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Telepresence: A 'Real' Component in a Model to Make Human-Computer Interface Factors Meaningful in the Virtual Learning Environment

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Abstract

A thorough review of the research relating to Human-Computer Interface (HCI) form and content factors in the education, communication and computer science disciplines reveals strong associations of meaningful perceptual "illusions" with enhanced learning and satisfaction in the evolving classroom. Specifically, associations emerge between spatial illusions (sensory space) and low-level learning objectives, e.g., memorization; and social illusions (interaction) and high-level learning objectives, e.g., evaluation. What are glaringly absent, however, are measures to define and associate the factors of the technologically advanced Virtual Learning Environment (VLE) with the illusions and levels of learning. The researchers detail the factors associated with the communication concept "telepresence" ("presence") that is particularly relevant to the illusions in the VLE. Through a synthesis of the literatures and extensive research at a N.Y. school, they create and test presence technology guidelines, measures, and learning assessments to enhance illusions, learning and satisfaction in the VLE (Selverian, 2005).

Introduction

From the mid-20th Century in the education, communication and computer science disciplines, there has been a gradual and yet powerful shift in the human-computer interaction (and more specifically, human-computer interface) (HCI) research, the effects of which are increasingly evident in the field of education. Namely, HCI factors are being called upon more often to improve the quality and meaningfulness of subjective perceptions of the learning experience, much more elusive considerations than those of computer hardware, software or even human cognitive or physical responses of the early HCI research (Card, Moran, & Newell, 1983; Chaffee & Hockheimer, 1985; Engelbart, 1963; Hewett et al., 1996; Salvendy, 1984). A fascination with how to bring the electronic and digital technologies to the traditional and distance learning classrooms through the 1900s is evolving into a driving curiosity as to how to bring the learner psychologically closer to the subject matter through virtual reality technologies in the Virtual Learning Environment (VLE) of the 2000s. In essence, the allure of the computer is becoming more transparent, while attention to the human in his/her entirety is becoming more apparent.

As virtual reality technologies are beginning to increase in accessibility, affordability and ease of use – namely in the form of 3-D (three-dimensional) desktop programs and through Internet resources – and as there is a gradual increase in interest and investment at the primary, secondary and higher levels of education in the successful integration of advanced technologies into curricula, this article focuses largely on the preparation of the academic world to guide this integration. Particular emphasis is placed on the achievement of a subjective perception of a seemingly “real” illusion of the subject matter through exposure to a collective system of sense-surrounding and interactive advanced technologies designed to enhance learning – the VLE. Researchers and educators in multiple disciplines have attempted to evoke the illusion of subject matter through the increasingly sophisticated technologies of the traditional classroom (face-to-face), distance learning environment (technology-connected) and emerging VLE. They have attempted to define and optimally use the evolving HCI form (structural) and content (subject matter) factors – namely the multiple sensory and interactive outputs (cues), learner-controlled navigation, first-person point of view and narrative techniques. Further, researchers have proposed guidelines that associate the illusions of subject matter in the classroom with the achievement of specific learning objectives. This article draws together some of the most frequently referenced technology form and content guidelines associated with illusions of subject matter and learning objectives in the education, communication and computer science literatures. It then synthesizes these guidelines into the form and content factors of a communication concept particularly relevant to the illusions of the VLE called “telepresence,” (or “presence”), a psychological state or subjective perception of non-mediation (International Society for Presence Research, 2008). Finally, “presence” is proposed as an essential element in a VLE model that offers form and content factors both precisely and comprehensively designed to make the technology invisible, the illusion more “visible,” and the learning objectives more highly achievable than ever before.

Form and content factors: a multi-disciplinary investigation

Primarily in the education, communication and computer science disciplines, there is much literature on the software and hardware engineering theories and methods that researchers and educators have used to bring HCI factors to the traditional, distance learning and virtual learning classrooms (Hunt, 1999; Stolterman, 2006). Additionally, ample HCI research has focused on the computer itself as a tool for storing, sorting and providing data (Hunt, 1999; Stolterman, 2006). Another section of the HCI literature has centred on the quantitatively measurable human cognitive and physical responses to the sorted data – namely memory, attention and motor response (Jacko & Sears, 2003). Very little of the research, however, has focused on the psychological perceptions of complex arrangements of data and sensory cues, and to the precise relationship of these perceptions to higher levels of cognition, interest, control and satisfaction. "Less than 1% of the literature is calling for the community to re-think its priorities in terms of humans controlling complex real-time systems with a greater degree of engagement" (Hunt, 1999). Equally significantly, there is little research that takes a multidisciplinary theoