, groups are often organized on a long-term basis, and the development of a sense of trust, a group identity, the role of the group in the larger social context, and one's role in the group can occur over a relatively long time-period. In the case of computer-supported collaborative learning groups in higher education, the timeframe is much more restricted, as is face-to-face time (if there is any).

An important developmental step for group identity is the development of group cohesion, a sense of group's role in the larger social context, and the roles of each member in the group.

Virtual world designers suggest allocation and labeling of place in the virtual world for a shared workplace and meeting place for each group, allowing customization according to group identity (Bartle, 2004). The shared workspace should embody and sustain group activities and history with persistent objects (Robins, 2002) and include a "reference channel for collaborative repository" (Okamoto & Kayama, 2005, p. 164). The related ability to create group artifacts through merged individual artifacts is also helpful to group process; for example, providing tools for taking and combining personal notes into single, unifying document to share among group members (Landay & Davis, 1999).

For task-based interactions, task ownership in a group consists of individual accountability (each individual is individually accountable for his or her own work), and positive interdependence ("each individual can be held individually accountable for the work of the group, and the group as a whole is responsible for the learning of each individual group member;" Kirschner et al., 2004, p. 54).

As team members interact over time, build trust and understanding, and a history of accountability, "social capital is formed when mutually satisfying interactions among members create a persistent social good . . . social capital refers to the accumulation of the social benefits of past social interactions in order to mitigate conflict and other risks in future interactions" (Carroll et al., 2006, p. 27). Social capital is often played out in informal relations that manifest in the organization of teams (and selection of members who have established their standing and trustworthiness).

Brown suggests that a key design goal should be to produce "a sense of group activity and belonging amongst users. For example, a system could automatically generate a history of what a group does together (such as in the form of a weblog), or of allocating a special game are to a particular group;" Brown & Bell, 2006, p. 241). Another important contributor to the sense of group identity is a repository for group memory, to retain artifacts that begin to represent a developmental history for the group.

In virtual world design for game play, strategies for developing group cohesion quickly that could be applied to a collaborative learning environment include (a) promoting "intergroup comparison through some in-game metric, with public acknowledgment"; (b) providing a central object on which the group can expend energy and time on, and [which] yields a visible reward and feedback to efforts put into it" (Rogers, 2005b, p. 32); (c) promoting stake-holding, where groups "own" some of the community space, care for it (the concept of owning property originated in MUDs) and customize it to reflect the group's personality (Bartle, 2004).

Tools and activities that allow the group to leave its mark–"we were here together and we did something fun"–support initial development of group sense of joint agency, appropriation of tools in the environment, creation of artifacts, and begin to create a sense of history for the next round of learners. This could be considered a version of what Kaptelinin and Nardi (2006) described as a *handprint*.

Rogers suggests that design attributes that promote “intergroup comparison or stake-holding” (Rogers, 2005b, p. 32) are a means toward building group identity. For affirmation of group members by each other, design should support approbation behaviors (Robins, 2002) through physical objects, gestures, or animations.

From the perspective of avatar identity as a member of a group, design should allow for: (a) connection displays of affinities; (b) shared “foci of interest” (situation, interest or person); (c) approval collections; and (d) the ability to filter connections/contacts through connection heuristics (Donath & Boyd, 2004).

Approval collections (or achievement badges) and peer ratings act as systems for tracking social capital, help build trust among group members (Rogers, 2005a), and ultimately can promote the sense of individual accountability as a responsible member of a collaborative team (Baker et al., 1999) that is important to task ownership (Kirschner et al., 2004).

Recommendations for implementing the design principle of supporting group formation and identity are:

1. Allocate and label meeting place and shared workplace for each group, customizable according to group identity.
2. Support approbation behaviors through gestures, objects, and animations.
3. Allow for individual display of connections and approval collections.

4. Preserve as persistent artifacts any constructs or other objects that result from collaborative work (record of problem state in process or interaction memory for group history of completed projects).

In Second Life installations, skillful use of group formation and identity features built into the virtual world platform include: (a) creating individual groups for collaborative teams; (b) encouraging use of group labels, charters, badges, costumes, etc.; (c) encouraging use of the group instant messaging application; (d) creating workspaces that groups can decorate and customize according to developing group identity; (e) providing repositories in group workspaces for artifacts of group work-in-process accessible only to the group; and (f) displaying and featuring results of collaborative teamwork in exhibit areas.

Situate Learner in Environment with Authentic Imperative for Action

In order for the individual learner to be engaged in the virtual world, the learner must: (a) be situated in the environment, (b) understand the goal of the virtual experience, (c) experience an authentic imperative for action and (d) perceive a unifying framework for actions (Sherman & Craig, 2003).

Kirschner et al. (2004) suggest designing for the emergent properties of learning (e.g., “probabilistic view of learning design” rather than deterministic or systemic. An activity theory perspective suggest that the following are important to situating the learning in an environment with an authentic imperative for action: (a) support learners’ appropriation or transformation of existing artifacts and creation of new artifacts to support learning activities as appropriate; (b) store artifacts associated with individual work-in-process; (c) display and share artifacts according to learners’ wishes; (d) provide built-in tools in the virtual world for collaborative work on artifacts (Ondrejka, 2004b); (e) provide a “palette of possibilities” (Farmer & Morningstar, 2006, p. 741); (f) where appropriate, keep learning resources “in-world,” or directly accessible from “in-world” to keep from breaking the sense of presence (Jeffery & Collins, 2008); and (g) include debriefing, “especially if objective are left unstated till after the experience has been completed” (Jeffery & Collins, p. 2631).

In order to implement this principle, design of the virtual environment would include the following actions:

1. Situate learner in the environment (Sherman & Craig, 2003).
2. Specify goal of virtual experience (Sherman & Craig).
3. Create imperative for action and unifying framework for [collaborative] actions that leverage the simulation environment (Sherman & Craig).
4. Take advantage of dimensionality and/or simulation capabilities of the virtual world (Sherman & Craig).
5. Provide physical cues as to genre (or departure from it) in form of narrative back story or clear task/purpose-oriented environment.
6. Establish co-references of social context for dynamic mapping of the shared workspace (Cottone & Mantovani, 2003).
7. Maintain balance between constraints and flexibility necessary to individual agency (Mateas & Stern, 2006).
8. Support responsive revelation of controls: controls are revealed as need to learner (Rogers, 2005b).

9. Support situation awareness with workplace widgets for joint attention (Cottone & Mantovani),
10. Keep learning resources “in-world” or directly accessible from “in-world” to keep from breaking the sense of presence (Jeffery & Collins, 2008).

The ability to create intelligent objects in Second Life creates the opportunity for the learning designer to create an active user interface that situates the learner, and describes a range of actions possible. A frequently-used example described in Weber et al. (2008) is to set up an object that detects the presence or proximity of an avatar, and to use the object as a “bot” to carry out an action that helps inform the learner about what is possible. This can be done in several ways: (a) by having the bot offer an explanatory note card; (b) through an action on the part of the bot, such as initiating an instant messaging session; and (c) by having the bot use a number of channels for communication, either through “whispering,” using the open chat channel (sparingly), opening a new channel for communication with the avatar or using short segments of floating text which displays above the object. Built into the Second Life interface is the mouse-over, which, like many web pages, provides information from an object when the learner “hovers” their mouse cursor over an object. However, a better design practice for those new to Second Life is to offer a button which can be clicked to provide the same information as the mouse-over.

Integrate Object Creation and Manipulation with Annotation and Collaboration

There are two advantages for a world that allows a high degree of resident-created content and creative self-expression. One is that “player-created content is extremely sticky, at least for those who do the creating” (Bartle, 2004, p. 457). The other is that creative self-expression provides “free-form ways to communicate themselves . . . to draw them more deeply into the world. . . feel more a part of it . . . and to discover more about themselves” (Bartle, p. 244). In addition, opportunities for self-expression (as a form of visibility) increase sense of control, ownership and responsibility through (Bregman & Haythornthwaite, 2003).

If content creation by residents is supported, the supporting architecture is key in setting the limits of experimentation and exploration of the world as a design space. As Ondrejka (2004a) notes, “atomistic construction” of predictably-behaving objects may be easier for designers and residents, and in fact some predictability is necessary to explore a design space. On the other hand, if the atomistic construction is carried out collaboratively in “a real-time, interactive, fully three-dimensional physically simulated implementation,” with objects that operate according to a set of rules that “interact in interesting and unexpected ways to allow experimenters and innovators to create truly new creations” (Ondrejka, 2004a, p. 15) truly emergent behavior can occur. This may result in an environment more supportive what Kirschner et al.’s (2004) probabilistic view of learning design.

Objects need to be integrated into the world, beginning with the general abstract object, properties of that object (physical characteristics, functions), and ownership (Bartle, 2004). A critical facet of object implementations in computer-supported collaborative learning is the extent to which collaborative or joint interaction around an object is supported. Features necessary for collaborative object construction are: (a) the support of simultaneous interaction around objects in the environment (Brown & Bell, 2006, p. 133); (b) for joint attention, shared focus, pointing, gesturing, and referring in relation to object (Heldal, Bråthe, Steed, & Schroeder, 2006); (c) multiple views of object and "multilateral perspectives" (Bailenson & Beall, 2006, p. 3); and (d) "situational context" which captures changes to the spatial structure of an interaction, as the interaction occurs in virtual space, and over time (Bailenson & Beall, p. 3)

In order to integrate object creation and manipulation with collaborative interactions (Brown & Bell, 2006), and support annotation, or "writing on the world" (Bolter, 1993), the following design elements are proposed:

1. Provide means for creating and organizing persistent objects, icons, symbols and other representations of self-expression associated to place (space + [represented] meaning=place; Harrison & Dourish, 1996).
2. Ensure object ownership (intellectual property) attaches to author (Ondrejka, 2004a).
3. Provide for creator control of display and sharing of artifacts.
4. Support object specialization, assembly, collection, containers (endo- and exo-), state changes and object persistence with some real-world properties (Sherman & Craig, 2003).
5. Provide means for sharing objects, icons, symbols and other representations.
6. Provide built-in tools in the virtual world for collaborative work on objects (Ondrejka, 2004a).
7. Support simultaneous interaction around objects, joint attention, shared focus, pointing, gesturing and referring in relation to object (Heldal et al., 2006).
8. Provide for multiple views of objects and "multilateral perspectives" (Bailenson & Beall, 2006).

9. Reflect “situational context”–changes to the spatial structure of an interaction, as it occurs in virtual space (Bailenson & Beall).
10. Support multimedia annotation (voice, text, gesture, pictorial) attached to different components of the world (location, object, view, time, combination, specific annotation container; Sherman & Craig, 2003).

Because Second Life is organized almost completely around the construction of objects, individual polygons can be constructed, textured, assembled into more complex objects with other polygonal figures, be placed inside other objects, and the assemblage can be provided with a script to provide other objects to an avatar, or to react or behave according to a script associated with the object. Object ownership, including object scripting, automatically attaches to the author of the object, who can also choose: (a) whether the object remains in their private inventory, or is persistently available in the environment whether their avatar is present or not; (b) if the object appears only in response to pre-specified variables; (c) where in the environment the object is maintained if persistent; (d) whether the object can be moved from or within its setting; (e) which avatars have access to the object, including groups of avatars; and (f) which objects are open for copying, purchase or other use.

As a Second Life avatar constructs an object, handles appear on the object for its manipulation, and camera views allow the author (and any observer) to zoom in anywhere on the object, look at the object from all perspectives, including a bird’s eye view. The author can place the object at a particular x-y-z coordinate, apply imported textures. Other avatars present can observe as the construction, editing or other manipulation occurs. If the object is set for open access, another avatar can edit the object (although not simultaneously).

Out of object assemblages, individuals have constructed entire re-enactments of historical periods. For example, Renaissance Island supports re-enactment and roleplaying by recreating the entire 16th century period–Elizabethan England, throughout the Renaissance, Tudor period, and Medieval ages–with objects such as period clothing, and structures from the period such as the Globe Theatre (Netsquared, n.d.).

Objects representing abstract ideas and interactions can also be constructed. For example, an accounting model has been developed that "allows students to visualize the equality of Assets, Liabilities and Equity. Students can interact with the model directly via chat or by writing a transaction on a notecard which is read by the accounting model. As each part of a transaction is entered the model provides feedback by saying whether the debit/credit is increasing/decreasing a particular account category . . . As transactions are entered into the 3-D model, floating text of the accounting equation is updated so students can see how the debits/credits are affecting the model both numerically and visually" (Hornik, n.d.).

Informal Chance Encounters and Group Awareness through Notification Systems

The purpose of the principle of supporting informal chance encounters and group awareness through notification systems is to facilitate unscheduled connections and persistent communication (Huxor, 1999), using notification systems for spatial and temporal proximity (Carroll et al., 2003; Kirschner et al., 2004; Kreijns et al., 2003).

Open University of the Netherlands researchers have been conducting empirical studies based on social affordances of computer-supported collaborative learning environments (Kirschner, 2001; Kirschner et al., 2004; Kreijns & Kirschner, 2001; Kreijns et al., 2002, 2003, 2004). Kreijns et al. (2003) suggest "the design of sociable CSCL environments aimed at providing non-task contexts that allow social, off-task communication (e.g., casual communication and that facilitate and increase the number of impromptu encounters in task and non-task contexts through the inclusion of persistent presence and awareness through time and space of the other members of the distributed learning group)" (p. 349).

The authors have developed a group awareness widget (GAW), a “software tool for implementing different kinds of group awareness while at the same time enabling its members to communicate with each other. GAWs create social affordances and, therefore, should be embedded in CSCL environments” (Kreijns et al., 2002, p. 16).

The authors address two forms of group awareness: (a) the type described above (an indication of who is online and available), described in other research as “social awareness” (Carroll et al., 2003) to address spatial proximity, and (b) “history awareness,” to overcome temporal proximity issues. Implicit in this treatment of proximity is the claim that “proximity is an important dimension of social affordances” (Kirschner et al., 2004, p. 59). Temporal proximity is achieved by providing information about who has been online and when (traces or “footprints”) and it increases in a visual snapshot the perception of sociability, that “the group member is not alone in the environment, even when there are no group members currently online” (Kirschner et al., p. 60). This also builds the perception of a place which persists whether the individual is online or not; group members may show up at regular times and this information is available to allow for detecting patterns, and predicting opportunities for contact (in the same way that a student may know that one of their fellow teammates operates in Hong Kong time, and gets in the habit as an early riser of signing in early to contact him synchronously).

Social awareness notification systems “provide information about changes in the social milieu–as an interaction progresses, users are notified of collaborators’ arrival, availability for interaction, involvement and departure” (Carroll et al., 2003, p. 611). They differ from sociability, visibility and availability in that the focus is on the collaborating group and task-oriented interaction, rather than casual, informal interaction among all members of the community; however, some of the same tools, such as instant messaging, support both kinds of interaction. For synchronous communications among group members, the ability to show one’s availability for interaction or check on another collaborator is particularly important, and the open IM window is an opportunity to collaborate.

Visibility and availability increase the sociability of the online environment by supporting informal communications and chance encounters. As mentioned before, these encounters are not necessarily task or project based, nor are they oriented around information exchange. These are what Nardi, Whittaker, and Bradner (2000) call “outeractions,” characterized by their “lightweight” informality, intermittency, and use to create and maintain a persistent sense of connection with others who share the “active communication zone” (e.g., an open chat window). For example, when someone has their instant messaging window open all the time (a “persistent” space), other learners can check in (often in language similar to that used for the title of this paper: “Are you there?"), touch bases, talk about family, friends, health (and occasionally, interact about the collaborative task or project as quick questions come up).

Nardi et al. (2000) use the term, "awareness moments," noting that as people check their buddy lists and notice people who are also online, they have a feeling of connection (which they typically express using a spatial metaphor). Because of the long-term "communication zones," which "delimit a virtual 'space'" (e.g., the IM window is open) with intermittent interactions that "are persistent and visible which helps preserve ongoing conversational context," there is more of a sense of shared social space (pp. 84-86). A phone conversation, on the other hand, can be characterized as a type of co-presence without the spatiality or sense of immersiveness, because it lacks casual, continuing but intermittent availability, and the persistence and visibility of previous exchanges to provide ongoing context (Nardi et al., 2000).

The principle of stimulating chance encounters and group awareness includes the following:

1. Display persistent icons associated with each group member, indicating whether present in the virtual world or not.
2. Use graphic notification systems for online group members to locate each other spatially in the virtual world (Kirschner et al., 2004).
3. Offer opportunities for impromptu communication using presence indicators ("light-weight, easily accessible, and easy to use mechanisms to facilitate the actions needed for initiating spontaneous interactions among geographically distributed users;" Farshchian, 2003, p. 212).

4. Provide visual representation of previous visits, “history awareness widgets” (Kirschner et al., 2004, p. 59) to facilitate sense the one is not alone in the environment, even if no group members are currently online.
5. Provide individual control of visibility and indicators of availability for informal interaction (Bregman & Haythornthwaite, 2003).
6. Provide tools for individuals to negotiate activity based on “state or attitude of online collaborators: timing, frequency, or intensity of activity” (Carroll et al., 2003, p. 611).
7. Provide “group awareness widgets” (Kirschner et al., 2004, p. 58).
8. Provide support for “negotiating availability, switching media, retaining context in conversation” with “communication zones [to] a virtual ‘space in which a series of conversations can take place” (Nardi et al., 2000, p. 86).

Notification Systems to Support Collaborative Awareness

Collaborative awareness has been studied using many different theoretical frameworks. The research conducted by Carroll et al. (2003) on notification systems for different types of awareness is based on an activity theoretic framework, and thus is particularly applicable to this study. The researchers used detailed analysis of awareness breakdowns (when a use problem interrupts an individual’s activity) to explore enhancing collaboration with notification tools.

They “analyzed awareness breakdowns…stemming from problems related to the collaborative situation, group, task and tool support” (Carroll et al., 2003, p. 605), and suggested three categories of collaborative awareness: group (social) awareness, action awareness, and activity awareness. Group awareness has been discussed separately in the previous section on facilitating chance encounters and group awareness, because the principle supports informal communication not necessarily related to collaborative awareness.

Action awareness. Activities are made up of actions, the chains of sub-goals that make up an activity system. Collaborative team members are concerned about what their teammates are doing, particularly with shared resources. This is the functional level of collaboration: information about the tasks and processes being performed, and by whom. Having such information can improve work flow, as one collaborator can pick up seamlessly where another has left off.

Examples of action awareness widgets are: (a) radar views, which are “miniatures of a large shared workspace which show . . . the viewpoint in which other participants are working and the workspace objects which are being manipulated” (Cottone & Mantovani, 2003, p. 254); (b) status indicators for objects in use; and (c) version control.

Activity awareness. Another type of awareness for collaborative work is activity awareness, which is essential for success for the collaborative group (Greenhalgh, 1999; Hudson & Bruckman, 2004; Parsons, 2005; Schroeder, 2006; Snowdon et al., 2004; Witmer & Singer, 1998).

An activity theoretic approach is used in two articles for which Carroll is the lead author, (Carroll et al., 2003, 2006) to explore activity awareness issues involved in “substantial and coherent collective endeavors directed at meaningful objectives” (2006, p. 25); that is, “an activity pursued by individual or groups within a community, working toward shared objectives or motives, and recruiting and transforming the material environment, including shared tools, data, social and cultural structures, and work practices" (2006, p. 27). The authors are quite resistant to applying their framework to formal collaborative activities in the classroom, where activities are contrived rather than "substantial and coherent collective endeavors directed at meaningful objectives, which we sharply distinguish from laboratory exercises and training tasks" (Carroll et al., 2006, p. 25). However, their approach might be applicable to a community of inquiry where there is development over time, such as a cohort of graduate students in which coursework is shared over several years, and real-world tasks are part of the curriculum.

A key aspect of activity theory is mediation of the subjects' activity: by tools, rules, roles, and community. Carroll et al. (2006) analyze the mediating effects "through the subprocesses of common ground [as a context for human communication] and communities of practice [as]. . . a subtle and domain-specific praxis" (p. 28). Also important to activity theory are issues of shared goals and motivations, and recognition of contradictions as an opportunity for development, which in this framework are represented as "social capital construction and human development" (p. 28).

Situation awareness is similar to activity awareness, but the perspective is that of the individual monitoring a situation and making decisions, whereas activity awareness emphasizes "aspects of the situation that have consequences for how a group works toward a shared goal over time" (Carroll et al., 2003, p. 213).

Grounding. The proposed activity awareness framework thus integrates several sociocultural frameworks, including situated learning, and suggests four aspects of activity awareness: (a) grounding; (b) communities of practice; (c) social capital; and (d) human development. For the purposes of this study, the design principle related to activity awareness focused on grounding.

Grounding is a subcategory of activity awareness, and is the process by which common ground is achieved within a collaborative group and is based on the conceptualization of language used as a mediating tool to propose, diagnose/compare, repair and negotiate mutual understanding, values, assumptions, in order to promote effective communication sufficient to a particular situation (or interaction); the tool itself is transformed in the process. Grounding involves communicative functions (“contact, perception, understanding and agreement”) and objects (“meanings, propositions, rights, obligations, images;” Baker et al., 1999, p. 37). The nature of the mediating technology also affects this negotiation, because it determines resources and constraints available to the process. Grounding is different from conceptual convergence in that “the role of grounding in collaborative learning requires a unit of cognitive analysis that includes agents, tools, and goals in situation, together with relations of understanding between them” (Baker et al., 1999, p. 43).

Grounding is a negotiation between collaborators concerning, among other things, the overall shared goal of the group, the rules of engagement, tasks that will be undertaken to accomplish the goals, how the tasks will be assigned (the division of labor), and tools that are to be appropriated by the group. To support this negotiation, the key issues that a collaborative learning environment designer must address include: (a) the transition between shared and individual activities; (b) flexible and multiple viewpoints and representations; and (c) a shared context.

Learning can begin with the grounding and appropriation processes themselves (Baker et al., 1999). In fact, grounding represents sense-making, in context, of ambiguous situations. As Cottone and Mantovani (2003) argue:

> If forming “common ground” within a community of learners depends in a decisive way on the capacity of that community to construct (at least partially) shared meanings for the ongoing situations, and if in turn the meaning of words, gestures, and actions depends on the possibility to refer them to their context, then the destiny of the highest forms of DL [distance learning] depends on the possibility of producing co-reference within the virtual space with a degree of efficacy near to that which can be achieved in everyday situations (p. 252)

The group agreements are “changing, various and ambiguous,” as they represent not a stable state of affairs, nor a set of static mental models, but a “crossroads of diversified perspectives” at a particular point in time (Cottone & Mantovani, 2003, p.252). As Dillenbourg notes, although common goals are established “as part of constructing common grounds, since actions cannot be interpreted without referring to (shared) goals, and reciprocally, goal discrepancies are often revealed through disagreement on action” (Dillenbourg, 1999, p. 8).

In a formal collaborative learning environment, “rules of engagement” may be imposed in the interests of having negotiation proceed relatively smoothly. These can be provided as norms for the community, imposed by the instructor, or implemented as formalisms within a “negotiation widget,” that signals, for example, the nature of the utterance (“contribution, verification, clarification, and elaboration;” Kirschner et al., 2004, p. 61). Kirschner found that with such a negotiation widget, groups actually spent more time on negotiation, but also, more members participated in the discussion, and a broader range of topics was introduced.

Turn-taking, one aspect of grounding, can be especially problematic in synchronous computer-mediated communication. Lobel, Neubauer, and Swedburg (2005) in their study “Comparing How Students Collaborate to Learn about the Self in a Real-Time Non-Turn-Taking Online and Turn-Taking Face-to-Face Environment,” reported that the ability to have simultaneous postings in the online environment led to a different dynamic in the class— more interactions among the students, rather than between the students and the teacher—resulting in better formation of group identity. They are quick to note that neither venue is superior over the other; “the goal of the inquiry is to understand both the similarities and the differences in order to formulate online learning theories and improve teaching effectiveness” in both venues (Lobel et al., p. 21).

Implementation of notification systems for collaborative awareness, including situation awareness, action awareness, activity awareness, and grounding involve the following design practices:

1. Convey location and focus of current activity (action awareness widgets such as radar views, status indicators, version control) [source]
2. Support visualization of participation, agreement and disagreement in discussion (Janssen et al., 2007).
3. Provide social cues with positive feedback loop (Hudson & Bruckman, 2004).
4. Support creation of persistent social goods (“accumulation of social benefits of past social interaction to mitigate conflict and other risks in future interactions” (Carroll et al., 2006, p. 26).
5. Provide for individual planning, tracking, and documenting of assigned tasks/actions, in context of larger object[ive].

6. Provide integrated tools for synchronizing task-oriented collaborative activity through maintaining activity awareness: negotiating rules of engagement; establishing common object[ive]; identifying and carrying out chains of actions necessary to achieve object[ive]; negotiating changes in "shared plans, evaluations or rationale; assignment or modifications of task roles; task dependencies based on roles, timing, resources; exception handling" (Carroll et al., 2003, p. 611).

Operationalization of the Sense of Presence and Implications for Design in Virtual World

The matrix, Presence and Design of Virtual Worlds for Collaboration, is presented in Table 1. The first column lists nine design principles for 3D multiuser virtual worlds used as computer-supported-collaborative learning environments (drawn from work on computer-supported collaborative learning literature, and on design of virtual worlds for education or entertainment). The remaining columns represent categories of related affordances, design attributes and related considerations, based on conceptualization of the development of the sense of presence in the virtual world as the ongoing result of a collaborative action-based process, in terms of contextualized human experience of collaborative learning activity. These columns constitute the four dimensions of presence: sense of place, social presence, individual (subject) agency, and collaboration mediation. The row and column intersections represent the operationalization of the design principles described in the first column.

Table 1

Presence/Collaborative Learning in Virtual Worlds Matrix

Design Principle	Sense of Place	Social Presence	Individual Agency	Collaboration Mediation
1. Travel interaction techniques: Maximize usability of travel interaction techniques (multiple travel techniques to support different travel tasks in the same application and minimum of effort required for most common travel tasks) (Bowman et al., 2005)	Build range of recognizable travel options for different tasks (with clear visual cues) including teleportation; wide, obvious paths; and flight paths. Clearly and visually divide design area into "public zones" with cues for travel techniques drawn from real-life examples for naïve or inexperienced visitors.	Provide indicators for and "put-me-there" navigation to sites with high degree of occupation and social activity.	Provide avatars with: continuous direct control of viewpoint movement (with quick tutorial designed for learning use of camera view); and choice of travel modes that range from more passive (ride-along, follow tour-guide), to "put-me-there" (teleportation) to completely self-controlled locomotion.	Provide multiple travel techniques to support different travel tasks that are part of learning activities: make simple travel tasks easier by offering target-based techniques for goal-oriented travel and steering techniques for exploratory travel (Bowman et al., 2005).
2. Wayfinding: Provide a variety of aids (landmarks, paths, maps, place names, instrument guidance, egocentric/exocentric views, orthogonal grid structure), and cues and techniques to support the learner's process of defining a path (Sherman & Craig, 2003).	Visually divide the world into distinct parts, preserving a unique sense of place for each; use a simple explicit organizational visual theme for unification; provide frequent directional cues; display structures and organizational elements on the world map (Darken & Sibert, 1996).	Locate landmarks at intersection/ crossroads of major paths, for socially-oriented functions and informal meeting spaces (combination of open and closed spaces) (Bowman et al., 2005). Partition the world to support smaller clusters of people (Bartle, 2004)	Provide early experiences for development of landmark, procedural knowledge, and survey knowledge for development of personal "map" (Bowman et al., 2005). Provide cues to ground avatar's perspective, orientation, and geocentric position (Darken & Sibert, 1996).	Support collaborative wayfinding tasks including exploration, naïve search, primed search, maneuvering, and specified trajectory movement (Bowman et al., 2005), and provide constant information as to location of group members.

(table continues)

Design Principle	Sense of Place	Social Presence	Individual Agency	Collaboration Mediation
3. Avatar and identity: Support developmental progression of relationship to avatar as unique self-representation in virtual world such that the learner identifies with the avatar as their representation in the online environment, (a persona) (Bartle, 2004).	Provide opportunities for avatars to create and customize personal spaces in the virtual world to reflect their identity.	Encourage use of avatar profiles as public annotations of themselves, and support use of labels for particular social settings (e.g., real names in virtual class); encourage private annotation of other avatar profiles to make personal notes of observations, judgments, experiences and personal history with others (Bartle, 2004).	Allow avatars to pick their own names; provide opportunities to customize appearance, clothing, accessories, and personalized gestures for unique and individual representation. Minimize lag and scale structures appropriately to maximize realistic control and coordination of body movement (Bowers et al., 1996)	Provide different modes of collaborative experiential opportunities for the development of identity (e.g., scenario, role-playing, simulation) (Lim & Chee, 2007); encourage development of electronic portfolio documenting achievements and activities.
4. Socio-emotional context and communication: Provide multiple channels for setting and communicating socio-emotional context (Fabri et al., 2004).	Design cues for appropriate social behavior in the architecture of buildings and structures (formal spaces, informal spaces) (Chen & Börner, 2005).	Create culturally-appropriate visual indicators (agreement, confusion, disagreement, questioning) for all avatars to share in common. Support optional VoIP for audio channel for expressiveness of voice.	Make available numerous customizable gestures, animations, poses, postures and movements for appropriation by individual avatars (Weber et al., 2008).	Enhance the “persuasiveness of interactivity [which is] not in the images per se, but in the fact that bodily behavior is intertwined with the formation of representations;” Ensure that support of socio-emotional channels is integrated with tools (Penny, 2004, p. 83).

(table continues)

Design Principle	Sense of Place	Social Presence	Individual Agency	Collaboration Mediation
5. Groups: Form and project shared group identity.	Allocate and label meeting place and shared workplace for each group, customizable according to group identity (Bartle, 2004).	Support approbation behaviors through gestures, objects and animations (Robins, 2002).	Allow for display of connections and approval collections (Donath & Boyd, 2004).	Embody and sustain group activities and history with persistent objects (Robins, 2002).
6. Authentic imperative for action: Situate learner in environment, specify goal of virtual experience, create imperative for action and unifying framework for [collaborative] actions (Sherman & Craig, 2003) that leverage the simulation environment.	Take advantage of dimensionality and/or simulation (problem cannot be tackled safely, economically or at all: "what-ifs" rather than "simple transference of content from sequential media" (Sherman & Craig, 2003, p. 419); Use physical cues as to genre (or departure from it) in form of narrative back story or clear purpose.	"Establish co-references of social context for dynamic mapping of the shared workspace" (Cottone & Mantovani, 2003).	Maintain balance between constraints and flexibility (necessary to individual agency; Mateas & Stern, 2006). Support responsive revelation of controls (controls are revealed as needed by learner; Rogers, 2005b). Allow direct live intervention (Sherman & Craig, 2003).	Support situation awareness with workplace widgets for joint attention: What You See is What I See, or What You See is What I Do (Cottone & Mantovani, 2003).
7. Annotation: Integrate object creation and manipulation with collaborative interactions (B. Brown & Bell, 2006). Leverage 3D nature to "[convey] ideas as artistic expression or noninvasive experimentation" (Sherman & Craig, 2003, p. 414)	Support object specialization, assembly, collection, containers (endo- and exo-),state changes and object persistence with some real world properties (Sherman & Craig, 2003) Provide means for creating and organizing persistent objects, icons, symbols and other representations of self-expression, associated with place.	Provide means for sharing objects, icons, symbols and other representations. Support simultaneous interaction around objects, joint attention, shared focus, pointing, gesturing and referring in relation to object (Heldal et al., 2006).	Provide for multiple views of objects and "multilateral perspectives" (Bailenson & Beall, 2006). Ensure object ownership (intellectual property) attaches to author (Ondrejka, 2004a) and provide for author control of artifacts. Support multimedia annotation attached to different components of the world (Sherman & Craig, 2003).	Provide built-in tools for collaborative work (Ondrejka, 2004a). Reflect "situational context" (changes to the spatial structure of an interaction) as it occurs in virtual space (Bailenson & Beall, 2006).

(table continues)

Design Principle	Sense of Place	Social Presence	Individual Agency	Collaboration Mediation
8. Informal Chance Encounters and Group Awareness: Stimulate chance encounters with other community members (Huxor, 1999). Use notification systems to deliver sense of spatial and temporal proximity (Carroll et al., 2003; Kirschner et al., 2004; Kreijns et al., 2003)	Display persistent icons associated with each group member (whether present or not); use graphic notification systems for online group members to locate each other spatially in the virtual world (Kirschner et al., 2004).	Provide simple presence indicators to offer opportunities for impromptu communication (Farshchian, 2003, p. 212). Use visual representation of previous visits to facilitate sense that one is not alone in the environment, even in absence of other group members (Kirschner et al., 2004).	Provide individual control of visibility and indicators of availability for informal interaction (Bregman & Haythornthwaite, 2003). Provide tools for individuals to negotiate activity based on "state or attitude of online collaborators: timing, frequency, or intensity of activity" (Carroll et al., 2003, p. 611).	Embed "group awareness widgets" (Kreijns et al., 2002) in collaborative tasks. Integrate access to collaboration resources and collaborative tools (Huxor, 1999) with communication tools. Provide support for "communication zones" (Nardi et al., 2000, p. 86).
9. Collaborative awareness. Support construction and maintenance of common ground with other collaborators through action and activity awareness (Carroll et al., 2003; Carroll et al., 2006).	Provide ability to create and place in collaborative space objects that represent planning artifacts for products of grounding at different stages (Baker et al., 1999, p. 37). Convey location and focus of current activity with action awareness widgets (Cottone & Mantovani, 2003).	Support visualization of participation, agreement and disagreement in discussion (Janssen et al., 2007). Provide social cues with positive feedback loop (Hudson & Bruckman, 2004). Support creation of persistent social goods (social capital) (Carroll et al., 2006, p. 26).	Provide for individual planning, tracking, and documenting of assigned tasks/actions, in context of larger object[ive].	Provide integrated tools for synchronizing task-oriented collaborative activity through maintaining activity awareness: negotiating rules of engagement; establishing common object[ive]; identifying and carrying out chains of actions necessary to achieve object[ive]; negotiating changes in plans (Carroll et al., 2003, p. 611).

Definition of Other Terms for the Purposes of the Study

Collaborative Learning

For the purposes of this study, successful collaborative learning in higher education is an activity with the following characteristics: (a) It is conducted by small (5-9) self-regulated groups of learners in higher education classes working together to achieve a common object (set formally in the context of a learning activity); (b) The groups each select the means to achieve the object (tools, actions, and operations); (c) Groups are responsible for the object as a group and monitor their own progress; (d) Individual accountability is maintained (each individual is individually accountable for his or her own work), as is positive interdependence ("each individual can be held individually accountable for the work of the group, and the group as a whole is responsible for the learning of each individual group member;"; Kirschner et al., 2004, p. 54); (e) The sets of expertise, skills, knowledge and previous experience of group members are asymmetric, and usefully applied to achieve the object as each group member learns according to mediation provided by their peers, in their zone of proximal development; (f) In the process of learning, the groups transform their tools and the environment; and (g) Learning is a creative process, as interpreted through an activity theoretic perspective:

> Activity theory's concept of mediation, combined with understanding creativity as the internal restructuring of a problem representation, helps us conceptualize creativity in groups. In a group setting, the mediation of conversation from other insightful people may help individual group members to frame problems in new ways and then contribute those insights to the group. Creative insights take place

> in concrete activity in which specific individual subjects converse, communicate, and respond to one another.(Kaptelinin & Nardi, 2006, p. 212-213)

This creativity is tied to individual reflexivity taking place in a social context. That is, although all activities are social, "inevitably involving other people, artifacts, and culture," (Kaptelinin & Nardi, 2006, p.214), it is "an individual student who assesses experience, sometimes reformulating its meaning, and communicating that meaning to others" (p. 229).

Presence

The definition of presence to be used in this study was based on an adaptation of the ethnographic, collaborative action-based approach to studying presence (Spagnolli et al., 2003), where presence is a dynamic process associated with an action in an activity system, occurring in a socio-cultural context over time, and consisting of four dimensions: sense of place, individual agency, co-presence, and mediated action/operation chains.

Action

The term, "action," has a special meaning drawn from activity theory for the purposes of this study. The unit of analysis for an activity system is the activity; for the purposes of this study, the focus was on the sub-unit of analysis, an *action* in an activity system; "actions are conscious goal-oriented processes that must be undertaken to fulfill the object" (Nardi, 2001a, p. 74). In common HCI parlance, actions are termed tasks.

Affordances

Because this is a human-computer interaction design study, the use of the oft-misused term "affordances" must be precise. Gibson (as cited in Flach & Holden, 1998) introduced the term affordances in terms of cognition and physical environment, and the relationships or “functional couplings” between an environment and an animal (or actor), and defined it as the possibilities or opportunities offered (afforded) for action by the environment to the animal. Because possibility for action is the linch-pin of the definition, Gibson emphasized constraints as fundamental: “how they shape and limit the functional couplings between animals and environments” (Flach & Holden, 1998, p. 93). The implications of Gibson’s definition is that

> the reality of experience is grounded in action. Thus, in the design of experiences in virtual environments the constraints on action take precedence over the constraints on perception. This approach predicts that the experience of space will depend more on the mode of locomotion than on the visual and acoustic images. The reality of a surface will be in its implications for action (e.g., does it impede locomotion) rather than its appearance (e.g., does it look like a wall). In this approach, the reality of experience is defined relative to functionality, rather than to appearances. (Flach & Holden, p. 94)

Zahorik and Jenison (1998) take an extreme action/task orientation with regard to presence with their emphasis on the dynamics of the perceiver/environment interaction and their dismissal of any subjective or social aspects:

> Successfully supported action in the environment is a necessary and sufficient condition for presence…When the environmental response is…commensurate with the response that would be made by the real-world environment in which our perceptual systems have evolved, then the action is said to successfully support our expectations. Since our knowledge of such environmental response is

> necessarily gained through perceptual processes, it may be seen that the couple between perception and action is crucial to determining the extent to which actions are successfully supported (perception/action coupling). (p. 85)

In addition, the relationship is reciprocal: "Actions of the organism have consequences for the environment, and the nature of the environment has consequences for the organism" (p. 85).

Norman (1999) is recognized for applying the concept of affordances to human-computer interface design as one of three key dimensions in the operation of a novel device: conceptual models, constraints, and *perceived* affordances that are properties of the world, specify the range of possible (desired, relevant) activities, and reflect the possible relationships among actors and objects. He makes a strong distinction between affordances and artificial, arbitrary and learned conventions, symbolic communications and constraints which have evolved over time; these are often mistakenly referred to as affordances instead of "examples of the use of a shared and visible conceptual model, appropriate feedback" (p. 41). Norman emphasizes the importance of the coherent, explicit, perceivable conceptual model over other design tools.

For the purposes of this study, presence affordances are irresistible invitations for action built into the interface or added by the learning environment designers. For example, virtual world interface designers have noted that wayfinding (the aspects of the world that guide the learner from one area to another) is important (Sherman & Craig, 2003). If the basic virtual world design provides a coordinate system with map and teleporting functions, the learning space designer can create transporters to move learners directly to a teleport sites (if it is the destination that is important in the learning experience). Thus, the learning space designer is availing themselves of the affordances for wayfinding built into the world. With the basic world design, a coordinate system with a map provides the learner with affordances for wayfaring, but these may be weaker without the work of the learning space designer.

Agency. A theory-based understanding of agency in a virtual world describes an individual's ability to interact with a virtual environment, to manipulate objects and the environment with tools (that they can either appropriate, or develop) or with the help of others, to produce an effect according to a desired or needed end (motivation and intention).

Design of Previous Studies

Given the enormous body of research on the sense of presence, the development of a new construct must be justified. The multidimensional construct for the sense of presence was developed because "there is no criterion or universe of content accepted as entirely adequate to define the quality to be measured" (Cronbach & Meehl, 1955, p. 282). The quality here is the sense of presence in collaborative learning environments that leverage the flexible design capacities of the new 3D open-ended, socially-oriented virtual worlds. In addition, "problems of stability and bias associated with simple rating scales [may be due to treatment of] presence as unidimensional presence ratings, when it is in fact multidimensional. Thus, a measure that takes account of the potential multidimensional structure of presence may prove to be more robust" (Lessiter et al., 2001, p. 285).

Unidimensional studies are useful as sources for research instruments which can be adapted and combined for the multidimensional construct, chosen on the basis of (a) match to the explicit definitions of each dimension in the construct (sense of place, social presence, and individual agency); (b) focus on a particular dimension, avoiding conflation of sense of place and social presence, for example; (c) match to underlying activity theoretic perspective on mind, learning and practice, where available; (d) number of studies using the measure in question; (e) validity if established in reviews of previous studies; (f) reliability, including Cronbach's alpha if provided by the study; and (g) sensitivity. Two reviews of prior research were primary sources for this information: Youngblut's (2003) *Experience of Presence in Virtual Environments*, and van Baren and Ijsselsteijn's (2005) *Compendium of Presence Measures*. Note that for most prior experiments, sample size has been relatively small.

In addition, post-"subjective questionnaires are the most common approach to measuring presence" (Youngblut, 2003, p. 5), so they are based on individual self-report. The advantages for this study is that; (a) they can be combined to assess a multidimensional construct; (b) they are relatively easy to use, and don't require special training of the participants or the researcher; and (c) they are unobtrusive during the experience itself (Youngblut). There are disadvantages as well: (a) they are static snapshots of an experience that may have varied over a range during the activity; (b) they rely on recall, especially if not completed immediately after the activity; (c) they are "vulnerable to subject bias;" (d) they can be "tedious to complete and lengthy questionnaires may result in a lack of due consideration being paid to each item" (Youngblut, pp. 10-11); and (e) the terms used to describe the experience can be undifferentiated and "fuzzy" (the phrase "sense of presence," for example, has over 50 definitions in the literature).

Sense of Place

The studies examined for use which focused on the sense of place dimension of the sense of presence included the Kim and Biocca study (1997), the ITC Sense of Presence Inventory (Lessiter et al., 2001), the Igroup Presence study (Schubert, Friedmann, & Regenbrecht, 2001), the Slater, Usoh and Steed study (1994), and the Usoh et al. study (2000).

The Slater, Usoh and Steed (1994) study was selected because: (a) the questions operationalized the sense of place as it has been defined in this study, (b) strong face validity, (c) use in well over 20 other studies, (d) use in several studies to compare experiences in the real world and an equivalent virtual world (and sensitivity to distinguish between environments and individual differences in several experiments).

Social Presence

The challenge for measurement of social presence is the wide range of definitions of the phenomenon and the inclusion of the sense of place. Both functional and social factors should be examined, to stay consistent to an activity theoretic approach. Most measures for social presence consider interactivity with the environment (Lombard & Ditton, 1997; not other learners), or only consider asynchronous communications (Gunawardena, 1995). Other sociocultural measures only look at group member interactions (Kreijns et al., 2004), rather than interactions between community members throughout the social space. Candidates for adaptation included the Biocca, Harms et al. (2001) Networked Minds Measure of Social Presence, the IPO Social Presence Questionnaire (IPO-SPQ; DeGreef & IJsselsteijn, 2000), the GlobalEd Questionnaire

(Gunawardena, 1995), the Nowak and Biocca (2003) Questionnaire, and the Semantic Differential Technique (Short, 1976).

The Networked Minds Measure of Social Presence (Biocca, Harms, et al., 2001) was selected primarily for its face validity: it was the only candidate which was theory-based, and for which the theory underlying the questionnaire was a measure of social presence as it has been defined for the purpose of this study (Biocca, Burgoon, et al., 2001; Biocca, Harms, & Burgoon, 2003; Biocca & Harms, 2002); that is, it measured what this researcher proposes to measure.

Individual Agency

The source of the questions on individual agency is the Witmer-Singer (1998) Presence Questionnaire (PQ), which was chosen because the questions related directly to the nature of the dimension of individual agency as it has been defined for the purposes of this study. In addition, the PQ has the following characteristics: it has been used in 32 studies, with demonstrated face validity, variation with related factors, stability for unrelated factors, comparison with other types, consistency across studies (Youngblut, 2003), a Cronbach’s alpha of .88 indicating inter-item correlation and the PQ discriminated between conditions in several experiments Youngblut and Perrin (as cited in van Baren & Ijsselsteijn, 2004)

For corroborative evidence among the presence questionnaires, most of the research is focused on the SUS Questionnaire and the Witmer-Singer PQ, with mixed findings. A significant positive correlation between the two questionnaires is found when “high” response was relaxed to include “5,” and that high SUS questionnaire results were consistently associated with high PQ questionnaire results, but the reverse is not found (Youngblut, 2003).

Issues Regarding Mediated Collaborative Action/Operation Chains

In conducting a theory-based research study concerning design for the sense of presence, internal validity depends upon successfully and fully operationalizing a unifying theory–in this case, activity theory. However, this has proven challenging with activity-theoretic human computer interaction studies, although different approaches have been suggested (Baker et al., 1999; Barthelmess & Anderson, 2002; Gifford & Enyedy, 1999; Jonassen & Rohrer-Murphy, 1999; Kaptelinin & Nardi, 2006; Korpela, Mursu, & Soriyan, 2002; Kuutti, 2001; Kuutti & Bannon, 1993; Mwanza, 2002; Turner, Turner, & Horton, 1999).

Most of the approaches used are applied to computer supported cooperative work, and the level of analysis is limited to the components of the activity system (subject, object, tools, roles, rules, community), with an emphasis on tool mediation, and does not address the full hierarchy of an activity system – the chains of actions that make up an activity, and the chains of operations that make up an action. Therefore, one of the most challenging issues in applying Activity Theory to an qualitative study is in incorporating these additional two levels, and this becomes yet more challenging when applied to emergent computer-supported activities, such as collaborative learning, in an open-ended environment that facilitates learners' open-ended development and adaptation of their tools and environment (analogous to a software system that supports user programming). A related limitation of most approaches is inattention to the developmental/transformative nature of activity systems (which seems particularly applicable for collaborative learning activities and the design of human-computer interfaces which support the transformation of operations to actions, as well as internalization and externalization processes).

The Activity Checklist (Kaptelinin & Nardi, 2006) was developed in part to address all aspects of Activity Theory, as an artifact “that makes concrete the conceptual system of activity theory for the specific tasks of design and evaluation” (Kaptelinin et al., 1999, p. 28). However Mwanza (2002) argues that the Activity Checklist is still specified at too high a level of abstraction to translate easily into research procedures for data collection or analysis. She acknowledges that by not specifying structured methodological procedures to translate theory into research practice, great flexibility in research design is maintained; on the other hand, Activity Theory concepts are already complex, intertwined and constantly evolving and the flexibility “has introduced difficulties in replicating, comparing, and criticizing the approaches taken to operationalize Activity Theory” (Mwanza, p. 92). One of the limitations that she identifies is that the Checklist is not directly helpful in defining the boundaries of the collective activity system which forms the unit of analysis. The actual process of gathering data about users is not defined, although ethnomethodological data collection techniques are recommended, and decomposition of an activity to understand means/ends is suggested. The Checklist’s strength is as a conceptual tool or “kind of theoretical scaffolding” (Kaptelinin et al., p. 31).

Conclusion

Based on the review of literature on computer-supported collaborative learning, the sense of presence, human-computer interaction design, and design practices for virtual worlds, and considering the issues associated with design of collaborative learning environments in 3D multiuser virtual worlds, this study argues that a new approach to design is needed to capitalize on the new capabilities (and address the new challenges introduced) by these open-ended, socially-oriented environments. From the exhaustive cross-disciplinary literature review, the researcher has created a measure based on a new multidimensional construct of the sense of presence as a collaborative action-based process (rather than just as an attribute of media or property of individual experience). A set of guidelines for the design of collaborative learning environments in virtual worlds based on this construct has been anchored with examples from customized environments in Second Life.

For the purposes of this study, the researcher applied two of the nine design guidelines to explore the development of the sense of presence across all four dimensions of presence. The study utilized activities that have been used in other research on presence and collaboration, which were carried out under three conditions to compare two design guidelines, as follows: (a) where wayfinding was foregrounded, (b) where annotation was foregrounded, and (c) where both wayfinding and annotation were implemented together to control for order effects. The study explored to what extent the subjective report of the experience of presence aligns with the hypothesized effect of designed-presence.

The guiding question for inquiry was: What is the effect on the sense of presence in collaborative learning spaces designed according to the sense of presence construct proposed, under three design conditions (wayfinding, annotation, and wayfinding and annotation together) in the 3D open-ended, socially-oriented virtual world, Second Life?

Another question of interest: what are the relationships (if any) among the four dimensions of presence described by the construct?

It is hoped that the research can begin to bridge the gap between abstract theory and practice, by providing a theory-based and validated set of guidelines for virtual world design to create customized collaborative learning environments (for higher education students) that invite the emergence of the sense of presence. To the extent the construct is validated, the design principles based upon it may be useful to learning environment designers for leveraging the capabilities of Second Life, and for addressing the issues and challenges that this new platform for designing learning environments introduces.

Chapter 3: Methodology

Overview and Purpose of the Study

The sense of presence has been studied intensively, as has computer-supported collaborative learning. However, little research has been done on the sense of presence in computer-supported collaborative environments, and there are even fewer studies evaluating the sense of presence in 3D open-ended, socially-oriented virtual worlds such as Second Life, used as collaborative learning environments. Given the context of new social spaces with the potential for being harnessed as learning spaces, and the historical work that demonstrates the worth and nature of the sense of presence, the researcher has developed a new construct of the sense of presence with four dimensions (sense of place, social presence, individual agency, and mediated collaborative action chains).

The construct of the sense of presence has been formulated in terms of precise, mutually-exclusive definitions of each dimension. The construct has been operationalized both with respect to the four dimensions of the construct and with respect to nine design principles. This study applied two design principles as interventions in creating three customized learning environments in Second Life. These interventions were designated Environment A, where the principle of wayfinding (See p. 87 and p. 118 in Chapter 2) was applied to the design; Environment B, where the principle of annotation (see p. 102 and p. 123 in Chapter 2) was applied to the design; and Environment C, where both principles were applied. Participants carried out a collaborative learning activity in each environment (recreating activities that have been used in other research on presence and collaboration), and completed an online survey at the end of each of the three experiences. Data was gathered from the surveys, as well as from observation of the participants during the learning activities, and from semi-structured online interviews of a sample of the students.

The study explored to what extent the subjective report of the experience of presence aligned with the hypothesized effect of designed-presence. A guiding question for inquiry was: In the 3D open-ended, socially-oriented virtual world, Second Life, what is the effect on the sense of presence in collaborative learning spaces designed according to the sense of presence construct proposed, using the two design principles, wayfinding and annotation? Another question of interest: What are the relationships (if any) among the dimensions of presence described by the construct?

It is hoped the research can begin to bridge the gap between abstract theory and practice, by providing a theory-based and validated set of guidelines for virtual world design to create customized collaborative learning environments (for higher education students) that invite the emergence of the sense of presence.

To the extent the construct is validated, the theory-based design metrics based upon it may be useful to learning environment designers who want to capitalize on the capabilities of Second Life, and to address the issues and challenges that this new platform for designing learning environments introduces.

Phase I of the research study consisted of a focus group session with three expert designers; Phase II consisted of voluntary participation by student subjects during the three designed environment interventions.

Research Methodology

The research utilized both quantitative and qualitative methods in exploring the emergence of the sense of presence in the 3D open-ended, socially-oriented virtual world, Second Life, as it is used as a formal collaborative learning environment by higher education learners. The methodological challenges were: (a) how to gather data about the experienced sense of presence, validating and operationalizing the construct and the two design principles; (b) how to model and collect data about collaborative action-based processes; (c) how to analyze data about experienced presence and processes.

For the quantitative aspects of the study in Phase II, means and standard deviations were evaluated based on the results of the post-activity surveys completed by the student participants at the end of each session where one of the design conditions was foregrounded. With 20 students participating, this resulted in 60 surveys.

The use of activity theory as a qualitative data collection (and analysis) tool in the study aligned the theories of computer-supported collaborative learning, presence, and human-computer interaction design in virtual worlds, and provided a means for organizing data collection and analysis consistent with this conceptualization. Qualitative analysis was required for an activity-theoretic exploration of the construct required, particularly with respect to the fourth dimension of presence, mediated collaborative action chains.

Observation and activity-theoretic modeling of interactions were conducted for the qualitative aspects of the study. Note that post-session semi-structured interviews conducted in Phase II were carried out as part of qualitative data collection. In addition, in Phase I, a focus group composed of expert designers reviewed the principles.

Subjects

For content (face) validity, three experts in the design of computer-supported collaborative learning environments participated in a two-hour focus group session in March, 2009. Using a semi-structured set of questions, focus group members were asked for feedback on the clarity, utility, and theoretical soundness of the sense of presence construct and the nine guidelines for the design of collaborative learning environments in virtual worlds.

The members of the three-person focus group were faculty and staff from higher education, chosen on the basis of: (a) experience with use of instructional technology in a university or college setting; (b) background in teaching university level classes in instructional technology at the masters or doctoral level or in supporting faculty in use of instructional technology use in a university or college setting; (c) experience with design and use of computer supported collaborative learning environments in a university or college setting; (d) research and writing on topics relating to enhancing and transforming teaching and learning in a university or college setting; (e) background in assessing the impacts of the use of advanced technologies on teaching and learning in a university or college setting; and (f) familiarity with use of virtual worlds such as Second Life as collaborative learning environments.

Members of the focus group were recruited by electronic mail to individuals in the Second Life Educators' electronic mailing list, from personal contacts made through in-world interactions with faculty and staff at educational events in Second Life, from contacts listed in the catalogue of universities, colleges and schools involved in the use of Second Life (SimTeach Wiki) and from individuals identified as faculty in master's or doctoral level educational technology programs in the EDUCAUSECONNECT database. The invitation included the purpose and description of the study, possible study timeline, the relevance of the study, system requirements, and contact information.

In Phase II, the study also involved the use of the virtual world, Second Life, which is utilized by students in the doctoral program in educational technology, in the Graduate School of Education and Psychology, Pepperdine University. The number of subjects for Phase II was determined by enrollment in Dr. Linda Polin's Spring 2009 classes, EDET 730 (Research Methods), and EDET 770 (Learning and Design), and by the number of volunteers from those classes. The subjects were selected because their background as K-12 teachers, corporate and staff development, educational researchers, or faculty or staff specializing in the use of instructional technology, and their interest in exploring advanced instructional technologies such as the use of virtual worlds for collaborative learning environments.

During a face-to-face presentation in January, 2009, the student subjects were introduced to the researcher, who described the opportunity to participate voluntarily, explained the research and its purposes, benefits and risks, and recruited volunteers to participate. During the researcher's introduction to the class, the professor reinforced the voluntary nature of the participation, and informed the subjects that their grades would not be affected by their choice to participate or not, nor by the nature of their participation. An informed consent form was provided and reviewed with potential participants, and signed informed consent forms were collected from those who choose to participate.

Twenty-two graduate students from the Graduate School of Education and Psychology participated in the first round of experiments, 20 in the second and third. Students who did not complete all three exercises were eliminated from the pool, thus the number of participants for the study was 20.

For this study of collaboration, in many ways the unit of analysis was the collaborative team. Students were divided as follows: Group 1 (3 members); Group 2 (4 members); Group 4 (4 members); Group 5 (2 members); Group 6 (4 members); Group 7 (4 members). Group 3 was disbanded before the first experiment, due to scheduling problems. A total of 20 students participated in the study, completing a survey at the end of each session, for a total of 60 surveys. Of the 20 subjects, 13 were female, and 7 were male. Note that half of the subjects were over 40 (2 of the participants were ages 26-30, 4 were 31-35, 4 were 36-40, 3 were 41-45, 4 were 46-50, and 3 were older than 50) as described in Table 2.

Gender

A t test (at 95% C.I) was done to determine if mean differences exist between males and females concerning the sense of place, sense of individual agency, or sense of social presence. No statistically significant mean differences exist.

Age

Using Pearson Correlation, age has a weak positive association ($r=.287$) with sense of place. Age is not significantly associated with sense of individual agency or sense of social presence.

Table 2

Gender and Age Crosstabulation

			Age						Total
			26-30	31-35	36-40	41-45	46-50	>50	
Gender	Female	Count	2	2	3	2	2	2	13
		% within Gender	15.4%	15.4%	23.1%	15.4%	15.4%	15.4%	100.0%
		% within Age	100.0%	50.0%	75.0%	66.7%	50.0%	66.7%	65.0%
		% of Total	10.0%	10.0%	15.0%	10.0%	10.0%	10.0%	65.0%
	Male	Count	0	2	1	1	2	1	7
		% within Gender	.0%	28.6%	14.3%	14.3%	28.6%	14.3%	100.0%
		% within Age	.0%	50.0%	25.0%	33.3%	50.0%	33.3%	35.0%
		% of Total	.0%	10.0%	5.0%	5.0%	10.0%	5.0%	35.0%
Total		Count	2	4	4	3	4	3	20
		% within Gender	10.0%	20.0%	20.0%	15.0%	20.0%	15.0%	100.0%
		% within Age	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	10.0%	20.0%	20.0%	15.0%	20.0%	15.0%	100.0%

*n=20

Intervention

For Phase II, quantitative data collection and analysis was conducted on the experimental results of post-activity surveys on three of the dimensions of the sense of presence: experienced presence in terms of sense of place, social presence, and individual agency as the three dependent variables. Three conditions implemented two of the nine design principles which were developed based on computer-supported collaborative learning research and research on design practices in virtual worlds. The three experimental conditions were: (a) where wayfinding is foregrounded (16 87); (b) where annotation is foregrounded (see p. 102); and (c) where annotation and wayfinding are both implemented. Thus, the principles from the matrix (see p. 116) were used to create three design conditions on Malibu Island (a Second Life site owned and maintained by Pepperdine University): (a) one customized site which foregrounded wayfinding, Environment A (see p. 118 for the matrix principle in Chapter 2); (b) another which foregrounded annotation, Environment B (see p. 123 for the matrix principle in Chapter 2); and (c) Environment C, which implemented both.

Instrumentation

For Phase I, after a discussion of the sense of presence construct and the research design, focus group participants were interviewed regarding each of the nine design principles in the matrix, using a semi-structured format. For Phase II, an online survey of learners participating in the collaborative learning activities provided subjective experienced-presence data; the post-activity online survey was administered to the student participants after each collaborative learning session. The survey included four demographic questions, three open-ended questions, and 39 scored questions. The instrument was based on a combination of questions from three survey instruments designed by prior researchers, to test sense of place (Slater et al., 1994; Usoh et al., 2000), social presence (Biocca, Harms, et al., 2001), and individual agency (Witmer & Singer, 1998; See Appendix A). A total of 18 semi-structured interviews were conducted online with a sample of participants; interviewees were selected based on the researcher's observations of behavior (See Appendix B).

Study Design

Through post-activity online surveys, the study, which was designed to validate the proposed sense of presence construct, collected data on the experienced-presence results on three dimensions of presence (sense of place, social presence, and individual agency) after two of the nine design principles were implemented (individually, and then jointly). The study also followed a line of inquiry on the mediation of collaborative action chains using activity theory.

Operationalization of the Variables

The study's multidimensional construct of the sense of presence consists of the four dimensions: the sense of place, individual agency, co-presence, and mediated action/operation chains in a collaborative learning activity. The first three were evaluated based on responses to an online survey completed after the collaborative learning activity conducted under the three experimental conditions. A combination of three experienced-presence questionnaires developed by other researchers (Biocca, Harms, et al., 2001; Slater et al., 1994; Usoh et al., 2000; Witmer & Singer, 1998) was selected on the basis of (a) match to the definitions being used in this study for the first three dimensions of presence, (b) the extent of their use in prior studies, and (c) external reviews by other researchers as to their validity, reliability, and sensitivity.

Sense of place. The sense of place is a property of human experience that is referred to in the literature as physical presence or spatial presence, and involves the sense that one feels "part of the phenomenological environment" created by the virtual world. For the purposes of the study, learners' sense of place (under the three experimental conditions) was measured using questions from Usoh et al. (2000). These operationalized the sense of place in terms of the sense of:

1. The extent to which being in the virtual environment compared to the normal experience of being in a place.

2. The extent to which the virtual environment was experienced as reality for the participant.
3. The extent to which the participant experienced the virtual environment as a collection of images or as a place visited.
4. The extent to which the participants felt they were in the virtual environment, or elsewhere.
5. The similarity of the structure of memory of the virtual environment to the structure of memory of other places visited by the participant.
6. The extent to which the participant often thought that they were actually in the virtual environment.

Social presence. The sense of social presence–defined as *We are together with others, with the ability to communicate and interact socially*–is the sense of being together with other people, with opportunities for interacting and communicating synchronously and asynchronously, and with some degree of mutual awareness, attention, understanding and assistance (Biocca, Harms, et al., 2001).

For the purposes of the study, learners' sense of social presence (under the three experimental conditions) was measured using questions from Biocca, Harms et al. (2001). The operationalization of the variables from Biocca, Harms et al. is described below.

1. Mutual awareness: the level of peripheral or focal awareness of the other, and the sense of the degree to which the other is peripherally or focally aware of them (p. 2).

2. Mutual attention, empathy, and mutual understanding: “The degree to which the observer allocates focal attention to the other, empathically senses or responds to the emotional states of the other, and believes that he/she has insight into the intentions, motivation and thoughts of the other” (p. 2).
3. Mutual assistance: The degree to which the participant felt they worked with the others to complete the task, and were helpful to others; and the degree to which they felt the others worked with them to complete the task, and were helpful to the respondent.

Individual agency. Individual agency is a property of human experience, the ability to manipulate objects and the environment with tools (through development or appropriation) “to produce an effect according to a desired or needed end (motivation and intention)” (Kaptelinin & Nardi, 2006, p. 242).

For the purposes of the study, learners’ sense of agency (under the three experimental conditions) was measured using questions from Witmer and Singer’s (1998) presence questionnaire; specifically, those relating to the control factors they defined, noting that “in general, the more control a person has over the task environment or in interacting with the VE, the greater the experience of presence” (p. 228). The control factors are listed below:

1. The degree to which the respondent experienced a sense of control over the environment.
2. The degree to which the respondent experienced immediacy of control, limiting the noticeable delays between the action and the result.

3. The degree to which the respondent was able to “anticipate or predict what will happen next, whether or not it is under personal control” (Witmer & Singer).
4. The degree to which the mode of control felt natural or artificial.
5. The degree to which the respondent felt they were able to modify physical objects.

Mediated Collaborative Action/Operation Chains

Within the activity theoretic perspective, the fourth dimension of the sense of presence, mediation of collaboration, is defined as: *We (a group subject, members of a collaborative group) can use tools to collaborate to carry out action/operation chains toward a shared object(ive) that relates to a formal learning activity (system).*

Actual tools appropriated (or not) for particular action/operation chains cannot be completely specified in advance. Use of activity theory argues for qualitative data collection methodologies. The Activity Design Oriented Model (Mwanza, 2002) was used to identify potential collaborative action/operations chains and tools associated with each row of the Presence/Collaborative Learning in Virtual Worlds matrix, and served as an organizing framework for data collection. Spagnolli et al.’s (2003) ethnographic, action-based approach was also used to guide data collection during observations and interviews of the learners.

Data Collection

Multiple sources for data informed measurement for the proposed construct. Analyses from Second Life interactions were conducted to validate the construct and two principles from the set of theory-based design guidelines based upon it. The design included a blend of (a) quantitative sources from post-experience subjective scores from doctoral students recruited from educational technology classes at Pepperdine University's Graduate School of Education and Psychology to determine the sense of experienced-presence, and (b) qualitative sources from general questions of an exploratory nature. These included: (a) open-ended observations (and videotaped recordings and recorded chats) of learners carrying out the assigned collaborative tasks under particular design conditions to observe success or failure of the collaboration, tools which were used to carry out the collaboration, environmental barriers to collaboration, and learner behavior in general; followed by (b) clarifying and confirmatory interviews with a sample of learners who participated in the collaborative learning activity; and separately, (c) a focus group session with learning environment designers to evaluate the sense of presence construct and the nine design principles from the matrix.

Initial Set of Participant Orientations

Two sets of ninety-minute orientations were held for both cadres. The first orientation was held during a face-to-face class meeting (January 28, 2009) for both Cadre XIII and Cadre XIV. A second orientation was held for both cadres during another face-to-face class meeting (Saturday, January 31, 2009). There was also a five to ten minute refresher orientation immediately before each experiment.

First orientation. The orientation was conducted as follows:

1. Dr. Polin introduced researcher and explained conditions of experiment (on the order of a voluntary field trip, an opportunity for students to explore the virtual world and its potential use for teaching and learning).

2. Researcher discussed benefits of experimenting with Second Life, and obtained signatures on informed consent forms for each participant.
3. Researcher helped participants (a) test logging in to Second Life; (b) set Malibu Island as home; and (c) landmark the coffeehouse on Malibu Island (15 minutes).
   - Login/Teleport test was conducted to ensure that participants had a working username, password, and that equipment that met the system requirements for use of Second Life.
   - Researcher helped participants set the central square as a landmark, and demonstrated how to teleport using a landmark.
4. Researcher reviewed navigation techniques (20 minutes):
   - Participants were encouraged to practice navigating their avatar using techniques displayed by the researcher.
   - Participants were asked to accept teleport to floating pillow meeting area on Malibu Island, and reminded to landmark the area (and rename the landmark more descriptively).
   - Participants were asked to navigate to a floating pillow in the cadre meeting area, and learned how to sit on an object.
5. Researcher instructed participants in how to use Second Life’s communication capabilities (20 minutes), as follows:
   - Open chat;
   - Shout;
   - Make friends;

- Informal instant messaging (IM) with assigned partner;
- Informal group messaging (with assigned groups).

6. Researcher instructed participants in use of camera view to change perspective on objects and the environment.

Second orientation. The second orientation was conducted as follows:

1. Researcher conducted a refresher on logging in, and chatting (10 minutes).
2. Researcher instructed participants in how to use Second Life's inventory control facilities (20 minutes), as follows:
    - Looking at one's inventory, noting types of inventory objects;
    - Accepting a new inventory item, a notecard from the researcher;
    - Finding the newly accepted notecard in inventory;
    - Creating and saving a new notecard.
3. Researcher introduced the use of building tools in Second Life (25 minutes), including:
    - Creating rectangles;
    - Naming objects;
    - Resizing rectangle/undo;
    - Move rectangle;
    - Change texture on rectangle;
    - Make quick copy of rectangle;
    - Link objects, rename;
    - Taking objects into inventory, and bringing objects out again.

4. Participants went through mastery challenge provided by the researcher, including the skills covered in the orientation (10 minutes), to confirm that the basic skills necessary had been attained, as follows (all participants completed the mastery test successfully):
    - Participants were asked to initiate a “field trip” to the Learning Theory Exploratorium on Malibu Island in Second Life.
    - Participants were asked to accept teleport to Directory Building for the Learning Theory Exploratorium.
    - Participants were asked to use the directory to meet with their assigned group in one of the rooms of the Exploratorium, to learn about a particular learning theorist.
    - Participants were asked to experiment with objects found in the room they had been assigned.
    - Participants were asked to obtain a notecard from one of the objects in the exhibit, and find it in their own inventory.
5. Researcher reviewed instructions for experiment with participants:
    - General instructions;
    - Reminder of voluntary nature of participation;
    - Group/collaborative nature of experiments;
    - Review of any questions concerning informed consent;
    - Scheduling for team meetings for three-week experimental period.

Detailed Experimental Plan

Each group session involved a brief orientation for each group immediately prior to the experiment (10 minutes for specific orientation to tools for use in the session), 40 minutes for the collaborative group project and 5-10 minutes to complete the online surveys (after each session).

Researcher invited various individuals to remain for an extra 20-minute semi-structured interview (resulting in a total of eighteen semi-structured interviews).

During each group session, researcher accompanied each group, making observations and saving the group and interview IM sessions for later analysis. A videographer made a videotape of each session.

Order

The order of experimental design conditions was organized as shown in Table 3:

Table 3

Group Order of Interventions

Group	Annotation (Build)	Wayfinding (Find)	Wayfinding + Annotation (Find & Build)
Groups 1, 4, 5	First experience	Second experience	Third experience
Groups 2, 6, 7	Second experience	First experience	Third experience

Interventions

Phase II involved three interventions (one hour for each group, over three weeks): (a) Environment A (Find), where the principle of wayfinding was applied to the design; (b) Environment B (Build), where the principle of annotation was applied to the design; and (c) Environment C (Find/Build), where both annotation and wayfinding were applied. The online experienced-presence questionnaires were administered three times, each time after participants carried out a collaborative learning activity in each of the three customized learning environments.

Wayfinding (find). Wayfinding involved providing a variety of aids (landmarks, paths, maps, place names, x-y-z coordinates) and cues and techniques to support the learner's process of defining pathways and building a personal map for themselves. The wayfinding exercise was preceded by a brief scripted orientation including how to initiate and participate in a group IM, how to read the island map, find directions, and find others on the map (see Appendix C).

The intervention involved the use of a treasure hunt, with clues organized on notecards given to the participants. Each group member was assigned a color and had different clues and directional cues/hints in a set of notecards for finding one hiding location from another in order to discover different colored objects. All group members had to share their clues to put together the treasure map necessary to discover the objects. The color order of the objects to be found was red (just before the Learning Exploratorium), yellow (inside the Learning Exploratorium), green (in the hobbit house), blue (at the base of the waterfall), and pink (inside the coffeehouse).

Annotation (build). Annotation, object creation and manipulation (building) involved integrating object creation and manipulation with collaborative interactions. Participants received a brief scripted orientation about use of building tools (see Appendix D), then performed a simple building exercise to replicate a model provided by the researcher.

Combined annotation and wayfinding (find and build). This exercise involved individuals building free-form objects, agreeing upon a group “hiding” place, arranging individual objects into a group object at that location, and then reverse- engineering a map to the object from the central plaza to the object location (See Appendix E).

Qualitative Data Collection

The researcher (and a trained second rater) observed learners engaged in a collaborative learning activity, collecting data using ethnomethodological techniques. A prospective mapping of the nodes of a collaborative learning activity system was performed to prepare for data collection using the Activity-Oriented Design Model (Mwanza, 2002).

Approaches to the data collection included: (a) collection of raw data from researcher observation of activity in Second Life, (b) “videotaping” activity (machinima), and (c) collecting chats and instant messages related to the collaborative learning activity. Observations were collected in a pre-specified format in field notes on in-world notecards, and notecards with transcripts of chats. Specific permission, documented in the chats, was requested for any direct quotations to be used in the dissertation, or for any photographs or videotape sequences to be used in the same manner. The following standardization of presence metadata was applied: “temporal data items synchronized with absolute timestamps; spatial data items need to be identified with spatial coordinate systems for position research; events-based data (actions performed by the subject or by the system, with accurate timestamps, using tuple structure” of actor, action, and parameters (Friedman et al., 2006, pp. 606-607). Semi-structured interviews were conducted with one to two students selected from the groups after each of the three rounds of collaborative learning activities (for a total of 18 semi-structured interviews).

The researcher created a research journal blog, in order to improve consistency and transparency through researcher reflection and journaling of the experience and researcher reactions (to recognize and clarify researcher bias). Documents, URLs, machinima movies, photos and other artifacts were presented on the researcher's blog, which was available by password only to the researcher's committee and members of the focus group. In addition to more systematic data collection and analysis, the researcher collected stories and anecdotes for the research journal that captured the gestalt of the experience (individual experiences of learners and researcher).

Content Validation through Expert Review Focus Group Session

To establish content (face) validity in Phase I, the researcher used one two-hour focus group session with a group of three participants who were experienced learning environment designers who have explored the use of Second Life or similar virtual worlds for teaching and learning. Focus group attendees were invited by electronic mail to participate (see Appendix F) and consent forms were obtained before the session. (See Appendix G.)

Two weeks prior to the focus group sessions, a packet of introductory materials and a copy of the Presence/Collaborative Learning in Virtual Worlds matrix was distributed to the members. The morning of the focus group session, members met on Malibu Island to discuss the matrix.

The agenda for the focus group session was as follows:

1. Brief introductions to follow up on the introductions made by electronic mail (10 minutes).
2. A five-minute orientation to the processes involved in the discussion (use of teleportation during the focus group session, structured group chats for discussion, saving of chats).
3. A 15-minute discussion of the sense of presence construct.

The focus group session then followed a discussion protocol using a set of semi-structured interview questions for all nine of the design principles in the matrix.

1. Are there other ways to describe the principle(s)?
2. Can you share examples from your own experience of the application of the principle(s)?
3. In what ways did the site exemplify the principle?
4. How could the site been improved (in order to implement the principle better, or for other benefits)?

Focus group members were asked for feedback on the clarity, utility, and theoretical soundness of the Presence/Collaborative Learning in Virtual Worlds model. A record was made of the online chat, which is reviewed and summarized in Chapter Four.

Data Analysis

Treatment Criteria

For the online sessions with the student participants, a checklist was developed for each treatment to use in reviewing the observed data, validating that the treatment did occur as planned.

Wayfinding (find). Immediately after each wayfinding session for each group, the following checklist for validation that the treatment in fact occurred as planned under the wayfinding condition was evaluated and results are presented in Chapter 4 (at least four of the nine criteria had to be met):

1. Group members shared or attempted to share their individual treasure map clues and directional cues/hints to derive a group treasure map.
2. Group members used the treasure map to find the colored blocks.
3. Team members helped point out color blocks to other members (e.g., the "red" member calls a green block to the attention of the group member who is assigned to collect it).
4. Group members recognized the different parts of the environment such as the central square, Learning Theory Exploratorium, wild back country (mountains and treehouse), sandbox area, and used this recognition to discover the blocks hidden there.
5. Group members noticed and followed directional cues such as the flight path to find different parts of the environment.
6. Group members used the world map to orient themselves.
7. Group members used the coffeehouse as an informal meeting place for socially-oriented, "hanging out" functions upon completion of the assigned task.
8. Group members were able to keep track of the location of each other.

9. Individuals developed a personal "map" of Malibu Island through their participation in the activity (confirmed through chat comments and post-session semi-structured interviews).

Annotation (build). Immediately after each group's session on annotation, the following checklist for validation that the treatment in fact occurred as planned under the annotation condition was evaluated, and results are presented in Chapter Four (at least four of the six criteria had to be met):

1. Group members were able to put together their individual parts of the Rubic's cube.
2. Group members could place the distinct parts of the Rubic's cube spatially in relation to the others (co-locate).
3. Group members used collaboration in attempting to build the Rubic's cube (even if not successful).
4. During construction, group members interacted simultaneously around the object, with joint attention, shared focus, and referring in relation to the object.
5. Group members used multi-lateral perspectives in constructing the object.
6. Group members used built-in tools for collaborative work.

Combined wayfinding and annotation (find and build). Immediately after each group's combined session on annotation and wayfinding, the following checklist for validation that the treatment in fact occurred as planned under the annotation condition was evaluated, and results are presented in Chapter Four (at least 5 of the 11 criteria had to be met):

1. Group members created objects for a group object.
2. Group members could place the distinct parts of the group object spatially in relation to others.
3. Group members used collaboration in attempting to build the group object (even if not successful).
4. During construction, group members interacted simultaneously around the object, with joint attention, shared focus, and referring in relation to the object.
5. Group members used multi-lateral perspectives in constructing the object.
6. Group members used built-in tools for collaborative work.
7. Group was able to create a map to their group object.
8. Group reverse-engineered a path from the central plaza to where their group created object was located, so that a novice could find the group object from the central plaza, using the map provided, directions (north, south, east, west) and obvious landmarks.
9. Group members used the Second Life world map to orient themselves.
10. Group members were able to keep track of the location of each other.
11. Individuals developed a personal "map" of Malibu Island through their participation in the activity (confirmed through semi-structured interviews).

Data Related to Dimensions of Sense of Place, Individual Agency and Social Presence

Three of the dependent variables (sense of place, social presence, and individual agency) constitute the quantitative data collected from the online surveys on experienced presence completed at the end of each learning activity; for 20 participants this resulted in

60 surveys. All questions were completed by all respondents. The researcher generated and examined means, standard deviations, cross-tabulations and summary statistics. The researcher also evaluated the quantitative results for correlations across the dimensions of presence. Results of this analysis are presented in Chapter Four.

Analysis of Data for Mediated Collaborative Action/Operation Chains

The data collected relating to the fourth dimension of the construct, mediated action/operation chains in the learning activities, included machinima recordings ("videos") of learners' carrying out a collaborative learning activity, transcripts of related chats in Second Life, and interviews with a sample of learners after completion of the learning activity. Video snippets were used to validate treatments and illustrate items of interest.

An adaptation of Mwanza's (2002) "Eight-Step Process" in her Activity-Oriented Design Model was used as one organizing framework for qualitative data analysis. The prospective mapping of the nodes of a collaborative learning activity system (performed to prepare for data collection) was revisited, given the action/operation chains observed during the learning activities. Mwanza's "Activity Notation" was used to decompose the situation's activity system into "manageable constitutive units or sub-activity systems…linked together through the shared object of the main activity system" (p. 191)

For example, research suggests that impromptu or chance encounters are important to collaboration and the sense of presence. Nardi et al. (2000) describe "a series of linked processes that interleave and feedback on each other" (outeraction; p. 86) that involves establishing social connection, negotiating conversational availability, negotiating about and switching media, facilitating intermittent interaction, and retaining context in conversation. The authors suggest that the synchronous communication tool, instant messaging, creates “communication zones [that] delimit a virtual ‘space’ in which a series of conversations can take place” (p. 86), to support what this study labels an action/operation chain. For this example, Table 4 describes the activity notation.

Table 4

Activity Notation

Actors	Action/Operation(s)	Mediator	Action/Operation(s)	Object
Learners	Establishing social connection; Negotiating conversational availability; negotiating about and switching media; facilitating intermittent interaction; retaining context	Tool – communication zone provided by IM	Simulates chance encounters with collaborative team members (from CSCL research), which increases the opportunities for collaboration to achieve . . .	Object of collaborative activity

This approach maintains the integrity of the operationalization of activity theory, by addressing the “three levels (activity, action, operation) that comprise an activity structure” (Jonassen & Rohrer-Murphy, 1999), without losing the relationship of each to the activity system’s object.

The activity notation was coded according to the Presence/Collaborative Learning in Virtual Worlds matrix, identifying design attributes or tools that supported the phenomenon (whether as designed or in new ways), or for gaps and unmet needs (additional features that might address problems observed in supporting sense of presence in the environment).

Fragments of the larger activity system may be actions or operations. In order to maintain the integrity of the mapping of actions to the larger activity system, each fragment was also parsed in the context of a sub-activity of the larger activity system (as an action or part of an action, or as an operation or part of an operation), through activity system structure analysis. This analysis was conducted at the action (functional) level, as activities "consist of individual cooperative actions and chains of operations [and] this hierarchy of activity, actions and operations describes the activity structure" (Jonassen & Rohrer-Murphy, 1999, p. 73).

While this analysis is similar to task analysis phases of instructional design, the difference is in its focus on intentionality–what was the learner's intention in carrying out the action or operation? The purpose of this approach is to identify "the interrelationships of all of the conscious and unconscious thinking and performances focused on the object" (Jonassen & Rohrer-Murphy, 1999, p. 73). The post-activity interview data was important here, and was used to verify the researcher's interpretation.

The purpose of this analysis was to identify tools (or characteristics of tools) that successfully mediate action and operation chains as they relate to the rows of the Presence/Collaborative Learning in Virtual Worlds matrix (design principles drawn from computer-supported collaborative learning research and design practice for virtual worlds for education or entertainment), thus completing validation of the fourth dimension of the construct, mediated action/operation chains.

Human Subjects Issues

Pepperdine University and the researcher subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort, and safety of subjects, according to Pepperdine University's *Protection of Human Participants in Research Policies and Procedures Manual* (Hall & Feltner, 2005).

Expedited Review

The Phase II research was classified as expedited under the following category: "(7) research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation or quality assurance methodologies" (Hall & Feltner, 2005). The study received approval to proceed from the Institutional Review Board on January 26, 2009.

Voluntary Student Participation

For Phase II, after a presentation by the researcher to each class (Spring 2009, Learning and Design EDET 770 and Research Methods EDET 730), students were given an opportunity to participate in the research study (and, if they chose to volunteer to participate, an opportunity to sign an informed consent form). These were adult students, the participation was voluntary, and the study was a low-risk intervention, conducted in a controlled space (the private area maintained by the Graduate School of Education and Psychology in Second Life).

The invitation presentation emphasized the voluntary nature of participation in the study, the purpose of the study, the nature of the participation, the benefit to the students participating, the time commitment involved in participating (3 hours over three weeks). The nature of participation was also described, which included signing up for a free Second Life account, participating in each of three synchronous sessions within Second Life, to be the subject of observation, and to fill out an experienced-presence survey (see Appendix A) at the end of each session. An incentive was provided to all participants who attend all three sessions and complete all three surveys: 1,000 Linden “dollars”, which are useful for purchasing items in Second Life. Those who participated in the post-experience interviews received an additional 250 Linden “dollars.” Team members for teams which completed the final session successfully were each given 100 Linden “dollars.”

During the initial presentation by the researcher, students were given the opportunity to ask questions or express any concerns about the potential risks of the research that they envisioned or were concerned about. Researcher was present to answer questions or concerns during each session, and an opportunity was given to privately address any concerns a student may have concerning the experience during each session. A student could withdraw at any time during the experiment.

Printed informed consent forms (see Appendix H) were distributed during the researcher’s presentation, reviewed with the students to clarify the nature of the project and collected with signatures on the informed consent forms from the students who wished to voluntarily participate. Copies of their signed forms were provided to the volunteers.

To ensure that participants’ responses are confidential, online surveys were constructed to send data to a separate computer file and initially stored in a personal online account that is available only to someone who knows the account login and password; that is, the researcher. The researcher alone will be handling the online responses, which will be downloaded from the online file to a separate, secure, stand-alone, password-protected computer in the researcher's home office, and deleted from the online file. Names used by students involved in Phase II of the experiment are online pseudonyms; however, personal identifiers, including online pseudonyms, were not published, and the risk of inferential disclosure was addressed through careful reporting of events or comments by the student participants. In questions balancing confidentiality, protection of intellectual property, and appropriate attribution of sources, permission was obtained to use any specific quotes from the semi-structured interviews or open-ended questions on the online surveys, and students were given the opportunity to be identified or not as they chose; their decision was obtained through confirmation in the session chat. Permission to use videotaped clips and pictures was also obtained through confirmation in the session chat.

The data will be used for research purposes only, and will be maintained for a minimum of three years, for current and future research, and will be destroyed on completion of research.

Permissions to Use Survey Instruments

Researcher contacted each survey author for permission to use his/her survey instrument. Permission was given by each author (See Appendices I, J, and K).

Summary Table of Data Collection and Purpose

The following table summarizes the sets of data collected and the purpose for each set:

Table 5

Summary of Data Collected and Purpose

Data Collected	Phase	Source	Purpose
Experienced-presence for 20 students	Phase II	Post-activity survey taken three times by 20 students	To determine self-reported sense of place, individual agency, and social presence after each intervention
Observations, video recordings, and recorded chats	Phase II	Collected during each group session, three sessions per group	To observe success or failure of collaboration, tools which were used, barriers, and evaluate intervention criteria checklist
Eighteen semi-structured interviews (recorded chats)	Phase II	Conducted with sample of individual participants after session	Explore or confirm researcher's observations; investigate underlying motivations for behavior
Mapped nodes of collaborative learning activity system	Phase II	Conducted using Activity Oriented Design Model (Mwanza, 2002)	Decompose the collaborative learning activity system into actions and operations; evaluate tool use
Recorded focus group session	Phase I	Interview with set of design experts	Evaluation of the nine principles in the matrix

Chapter 4: Results

Introduction

Chapter 4 addresses the quantitative and the qualitative results of the study. The quantitative sections discuss three of the independent variables: sense of place, sense of individual agency and social presence. The qualitative section discusses qualitative aspects of the three dimensions as well as the fourth dimension of the sense of presence from the construct, the mediation of collaboration.

The guiding question for inquiry was: In the 3D open-ended, socially-oriented virtual world, Second Life, what is the effect on the sense of presence in collaborative learning spaces designed according to the sense of presence construct proposed, using the two design principles, wayfinding (Find) and annotation (Build)? (In this chapter, the term “Find” is a synonym for wayfinding, and the term “Build” is a synonym for annotation.) The sense of presence construct is made up of four dimensions: (a) sense of place, (b) sense of individual agency, (c) social presence, and (d) mediation of collaboration. Another question of interest: What are the relationships (if any) among the dimensions of presence described by the construct?

The first section of Chapter Four covers sense of place and sense of agency and is organized by survey section and question. The second section is organized by group, as is appropriate for task performance evaluation. The third section is organized by individual and group, for a contrasting view, and a more appropriate treatment of the sense of social presence. The fourth section synthesizes the analysis of sense of place, individual agency and social presence in the context of the group, session and individual. The fifth section summarizes the focus group session. The sixth section includes an analysis of the mediation of collaboration in the context of activity theory.

Section 1: Quantitative Analysis by Survey Question

This section is divided into a subsection on sense of place and sense of individual agency, numeric variables.

Normality

The sample size is small (20 participants, and 60 surveys). Generally speaking, the distribution is well-approximated by a normal distribution evaluated using summary statistics and Q-Q Plots.

Sense of Place

Sense of place is defined to be the sense of physical and spatial presence (*There is a "there" there*). Data on this variable was collected through 6 questions scored on a Likert scale of 1 to 7 (treated in this study as equal interval scale data), taken with permission from a survey by Usoh et al. (2000). The research question is: what is the effect on the sense of presence in collaborative learning spaces (specifically, one of the dimensions, the sense of place) designed according to the sense of presence construct proposed, using the two design principles wayfinding (find) and annotation (build)?

Analysis of sense of place for activities one and two, find or build. From Table 6, the major observed patterns in individual questions were as follows regarding effect on the sense of place of the Find or Build interventions.

1. When Find was first in order, participants' experience was closer to the normal feeling of being in a "real" place, compared to those participants for whom Build was first. When Find was first, participants felt more like they

were actually in the environment rather than someplace else. Whether Find was first or second, the virtual structure of memory (extent to which there is a visual memory of the environment, in color, vivid or realistic, with memory of size, location in the imagination) was more similar to the structure of memory for actual places visited. The Find experience involved extensive movement through the environment, which may have contributed to these three aspects of the sense of place.

2. Whether Build was first or second, participants experienced the environment as someplace visited, rather than as images seen. When Build was first, participants experienced more of a sense of place of currently being in the environment rather than being someplace else. That is, even though the Build exercise actually focused on manipulation of objects (images), it was in the act of doing that the sense of place was reinforced.

Based on individual questions, the experience of wayfinding (Find) resulted overall in an observed pattern of a slightly stronger sense of place. While fruitful for future exploration and study, these findings are not statistically significant.

Table 6

Sense of Place, Means and Standard Deviations, Activities 1 and 2

	BUILD FIRST		FIND FIRST	
Item	Mean	SD	Mean	SD
ACTIVITY 1				
1. Like normal feeling of being in a place	3.67	(1.58)	4.00	(1.10)
2. Extent virtual environment was reality	3.44	(1.67)	3.27	(1.95)

(table continues)

Table 6

Sense of Place, Means and Standard Deviations, Activities 1 and 2

Item	BUILD FIRST Mean	BUILD FIRST SD	FIND FIRST Mean	FIND FIRST SD
ACTIVITY 1				
3. More as somewhere visited than as images seen.	4.44	(2.24)	3.55	(1.63)
4. Currently somewhere else or in the virtual space.	4.22	(1.86)	3.82	(1.72)
5. Structure of memory similar to real places.	4.00	(1.87)	4.27	(1.95)
6. Often thought actually in the virtual environment.	2.89	(1.45)	4.00	(1.79)
ACTIVITY 2				
	BUILD SECOND		FIND SECOND	
1. Like normal feeling of being in a place	4.36	(1.29)	3.89	(1.17)
2. Extent virtual environment was reality	3.73	(1.49)	3.33	(1.00)
3. More as somewhere visited than as images seen.	4.36	(1.57)	3.11	(1.36)
4. Currently somewhere else or in the virtual space.	4.27	(1.62)	4.33	(1.22)
5. Structure of memory similar to real places.	3.91	(1.70)	4.22	(0.97)
6. Often thought actually in the virtual environment.	3.82	(1.89)	3.56	(1.24)

*n=20 for all tables.

Analysis of activity three, sense of place, find and build combined. From Table 7, for all questions concerning the Find and Build activity for activity 3, those whose first activity had been the Find exercise experienced a slightly stronger sense of place, especially in their experience regarding currently being in the virtual space, and having the structure of memory of the virtual place be similar to the structure of memory of a real place.

Table 7

Sense of Place, Means and Standard Deviations, Activity 3

ACTIVITY 3: Item	FIND & BUILD (BUILD FIRST)		FIND & BUILD (FIND FIRST)	
	Mean	SD	Mean	SD
1. Sense of being in the environment	4.33	(1.66)	4.55	(1.51)
2. Extent virtual environment was reality	3.89	(1.36)	3.91	(1.87)
3. More as somewhere visited than images seen.	4.22	(1.39)	4.36	(1.69)
4. Currently somewhere else or in the virtual space.	4.78	(1.39)	5.27	(1.01)
5. Structure of memory similar to real places.	3.78	(1.86)	4.64	(1.36)
6. Often thought actually in the virtual environment.	4.00	(1.87)	4.27	(1.68)

*n=20 for all tables.

As noted before, there are no significant differences between the Build or Find means for the sense of place (see Table 8). The mean for the sense of place for the combined Find and Build exercise is the highest, which might be expected since this is the third exercise, and represents the greatest total experience of the environment.

Table 8

Sense of Place, Summary Statistics

SENSE OF PLACE	BUILD		FIND		FIND & BUILD	
	Mean	SD	Mean	SD	Mean	SD
TOTAL	3.94	(1.67)	3.78	(1.48)	4.35	(1.55)

*n=20 for all tables.

Sense of Individual Agency

Sense of individual agency is tied to individual action, and the manipulation of objects and the environment with tools; data on this variable was collected through eleven questions (Question 1 through 11 in the Sense of Individual Agency section of the Questionnaire, on a Likert scale of 1 to 7, treated in this study as equal interval scale data). The survey questions were taken with permission from an instrument by Witmer and Singer (1998). Means and standard deviations are provided in the Table 9. The research question is: what is the effect on the sense of presence in collaborative learning spaces (specifically, one of the dimensions, the sense of individual agency) designed according to the sense of presence construct proposed, using the two design principles wayfinding (find) and annotation (build)?

Analysis of sense of agency. From Table 9, the major observed patterns in individual questions were as follows regarding effect on the sense of individual agency of the Find or Build interventions:

1. Whether Build was first or second, participants felt the environment was more responsive to actions initiated, the ability to survey the environment using vision was stronger, and moving and manipulating objects was easier.
2. When Build was first and Find was second, participants experienced a lower sense of delay between actions and outcomes.
3. When Find was first and Build second, interactions and movement seemed more natural to participants, participants felt more proficient in moving or interacting at the end of the exercise, and experienced a lower level of interference from control devices.

These findings are not statistically significant. However, they may be fruitful for future exploration and study.

Table 9

Sense of Agency, Means and Standard Deviations Activities 1 and 2

Item	BUILD FIRST Mean	SD	FIND FIRST Mean	SD
ACTIVITY 1				
1. How much were you able to control events.	3.44	(1.33)	3.27	(1.95)
2. How responsive was environment to actions initiated.	4.56	(1.24)	3.55	(1.63)
3. How natural were interactions.	2.89	(1.69)	3.82	(1.72)
4. How natural was movement.	2.89	(2.03)	4.27	(1.95)
5. Ability to anticipate what would happen next.	3.88	(1.55)	4.00	(1.79)
6. Ability to survey the environment using vision.	5.11	(1.36)	4.10	(1.45)
7. Ability to move or manipulate objects.	4.11	(2.03)	4.00	(1.61)
8. Low level of delay between actions and outcomes.	5.44	(1.81)	3.27	(1.49)
9. How quickly did you adjust to virtual environment.	3.89	(2.03)	3.45	(1.57)
10. How proficient in moving or interacting at the end.	3.78	(2.05)	4.36	(1.91)
11. Low level of interference from control devices.	4.11	(1.90)	4.82	(1.25)
ACTIVITY 2				
	BUILD SECOND		FIND SECOND	
1. How much were you able to control events.	3.73	(1.49)	3.67	(1.41)
2. How responsive was environment to actions initiated.	4.36	(1.57)	4.00	(1.66)
3. How natural were interactions.	4.27	(1.62)	3.22	(1.39)

(table continues)

ACTIVITY 2	BUILD SECOND		FIND SECOND	
4. How natural was movement.	3.91	(1.70)	3.22	(1.30)
5. Ability to anticipate what would happen next.	3.82	(1.89)	3.89	(1.62)
6. Ability to survey the environment using vision.	4.55	(1.13)	4.33	(1.50)

(table continues)

	BUILD SECOND		FIND SECOND	
Item	Mean	SD	Mean	SD
7. Ability to move or manipulate objects.	4.64	(0.50)	3.78	(1.20)
8. Low level of delay between actions and outcomes.	3.09	(1.45)	4.00	(1.41)
9. How quickly did you adjust to virtual environment.	3.09	(1.51)	3.89	(1.17)
10. How proficient in moving or interacting at the end.	4.64	(1.50)	3.89	(1.36)
11. Low level of interference from control devices.	4.73	(1.62)	4.00	(0.87)

*n=20 for all tables.

From Table 10, analysis for the combined activity, Find and Build together, is as follows:

1. As in Activities 1 and 2, naturalness of movement and interactions were higher when Find was the first activity in the entire sequence.
2. As in Activities 1 and 2, when the ability to survey the environment using vision was strongest whether Build was the first or second activity, the ability continued to be strongest in the combined activity when Build had been the first activity in the entire sequence.

3. Interestingly, the ability to move or manipulate objects was seen as easier during the Find and Build combined exercise, when Build had been the second exercise. For the combined Find and Build activity, participants adjusted more quickly to the virtual environment if the Build activity had been the first in the entire sequence.
4. For the combined Find and Build activity, participants experienced the lower level of interference from control devices (and thus the higher sense of individual agency), when Find had been the first exercise in the entire sequence.

In seven of the 11 questions, the mean was higher for the combined Find and Build exercise (Activity 3), when Find had been the first exercise in the entire sequence, and Build the second. One possibility is that Build had been the most recent exercise, and it had been a restricted exercise both in form of object (constrained to creating a cube that matched a model) and in location of object (limited to the confined building area). For the combined exercise, participants were free to build creative objects and move the objects to the group's desired location (rather than in a specific building area); this contrast to the limits of the most recent exercise may have increased the relative sense of individual agency.

Table 10

Sense of Agency, Means and Standard Deviations, Activity 3

ACTIVITY 3	FIND & BUILD (BUILD FIRST)		FIND & BUILD (FIND FIRST)	
Item	Mean	SD	Mean	SD
1. How much were you able to control events.	4.11	(1.45)	3.91	(1.87)
2. How responsive was environment to actions initiated.	4.22	(1.09)	4.36	(1.69)
3. How natural were interactions.	3.33	(1.50)	5.27	(1.01)
4. How natural was movement.	3.67	(1.80)	4.64	(1.36)
5. Ability to anticipate what would happen next.	4.00	(1.50)	4.27	(1.68)
6. Ability to survey the environment using vision.	4.67	(1.66)	4.36	(1.21)
7. Ability to move or manipulate objects.	3.89	(1.62)	4.27	(0.90)
8. Low level of delay from actions and outcomes.	4.33	(1.94)	4.09	(1.14)
9. How quickly did you adjust to virtual environment.	4.22	(1.99)	3.82	(1.08)
10. How proficient in moving or interacting at the end.	4.11	(1.54)	4.27	(1.19)
11. Low level of interference from control devices.	4.11	(1.76)	4.91	(1.45)

*n=20 for all tables.

As noted before, there are no significant differences between the Build or Find means for the sense of individual agency (see Table 11). Unexpectedly, the mean for the sense of individual agency is highest for the Build exercise rather than the combined Find and Build exercise, although only slightly. The Find exercise on its own did not contribute to the sense of agency as much as the Build and combined Find and Build exercises, which is consistent with the definition of the sense of agency as tied to individual action, and the manipulation of objects and the environment with tools.

Table 11

Sense of Agency, Summary Statistics

SENSE OF AGENCY	BUILD		FIND		FIND & BUILD	
	Mean	SD	Mean	SD	Mean	SD
TOTAL	4.29	(1.66)	3.98	(1.45)	4.24	(1.42)

*n=20 for all tables.

Summary Statistics, Sense of Place and Sense of Agency, by Activity

Patterns as observed in the summary table, Table 12 below are not statistically significant. However, they are worth further exploration and study:

Analysis from Table 12 shows the following:

1. For Activity 1 (Build First, Find First) and for Activity 2 (Build Second, Find Second), the sense of agency is higher than the sense of place.
2. For the final activity, Find and Build combined, the sense of place is higher than the sense of agency. Maybe the combined activities in the final exercise influenced the sense of place more than the sense of agency, possibly because this activity required considerable movement through the environment, to first of all choose a location for the group's objects, and then to reverse-engineer a path from the central plaza to the location of the group object, in order to create a map.

Table 12

Sense of Place and Sense of Agency, by Activity

Item	BUILD FIRST		FIND FIRST	
	Mean	SD	Mean	SD
	ACTIVITY 1			
Sense of Place	3.78	(1.86)	3.82	(1.64)
Individual Agency	4.01	(1.78)	4.12	(1.50)
	BUILD SECOND		FIND SECOND	
	ACTIVITY 2			
Sense of Place	4.08	(1.75)	3.74	(1.05)
Individual Agency	4.52	(1.67)	3.81	(1.30)
	FIND & BUILD		FIND & BUILD	
	BUILD FIRST		FIND FIRST	
	ACTIVITY 3			
Sense of Place	4.17	(1.44)	4.50	(1.58)
Individual Agency	4.06	(1.58)	4.38	(1.27)

*n=20 for all tables.

Correlation of Sense of Place and Sense of Agency

Using summary statistics for overall sense of place and sense of agency, there is a positive association between sense of place and sense of agency (r=.570, significant at the 0.01 level, two-tailed.)

Section 2: Analysis of Task Performance by Group

A third element emerged during the experiments, as each team was evaluated according to the intervention criteria described in Chapter 3, and the group’s successful performance of each task. Table 13 and 14 below provide the results.

For the Find exercise, the highest score possible was 10. During the Find exercise, Groups 2 and 4 did not successfully complete the task (see Table 13). In addition, none of the individuals had developed a personal “map” of Malibu Island after the first exercise (the purpose of the Wayfinding exercise). For the Build exercise, the highest score possible was 7; all but two groups (Groups 2 and 4) completed an accurate build of the model. For the Find/Build exercise, the highest score possible was 12, and all six groups completed the task successfully.

Table 13

Task Performance by Group

Item	BUILD FIRST			FIND FIRST		
	Group 1	Group 4	Group 5	Group 2	Group 6	Group 7
WAYFINDING (FIND)						
Completed wayfinding successfully	X				X	X
Group members shared treasure map clues.			X	X	X	X
Group members used treasure map.	X		X	X	X	X
Helped point out different color blocks to others.	X	X	X	X	X	X
Recognized different parts of Malibu Island.	X		X		X	X
Followed directional cues such as flight path.		X	X		X	X
Used World Map.			X		X	
Socially-oriented hanging out in coffeehouse.	X				X	X
Kept track of each other’s location on the island.		X	X		X	
Developed personal “map” of Malibu Island.						
TOTAL, Wayfinding	5	3	7	3	9	7

(table continues)

Item	BUILD FIRST			FIND FIRST		
	Group 1	Group 4	Group 5	Group 2	Group 6	Group 7
ANNOTATION (BUILD)						
Completed accurate build of model.	X		X		X	X
Put together individual parts of the cube	X	X	X	X	X	X
Place spatially (accurately) in relation to others.	X		X		X	X
Used collaboration in building cube.	X	X	X	X	X	X
Interacted simultaneously around object.	X	X	X	X	X	X
Used multi-lateral perspectives.	X	X	X	X	X	X
Used built-in tools for collaborative work.	X	X	X	X	X	X
TOTAL, Annotation	7	5	7	5	7	7

Item	BUILD FIRST			FIND FIRST		
	Group 1	Group 4	Group 5	Group 2	Group 6	Group 7
FIND & BUILD)						
Created individual objects for group object.	X	X	X	X	X	X
Placed distinct parts of group object spatially.		X	X	X	X	X
Used collaboration in building group object.	X	X	X	X	X	X
Interacted simultaneously around object		X	X	X	X	X
Used multi-lateral perspectives.			X	X	X	X
Used built-in tools for collaborative work.	X	X	X	X	X	X
Created map to their object.	X	X	X	X	X	X
Reverse-engineered path for treasure map.	X	X	X	X		X
Used World Map	X		X		X	X
Kept track of each other’s location.		X	X		X	X
Developed personal “map” of Malibu Island.	X	X	X		X	X
Built group object and made map.	X	X	X	X	X	X
TOTAL, Find & Build	8	10	12	9	11	12
GRAND TOTAL	20	18	26	17	27	26

An analysis of overall group performance was completed. The consistent high scorers were Groups 5, 6 and 7 (see Table 14).

Table 14

Summary of Task Performance by Group

Task Performance: Item	BUILD FIRST			FIND FIRST		
	Group 1	Group 4	Group 5	Group 2	Group 6	Group 7
Building (Build)	7	5	7	5	7	7
Wayfinding (Find)	5	3	7	3	9	7
Find & Build	8	10	12	9	11	12
GRAND TOTAL	20	18	26	17	27	26

*n=20

Section 3: Social Presence, by Individual, Group and Activity

Social presence is defined as follows: *We (I and other learners) are together with ability to communicate with each other asynchronously and synchronously and to interact socially.* The research question is: what is the effect on the sense of presence in collaborative learning spaces (specifically, one of the dimensions, social presence) designed according to the sense of presence construct proposed, using the two design principles wayfinding (find) and annotation (build)?

Because social presence in this experiment was a group and session-based phenomenon, and the instrument was significantly different than the other instruments for sense of place and sense of agency, social presence is evaluated by individual, by group and by session. This also allows for within group analysis. Discussion of the social presence score in the context of observed behavior, semi-structured post-activity surveys or commentary by group and by session, is also provided in the qualitative section following this section.

Measurement of Social Presence

Social presence was measured through a series of twenty-two questions in the sense of social presence section of the survey, used by permission from an instrument authored by Biocca, Harms, et al. (2001). These were organized as a paired list of items (check all that apply), organized around four categories: mutual awareness, mutual attention, mutual understanding, and mutual assistance. Statements were either negative with regard to social presence ("I hardly noticed the other individuals"), or positive ("I was often aware of others in the environment"), and referred to the group as well as the individual ("Others were often aware of me in the environment"). Positive statements (tending toward social presence) were scored as 1, negative statements (tending away from social presence) were scored as -1.

The highest possible social presence score for an individual in a session was 12 (if all positive pairs were checked), the lowest number was -10 (if all negative pairs were checked). For all three sessions added together, 36 was the highest total score per individual possible, -30 the lowest total score.

Analysis of Social Presence

Analysis of Table 15 is as follows:

1. For Groups 2, 6, and 7, the social presence score from the Build exercise was higher than the social presence score from the Find exercise (these groups did the Find exercise first). For Groups 1, 4, and 5, the social presence score from the Find exercise was either equal to or higher than the Build exercise (these

groups did the Build exercise first). For Group 4 this difference was significant –group score of -1 for the Build vs 12 for Find. That is, the social presence score increased from Activity 1 to Activity 2.

2. The social presence score for the Find/Build exercise was not the highest score for Groups 1, 4, 6, and 7, although it was close to the Build score except for Group 6 (27 for Find/Build exercise vs 40 for Build exercise). That is, the social presence score was not the highest of the three scores for all groups, even though this was the last activity (not cumulative).
3. The lowest average group social presence score was for Group 4 (2), which was not successful in either the Build or Find exercise (and had a Task Performance score of 18 out of 29); the highest average group social presence was for Group 7, which was successful in all three activities (with a Task Performance score of 26 out of 29).
4. Note that, on the other hand, Group 6 had the highest Task Performance score (27), but the second lowest average social presence score, due to a low average (4.67) of one participant.

Table 15

Social Presence by Group, Individual, and Intervention

Group	Subject	Build	Find	Find/Build	Total	Average
1	11	6	11	12	29	9.67
	12	12	12	11	35	11.67
	13	9	4	2	15	5.00

(table continues)

Group	Subject	Build	Find	Find/Build	Total	Average
	Total, Group 1	27	27	25	79	8.78
	%	34%	34%	32%	100%	
2	21	8	4	8	20	6.67
	22	12	9	12	33	11.00
	23	6	4	9	19	6.33
	24	10	9	8	27	9.00
	Total, Group 2	36	26	37	99	8.25
	%	36%	26%	37%	100%	

Group	Subject	Build	Find	Find/Build	Total	Average
4	41	-5	2	0	-3	-1.00
	42	-1	1	8	8	2.67
	43	6	5	2	13	4.33
	44	-1	4	3	6	2.00
	Total, Group 4	-1	12	13	24	2
	%	-4%	50%	54%	100%	

Group	Subject	Build	Find	Find/Build	Total	Average
5	51	11	12	12	35	11.67
	52	7	9	8	24	8.00
	Total, Group 5	18	21	20	59	9.83
	%	31%	36%	34%	100%	

(table continues)

Group	Subject	Build	Find	Find/Build	Total	Average
6	61	11	5	12	28	9.33
	62	5	4	5	14	4.67
	63	12	7	6	25	8.33
	64	12	11	4	27	9.00
	Total, Group 6	40	27	27	94	7.83
	%	43%	29%	29%	100%	

Group	Subject	Build	Find	Find/Build	Total	Average
7	71	12	10	12	34	11.33
	72	12	10	10	32	10.67
	74	10	10	11	31	10.33
	Total, Group 7	34	30	33	97	10.78
	%	35%	31%	34%	100%	

	Build	Find	Find/Build	Total
Total, All Groups	154	143	155	452
%	34%	32%	34%	100%

Section 4: Synthesis of Qualitative and Quantitative Analysis

Continuing the focus from the previous section, this section is on the individual, group and activity. The following chart which summarizes individual means for sense of place, sense of agency, and sense of social presence (see Table 16) will be used in the discussion in this section.

Table 16

Sense of Place, Agency and Social Presence, Individual Averages

Subject	Place	Agency	Social Presence
11	3.06	3.76	9.67
12	**5.17**	**5.52**	**11.67**
13	**2.56**	**2.03**	5.00
21	4.89	4.79	6.67
22	3.44	3.39	11.00
23	**1.56**	4.65	6.33
24	**3.00**	**2.67**	9.00
41	3.61	4.03	**-1.00**
42	3.94	3.76	**2.67**
43	4.33	4.39	4.33
44	3.28	**3.12**	**2.00**
51	4.28	3.33	**11.67**
52	4.83	**5.70**	8.00
61	5.33	**5.48**	9.33
62	4.22	3.39	4.67
63	**5.83**	4.06	8.33
64	**5.44**	5.27	9.00
71	4.67	5.21	**11.33**
72	3.33	4.39	10.67
74	3.72	4.42	10.33

(table continues)

* Top three and bottom three are boldfaced.

Qualitative Analysis by Group, Session and Individual

The detail that may be less obvious in the quantitative analysis of medians and standard deviations might be regained in a discussion of individual scores in the context of session observations. Recorded chats and videotapes of the sessions were reviewed and informally coded by the researcher to obtain the following information. Intervention criteria and task performance were evaluated immediately after each session. Patterns by group, session and individual are described in this section, concerning three of the dimensions, sense of place, sense of agency, and social presence, from Table 16 above, which provides summary statistics. Statements below were obtained from chat messages posted during the Second Life sessions in 2009, as follows:

- Group 1: February 13, February 27, March 13
- Group 2: February 10, February 18, February 24
- Group 4: February 8, February 15, February 22
- Group 5: February 9, February 16, February 23
- Group 6: February 10, February 19, February 24
- Group 7: February 12, February 19, February 26

Group 1. During the sessions with the lowest social presence scores, the group lost track of each other several times; for example, Subject 13 commented several times "I'm lost. Where is everyone?" Subject 13 had expressed frustration during the orientations as well as the sessions, noting that he found "all immersive systems to be intrusive," preferring individual chat and skype. This individual had the lowest social presence scores for that group in the Find and Find/Build activities, as well as low sense of place (2.56) and sense of agency (2.03) averages in relation to all participants. This participant noted that by the final exercise “controls and interfaces were [still] confusing and I haven’t gotten any better at it over time.”

On the other hand, Subject 12 was very comfortable in the environment (had been experimenting in the environment on her own as recently as one month ago, and had been one of the leaders in an earlier Second Life orientation for another group), although she self-rated her level of experience as moderate. Her overall sense of presence score was 11.67, which was the highest of all the individuals in the experiment (tied with Subject 51 in Group 5), and she identified communication as the key element in successful completion of all three activities. She also had relatively high sense of place (5.17) and sense of agency (5.52) scores. She mentioned after the Build exercise that “The object coordinate system and grid layout helped place the regular objects more accurately.”

Subject 11 was the only one in the group who had World of Warcraft experience (last played, 3 months ago, experience level low).

Group 2. Group 2 started the Find exercise 15 minutes late, and had difficulty communicating because of repeated inadvertent transfers between group and local chat (local chat has broadcast range of 100 meters, which is insufficient once members get out of “eyesight.”) One individual in particular had repeated difficulties switching modes; if trying to use local chat with other members too far away to receive, she would not be receiving responses to her posts, and it would seem as though the other group members were ignoring her. Subject 23 got lost during the Find exercise (accidentally teleported somewhere and had difficulty rejoining the group). Subject 23 also had the lowest sense of place score for all participants (1.56).

Subject 22 also got lost during the Find: “I was stuck in the beginning in Vgotsky’s room. I’ve been there since F2F. I’ve been trying to get out when I logged in prior to the session. During the session, I had to ask [the team leader] to get me out.” Subject 22 mentioned the help of her teammates several times; she had the third highest sense of social presence average score of all individuals (11), with 12 for both Build and Find/Build, and 9 for the Find session.

Members had trouble keeping track of each other during the Find exercise, at one point spread from one end of the island to the other. When they lost track of each other, they didn’t teleport each other or find some other way to regroup. They did not successfully complete the Find exercise.

Subject 21 was the group leader, and expressed frustration with keeping the group together. Also, although this individual had the highest previous experience with Second Life of any of the individuals (a year or more), and had led Second Life orientations, their social presence average score was only 6.67 out of 12, and sense of place score was 4.89 and 4.79 out of 7 respectively. Subject 21 had considerable experience with World of Warcraft, having played it within the week, with over a year’s experience, and low level of experience with other unspecified virtual world. During the Build exercise, the team leader created a new tool, a “base” around which to align the panels to make the cube in the building exercise.

During an interview after the Build exercise, Subject 22 mentioned her frustration with the lack of “a tactile tool that would allow me to manipulate the objects . . . holding on to a gadget that will allow me to move objects around, something like a ‘joystick’ of some sort.” Subject 22’s social presence score was relatively high (11), but sense of place and agency relatively low (3.44 and 3.39 respectively). Subject 24 also mentioned the need for a “nudge” tool several times during the Build session, and afterward in the interview, that would allow minute changes in positioning of objects; she found positioning of objects to be unnecessarily difficult. During the Find/Build she went exploring and couldn’t find her way back. Her sense of agency score was the second lowest for all participants, at 2.67 (social presence score was 9.00) and her sense of place score was third lowest at 3.00. Subject 24 had been experimenting with other virtual worlds, including World of Warcraft, but she self-assessed her experience level as “low.”

Group 3. Group 3 was disbanded due to lack of attendance by group members. Experimental design required participation at all sessions for all group members.

Group 4. The lowest social presence scores for all individuals in the experiment for all exercises were in the Build exercise for this group, with Subject 41 having the lowest average (-1.00).

One participant (Subject 42) commented that “a late arrival caused a late start [then] people [weren’t] following directions. Directions were very clear, however some members decided to go on their own agenda, bringing the group down.” This individual was the team leader, and had the third lowest social presence score of all participants (2.67). Subject 42 had other virtual world experience (six months ago, World of Warcraft, self-rated as low level).

One characteristic that distinguished this group from the others is that members were taught how to share their objects, giving each other the power to move others’ objects (there was insufficient time to do this in the other groups, most of which started even later). One participant’s object (Subject 41) was essentially deleted (moved to the other end of the island) by another individual, Subject 43. Subject 41 also mentioned having trouble walking and flying during this exercise, and spent much of the time during the Build hovering above the building field. Subject 41's score for the Build exercise was -5, the lowest of any social presence score during any individual session. During the Build exercise, Subject 44 placed her avatar and remained at the far extreme end of the building field throughout the exercise, with the other participants centered in the middle; this participant had difficulty with the Build, and was never successful in placing their object. Subject 44 had the second lowest average social presence score (2.0), and the third lowest sense of agency score (3.12).

The Find exercise required that all members share all their clues, in order to find the hidden objects, and this group did not share their clues with each other until late in the exercise. One participant commented: "I was a bit frustrated that my team mates didn't give their clues." One participant also had trouble with switching back and forth between local and group chat mode: "We seemed to 'talk' in two different places and I wasn't quite sure where to discuss." For this group, the group chat couldn't be used during the Find exercise, because one member was having difficulty with it, so local chat was to be used throughout, but some group members kept moving to group chat. However, the group kept close physical track of each other's avatars and stayed together through much of the session to overcome the range limits of local chat. The group did not successfully complete the exercise, but when they wandered, they wandered together and kept track of each others' location more so than any other group.

During the final exercise, the Find/Build, one group member arrived a half hour late, missing all of the instructions and a good part of the group activity. The other group members were occupied with the exercise, and while they greeted him, made no attempt to help the individual “catch up.” This group again tried to move each other’s objects as they had in an earlier session. Some were not set to be shared, and the group had the additional difficulty of encountering a bug in the program (the base object created by the team leader got “stuck” halfway in and out of a window). While the team leader was occupied for the last part of the exercise in creating the map to the object, Subject 41 was trying to provide leadership in moving all the objects together into a group formation, and was not successful in doing so because of a bug and a design flaw in one of the island’s buildings.

One setting of the wall appearance in one of the buildings (the “hobbit house”) set windows to transparent, another setting made them opaque (and in fact, emphasized the appearance of two rounded hills). The affordances of windows on the island were contradictory: in some locations on the island, windows were phantom (avatars could pass through them as though they were doors; in other locations, specifically the hobbit house, the windows, while transparent, could not be passed through. This confused one group, which, while aware of the door into the hobbit house through a considerable amount of play with it during a previous exercise, tried to build their group object inside the house through the windows. A bug in the program allowed one participant to put their object half in and half out of the window, but made it uneditable from that point on, which was disconcerting to the rest of the team, who spent most of the rest of their time unsuccessfully trying to execute their original plan to build inside the hobbit house.

Subject 43 was the only member of the group with other virtual world experience: World of Warcraft, last played 3 months ago, low level of experience.

Group 5. Group 5 was the smallest group at 2 members, and was successful during all three exercises, had the second highest score in task performance, and the second highest group average for social presence. The group leader attended to the location of the other member at all times; the other group member, Subject 51, mentioned that she experienced a high level of teamwork; she had the highest average social presence score of 11.67 over all participants (tied with Subject 12). The team leader had a year or more of experience in Second Life; sense of agency score was 5.70, the highest average for all the participants. Subject 52 also had other virtual world experience (with Active Worlds, last used within the week, moderate level of experience; and with other unspecified virtual world, last used three months ago, low level of experience).

Note that the sample size of those with prior experience in other virtual worlds is seven of the 20, mostly with “low” level of expertise, with only 2 having been in the alternate world (World of Warcraft) within the previous week, so it is not possible to assert one way or the other that experience in other virtual worlds is associated with higher sense of presence, sense of place, or sense of agency scores.

Group 6. Group 6 was successful in all three tasks, and had the highest task performance score (27 out of 29). For the final find/build task, the group exercised a great deal of creativity, both in the construction of their objects, and in “hiding” the group object inside the waterfall on Malibu Island. Note that this is the group that had the second lowest social presence score, due primarily to Subject 62’s average score of 4.67. (The others averaged 9.33, 8.33 and 9).

Subject 61 mentioned having learned several specific new skills and tools (more so than other participants), and noted “The situated learning experience and having just in time support facilitated the learning activity. We were able to get instructions on how to build things immediately when we were using the knowledge in context. Although we had built things in class, the action had limited meaning." This participant had the highest sense of agency average of all participants (5.70). In addition, Subject 61 had previous experience with another virtual world, World of Warcraft, most recent play six months ago (used and then quit).

Subject 62 had difficulty during the Build exercise ("AARGH!!! I hate building things"), and got lost several times during the Find exercise and Find/Build exercises, and spent a lot of time flying around in search of the others. These experiences may explain her low sense of presence scores of 5, 4 and 5 respectively during those exercises.

Subject 63 mentioned use of the map more often than other participants (both in her interview, in her open-ended comments, and in suggestions to teammates during the exercises), as well as use of coordinates for precise location in the world, and teleporting friends. She noted that the acquisition of a new faster computer with much larger screen had changed her experience considerably. During a session, she commented that she had explored other areas of Second Life (with mixed results). She also led her teammates directly to the waterfall once it had been chosen as the building site for the find/build session, and teleported immediately to inside the waterfall using the map (a difficult maneuver that her other teammates were not able to accomplish, and which caused the team some difficulty in assembling their group object, although they figured it out speedily). Her sense of place average score was the highest of all participants at 5.83.

Subject 64 rated noted that they had a year or more experience with Second Life, and had experience with World of Warcraft (within the week, high level of experience) and other virtual worlds (within the week, high level of experience). His sense of place average was second highest for all participants (5.44), sense of agency was reasonably high (5.27) and sense of social presence was 9.00.

Group 7. Group 7 was successful in all three tasks, with a score of 26 (out of 29). chose to build their group object in the waterfall during the final exercise, and created a striking object. Group 7 also evidenced a high level of communication and cooperation. The group spent the most time of any group socializing in the coffeehouse after completion of their Find/Build task, being playful with the espresso machine and the different seats and poses, and chatting about various topics. The group cooperated better than any other group during the creation of the map back to their group object, with one group member walking the path forward from one end, the other walking the path from the other end, and one in the middle and to one side; all three communicated with the group leader who ultimately created the group map. As a group, Group 7 had the highest average social presence score (10.78).

Subject 71, the group leader, in particular had a high social presence score (11.33 out of 12). Although this individual experienced several crashes, she expressed her appreciation for help: “We worked well together and the others helped me catch up from being booted, as did our host.”

Section 5: Focus Group Session

A single focus session was held with another set of three individuals who were experienced learning environment designers who have explored the use of Second Life.

The findings from the three-person focus group session included general commentary on the four-dimensional construct for the sense of presence, and reactions to each principle.

General Commentary

In general, focus group participants agreed that the right questions are engendered by the principles, and that it forms a framework for assessment, among other things. One focus group member noted that the sense of presence is experienced differently in different types of worlds:

> If [we are] talking about a mirror world that is meant to be a simulation of the real world, and if interacting there and something obviously doesn't map to how the real world is, that's a trigger for the sense of presence to be compromised. If [the world] is intended to be a fantasy, moving away from a real world experiment, then having those little breakdowns might not deplete the sense of presence.

Another participant wondered if the sense of presence was a psychological construct, experienced differently based on individual characteristics rather than the environment. Another noted that the first three dimensions (sense of place, social presence, sense of individual agency) were a triad that rang intuitively true, but the plural form of individual agency, the mediation of collaboration, was a more difficult concept: they were not convinced that it was a dimension of its own within a sense of presence. It was not intuitive that the ability to use tools collaboratively gives a sense of agency different from the sense of individual agency.

One participant noted that while Second Life was their preferred virtual space, they acknowledged that other emerging worlds such as Project Wonderland challenge the

Second Life paradigm by embedding productivity applications within the world, and "once the open source community starts banging away," using new open source standards such as used in development of Sony Playstation III, might start to see other virtual worlds "quickly pass Second Life for application for business and education." It is not clear whether Second Life's structure as one big contiguous space is more accessible and useful than that of "Wonderland, which is a series of isolated worlds."

Maximize Usability of Travel Interaction Techniques and Wayfinding

Participants discussed the difference between the two principles (usability of travel interaction techniques and the wayfinding principle). They noted that open-ended exploring (wayfinding) is "different from getting from one place to another in shortest amount of time for own exigency." One participant commented on the interaction between the two: for example, one might visit a new place such as Vancouver, wander around with no particular destination in mind (wayfinding), stumble across an antique shop, and then become goal-directed to look for other antique stores. He recommended that the design of an area be able to accommodate people's ability to go back and forth between exploratory and goal-directed modes.

Participants found the principle to be clear, but the challenge to be "in how we create design, which becomes complicated and interesting…how do we help people travel and understand their landscape?"

Travel has game elements, with an open-ended, branching structure. When signs, paths and teleports are busily arranged, people can get more confused; that is, choice adds to complexity. Sometimes the solution is to make "contingent paths much more highly constricted." Another approach is for design to support both a travel interaction and an opportunity for the participant to see clearly where they are going (a wayfinding characteristic). An example of this is a balloon or other transportation vehicle ride, used by many larger sites to provide an orientation tour.

Another participant noted the importance of reducing cognitive load, otherwise "you forget why you are there when you are trying to figure out where you are going and how to get there." She also commented on how the use of the term travel as a "task" was confusing, since it was not language we often use when we think about transportation and destinations.

Support Developmental Progression of Avatar and Identity

A participant described her first awareness of the close alignment of an avatar and one's sense of control and self: "Identity is such a complex piece to unravel when talking about design. For example, I like to listen to live music in Second Life. I went to an Irish pub where I felt embarrassed to stand still while everyone was dancing, then took a drink of animated beer that immediately made my avatar to behave as though drunk. ***I*** was embarrassed, not my avatar."

Another focus group member commented that the obsession with how avatars appear in Second Life is a fascinating phenomenon: whether one's avatar will look like who they are, or used as an opportunity to express creativity. She described an observed developmental process, "where people walk around for periods of time, and lose sight of how they appear to others. Once they reach a point where they are know who they are in the world, they make other changes that have less to do with the external and more with the internal." She noted the sense of fun during initial development, and then appearance "becomes symbolic and representational."

One participant described his own process of determining his appearance. He initially played with avatar forms like clothes three or four times per session, and then reached a point where that was no longer that fascinating. He modified a “gargoyle skin, and [that] became how I was recognized (how ugly I was), and it sort of stuck, the self-styled punk rocker from Montana.” The avatar appearance is still fluid; for example, in entering the hobbit house, which has a relatively small entrance, he made himself shorter, and might just as easily leave himself at that height as make any further changes.

Some Second Life inhabitants work hard to make their avatar appearance approach their real life appearance; on the other hand, one focus group member was struck by how so many avatars in Second Life are very young, thin, healthy, tall. Appearance also become important in context: she was “appalled that, at a Sloan Emerging Technologies conference, the president of a college designed herself to look like Lindsey Lohan on a bad day.” Another participant noted that in a project involving business use of virtual worlds for collaboration, “a number of business people want their avatar to look like them, and have the same first and last name, because their avatar is a projection of their business personification.”

Provide Socio-Emotional Context and Communication Channels

One group member commented on the situation where people enter Second Life bringing norms about interaction, communication and negotiation from prior experience, and this is something that can be a barrier to those who haven’t gamed or had previous experience with Second Life.

Focus group members noted the influence of one channel of communication, voice, as having mixed results in Second Life. One participant had “made careful arrangements to be incredibly gentlemanly, to be disarming and professional, but by adding voice, it has taken away the potential for some degree to have that character, for imagining and projecting that self in text." He noted that voice, as an additional channel, might actually limit bandwidth, especially for people who came into Second Life and used their avatar as a projection of someone other than who they were; one common example was gender-switching.

Those who were excited by voice and welcomed it included business people, and those for whom typing was a limiting mode for interaction. There is a choice whether to use voice or not (by region, and as an individual character). However, there tends to be group pressure to use voice but it also might represent someone who is subtly giving something up, but who is not going to voice that opinion because voice is easier for the group.

Note that voice was not used for the broader experiment, and every group commented on and complained about its artificial absence.

Group Identity

Focus group participants interpreted group identity as being part of a community, and that Second Life has successfully created tools both for building objects, and for group communication, such that "tribal" areas are supported, as well as multiple identities. One focus group participant found it interesting that:

> Second Life has great group roles, permission settings and other features that go to a fine grain, but are not used to the degree that they could be to create cohesiveness that a true community might need to form an identity in a particular virtual space. The layers of complexity to develop have not yet been well-

> explored by people. Given that the interface is so complex, we're still operating as a group of innovators, still feeling our way through this. I see a lot of people using [linking from Second Life to] the world wide web in more traditional avenues for instantiating the community development, like wikis or listservs, rather than trying to develop it from inside the virtual world explicitly.

Another mentioned a project being developed by the registrar for a 30,000 student body, framed within student services to help address Hispanic retention and attrition. This student segment may have been raised in homes where Spanish alone was spoken, and thus are "uncomfortable with language proficiency. Second Life allows speaking different ways: notecards, typing, Voice over IP." Further, in the Spanish-Latino community the sense of community and identity is important, and the focus of the project is to facilitate the development of an affiliation with university community.

Authentic Imperative for Action

One focus group participant commented that this principle "nailed it as an authentic imperative. If people wander in and wander about, they think it is empty, there is nothing there. If lured into Second Life by an incredible speaker for the New Media Consortium…listen to Howard Rheingold or George Simmons, [then they] are there for a purpose. If I don't have someplace to go, it feels very lonely."

Another argued that one imperative is again that of community, that people don't feel a sense of purpose lacking that, and that "engagement in Second Life is from the social interaction tools and construction tools. When the two things are combined together, creates a powerful medium for social collaboration and co-construction." He also noted that one difficulty to overcome in becoming engaged is the nature of Second

Life, in that content is created almost entirely by residents, using a “plastic” set of tools, giving the user more to do, with a greater breadth of what is possible, but an entirely different experience than other graphic computer-based worlds. In one sense, Linden Labs is a “real estate company, not a software company.”

Annotation, Object Creation and Manipulation

In discussing annotation, object creation and manipulation, one focus group participant introduced the concept of stigmergy, and its interesting potential for collaboration and group identity. Stigmergy is “a mechanism of spontaneous, indirect coordination between agents or actions, where the trace left in the environment by an action stimulates the performance of subsequent action” (Wikipedia, n.d.). In Second Life, the potential for stigmergy, a principle of self-organization, is based in:

> The capacity for someone to create something in a plastic environment; people come in later and react to or add to object; their behavior is in turn changed by the thing you created. Everybody can construct things . . . creates a whole new realm of cultural involvement that is non-verbal, not based on text or speech . . . where the communication could occur . . . as people work in tandem, without using [conventional] symbolic language, directly change each other’s experience.” (Wikipedia, n.d.)

Informal Chance Encounters and Group Awareness

All focus group participants mentioned that support of informal chance encounters and group awareness is a challenge in Second Life. One noted that she has “a great sense of being lost in Second Life when I arrive places . . . looking for something or someone,” and others agreed. In some diffuse way, Second Life doesn’t always help people to connect up with each other, that a feature or structure needs to "take away that lack of ease that many of us feel in trying to connect."

This gap was ascribed by one participant to the relative newness of the world and the complexity of human interaction. There is this sense that the world is unknowable, too big, lacking "markers that allow people to find each other" and further "no metadata to put around the thing you are looking for in Second Life." This participant believed that the solutions to fill in those gaps are forthcoming, "even though a lot has been done well," including such things as groups, friends, IMs, teleports.

Another participant noted that part of the reaction is the same as an individual's usual reaction to new places or people: "Different people have different degrees of openness and sense of adventure. When they find themselves in a foreign land, some people shut down: 'I don't know where I am, I'm lost, I'm going to sit down and wait or I'm going to call someone and get directions.' [Others] wander around to see if they can bump into someone or something."

Section 6: Qualitative Analysis, Mediation of Collaboration

The fourth dimension of the construct for the sense of presence used in this study is the mediation of collaboration, which is defined as follows" "We (a group subject, members of a collaborative group) can use tools to collaborate with each other to carry out action/operation chains toward a shared object(ive) that relates to a formal learning activity.

The data collected relating to the fourth dimension of the construct, mediated action/operation chains in the learning activities, included machinima recordings ("videos") of learners' carrying out a collaborative learning activity, transcripts of related chats in Second Life, and interviews with a sample of learners after completion of the learning activity. Video snippets were used to validate treatments and illustrate items of interest.

An adaptation of Mwanza's (2002) "Eight-Step Process" in her Activity-Oriented Design Model was used as one organizing framework for qualitative data analysis. The prospective mapping of the nodes of a collaborative learning activity system (performed to prepare for data collection) was revisited, given the action/operation chains observed during the learning activities.

Mwanza's "Activity Notation" was used to decompose the situation's activity system into "manageable constitutive units or sub-activity systems…linked together through the shared object of the main activity system" (Mwanza, 2002, p. 191)

The ADOM (Mwanza, 2002) was used to identify potential collaborative action/operations chains and tools associated with each row of the Presence/Collaborative Learning in Virtual Worlds matrix, and served as an organizing framework for data collection.

Activity Notation, Build Exercise

The following table (Table 17) shows the operations and activities associated with the Annotation (Build) exercise, including references to the nine design principles (travel interaction, wayfinding, avatar and identity, socio-emotional context and communication, group identity, authentic imperative for action, annotation, informal chance encounters and group awareness, and collaborative awareness).

Table 17

Activity Notation, Build Intervention

Subjects	Action/Operation	Mediator Tools	Action/Operation	Goal/Intentionality
Experimenter	1. Constructs sample model prior to arrival of participants (Annotation)	Tools for building, object sizing, texturizing	Provide demonstration model of cube to participants	So group can see nature of object to be constructed
Experimenter/ Participants	2. Exchange information about day and time of experiment (Collaborative Awareness)	Electronic Mail	Remind group members about date and time	So group members arrive in time and are present during experiment
Early arrivals	3. Discuss assignments, class progress (Informal Chance Encounters)	Instant Messaging	Post messages, socialize	Increase social ease, decrease tension about coming exercise, get help on confusing aspects of SL
Participants in collaborative activity	4. Detect arrival of other participants in virtual world (Group Awareness)	Visual contact; Communicate/ Contacts Online Indicator	Collect with other avatars into collaborative group	So group can be together and obtain instructions about how to make model

(*table continues)*

Subjects	Action/Operation	Mediator Tools	Action/Operation	Goal/Intentionality
Experimenter	5. Detect arrival of other participants in virtual world (Group Awareness)	Visual contact; Communicate/ Contacts Online Indicator; Map Locator, Friends arrival notice	Collect avatars into collaborative group	So experimenter can give instructions for making model to collaborative group
Participants	6. Move avatar to planned location of collaborative activity (Travel Interaction)	Flying, teleporting, use of Second Life URL	Collect with other avatars into collaborative group	Arrive at site where joint construction will occur
Participants	7. Receive instructions on construction of model (Collaborative Awareness)	Sample Model Group Chat/IM [VoIP]	See shape, size, color and positioning of parts of the model	So group can begin construction of their part of the model
Participants	8. Build shapes (Annotation)	Sample Model; Tools for building, object sizing, texturizing	Modify into objects of specified shape, size and color	Construct their part of the model (each constructs one side)
Participants	9. Position avatar (Travel Interaction)	Avatar movements	Gain perspective	Move their objects into position

(*table continues)*

Subjects	Action/Operation	Mediator Tools	Action/Operation	Goal/Intentionality
Participants	10. Position Shapes (Annotation)	Camera view	Change perspective	Zoom view closer to and around object
Participants	11. Position Shapes (Annotation)	Sample Model; Building tools for positioning and rotation	Orient the objects they've built to mimic the model	Build copy of model
Participants	12. Discuss positioning of shapes (Collaborative Awareness)	Communication tools (Group Chat/Group IM)[VoiP]	Synchronize positioning of objects	Build copy of model
Participants	13. Share appreciation for teamwork (Group & Avatar Identity)	Chat/Group IM, Gestures	Share approbation and mutual approval for good work	Increase sense of group identity connection and accomplishment; show unique avatar-related gestures with real-world analogs
Individuals	14. Return to correct their part of the model (Annotation)	Sample Model; Tools for building, object sizing, texturizing	Change orientation of object, reposition	Sense of closure, satisfaction in matching model

The goal for the designer would be to provide tools that support the unconscious use of tools (at the operational level), so attention could be focused on the actions (conscious, goal-directed) that result in successful completion of the activity (in this case, building the model) and support of intentionality.

Based on observations and experience, the items can be classified as follows (numbers correspond to those on Table 17, Activity Notation, Build Intervention):

1. Researcher’s construction of sample model is an operation with use camera view and considerable previous experience.
2. Electronic mail exchange is an operation, because of high level of previous experience.
3. Casual instant messaging is an operation, because of high level of previous experience with similar tools.
4. Detection of arrival of other participants is an action, requiring considerable attention, in part because of the multiple ways this is accomplished, and the lack of experience with any similar software application (friends’ arrival notice is in lower right of screen, map locator and contacts online requires opening another window).
5. Action for same reasons.
6. Avatar movement is an action, because in Second Life it requires a great deal of conscious attention and is not at all intuitive, requiring use of arrow keys or keyboard shortcuts. Especially for those with experience in other virtual worlds, the motion tools are sufficiently different to cause confusion and frustration.

7. Receive instruction on construction of model is an operation, because of significant prior experience in using group chats.
8. Building shapes is an action, using completely unfamiliar tools.
9. Positioning one's avatar is an action, for the same reasons as discussed in item 6.
10. Use of the camera view to change perspective is one of the most powerful and difficult of all of the Second Life tools, and requires conscious action.
11. Positioning shapes is an action, using completely unfamiliar tools.
12. Discussion of positioning of tools using group chat is an operation, for same reasons as discussed in item 3.
13. Sharing appreciation for teamwork using group chat is an operation, for the same reasons as discussed in item 3.
14. Returning to correct individual object's position is an action, requiring use of unfamiliar tools.

The items that are the most notable have to do with avatar movement as an action (which in real life is an operation), and use of the camera view, which has no real-life analog, because it represents an action that has no analog in the real world (e.g. one can't look behind oneself without turning around in the real world). Use of other specialized building tools remains an action until considerable experience has been gained in their use, as is the case for the researcher.

Activity Notation, Find Exercise

For Table 18, a similar analysis has been done of the Find exercise. Those items that are redundant and won't be repeated include 2, 3, 4, 5, 6, and 13 above. In order to reduce confusion, item numbering for annotation of the Find exercise starts at number 15.

Table 18

Activity Notation, Find Intervention

Subjects	Action/Operation	Mediator Tools	Action/Operation	Goal/Intentionality
Participants	15. Receive instructions for treasure hunt (Collaborative Awareness)	Notecards, inventory control	Find out clues for treasure hunt	Determine responsibilities for treasure hunt
Researcher	16. Provides instructions on how to orient oneself in world	World map	Understand position in relation to world	Find objects and find one's way back to gathering point
Participants	17. Move communications into group mode (Collaborative Awareness)	Group instant messaging	Increase range of communication beyond local chat	Communicate as travel to carry out the treasure hunt

(table continues)

Subjects	Action/Operation	Mediator Tools	Action/Operation	Goal/Intentionality
Participants	17. Pick team leader (Collaborative Awareness)	Group instant messaging	Agree upon group leadership roles	Organize group actions
Participants	18. Share clues (Collaborative Awareness)	Notecard, Group instant messaging	Cut and paste from notecard to group instant messaging	Collect clues to determine next steps
Participants	19. Navigate to locations described on clues (Wayfinding and Travel Interaction)	Notecard, avatar movements	Fly or walk to location	Get objects described on clues
Participants	20. Navigate together to locations (Group and Travel Interaction)	Follow tool	Keep group together	Continue to share clues and find objects

(table continues)

Subjects	Action/Operation	Mediator Tools	Action/Operation	Goal/Intentionality
Participants	21. Obtain objects	Take copy tool	Point to and select object	Pick up copy of object as part of treasure hunt
Participants	22. Navigate to origination point (Travel Interaction)	Avatar movement tools	Prove objects from treasure hunt were obtained	Complete treasure hunt

Again, the analysis of whether an item from Table 18 is an operation or an action is as follows:

15. Receive instructions is an action, because it involves the use of notecards and inventory control, which are not intuitive applications in Second Life.
16. Use of the World Map is also an action; while it has analogs in real life, the map is rich with detail and clutters the participants' windows, especially if they have a notecard window open.
17. Moving communications to group instant messaging is difficult, because it requires yet another open window, which is different from the group chat window. Participants often have difficulty distinguishing where their cursor is, and therefore which type of communication they are using when they post a message, making this an action, not an operation (unlike group chat).
18. Picking team leader is conscious action.

19. Sharing clues is difficult, as it requires copying from a notecard and pasting into the group instant messaging window, requires coordination with other participants, requires that all clues are shared, and that participants read through all of the clues before they start looking for the object. This was one of the most frustrating steps in the exercise, requiring as it did several conscious actions, and multiple windows. At one point, a participant could have three windows open–the group instant messaging window, the notecard window, and the world map window–which left little real estate for actually looking for an object.
20. Navigate together to locations is another action, due to the absence of good tools for “herding,” or following (a following tool is available, but requires an esoteric mouse/control key process).
21. Obtaining objects was an action, although with practice this could become an operation. The application requires a right-click on the object (which is an action that works for many tasks), and a choice of an item on a second level menu, so taking a copy is not straightforward.
22. Navigating to origination point was an action, because, again, avatar movement controls are difficult, and do not become unconscious operations, even for experienced Second Life users.

As can be seen from this discussion, the Find exercise was the most difficult of the three. The Build and Find exercise was a combination of the two, but because it had much greater flexibility in the building of the objects, the placing of the objects, and Find was a reverse-engineering process, there were many more comments that it was a fun exercise for most groups.

Chapter 5: Conclusions and Recommendations

Introduction

The purpose of the study was to explore the effect on the sense of presence under three design conditions in the virtual world, Second Life, in order to understand the sense of presence and its implications for the design of virtual worlds.

Sense of Presence Construct

Some presence researchers concentrate on the attributes of a medium; for example, sensory realism, the extent to which the virtual medium matches the “real” thing with regard to human perception (Lombard & Ditton, 1997). Others define presence in terms of a private, individual human experience. For the purposes of this study, the sense of presence was defined dynamically as the ongoing result of a collaborative action-based process (Spagnolli et al., 2003). This definition moves beyond a snapshot in time, and beyond the subjective (because actions can be observed), and highlights the role of artifacts as created, perceived, and used by learners.

A Presence/Collaborative Learning in Virtual Worlds matrix was developed by the researcher, mapping nine design guidelines against four broad dimensions: sense of place, social presence, individual agency and mediation of collaboration. The four dimensions for the sense of presence were defined as follows: (a) Sense of place (*There is a “there,” there);* (b) social presence (*We are together with others, with the ability to communicate and interact socially);* (c) individual agency (*I can interact with the environment and objects in it to produce an effect);* and (d) mediation of collaboration (*We can use tools to collaborate with each other toward a shared objective).*

Nine design principles were synthesized from an extensive literature review. They included: (a) Maximize usability of travel interaction techniques (Bowman et al., 2005), (b) Facilitate wayfinding (Sherman & Craig, 2003), (c) Support development progression of avatar and identity (Bartle, 2004), (d) Provide socio-emotional context and communication channels (Fabri et al., 2004), (e) Encourage group formation and identity development (Bartle), (f) Situate learner in environment with authentic imperative for action (Sherman & Craig, 2003), (g) Support personal and group annotation of the world (Brown & Bell, 2006), (h) Use notification systems to stimulate chance encounters and group awareness (Carroll et al., 2003; Huxor, 1999; Kirschner et al., 2004), and (i) Use notification systems to support grounding and collaborative awareness (Carroll et al., 2003, 2006).

The sense of presence construct is expressed as a matrix with four columns (sense of place, social presence, individual agency and mediation of collaboration), mapped against the nine design principles.

Research Question

The guiding question for the study's exploration of the sense of presence was: In the 3D open-ended socially-oriented virtual world, Second Life, what is the effect on the sense of presence in collaborative learning spaces designed according to the sense of presence construct proposed, using two design principles, wayfinding and annotation? Another question of interest was: What are the relationships, (if any) among the four dimensions of presence described by the construct?

The study explored to what extent the subjective report of the learners' experience aligned with the hypothesized effect of designed-presence. The study applied the two design principles wayfinding and annotation. Wayfinding suggests that the designer provide a variety of aids and cues such as landmarks, paths, maps, and place names and cues to support the learner's process of defining paths throughout the virtual world: a personal map of the world. Annotation involves leveraging the 3D virtual world to support personal and group annotation of the world through the integration of object creation and manipulation with collaboration.

Design Environment

The study was conducted in a three-dimensional, socially-oriented multiuser virtual world, in a controlled space, "Malibu Island," a private area maintained in Second Life by the Graduate School of Education and Psychology (Pepperdine University).

Second Life has been variously described as a tool for social networking, for holding three-dimensional visual conversations, and for programming intelligent objects (Brogden, 2007). More than a virtual world, it is, like Active Worlds Educational Universe (see http://www.activeworlds.com/edu/index.asp), one of a few services that support the development of 3D multiuser environments, integrated with text and voice communications (Rodriguez, 2006). Second Life is developed and maintained by Linden Research, Inc. Second Life is not a game, unlike World of Warcraft, with its built-in quests, internal plots and characters; residents build 99% of the content in Second Life (Ondrejka, 2004a).

Methodology

The research utilized both quantitative and qualitative methods. The methodological challenges were: (a) how to gather data about the experienced sense of presence, validating and operationalizing the construct and the two design principles; (b) how to model and collect data about collaborative action-based processes; and (c) how to analyze data about experienced presence and processes.

Twenty learners recruited from the Graduate School of Education and Psychology at Pepperdine University carried out assigned collaborative activities in Second Life under three conditions: (a) where wayfinding was foregrounded; (b) where annotation was foregrounded; and (c) where both wayfinding and annotation were foregrounded. Participants carried out a collaborative learning activity in each environment. In the case of annotation, the intervention involved the collaborative construction of a four-sided cube by creating colored planes and aligning them according to a model provided by the researcher; similar activities have been used in other research on presence and collaboration (Axelsson et al., 2001). In the case of wayfinding, participants were given clues that had to be shared in order to find objects in a “treasure hunt.” For the third activity, a combination of the two, participants created individual objects of their own design, put them together into a group object and “hid” them on the island, and created a treasure hunt map that reverse-engineered the path from a central location to the location of the group object.

Participants were divided into six small groups of two to four individuals. For observation purposes, only one group at a time carried out the activities. The order of the activities was varied: groups 1, 4, and 5 experienced the annotation intervention in the first week, followed by the wayfinding intervention the second week; and groups 2, 6, and 7 experienced the wayfinding intervention first, followed by the annotation intervention the next week. All groups experienced the combined intervention (annotation and wayfinding) as the final experience in week 3.

During each session, task performance was tracked using intervention criteria. After each of the three sessions, participants completed an online survey. The survey was a combination of three experienced-presence questionnaires developed by other researchers, to test sense of place (Usoh et al., 2000), social presence (Biocca et al., 2003), and sense of individual agency (Witmer & Singer, 1998). With 20 students participating, this resulted in 60 surveys. For the quantitative aspects of the study, means and standard deviations were evaluated based on the results of the post-activity surveys. Generally speaking, the distribution is well-approximated by a normal distribution using summary statistics and Q-Q plots.

In addition to the data gathered from the surveys, qualitative data was gathered from observation, videotaping, and review of videotapes of the participants during the learning activities, and from eighteen semi-structured online interviews of a sample of the students. Finally, a focus group composed of expert designers reviewed the nine principles.

In order to evaluate the mediation of collaboration, the study followed a line of inquiry on the mediation of collaborative action chains using activity theory. The Activity Design Oriented Model (Mwanza, 2002) was used to model the collaborative action/operation chains and tools associated with each row of the Presence/Collaborative Learning in Virtual Worlds matrix, and served as an organizing framework for data collection and analysis.

Findings

The analysis was based on the nature of the data at different levels: (a) by question and order of intervention for sense of place and sense of agency; (b) by group and by individual for social presence; (c) by group and intervention for task performance; and (d) by group, intervention and individual to synthesize the qualitative and quantitative data for all three. The focus session, which focused on the entire matrix including all nine design principles was also summarized and analyzed.

Sense of Place

The sense of place is defined to be the sense of physical and spatial presence. Data on this variable was collected through six questions scored on a Likert scale of 1 to 7 (treated in this study as equal interval scale data), from a survey developed by Usoh et al. (2000).

Considering major observed patterns in individual questions for those who experienced wayfinding first, (a) participants' experience was closer to the normal feel of being in a "real" place, (b) more like they were actually in the environment rather than somewhere else, and (c) their visual structure of memory was more similar to the structure of memory for actual places (Murray, 1997; Usoh et al., 2000) compared to participants who experienced the annotation intervention first. In addition, during the combined intervention, the experience of *currently* being in the virtual space was strongest in those who had experienced the wayfinding intervention first.

As might be expected, the mean for the sense of place for the combined intervention was highest, indicating a cumulative effect of "being in the place."

Based on individual questions, the experience of wayfinding resulted overall in an observed pattern of a slightly stronger sense of place. While fruitful for future exploration and study, these findings were not statistically significant.

Sense of Individual Agency

Sense of individual agency is tied to individual action, and the manipulation of objects and the environment with tools. Data on this variable was collected through 11 questions scored on a Likert scale of 1 to 7 (treated in this study as equal interval scale data) from a survey designed by Witmer and Singer (1998).

Again, order of intervention mattered. In this case, according to patterns observed in the means, the ability to survey the environment using vision was stronger, manipulating and moving objects was easier, and participants experienced a lower sense of delay between actions and outcomes when the annotation intervention was the first experienced (this held for the combined intervention). Interactions and movement seemed more natural, control devices were felt to be less interfering, and participants felt more proficient in moving or interacting at the end of the intervention if the wayfinding intervention was first; this makes sense considering that the wayfinding intervention focused on movement through the environment.

The mean for sense of agency was higher for the combined intervention if annotation was experienced as the second intervention. One possibility is that the participants felt a strong contrast between the highly restricted annotation intervention (participants were constrained to a particular building site, and a requirement to match a model) and the creative aspects of the combined intervention, where they were able to build what and where they chose.

The wayfinding intervention on its own did not contribute to the sense of agency as much as the annotation and combined annotation and wayfinding intervention, which is consistent with the definition of the sense of agency as tied to individual action and the manipulation of objects and the environment with tools.

While there was a cumulative effect of the three interventions on the sense of place, this did not hold for the sense of agency; the mean for the sense of agency is slightly higher for the annotation intervention than the combined intervention.

Again, while fruitful as patterns for further exploration, these findings were not statistically significant.

Sense of Agency and Sense of Place

Combined activities in the final intervention influenced the sense of place more than the sense of agency, possibly because this activity required considerable movement through the environment, to first of all choose a location for the group's objects, and then to reverse-engineer a path from the central plaza to the location of the group object, in order to create a "treasure map."

Using summary statistics for overall sense of place and sense of agency, there is a positive association between sense of place and sense of agency (r=.570, significant at the 0.01 level, two-tailed).

Sense of Social Presence

Social presence is defined as follows: being together with others with the ability to communicate with each other asynchronously and synchronously and to interact socially. Social presence was measured through a series of twenty-two questions, organized as a paired list of items (check all that apply), from a survey designed by Biocca, Harms, et al. (2001). Statements were either negative with regard to social presence ("I hardly noticed the other individuals"), or positive ("I was often aware of others in the environment") and referred to the group as well as the individual ("Others were often aware of me in the environment").

Social presence increased over the first and second interventions for all groups. For four of the groups, this cumulative effect did not hold for the third (combined) intervention.

The lowest average group social presence score was for one of the groups which was not successful in either the annotation or wayfinding intervention. The highest average group social presence score was for a group which was successful in all three activities. Note that, on the other hand, the group that had the highest task performance score had the second lowest average social presence score, due to a low average score of one participant in the group. This participant indicated her strong dislike for building (annotation), and got separated from the rest of the group several times during the wayfinding intervention.

The sharing of power is not necessarily conducive to the development of the sense of social presence. The group with the lowest average sense of presence was also the only group which used the feature in Second Life which permits the sharing of (and control over) others' objects, and this resulted in unintended consequences. For example, the object created by one participant was deleted accidentally by another group member.

Task Performance

A fourth element, task performance, involved evaluating each team according to a set of intervention criteria, and the group's successful performance of each task.

The most difficult intervention proved to be the wayfinding exercise. The evaluation of the groups revealed that the participants did not develop a "personal map" of Malibu Island by the end of the wayfinding intervention, although that was the major goal of the intervention. During the wayfinding intervention, two groups did not successfully complete the task, nor did they score high enough to meet the criteria that an intervention had occurred. By the end of the combined annotation and wayfinding intervention, individuals did develop personal maps.

As mentioned before, social presence and success at the tasks appeared to have a positive relationship; it follows that a good design of learning activities provides for early success, to promote social presence.

Major Themes of Literature Review

The overarching theoretical framework was a sociocultural framework for learning as a social practice. The learning, thinking and knowing arose from relations within each small group and from their socially and culturally constructed world (Lave & Wenger, 1991) as a matter of "practice, that is, doing and activity" (Nardi, 2001b, p. 14). The relationship to presence is that it is linked to successful action in the environment (Zahorik & Jenison, 1998).

Activity-theoretic sociocultural framework and sense of agency. By definition within the activity-theoretic conceptual framework, agency is the "ability to act…to produce an effect according to an intention or need" (Kaptelinin & Nardi, 2006, p. 242). The importance of the sense of agency (doing) to the sense of presence has been argued by Lombard and Ditton (1997), Murray (1997), Nowak and Biocca (2003), Slater et al. (2000), and Witmer and Singer (1998), and was affirmed by this study.

The design principles for annotation (the building intervention) included integration of object creation and manipulation with collaborative interactions (Brown &

Bell, 2006). Sherman and Craig (2003) argued in particular that the 3D nature of the world should be leveraged to convey “ideas as artistic expression.” The second combined intervention, which was the most creative and offered the most choices to participants, resulted in the highest sense of place.

The other important aspect of the annotation design principle for the sense of place is the *persistence* of objects and other representations of self-expression, associated with place (Sherman & Craig, 2003). The design principle is affirmed by several cases in which participants returned to refine their group object after the session.

Sense of place. Interestingly, with regard to the one aspect of the sense of presence in the study, the question of whether participants experienced the environment as someplace visited, rather than as images seen, whether the annotation experience was first or second, the sense of place was stronger. That is, even though the annotation intervention actually focused on manipulation of objects (which were in fact, images), it was in the act of doing (joint construction) that the sense of place was reinforced in this case.

Many authors have argued that a major component (if not the entirety) of the sense of presence is determined by the sense of place including Axelsson et al. (2001), Bailenson et al. (2005), Harrison and Dourish (1996), Heeter (1992), Lombard and Ditton (1997), Slater et al. (1994), Turner and Turner (2006), and Witmer and Singer (1998).

The intervention of wayfinding resulted overall in an observed pattern of a slightly stronger sense of place. Recall that the wayfinding intervention was also an active one, with participants moving throughout the environment, following clues, and picking up objects. Again, the theoretical framework that argues that learning is a social practice, a matter of doing, is reinforced by these findings. The other elements of the design principle most associated with the sense of place, wayfinding, were successfully implemented in the study, with landmarks, maps, place names and other cues and techniques to help an individual define a path. Visually dividing the world into distinct parts, preserving a unique sense of place for each, providing frequent directional cues (Darken & Sibert, 1996) all contributed to the sense of place.

Social presence. Social presence as a phenomenon of the sense of presence was the most difficult to define, as in the literature it had been seen variously as: (a) a sense of engagement with another (Lessiter et al., 2001); (b) social richness of the environment (Gunawardena, 1995; Rice, 1992; Short, 1976); (c) the ability to project socially and emotionally as a real person with other real people (Garrison et al., 2000); (d) the extent to which others appear to exist and react as real people do (Heeter, 1992); or (e) avatar realism (Bailenson et al., 2005).

Thus, social presence proved to be the slipperiest and the most mysterious of the dimensions of the sense of presence construct. Perhaps it is not a phenomenon separate from the other dimensions? Some researchers merge sense of place and social presence (Axelsson et al., 2001; Schroeder et al., 2001), or this merger is termed “co-presence” (IJsselsteijn & Riva, 2003). On the other hand, co-presence is also used by others as a synonym for social presence (Casanueva & Blake, 2000; Lombard & Ditton, 1997). No association with sense of place or sense of agency was observed in this study.

The social presence instrument used in this study (Biocca, Harms, et al., 2001) was chosen for its definition of presence, as being together with other people, with opportunities for interacting and communicating synchronously, with some degree of mutual awareness, attention, understanding and assistance. The instrument was relatively untested in prior research by other researchers compared to the other instruments.

Mediation of collaboration. The analysis of the mediation of collaboration was carried out by reviewing the actions (conscious, goal-directed tasks) and operations (lower level tasks carried out unconsciously) that made up each of the three activities, the tools to carry out the actions and operations, and the design principle related to each action and operation. Activity theory was used to frame each collaborative learning activity as an activity system:

1. The collaborative group (as the *subject*).
2. An object(ive) which is shared by the collaborative group in order to carry out the assignment successfully.
3. A social context of a cultural framework–what are the rules of this assignment, what are the expectations of how we should go about the work, what are the norms of the community?
4. Negotiation of meaning and action–what is the goal, how will we achieve it, and how will we divide up the work?
5. The real possibility of group action (Riva & Mantovani, 2000).
6. Tools for carrying out actions and operations.

Activities are made up of chains of actions (tasks that are conscious and goal-directed). Actions are made up of chains of operations, which are so routine as to be unconscious, such as typing on a keyboard. However, if tools are poorly designed, or there is a breakdown in a tool that is used to carry out the operation, the task becomes an action (Jonassen & Rohrer-Murphy, 1999; Kaptelinin & Nardi, 2006). The goal for the designer would be to provide tools that can be used at the operational level, so attention could be focused on the actions that result in successful completion of the activity (for example, building the model in the annotation intervention) and support of intentionality. As noted in the next section, in the case of the environment in use, Second Life, window management, group instant messaging, detection of arrival of other participants, avatar movement are all design features that should be implemented at the operational level, but are not. These and similar issues are discussed in the next section.

Recommendations and Conclusions

Recommendations and conclusions are organized as follows: (a) recommendations relating to the two design principles which were the focus of the study (wayfinding and annotation),(b) recommendations about other aspects of design which do not deal with the focus of the study but which also emerged from observations of participant behavior, (c) a virtual world grid and a discussion of which aspects of the sense of presence apply and (d) larger meaning for findings in light of trends in use of virtual worlds.

When exploring recommendations for design, it is important to note that there are four broad categories that impinge on the implications of the sense of presence on design in a virtual world: whether the design element results from (a) design of the learning experience within the virtual world; (b) positive design elements that are intrinsic to the virtual world itself, which the learning environment designer can leverage; (c) negative design elements that are intrinsic to the virtual world itself, for which the learning environment designer can compensate; and (d) negative design elements that are intrinsic to the virtual world itself, which the learning environment can neither leverage nor mitigate.

Wayfinding

A strong attribute of Second Life is its support for the wayfinding design principle, and learning environment designers can leverage these, which include the ability to: (a) visually divide an area into distinct parts; (b) provide a variety of aids such as landmarks, paths and place names; and (c) to support collaborative wayfinding tasks including exploration, primed search, and provide constant information as to the location of group members.

The wayfinding treasure hunt was designed to provide development of landmark, procedural knowledge and survey knowledge for development of a “personal map” of the island. The wayfinding intervention would have been better designed if it had involved the participants creating the treasure map, rather than following the constraints of one provided to them. The lure of the unknown, the ability to choose where to go next, the sense of exploration and discovery would have contributed to the development of a personal map of the island, which did not occur in any of the sessions devoted to wayfinding, and did not in fact emerge until the combined intervention, which was characterized by this sort of freedom.

One striking response to the post-session interview question, “How much of a personal map do you think you’ve made of the island?” was “I don’t really know it, but it seems small now . . . [before] it didn’t seem big so much as it was just unknown, I guess.” An unexpected and semi-humorous response was given by one of the participants who got lost: “[It was] fun to get lost actually . . . practicing getting lost could be a useful activity.”

Visually dividing the world into distinct parts, preserving a sense of place for each, elicits the sense of place. One aspect important to effective landmarks is that they have memorable but commonly-understood names. One of the features of the island is known as the “hobbit house”, which is made up of two rounded hills with one round door entryway. The feature’s name did not map to its appearance for some people (and others may not have been aware of the allusion); this made finding the hobbit house difficult to find and to enter for several of the groups, even with directional cues (and clues) such as a series of green steps that led up to the house and the door.

A technique used by a couple of groups indicated use of the map of the island, without building a “personal map” of the island. When coordinates are used, as one group did to teleport directly inside of a waterfall feature, an effective travel interaction occurs, but because it is point-to-point, the intervening features of the landscape are missed, so the wayfinding experience is limited.

From this experience, and from feedback during the focus session, it would have made sense to combine the travel interaction and wayfinding design principles (and created an intervention representing both), since the design of an area should be able to accommodate people’s ability (and natural inclination) to go back and forth between exploratory and goal-directed modes.

Regarding the social presence dimension of wayfinding, one principle suggests that the designer locate landmarks at intersections/crossroads of major paths, for socially-oriented functions and informal meeting spaces, and use architectural cues to encourage socializing. For example, groups which completed the wayfinding intervention took time to socialize in the coffeehouse on the island, playing with the espresso machine and trying out the different sitting poses at the coffeebar (and the group that spent the most time in the coffeehouse had the highest sense of presence score).

Annotation

In Second Life, the annotation principle is well-supported and the learning environment designer can leverage this strength. Object specialization, assembly and collection are supported, as are means for simultaneous interaction around objects, joint attention and shared focus, persistence of objects, and a wide range of built-in collaborative tools for building.

The annotation intervention took advantage of these strengths, and appeared well-designed for its purpose: encouraging group collaboration in the building of a group object that conformed to a model. All groups were successful in creating an object, but two of the groups did not create a perfect match with the model. An individual from each of those groups came back on their own to perfect the group object. This was more likely to achieve closure rather than to successfully complete their role in the group, since this was done on their own and without fanfare.

Particularly in the annotation (building) intervention, the power of perspective in a 3D virtual world is one of the most compelling categories, and it also represents a set of positive design elements which the learning environment designer can leverage. Subcategories for perspective include multi-lateral perspectives achieved through avatar movement, through avatar positioning, and through use of the Camera View. Multi-lateral perspectives are aspects of annotation that relate most closely to individual agency, as they are tied to the manipulation of objects and the environment with tools and provide for multiple views of objects from different perspectives.

Multi-lateral perspectives achieved through avatar movement. Multi-lateral perspectives can be accomplished by moving one's avatar around the object under construction, or flying above the object. As mentioned by several participants, this is the most intuitive approach, since it maps closely to real-world behavior, and the designer can encourage the behavior. Observation of avatar behavior demonstrated that those participants who moved their avatars around the object under construction were more successful in completing the intervention than those that remained stationary. From one perspective, the plane is a single thin line. Unless one is flying, it is difficult to position it in relation the other planes of the cube. From any one angle, the builder would have difficulty positioning their plane with respect to the others. The most successful participants walked in a 360 degree circle around their object and those of their team mates. This was demonstrated repeatedly, as those with avatars that remained stationary weren't able to attain lateral perspectives, couldn't see the misalignment of their planes, and were unable to position their planes correctly (and their team mates often exhorted them to "move around").

Multi-lateral perspectives through avatar positioning. Avatar positioning is another approach; it is closely related to avatar movement, but refers to the stationary position in which the participant maintains the avatar, in relationship to the building floor, and to the other avatars. The most successful positioning occurred in two different groups, when avatars were equidistant from each other, in a triangle formation, with one avatar positioned close to the wall of the building area, and the other two close to the edges. Proximity and physical configuration of the group thus became a collaboration tool. Successful builders would move in and out of the proximity triangle, always returning to the equidistant position. The least successful builders positioned themselves some considerable distance from the other participants, and remained there the entire time. One participant commented, “I first moved there because there was more space to work and move…as the session progressed I was a bit lost so I was trying to figure things out…I realized that affected my sense of presence.” Again, the problem of perspective interfered with their successful alignment of their planes with the others making up the cube. The learning environment/experience designer can affect initial placement; where the researcher suggested “spreading out,” the more successful equidistant triangle was not used, and participants’ original position was in a line down the front of the building floor.

The learning environment designer could encourage this approach through careful design of the building area. A square or triangularly-defined area would afford the more successful equidistant triangle approach (where a long-sided rectangle does not).

Multi-lateral perspectives through camera view. A Second Life utility, the camera view, is an alternate approach to multi-lateral perspectives involving use of a unique utility, which provides a widget to the builder for obtaining views by panning around, above, below, zoomed-in and zoomed-out, without moving the avatar. Camera views are necessary to any precision building, but the tool is in no way intuitive.

During the experiment, the learning experience design which leveraged this intrinsic feature of the virtual world included an orientation to camera views, and a limited number of researcher reminders (one) during the experiment (participants tended to remind each other of the facility as well). In addition, the building took place on a white “floor” which provided high-contrast for precision building.

The researcher could not directly observe whether camera views were used, and addressed this by asking participants during the semi-structured interviews that immediately followed the intervention. Members of all groups mentioned use of the camera view (once they had received the orientation in its use). Many mentioned use of camera view in combination with moving their avatar around. Two typical comments: (a) “I always use camera view, but I also find it more intuitive to move around.” (b) “I used [camera view] to get a better perspective on the object . . . other than that I really just moved myself around.”

Persistence and identification with objects. During the annotation (build) intervention, participants were constructing panels which they then used to build a cube based on a model provided by the researcher. One of the principles supporting the sense of place is to “provide means for creating and organizing persistent objects, icons, symbols and other representations of self-expression, associated with place.” One practice of the researcher was to wait until just before the next group to delete the cube made by the previous group, making the object persistent for a short time. Persistence of objects is an aspect of Second Life which is easily be leveraged by the designer.

With such a mundane object with low self-expressiveness (constrained to a model), the researcher did not expect much identification or sense of ownership associated to the objects built during this intervention. On the contrary, on two occasions team members came back after the session to “tweak” their object to match the model better. In one case, the green side of the cube had “fallen” down, and one participant returned and experimented with rotation on her own, until the panel was in correct alignment: “I did go back in late last night to put up my side that had fallen. It drove me nuts that my side fell down and [I] didn’t have time to fix it. lol.”

In the case of another group (the only one which was taught how to share objects), someone returned later to move the yellow panel into alignment, to make the cube match the model perfectly.

Another group made the model quite quickly and “good enough for government work,” and then spent another ten minutes tweaking it so it would be a perfect match, until one group member told the other to “step away from the wand,” referring to the building tool.

All of the groups wanted their picture taken with their object, and spent some time positioning themselves around it for a good picture.

During the combined annotation/wayfinding intervention, several groups created quite beautiful objects which they then labeled “art,” and also asked that pictures be taken of their work (which the researcher did). One respondent commented humorously: “I’m quitting my job and becoming a sculptor in SL.”

Object sharing, the two-edged sword. One of the limits to the execution of the research was the limitation in time. Even though a three-hour orientation had been given to Second Life to all the participants including all of the skills necessary to carry out the interventions, the steep learning curve of Second Life limited the retention of the material. A brief (10-minute) orientation preceded each intervention, but all skills necessary could not be reviewed during this period. As a consequence, only one of the groups received training in the sharing of objects (which allows participants to move others' objects).

The results and attitudes concerning this facility were quite mixed. In the one session where sharing was used, one participant accidentally moved another's panel to the other side of the island ("losing" it effectively). Besides blaming the researcher ("Wendy did something to it"), the original creator had no idea what had happened to their panel, and had to rebuild it.

For sessions where sharing was not enabled, the researcher queried the participants as to whether this feature would be a help or a hindrance during the post-intervention interview, the results were mixed:

1. "[I] wanted to 'help' by grabbing the panels [during the building intervention], but couldn't."
2. Comment: "Moving others' objects might be a social problem." Response: "It would make it easier to move objects." Response: As long as we agree it would be easier . . . But if I walked up and started resizing your object you might say–hey–what the heck are you doing? Response: "Yes I would not like that."
3. [Sharing objects would have been] "a hindrance because someone might take over" (other respondents agreed), "and I'd never have learned anything."

Hyper-sensitivity of positioning tools. An intrinsic weakness in the Second Life virtual world design is the excessive sensitivity of the object positioning function. After two different annotation (building) sessions, the researcher found panels floating out in space over the ocean, on different sides of the island. These objects had been "lost" during the positioning portion of the building intervention; the participants had to rebuild their objects.

Because relative distances are also difficult to distinguish, attempting to positioning objects by entering x, y and z coordinates also resulted in loss of objects.

In the case of the Second Life virtual world, the only mitigation to this weakness is to teach one of the finer points of positioning, using the up-down arrows in the edit window to move the object very slightly in one direction or another. The researcher did not teach this technique because of time limitations, but one group requested such a tool: “I was looking for what I know as a nudge . . . in some programs you can use the arrow keys to just move something a tiny bit rather than dragging.” Another respondent commented: “Like two magnets . . . get them real close and they ‘snap’ together just right.” Again, variations of these tools, such as “snap to grid,” and “snap object xy to grid,” are available in Second Life, but require more training in order to use them.

Other Design Recommendations

The second set of recommendations has been formulated according to the following specific categories: (a) authentic imperative for action, (b) wayward windows; (c) avatar and group identity, and (d) missing tools and interface elements.

Authentic Imperative for Action

Learning environment designers for collaborative learning environments in Second Life should attend particularly to providing an authentic imperative for action. The three interventions were designed carefully to situate the learner in the environment, specify the goal of the virtual experience, creative an imperative for action, and provide a unifying framework for collaborative actions (Sherman & Craig, 2003).

As noted by one focus group member, “if people wander in and wander about, they think it is an empty space, there is nothing there . . . if I don’t have someplace to go, it feels very lonely.”

Wayward Windows

Window management is problematic in all sophisticated applications, but in Second Life, the text communication window always becomes dominant when any communication occurs because the default and most prevalent use of the world is assumed to be communication rather than avatar movement. In order to move or take any other action, the participant needs to hit <ESC> or click out of the communications window in order to move from communicate to navigate mode; thus mode switches required a specific and non-intuitive step. Avatar movement should occur at the level of an operation (an unconscious act carried out as a part of a chain of operations that makeup an action). When movement functions as an operation, attention and awareness can be released for use for a higher-order conscious action. Every group complained about this aspect of Second Life. Typical comments included: (a) “I find it annoying to keep clicking <ESC> or outside the box; (b) “It is difficult [to be] continually moving back and forth between text box to moving.”

The converse was also true. Keystrokes intended for IM or chat when the avatar is in movement mode causes an avatar movement – for example, the avatar switches to fly mode when the f key is pressed. Even experienced users cause their avatars to jump when they mean to be typing a character in the communicate window: “Sometimes my keystrokes caused unanticipated happenings.”

Another windows-based flaw is the relationship between local and group IM. The local chat window is at the bottom of the screen, which makes it easier to type in when moving (you don't have to click in and out of the window to switch modes). When the communicate window is used, local chat becomes one of the tabs, along with any group IMs in session. However, any group IM postings appear both in the communicate window, and also in a posting labeled "IM" just above the chat window at the bottom of the screen. As a result, individuals' attention is drawn downward to the local chat window, and they accidentally and repeatedly switch back and forth between local chat and group IM. This occurred for every group. This problem was particularly egregious during the wayfinding intervention, which required the use of group IM when avatars were traveling at some distance from one another (local chat only works when avatars are within 100 meters of each other). Participants would accidentally switch to local chat, and find after some time that no one else in the group was "hearing" them.

The learning environment designer can use a mitigation for the accidental switching between local chat and group IM, which is to encourage learners to "tear off" the local chat from the communicate window, and place it separately at the lower left of the screen. Local chat becomes a separate more prominent window, less likely to be used accidentally when the participant intends to use a Group IM.

Finally, experiments which depend on management of multiple windows, as was the case in the wayfinding exercise (communicate, notecard, map, building edit window) should be avoided, especially for novice users. Even when the windows go transparent (if they are not the active window) they result in a significant barrier to the sense of presence, an intervening, distracting curtain veiling the world and the activities going on there. As noted by a participant, “Managing the windows really reduces the real feel to being there…the sense of presence diminishes then, I feel like I am on a computer sort of like fooling around on the desktop with [Microsoft] Windows.” Note that control of windows is limited to within the Second Life screen – a window can’t be moved off the primary Second Life screen (as is true for many other game environments).

Partial mitigation of the windows design flaw can only be achieved through use of voice, which moves communication to a non-window mode, and allows the default mode to be movement instead of communication. Second Life does provide in-world Voice over IP (VoIP), and several participants commented that voice would be easier: “My sense of presence would have been enhanced by talking.” In fact, one team had very little communication in the communicate window, yet appeared to be communicating quite complex topics in the wayfinding intervention; the researcher wonders if the one team used skype or some other VoIP, as they joked about it.

On the other hand, where it was important to review a series of comments to obtain an overall understanding (as was necessary during the sharing of clues for the wayfinding intervention), voice may have had more limitations than chat or IM.

Voice is a powerful tool and its use has more advantages than disadvantages.

Avatar and Group Identity

Many of Second Life’s features are designed to support the development of avatar and group identity.

Group identity in particular has “great group roles, permission settings and other features that go to a fine grain, but are not used to the degree that they could be to create cohesiveness that a true community might need to form an identity in a particular virtual space" (focus group member). Designers should allocate and label a meeting place and shared workplace for each group, customizable by the group (termed by one focus group member as "tribal areas"). On Malibu Island, several cohorts of students have created different features for their group meetings, including a treehouse, a hobbit house, and an area of floating pillows.

One of Second Life's strengths that the learning environment designer should leverage is the wide range of customizable gestures, animations, poses and postures that are available for appropriation by individual avatars (Weber et al., 2008).

While the principle of group identity was not of the design principles under study, every group participated in group approbation behaviors during and after their sessions, making comments like "We make a good team!" or "Good teamwork." One participant from a group that got lost during the wayfinding intervention noted "We like each other even when we are lost and have no clue."

At the completion of the annotation/building intervention, group members from most groups used gestures such as hand-clapping, dancing, muscleman posing. There is often interest in learning how to do such gestures: "I was able to practice the gestures since there was time after the photo op to do something else. I tried clap, dance, among other things." Response: "I saw you clapping…I want to learn that move."

Another aspect of identity, avatar identity, is well-supported in Second Life, as each participant could (and did) customize their appearance, clothing, and accessories. As noted by one focus group member, the obsession with how avatars appear in Second Life is a fascinating phenomenon: there is an observed developmental process that begins with experimentation, stablizes, and then in some cases, avatars modify their appearance to match their real-life appearance, as the researcher has done.

Missing Tools

Participants mentioned tools they missed during their session. During a post-session interview, one participant indicated that a “show me” tool would have been beneficial for demonstration purposes: “Let me take over your screen and watch the mouse. Now you do it just like I showed you.” Another suggestion for the Second Life interface included: “I think there needs to be a ‘rookie’ interface to Second Life, something very simplified. The environment gets in the way.”

The coordinate system in Second Life is very well-developed, as is the mapping capability. The map shows green dots to indicate where others are located on the island. One can teleport directly to any place on the island by double-clicking on that location on the map. In addition, team members can offer teleport by double-clicking on the name of another in an IM chat. When someone on one’s friends’ list comes on line, there is an immediate notification message.

However, all of these together do not add up to an easy-to-use method for knowing where one’s team mates are, and moreover, there are no clear tools to help a group stay together or a team leader to keep the group together as they travel about the island (“herding tool”). One team leader noted: “I was tempted to CALL my classmates on the phone to walk them through, but I found that ‘dragging’ them along (via teleport) is sometimes all that is needed.”

Although the second orientation reviewed the use of the map for keeping track of the location of others, and transporting directly to a location on the map was covered during the third orientation, it took some time before most team members figured out the use of the map for these purposes. Two of the groups were unable to keep track of each others' locations in both the wayfinding and the combined wayfinding/annotation intervention.

Another difficulty in locating one's team mates is that it is not immediately apparent from the green locator dots on the map whether a participant is flying or not. It is hard to look "up" in Second Life, but relatively easy to look "down" when flying, with the paradoxical effect that some members tended to fly high above the island and hover to discover the location of other members (making their own location harder to discover).

Several group members mentioned that Second Life was too "mouse-centric," one stating "I wish I had a controller like the XBOX with the two arrow things". Technically, since January 2009 a joystick flycam offers interfaces with 3DConnexion SpaceNavigator, PS2 controller clones, and XBOX 360 controller, but users complain that the device "acts more like a 3D cursor than a joystick" (Second Life Wiki, n.d.).

Again, these more advanced tools were not accessible to the participants given the relatively short time for orientation. Several of the tools mentioned are actually available for more advanced use (there is a "follow tool," from a keystroke combination, for example), but not necessarily accessible given the almost 130 menu items in Second Life (counting only top-level menus): the paradox of feature-rich software is that users tend to be unaware of the many of the features.

Presence and Design of Other Virtual Worlds for Collaboration

The Presence/Virtual World Design for Collaboration matrix can be applied to a range of other virtual worlds. See Appendix L for an analysis of (a) World of Warcraft;

(b) multi-player first-person shooters; (d) a peer-to-peer "furniture arranging" game, Animal Crossing for the Nintendo Wii; and (e) a multi-player puzzle-based game, Puzzle Pirates.

New Worlds, New Possibilities

With the explosion of distance education and the adoption of hybrid or blended instruction, institutions of higher education have begun to depend much more heavily on virtual learning environments. An emerging concern is the effect on the quality of education of this increased use of virtual environments. A challenging aspect for the design of online environments for computer-supported collaborative learning is the development and maintenance of the sense of presence. Design elements and implementation practices can facilitate or hinder this development.

The changes in the landscape of higher education, increase in online offerings, nature of next generation learners and advancements in technology have converged to elevate the importance of the design of online learning environments for collaborative learning in higher education. Simultaneously, a new genre of virtual environments has emerged, designed for entertainment, personal expression, commerce and social interaction.

Open-ended socially-oriented virtual worlds such as Second Life offer a wide range of new capabilities, balanced against the challenges that use of such worlds bring. Research indicates the importance of the sense of presence for computer-supported collaborative learning. To realize the potential of virtual worlds for learning we need to understand the implications of design on the emergence of the sense of presence. Although adoption of the use of virtual worlds is increasing in higher education, absent a theory-based set of guidelines, most learning environment designers are not capitalizing effectively on the potential of these new virtual worlds. As one commentator noted, “We are like gods without a manual in Second Life” (J. B. Rhoads, personal communication, June 4, 2007).

This research is an attempt to bridge the gap between abstract theory and practice, by providing a theory-based and validated set of guidelines for virtual world design to create customized learning environments (for higher education students) that invite the emergence of the sense of presence.

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APPENDIX A

Sense of Presence Survey

Sense of Presence Survey

1. Information About Experiment

Collect information about group number, date, time.

1. Today's Date

2. Time

3. Which Group are you in?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7

Sense of Presence Survey

2. Demographic Information

Could you please tell me a little about yourself?

1. Did you sign the informed consent form? If you have not yet signed the form, and you do wish to participate in the "Sense of Presence" study, please contact Vicki Suter at [redacted].

- ○ No, I have not signed the form. (If you wish to participate, the researcher must have a signed informed consent form).
- ○ Yes, I have signed the form.

Other (please specify)

*** 2. What is your name and your email address?**

Name:

Email Address:

3. To which Pepperdine cadre do you belong

○ Cadre 13 ○ Cadre 14 ○ Other

4. Age

○ 20-25 ○ 26-30 ○ 31-35 ○ 36-40 ○ 41-45 ○ 46-50 ○ 51 or older

5. Gender

- ○ Female
- ○ Male

6. Please check any virtual world(s) that you used prior to this experience.

- ☐ Active Worlds
- ☐ Second Life
- ☐ World of Warcraft
- ☐ Other

Other (please specify)

Sense of Presence Survey

7. Please tell me more about virtual worlds with which you've had previous experience (choose from the pull-down menus below)

	Your most recent use of the world	Level of experience (1 for low, 5 for high)
Active Worlds		
Second Life		
World of Warcraft		
Other specified in previous question		

Add any comments about previous experience

Sense of Presence Survey

3. Sense of Place

Rate your sense of physical or spatial presence ("There is a there, there"). [Source of questions: Slater et al. (1994) See also http://www.presence-research.org/Questionnaires.html#SUS.]

1. Please rate your sense of being in the virtual environment, on a scale of 1 to 7, where 7 represents your normal experience of being in a place.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7

2. To what extent were there times during the experience when the virtual environment was the reality for you (where 1 is never, and 7 is to a great extent)

○ 1 Never ○ 2 ○ 3 Occasionally ○ 4 ○ 5 Much of the time ○ 6 ○ 7 To a great extent

3. When you think back on the experience, do you think of the virtual environment more as images that you saw or more as somewhere that you visited?

○ 1 As images ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 Somewhere I visited

4. During the time of the experience, which was strongest on the whole: your sense of being in the virtual environment or of being elsewhere?

○ 1 Being elsewhere ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 Being in the virtual environment

5. Consider your memory of being in the virtual environment. How similar in terms of the structure of memory is this to the structure of memory of other places you have been today? By "structure of memory" consider things like the extent which you have a visual memory of the environment, whether that memory is in color, the extent to which the memory seems vivid or realistic, its size, location in your imagination, the extent to which it is panoramic in your imagination, and other such structure elements.

○ 1 Memory structure not similar to real world place ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 Memory structure very similar to real world place

6. During the time of your experience, did you often think to yourself that you were actually in the virtual environment?

○ 1 Never ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 Often

Sense of Presence Survey

4. Sense of social presence

Please rate your sense of social presence ("I was together with others, with the ability to communicate and interact socially.") [Source: Biocca's Networked Minds Measure of Social Presence (Biocca, Harms, & Gregg, 2001).]

1. Please check all that apply.

- ☐ I hardly noticed the other individuals.
- ☐ The other individuals didn't notice me.
- ☐ I was often aware of others in the environment.
- ☐ Others were often aware of me in the environment.
- ☐ I sometimes pretended to pay attention to the others.
- ☐ The others sometimes pretended to pay attention to me.
- ☐ The other individuals paid close attention to me.
- ☐ I paid close attention to the other individuals.
- ☐ My team mates were easily distracted.
- ☐ I was easily distracted.
- ☐ The other individuals tended to ingnore me.
- ☐ I tended to ignore the other individuals.
- ☐ My opinions were clear to the others.
- ☐ The opinions of the others were clear to me.
- ☐ My thoughts were clear to my team mates.
- ☐ My team mates' thoughts were clear to me.
- ☐ The others understood what I meant.
- ☐ I understood what the others meant.
- ☐ My team mates did not help each other very much.
- ☐ I did not help the others very much.
- ☐ My team mates worked with me to complete the activity.
- ☐ I worked with my team mates to complete the activity.

Sense of Presence Survey

5. Individual agency

Please rate your sense of control and agency in the environment. ("I can interact with the environment and objects in it to produce a desired or needed effect.") (Kaptelinin & Nardi, 2006). Please choose a rating for each of the questions below. [Source for questions: Witmer and Singer, 1998]

1. How much were you able to control events?

○ 1 Low sense of control ○ 2 ○ 3 ○ 4 Moderate sense of control ○ 5 ○ 6 ○ 7 High sense of control

2. How responsive was the environment to actions that you initiated (or performed)?

○ 1 Low responsiveness ○ 2 ○ 3 ○ 4 Moderately responsive ○ 5 ○ 6 ○ 7 Highly responsive

3. How natural did your interactions with the environment seem?

○ 1 Low sense of naturalness ○ 2 ○ 3 ○ 4 Moderately natural ○ 5 ○ 6 ○ 7 Highly natural

4. How natural was the mechanism which controlled movement through the environment?

○ 1 Low sense of naturalness ○ 2 ○ 3 ○ 4 Moderately natural ○ 5 ○ 6 ○ 7 Highly natural

5. Were you able to anticipate what would happen next in response to the actions that you performed?

○ 1 Low ability to anticipate ○ 2 ○ 3 ○ 4 Moderate ability to anticipate ○ 5 ○ 6 ○ 7 Very able to anticipate

6. How completely were you able to actively survey or search the environment using vision?

○ 1 Low ability to search ○ 2 ○ 3 ○ 4 Moderate ability to search ○ 5 ○ 6 ○ 7 Completely able to search

7. How well could you move or manipulate objects in the virtual environment?

○ 1 Difficult to manipulate ○ 2 ○ 3 ○ 4 Moderately easy to manipulate ○ 5 ○ 6 ○ 7 Easily manipulated objects

8. How much delay did you experience between your actions and expected outcomes?

○ 1 High level of delay ○ 2 ○ 3 ○ 4 Moderate level of delay ○ 5 ○ 6 ○ 7 Low level of delay

Sense of Presence Survey

9. How quickly did you adjust to the virtual environment experience?

○ 1 Not quickly ○ 2 ○ 3 ○ 4 Moderately quickly ○ 5 ○ 6 ○ 7 Very quickly

10. How proficient in moving and interacting with the virtual environment did you feel at the end of the experience?

○ 1 Low level of proficiency ○ 2 ○ 3 ○ 4 Moderate level of proficiency ○ 5 ○ 6 ○ 7 Highly proficient

11. How much did the control devices interfere with the performance of assigned tasks or with other activities?

○ 1 High level of interference ○ 2 ○ 3 ○ 4 Moderate level of interference ○ 5 ○ 6 ○ 7 Low level of interference

Sense of Presence Survey

6. Open-Ended Questions

Things that hindered or helped

1. What new techniques (if any) did you learn that enabled you to improve your performance?

2. Please list any things that hindered you from successfully accomplishing the activity.

3. Please list any things that contributed to successful completion of the activity.

APPENDIX B

Post-Session Semi-Structured Interview Protocol

Researcher will be present during each collaborative learning activity session, collecting raw data from observation, and from chats and instant messages related to the collaborative learning activity. Observations will be collected in a pre-specified format, in field notes on in-world notecards, and notecards with transcripts of chats (date and time of session, participants involved, participant comments in group chats or instant messages, activities to review later from the activity recording, notes about synchronization points to relate chat commentary to participant activities including time stamps, spatial data about location of activities).

For those participants who volunteer to participate in an optional post-session semi-structured interview, the following structured questions will be asked:

1. What things hindered you from successfully accomplishing the activity?
2. Specifically regarding the mechanism which controlled movement through the environment: what aspects of it required additional attention that may have hindered your completion of the activity? What changes would have been helpful?
3. Specifically regarding the mechanism for communication (group IM/chat), what aspects of it required additional attention that may have hindered your completion of the activity? What changes would have been helpful?
4. Specifically regarding the number of windows required to carry out an activity: to what extent were you able to manage the number of open windows successfully? To what extent were they a hindrance?
5. What things contributed to the successful completion of the activity?
6. What assisted the team’s collaborative effort?

7. What hindered the team’s collaborative effort?
8. What new techniques did you learn during the experience that enabled you to improve your performance?
9. What other tools would have been beneficial?

Additional Questions:

10. Would being able to move others’ objects have been a help or a hindrance?
11. Regarding camera view, did you use it to build your object or work on the group object? If you did not use it during any of the sessions, can you tell me a little bit about why?
12. Could you tell me a little bit about moving your avatar around for multiple perspectives on the object(s) you were building?
13. Were you able to create a “personal map” of the island?

APPENDIX C

Wayfinding Script

The script used for Experiment A, using the wayfinding (Find) intervention, is given below.

1. PREPARATIONS: Experiment A Assignment and Instructions notecard given prior to session; Clues given prior to session.
   a. If things get too dark, switch to Midday Sun: World from top pull-down menu, Choose “Environment,” then choose “Midday”.
   b. Remind people the session is being videotaped, and snapshots are being taken for later review, and get permission to use in final defense. Introduce Judy Brune, the videographer.

ALL: Please don’t leave the session without taking the survey at the end, which you can get by clicking the box on the ground beside Wendy’s desk, in the red-tiled Malibu Island Central Plaza, where the black cat roams. Don’t worry if you don’t finish collecting all the tiles, but you do need to leave 10 minutes for the survey.

The schedule for the experimental session is as follows:

10 minutes for rules and map orientation

40 minutes for treasure hunt

10 minutes for survey

   c. Please don’t use VoIP – it will change the character of the experiment.
   d. Start the Group IM and everybody start using it (local chat does not work across distances). Click “Communicate” button at bottom of screen, “Contacts” from the bottom tab in the communicate window, “Groups” from the top tab in the communicate window (next to “Friends”) Highlight your Cadre (Cadre14 or

CadreXIII), then double-click on your cadre name (may need to click on “Join Call”).

e. Make sure the tab with your cadre shows up next to the Local Chat tab in your “Communicate window”, and click on the Cadre tab to make it active. Everybody check in and make sure you are using the group IM, not the local chat. (Give your permission to have videotape clips and snapshots be used later in my final defense, in the group IM)

f. NOTE: You can <ESC> out of your IM window so you can move around or do other functions, just click back into it to post a message. <ESC> works to get out of other windows too, like the Map window.

g. Pick a team leader, and make sure everybody is an SL friend if not already. That way friends can quickly teleport you if you get lost. (Right-click on other’s avatar, and “Add a Friend” from the pie menu.) [Teleport a friend to you by clicking in the Communicate window on Contacts from the bottom tab/Friends from the top tab; look for your friend and click on their SL name, and click on teleport.]

2. MAP ORIENTATION: Start out at location: “sandbox/grassy knoll”.

   a. <ALT>-Left mouse click to center yourself in the screen.

   b. Zoom out a bit using your mouse scrollbar so you can see yourself and your surroundings. (Remember zoom in and zoom out anytime to help you orient yourself in the world).

   c. Note that the “grassy knoll” is really the island sandbox for freeform building. There are four bright green flags delineating the sandbox, which you should be able to find again easily as an orientation point for your travels.

d. Move your avatar, using the left or right arrows, until you are facing the same way I am, toward the large white building with windows and blue exhibit tables, the Exhibition Pavilion.

e. Click on the “Map” button at the bottom of your screen (you can resize it so you can see more of the screen.) You can also reposition the Map window; I often put mine in the lower left or right so I can see what’s in front of me better.)

f. The Map window is now the primary window; press <ESC> to put the Map window in the background. It will continue to show your location. (You can press <ESC> at any time to get out of the Map window, the Chat window, etc. so you can move around with the arrow keys).

g. Note that you are now facing SOUTH (the yellow dot on the map represents your avatar, the light-colored triangle of light represents what is in your range of vision facing that way). You can see the large white building on the map. This is the Exhibition Pavilion**.** *Note that you are represented by a yellow dot, and everyone else by a green dot.* [Make sure map is clearly rendered]

h. Move your avatar to face right (face the same way I am facing now, note you moved your view triangle toward the WEST on the map).

i. Note that there is a red-tiled area (The Malibu Island Central Plaza) and a large purple statue). You can see the red tiles and the purple statue on the map as well if you look closely. This is also where a survey box is located, as well as here in the sandbox.

j. Move your avatar using the right arrow until your view triangle on the map is facing out toward the NORTH. Note you can see out over the ocean (the brown buildings are dressing rooms for trying on different outfits another time).

k. Move your avatar to the right again so that you are facing EAST. Note that the pillow area is to the east of the grassy knoll, and if you look closely you can see the brightly colored dots for the pillows. Follow Wendy to the Green Spire to the east.

l. Note that there is a red arrow pointing toward the OMET Exhibit (Learning Theory Exploratorium) at the beginning of the flightpath.

m. Click on “Fly”. Notice that you can look down on the ground by setting the focus there: Point to the ground slightly ahead (the next arrow in the flight path) <ALT>-LEFT CLICK to center it in your window. That’s a way of looking down and flying from arrow to arrow.

3. START THE TREASURE HUNT: Everybody check in so I know everyone is still with me.

   a. Now, Open your Clues notecard to share clues with others and the rules from Wendy (Clues to Share for Red, etc.) (Find your notecard in the “Inventory” (bottom right of screen) under “Notecards” – and take a look at it now.) There will be separate hints for each of you on all of the notecards as you go through the treasure hunt. *ALL – Six places to go, counting the survey location.*

   b. Notice from your notecard that your first clue in the list (numbered 1.1, 1.2, or 1.3, etc.) are all clues to help find the RED building block. Second set of Clues (2.1, 2.2, or 3.3 etc.) help find the YELLOW building block, Third clues (3.1, 3.2, or 3.3, etc.) help find the GREEN building block. Fourth clues (4.1, 4.2, or 4.3, etc) help find the BLUE building block and Fifth set of clues (5.1, 5.2, or 5.3, etc) to help find the Pink. You will need to share clues for EACH colored building block BEFORE you start off to get to where the building block is hidden. NOTE: when you are done as a group collecting all the prizes (the different colored building blocks), have a cup of coffee with Wendy, and take the survey.

c. Team stays together to help each other with the clues and the rules. Each of you has clues on your notecard for the other players, which in combination will give you the information you need. Some of the prizes are hidden, and all eyes will help find them. The prizes are found in a certain order: RED, YELLOW, GREEN, BLUE, PINK.

d. For example, everyone look at your notecards to figure out all the clues related to RED (#1.1, 1.2, 1.3, 1.4), copying from the #1 clues into the IM window to compare notes and collect up clues. You'll use those clues to find red building block # 1; focus on all the #1 clues (1.1, 1.2, 1.3, etc) until you find the red Building block.

e. When you find the block, take a copy (Right-click on the object, click on "More", "Take a copy"). Somebody get a copy (and let the others know when you do), then focus on the #2 clues to decide where and how you need to go next, and then the team leader leads the way when everyone is ready. This is repeated for each color building block.

f. The leader's job is to collect everyone up, make sure each tile has been picked up by the assigned color, ask if everybody is ready to head off again. I may disappear from time to time, since I am observing. Don't worry about it, I'll be there when you are ready to head off again.

g. TIP: Look all around you when you are flying . . . you may see a location you will be returning to later. I'll be around, let me know if you need a hint or help. [Now . . . you can go to look for the Red Building Block.]

4. AT END: Have a cup of coffee and fill out the survey (pet the kitty if you want). How fun on a scale of 1 to 5? Permission to share snapshots and clips of videotape in final defense?

APPENDIX D

Building Script

1. PREPARATIONS:

   a. If things get too dark, switch to Midday Sun: World from top pull-down menu, Choose “Environment,” then choose “Midday.”

   b. Remind people the session is being videotaped, and snapshots are being taken for later review, and get permission to use in final defense. Introduce Judy Brune, the videographer.

   c. The experiment is an hour long:

      10 minutes for brief orientation

      40 minutes to collaboratively build a shape

      10 minutes to complete survey

   d. Note: If my avatar disappears or seem to be unresponsive, it will either be because of lag, or because I've lost my network connection, and I'll come right back as soon as I can.

   e. Please don’t use VoIP – it will change the character of the experiment.

   f. Open and review this instruction notecard (Wendy will offer it to you during the session, be sure to choose “Keep,” and leave notecard open.) [Mac commands are listed below and in brackets in the document].

      FLY UP ... FN + page-up

      FLY DOWN ... FN + page-dwn

      Bring up Item Menu (the circular menu)

click on object then: APPL key + CLICK

To Focus On an Object

ALT/OPT key + click

To ZOOM in and out on that object:

ATL/OPT key + page-up or page-down

g. If you lose the notecard window, choose "Inventory" from the bottom of the screen, look for your notecard folder, and look for notecard named "Experiment B Assignment and Instructions.

h. Optional: Use the “Communicate” button, choose “Contacts” from the bottom tab, then “Groups” from the top tab. Your current active group will be bold-faced. If not, click on the group and click on the Activate button.

i. Wait for Vicki to initiate a Group IM so that your conversation will be in one place and you can scroll down and up. (Or Choose IM/Call from the “Communicate” window, and then click on “Join Call” in the Group IM window). You should be able to see a tab at the bottom of the Communicate window next to “Local Chat,” with the Cadre name. That's where I'll be giving instructions and help, rather than in Local Chat. Note that when a message is posted, the "Communicate" window becomes the primary window. Use <ESC> to get back to avatar control.

j. Move your “Communicate” and Notecard” windows so they are out of the way of your building area.

k. Get your color assignment (Red, Blue, Green, Yellow or Pink) (remind about Group Assignment)

l. The object sitting at the edge of the white floor of the white photo studio is your model; notice the green in the center, red on one side, blue on the other).

2. ASSIGNMENT: Individually, using Build button at bottom of Screen. Edit window, Object tab, build and size a square shape on the floor of the white photo studio (it has white wall and white floor, next to the red tile steps down to the Central Plaza).

   a. The object will be one side of the square. The size of the object is:

      X= 1 meter

      Y = .010 meter

      Z = 1 meter

   b. Using "Texture" tab in Edit Window, make the object the color you are assigned (red, blue, green, yellow or pink)

3. Using "General" tab in the Edit Window

   a. Make sure the creator is yourself, the owner is yourself, and the group is set to your Cadre.

   b. Give the object a name made up of your name plus your assigned color

   c. Make sure you have the following items checked:

      Share with Group

      Allow anyone to move

      Allow anyone to copy

4. Practice manipulating your individual objects. Hints:

   a. Focus on the object using ALT-left click [ALT/OPT key + Click]

b. Use your camera controls (View from pull-down menu at top, Choose Camera)

c. Using the camera widget,

pan left around the object with the left arrow in the widget,

right with the right arrow in the widget,

move to birds' eye view from top using up arrow

d. Zoom in or out using mouse scrollbar [ALT/OPT Key + page-up or page-down]

e. Move the object by clicking and dragging on the edit arrows. (you will need to do this to make sure everything lines up.)

f. If you lose the edit window, Right-click and choose edit from the pie menu [Click, APPL Key = click]

5. Collaborate to line up your objects to make the shape the same as the model shape (doesn't have to be perfect.) Hints:

a. To rotate an object to get it at a right angle perpendicular to another object, experiment with:

setting Z to 90 degree rotation using "Object" in Edit window

setting X to 90 degree rotation using "Object" in Edit window

setting Y to 90 degree rotation using "Object" in the Edit window

6. Pose together around object for a picture.

7. Complete online survey at:

http://www.surveymonkey.com/s.aspx?sm=gJccdJk_2fQ_2bUmWxcVXp_UWUg_3d_3d

better to open a new regular browser window

(You can click on the box at the foot of the Sandbox flag next to the photo studio wall to go directly to the URL).

8. Come back from survey for brief interview if you are interested in extra $250.

APPENDIX E

Combined Wayfinding and Building Script

1. PREPARATIONS:

    a. If things get too dark, switch to Midday Sun: World from top pull-down menu, Choose “Environment,” then choose “Midday.”

    b. Remind people the session is being videotaped, and snapshots are being taken for later review, and get permission to use in final defense. Introduce Judy Brune, the videographer.

    c. The experiment is an hour long:

        15 minutes for orientation

        40 minutes to collaboratively build a shape and create a treasure ma

        5 minutes to complete survey

    d. Note: If my avatar disappears or seem to be unresponsive, it will either be because of lag, or because I've lost my network connection, and I'll come right back as soon as I can.

    e. Please don’t use VoIP – it will change the character of the experiment.

    f. Get set up to join Group IM for your cadre.

    g. Use the “Communicate” button, choose “Contacts” from the bottom tab, then “Groups” from the top tab. Your current active group will be bold-faced. Double-click on the group to initiate a Group IM.

    h. You should be able to see a tab at the bottom of the Communicate window next to “Local Chat,” with the Cadre name. That's where I'll be giving instructions and help, rather than in Local Chat.

i. Note that when a message is posted, the "Communicate" window becomes the primary window. Use <ESC> to get back to avatar control.

2. ORIENTATION (Practice Building and Creating a Notecard) [Spread out along the white building floor]

   a. Click on the “Build” button at the bottom of the screen.

   b. Change from the default square to another shaped object. (From the second and third rows at the top of the edit window, you choose the shape you would like to build - box, prism, cylinder, etc.).

   c. Click the “magic wand” on the ground in front of you to start with the shape you’ve chosen

   d. Reminder: if you click elsewhere you get out of active edit mode and you won’t see the red, green and blue lines or an active edit window. Just right-click on the object and choose “Edit” from the pie window to get back into active edit mode for that object.

   e. Using the “General” tab, rename your object to your name (in the Name: field) so you don’t end up with a number of objects called “Object.”

   f. You change the size of the object by holding down the <CTRL>-<SHIFT> keys, noting the little blocks of color that appear.

   g. Continue to hold down the <CTRL>-<SHIFT> the keys, point to one of the little color boxes that shows the side you want to resize (red, green, or blue and click and drag to resize).

h. Click on the “Texture” tab of the Edit window, double-click on the “Texture” box that appears (the default texture is “wood”), note that your inventory window opens.

i. Look for the Texture folder and texture in there you would like to try, and click on it (your object will immediately change to the new texture.)

j. Double-click on the Color window and change the color.

k. Close the Color and Texture windows.

l. Click on the “Object” tab of the edit window, and play with twists, tapers, shears and hollowing (some won’t be available to objects that are already hollow, for example) so you can get a sense of how you can change object shape. You can always set these back to zero.

m. Right-click on your object and choose “Take.” Click on the inventory button, and notice that your object is now in your inventory under the “Object” folder, in alphabetical order by the name you gave the object.

n. To put the object back for editing, click and drag from the inventory to the ground in front of you (avoid dragging onto your avatar, or you will end wearing the object).

o. NOTE: While it is possible, better not to try and move each other’s shapes (share setting needed).

p. How to create a notecard: Click on the inventory button. Choose the pull-down menu “Create” and choose “New Note.”

q. Inside the inventory window, you will see a notecard highlighted named “New Note”. Type a new name (your name is ok). Type a short note inside of your notecard, and click on “Save.” Your notecard will be kept in your inventory in the Notecard folder.

r. Close your note window and inventory windows.

3. ASSIGNMENT: Goal: Create a group object and win $100 Linden for each team member by writing a good treasure map for finding it. Follow me to the purple statue by the coffeehouse.

   a. Check out your map so you can get back here (Click on “Map”) - you can see you are in the red-tiled area.

   b. Choose a group leader.

   c. As a group, you will navigate to another non-obvious location on the island (away from the purple statue in the red-tiled area, and not in the sandbox area). You can double click on a place in your map and teleport there immediately once your team decides – but remember you are going to have to find your way back to the purple statue, so don’t hide your object so well you can’t write a treasure map back to it. Keep it simple.

   d. At that location, you will create a *simple* group object by putting together the objects you made earlier (editing them further if you need to). Remember to click and drag the object from your inventory to the ground to edit it and putting it together with the other group objects. Take about 15 minutes to create your group object. (Remember your camera view for getting good perspectives on the objects as you move them around and put them together.)

e. Then for the last 25 minutes you should reverse-engineer the path from the purple statue to where your jointly-created object is, so that a novice can find your object starting from the purple statue, using the map and obvious landmarks (e.g., go south past the sandbox, follow the flight path to the stone steps, go west to just past the hobbit house)

f. The group leader creates a notecard, enters the treasure map into a new notecard. Everyone comes back to the purple statue in time for the group leader to give it to Vicki (click and drag notecard over the Wendy Widget avatar).

g. Whichever group writes a good treasure map will win $100 Linden per group member.

4. Everyone gets $1,000 Linden for participating in the three experiments and filling out the survey.

5. [Mac commands are listed below]

FLY UP ... FN + page-up

FLY DOWN ... FN + page-dwn

Bring up Item Menu (the circular menu)

click on object then: APPL key + CLICK

To Focus On an Object

ALT/OPT key + click

To ZOOM in and out on that object:

ATL/OPT key + page-up or page-down

APPENDIX F

Email Invitation to Focus Group Participants

Dear [name]

As you are an expert in the design and use of instructional technology, particularly collaborative learning environments, I would like to invite you to be a member of a five-person focus group to review nine design guidelines I have proposed as part of a research project designed to study the effect of the guidelines on the sense of presence in collaborative learning, and also to investigate the relationships, if any, among four dimensions of presence: sense of place, social presence, individual agency, and mediated collaboration. I am a doctoral student in educational technology at the Graduate School of Education and Psychology (GSEP), Pepperdine University, under the supervision of Dr. Linda Polin [email address].

Your colleagues on the focus group will be university faculty and staff like yourself, who also have experience with the use of instructional technology in a university or college setting; background in use of instructional technology; background in teaching university classes in instructional technology or in supporting faculty in use of instructional technology; experience with the design and use of computer-supported collaborative learning environments; background in assessing the impacts of the use of advanced technologies in teaching and learning; and familiarity with use of virtual worlds such as Second Life as collaborative learning environments.

As a focus group member, you would participate with the other focus group members in three focus group sessions (each an hour long, reviewing one of three clusters of design guidelines). The focus group sessions are tentatively scheduled in late January and early February of 2009, to be conducted in Second Life, on a private island

(Malibu Island) maintained by GSEP for use by Pepperdine University students. Two weeks prior to the first focus group, you would receive an orientation packet including a six-page matrix describing the nine design guidelines, introductions to your fellow focus group members, instructions for logging on to Second Life and visiting the island, and other information about the focus group sessions.

A report describing the results of the focus group sessions would be provided to participants, for review and commentary, and an opportunity to clarify or correct any comments or interpretations. Unless you give permission otherwise, your Second Life pseudonyms or other personal identifiers will not be given. However, in questions balancing confidentiality, protection of intellectual property, and appropriate attribution of sources, permission will be obtained to use any specific quotes, and you will be given the opportunity to be identified or not as you choose (your decision would be obtained via email).

The focus group sessions will be designed to be engaging, fun, and informative, and the results of the sessions may prove helpful to you in the design of collaborative learning environments.

Please contact me at [email address] to let me know whether you would like to participate, and thank you in advance for your time and interest.

APPENDIX G

Phase I Informed Consent Form

Please read the text below, and if you agree, indicate your consent by return email to the researcher at [e-mail], signifying that you have had an adequate opportunity to consider the information, and that you voluntarily agree to participate in the project.

If you have any concerns or questions that you would like addressed before completing the consent form, please send an email to [email address], or contact by phone at [phone number].

Pepperdine University and the researcher subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort, and safety of subjects. This form and the information it contains are given to you for your own protection and full understanding of the procedures involved. If you are confused or concerned by any issue that arises during your participation in the study, the researcher will be present to answer questions or concerns.

Informed Consent Form

I authorize Vicki Suter, a doctoral student under the supervision of Dr. Linda Polin, in educational technology at the Graduate School of Education and Psychology at Pepperdine University to include me in the research project entitled, “Sense of Presence: Implications for Virtual World Design.” This is a research project designed to study the effect on the sense of presence in collaborative learning spaces designed according to guidelines proposed by the researcher, and also to investigate the relationships, if any, among four dimensions of presence: sense of place, social presence, individual agency, and mediated collaboration. I understand that my participation in this study is strictly voluntary. I understand that I have the right to refuse to participate in, or to withdraw from, the study at any time. I also have the right to refuse to answer any question that I choose not to answer. I also understand that there might be times that the investigator may find it necessary to end my study participation.

I have been asked to participate in this study on the basis of my experience with use of instructional technology in a university or college setting. I understand that my other five colleagues on the focus group will be university faculty and staff like myself, who also have experience with the use of instructional technology in a university or college setting; background in use of instructional technology; background in teaching university classes in instructional technology or in supporting faculty in use of instructional technology; experience with the design and use of computer-supported collaborative learning environments; background in assessing the impacts of the use of advanced technologies in teaching and learning; and familiarity with use of virtual worlds such as Second Life as collaborative learning environments.

The study will require review of a set of nine principles for the design of virtual worlds. I understand that my participation in the study will be to meet online with the other focus group members in three focus group sessions (each an hour long, reviewing three design principles at each). The focus group sessions are tentatively scheduled in late February or early March, to be conducted using group chat in Second Life, on a private island (Malibu Island) maintained by the Graduate School of Education and Psychology for use by Pepperdine University students. Two weeks prior to the first focus group, I will receive an orientation packet including a nine-page matrix describing the nine design principles, introductions to my fellow focus group members, instructions for logging on to Second Life and visiting the island, and other information about the focus group sessions.

I understand that the group chat sessions will be recorded. The recordings will be used for research purposes only, and will be stored on the researcher’s computer, behind a secured firewall. The recordings may be kept for a minimum of three years, for future research.

I understand that the possible benefits from my participation in this study include an increased familiarity with virtual worlds such as Second Life, and their use in computer-supported collaborative learning; access to design guidelines which I may use as a designer of collaborative activities and environments in virtual worlds and other online environments; and if desired, a briefing on the issues associated with research design and methods in virtual worlds. The potential risks from participation are minimal, and may include, for example, fatigue, frustration or boredom.

I understand that no information gathered from my study participation will be released to others without my permission, or as required by law. I understand that a report describing the results of the focus group sessions would be provided to participants, for review and commentary, and an opportunity to clarify or correct any comments or interpretations. Unless I give permission otherwise, my Second Life pseudonyms or other personal identifiers will not be given. However, in questions balancing confidentiality, protection of intellectual property, and appropriate attribution of sources, permission will be obtained to use any specific quotes, and I will be given the opportunity to be identified or not as I choose (my decision will be obtained via email).

The data gathered will be stored on a secure stand-alone computer behind a firewall during the research study. The information gathered may be made available to other investigators with whom the researcher collaborates in future research. If such collaboration occurs, the data will be released without any personally identifying information so that I cannot be identified, and the use of the data will be supervised by the researcher. The data may be kept for an indefinite period of time for research purposes. After completion of research, the data will be destroyed.

I understand that if I have any questions regarding the study procedures, I can contact Vicki Suter at [phone number], or send her email at [email address], to get answers to my questions. If I have further questions, I may contact Dr. Polin at [email address]. If I have further questions about my rights as a research participant, I may contact Dr. Doug Leigh, Chairperson, Graduate and Professional Schools Institutional Review Board, Pepperdine University, at [phone number].

I understand to my satisfaction the information in the consent form regarding my participation in the research project. All of my questions have been answered to my satisfaction. I have received a copy of this informed consent form which I have read and understand. I hereby consent to participate in the research described above.

I have explained and defined in detail the research procedure in which the subject has consented to participate. Having explained this and answered any questions, and having received consent via electronic mail, (see attached). I am cosigning this form and accepting this person’s consent.

Principal Investigator’s Signature Date

APPENDIX H

Phase II Informed Consent Form

Please read the text below, and if you agree, indicate your consent by signing the form and submitting it to the researcher. If you have any concerns or questions that you would like addressed before completing the consent form, please send an email to vicki.suter@pepperdine.edu (or discuss them in the orientation meeting).

Pepperdine University and the researcher subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort, and safety of subjects. This form and the information it contains are given to you for your own protection and full understanding of the procedures involved. If you are confused or concerned by any issue that arises during your participation in the study, the researcher will be present to answer questions or concerns.

Your signature on this form will signify that you have had an adequate opportunity to consider the information, and that you voluntarily agree to participate in the project.

Informed Consent Form

I authorize Vicki Suter, a doctoral student under the supervision of Dr. Linda Polin, in educational technology at the Graduate School of Education and Psychology at Pepperdine University to include me in the research project entitled, “Sense of Presence: Implications for Virtual World Design.” This is a research project designed to study the effect on the sense of presence in collaborative learning spaces designed according to guidelines proposed by the researcher, and also to investigate the relationships, if any, among four dimensions of presence: sense of place, social presence, individual agency, and mediated collaboration. I understand that my participation in this study is strictly voluntary, and that my grades will not be affected whether I choose to participate or not. I understand that I have the right to refuse to participate in, or to withdraw from, the study at any time without prejudice to my grade or standing in the course. I also have the right to refuse to answer any question that I choose not to answer. I also understand that there might be times that the investigator may find it necessary to end my study participation.

I have been asked to participate in this study because I am a student in the doctoral program in educational technology, in the Graduate School of Education and Psychology, Pepperdine University, enrolled in one of Dr. Linda Polin's Spring 2009 classes–EDET 730 (Research Methods) or EDET 770, (Learning and Design) which utilizes the virtual world, Second Life, as a collaborative learning environment.

The study will require two orientation meetings of one and one-half hours each, and three small group sessions of one hour each. I will be asked to complete a survey after each of the small group sessions. If I choose to do so, I may also participate in a short interview after the small group sessions. I understand that I will not receive monetary compensation for the study, but I will receive 1,000 in Linden “dollars” (for my use in Second Life) at the end of the final session of three sessions (contingent upon completion of an online survey at the end of each session). I understand that if I choose to participate in an individual interview at the completion of a group session, I will receive an additional 250 in Linden dollars.

I understand that the sessions will be recorded (including group chats and the activities in which I participate during the session). The recordings will be used for research purposes only, and will be stored on the researcher’s computer, behind a secured firewall. The recordings may be kept for a minimum of three years, for future research.

Attachment 1, **Phase II** Informed Consent Form, "Sense of Presence Research Study," Page 2

I understand that the possible benefits from my participation in this study include an increased familiarity with virtual worlds such as Second Life, and their use in computer-supported collaborative learning; access to design guidelines which I may use as a designer of collaborative activities and environments in virtual worlds and other online environments; and a briefing on the issues associated with research design and methods in virtual worlds. The potential risks from participation are minimal, and may include, for example, fatigue, frustration or boredom.

I understand that no information gathered from my study participation will be released to others without my permission, or as required by law.

If the findings are published or presented to a professional audience, no personally identifying information will be released. The data gathered will be stored on a secure stand-alone computer behind a firewall during the research study. The information gathered may be made available to other investigators with whom the researcher collaborates in future research. If such collaboration occurs, the data will be released without any personally identifying information so that I cannot be identified, and the use of the data will be supervised by the researcher. The data may be kept for an indefinite period of time for research purposes. After completion of research, the data will be destroyed.

I understand that if I have any questions regarding the study procedures, I can contact Vicki Suter at [redacted] or send her email at vicki.suter@pepperdine.edu, to get answers to my questions. If I have further questions, I may contact Dr. Polin at linda.polin@pepperdine.edu. If I have further questions about my rights as a research participant, I may contact Dr. Doug Leigh, Chairperson, Graduate and Professional Schools Institutional Review Board, Pepperdine University, at 310-568-2389.

I understand to my satisfaction the information in the consent form regarding my participation in the research project. All of my questions have been answered to my satisfaction. I have received a copy of this informed consent form which I have read and understand. I hereby consent to participate in the research described above.

Participant's Signature Date

I have explained and defined in detail the research procedure in which the subject has consented to participate. Having explained this and answered any questions, I am cosigning this form and accepting this person's consent.

Principal Investigator's Signature Date

GPS IRB APPROVAL
PEPPERDINE UNIVERSITY

JAN 26 2010

VALID UNTIL
DATE ABOVE

APPENDIX I

Permission to Use Instrument (Biocca)

Vicki Suter

From: Frank Biocca [biocca@msu.edu]
Sent: Tuesday, December 09, 2008 3:02 PM
To: Suter, Vicki (student)
Cc: Polin, Linda
Subject: RE: Permission to use questionnaire

Yes, no problem. Let me know if you need more support.

From: Vicki Suter [mailto:vicki.suter@pepperdine.edu]
Sent: Friday, November 07, 2008 5:23 PM
To: biocca@msu.edu
Cc: 'Linda Polin'
Subject: Permission to use questionnaire

As you are the author of some of the seminal works on social presence in virtual environments, and you are using a theory-based approach that uses a more precise definition of social presence than other studies, I would like to use your survey instrument (focusing in particular on mutual awareness, attentional allocation, mutual understanding, and mutual assistance) in my doctoral research. May I have your permission to use the instrument you describe in your article, "The Networked Minds Measure of Social Presence: Pilot Test of the Factor Structure and Concurrent Validity," (with attribution of course)?

I am a doctoral student at the Graduate School of Education and Psychology at Pepperdine University, and my topic is the sense of presence and implications for design of virtual worlds, with the open-ended, socially-oriented virtual world Second Life as a research testbed. My advisor is Dr. Linda Polin (linda.polin@pepperdine.edu).

Vicki Suter

Doctoral Student, Graduate School of Education and Psychology, Pepperdine University

vnsuter@pepperdine.edu

[redacted]

12/9/2008

APPENDIX J

Permission to Use Instrument (Singer)

Vicki Suter

From:	Singer, Mike [Michael.Singer@us.army.mil]
Sent:	Monday, November 10, 2008 9:44 AM
To:	'vicki.suter@pepperdine.edu'
Cc:	Jerome, Christian
Subject:	RE: Permission to use Presence Questionnaire (UNCLASSIFIED)
Attachments:	Presence Vs4 RO.doc

Presence
RO.doc (128

Classification: UNCLASSIFIED
Caveats: NONE

Ms. Suter,

We almost always allow use of the Presence Questionnaire. A copy with scoring instructions is attached.

Please note that Dr. Witmer has retired, and Dr. Jerome is also working on presence, immersion, and gaming.

Regards,
Mike Singer

*********************>> Forwarded by Dr. Michael J. Singer <<************%)
Classification: UNCLASSIFIED Caveats: NONE

U.S. Army Research Institute for the Behavioral & Social Sciences
ARI-Orlando Research Unit
12350 Research Parkway, Orlando FL, 32826-3276
(407) 384-3993; DSN: 970-3993; FAX: (407) 384-3999
michael.singer@us.army.mil

-----Original Message-----
From: Vicki Suter [mailto:vicki.suter@pepperdine.edu]
Sent: Friday, November 07, 2008 5:23 PM
To: Bob_Witmer@stricom.army.mil; Singer, Mike
Cc: 'Linda Polin'
Subject: Permission to use Presence Questionnaire

As you are the authors of some of the seminal works on measuring presence in virtual environments, and widespread use and evaluation of your Presence Questionnaire has demonstrated its validity and sensitivity, I would like to use your survey instrument (focusing in particular on the set of questions related to control factors) in my doctoral research. May I have your permission to use the instrument you describe in your Presence article, "Measuring Presence in Virtual Environments: A Presence Questionnaire," (with attribution of course)?
I am a doctoral student at the Graduate School of Education and Psychology at Pepperdine University, and my topic is the sense of presence and implications for design of virtual worlds, with the open-ended, socially-oriented virtual world Second Life as a research testbed. My advisor is Dr. Linda Polin (linda.polin@pepperdine.edu).

Vicki Suter
Doctoral Student, Graduate School of Education and Psychology, Pepperdine University
vnsuter@pepperdine.edu [redacted]

Classification: UNCLASSIFIED

APPENDIX K

Permission to Use Instrument (Slater)

Vicki Suter

From: [redacted]on behalf of Mel Slater [m.slater@cs.ucl.ac.uk]
Sent: Saturday, November 08, 2008 9:19 AM
To: Vicki Suter
Cc: m.usoh; A.Steed; Linda Polin
Subject: Re: Permission to use SUS questionnaire

Hello, yes, the questionnaire is not copyrighted or restricted in any way.
regards
Mel Slater.

On 07/11/2008, Vicki Suter [redacted] wrote:
> As you are the authors of some of the seminal works on measuring presence in
> virtual environments, and widespread use and evaluation of the SUS
> Questionnaire has demonstrated its validity and sensitivity, I would like to
> use your survey instrument (focusing in particular on the set of six
> questions related to sense of place) in my doctoral research. May I have
> your permission to use the instrument you describe in your articles, "Using
> Presence Questionnaires in Reality," and "Depth of Presence in Immersive
> Virtual Environments" (with attribution of course)?
> I am a doctoral student at the Graduate School of Education and Psychology
> at Pepperdine University, and my topic is the sense of presence and
> implications for design of virtual worlds, with the open-ended,
> socially-oriented virtual world Second Life as a research testbed. My
> advisor is Dr. Linda Polin (linda.polin@pepperdine.edu).
>
>
> Vicki Suter
[redacted]
>
>
>

Appendix K

APPENDIX L

Sense of Presence and Virtual World Grid

Table L1

Presence/Virtual World Comparison Chart

Virtual World	Sense of place	Social presence	Individual agency	Mediation of collaboration
World of Warcraft	Broad range of travel options; cues and landmarks; recognizable, unique persistent places; (no personal spaces or persistent group space)	Support for multiple channels of communication; VoIP in-world; chat topics include the personal; high level of mutual awareness, attention, and assistance	Strong backstory for authentic imperative for action; clear task-oriented quests and raids for leveling up; customization and unique identity through object collection from range of “menu” choices	Guild and instance structure strong mediation tool for collaboration; selection of roles to choose from; strongly-enforced social norms; well-developed communities of practice (many external)

(table continues)

Virtual World	Sense of place	Social presence	Individual agency	Mediation of collaboration
Multi-player first-person shooters (American Army, Counterstrike, Halo)	Very important in military engagement for strategic view of space–holding high ground, etc. (aesthetics less important) Maps not usually generated per instance, have to memorize where spawn points or resources are generated; radar view shows terrain and where enemies are currently	Emphasis on using keyboard and mouse for movement/aiming; can go into text chat, in chat mode but not operating mode; game not designed to facilitate social environment; emotional support is counter to the general practice; often worst of 9-year-old male trash talk; Some use VoIP in-game or separate agreed-upon channel;	Authentic imperative for action; requirement to maintain standard avatar “shootable area” so customization through skins over same wireframe graphic; Can blow up landscape, manipulate objects (no persistence); can accrue power (level up) in some games	External community of practice (sharing hint files of jpeg maps showing concentrations of enemies and resources); Coordinating attacks for team-based games; in general no permanent guilds; home server structure such that may play more games with that clique than elsewhere; can choose roles

(table continues)

Virtual World	Sense of place	Social presence	Individual agency	Mediation of collaboration
Sims style “furniture arranging” games (Animal Crossing for Nintendo Wii peer-to-peer, not multiplayer)	Very concrete sense of place: map and home gets generated as part of running first game; players can put flowers, trees, other decorations, furniture, customize their homes and yards	Socio-emotional communication channels, with smile, heart, hug; voice chat and text chat; point of game is to visit, play with each other and socialize	Within backstory of game, authentic imperative for action: make town the perfect town, for example, find (buy) and add things to town’s museums (fossils, fish, insects)	Mutual cooperation benefits both players; game tools like stop watch for hide and seek, bubble wands, chess pieces; in-game economy and auction houses for goods

(table continues)

Virtual World	Sense of place	Social presence	Individual agency	Mediation of collaboration
Multi-player Puzzle Pirates	Place is persistent and pirate avatar is where you last left it; multiple oceans with their own map and island, routes that ships must navigate, some characters have role of memorizing charts	External life events discussed in-game using chat; Can tell when one's "hearties" come online (group awareness); social cueing to build memberships (crews and flags); teams recruited through relationships	Authentic imperative for action: solve interactive arcade-type puzzle (mostly object/pattern manipulations or Tetris-like puzzles; Avatar highly customizable; ranking up supported; menu-based construction of resources	Persistent world with two level team structure: crews and flags; tasks are allocated by roles; player can be free-agent or guild-loyal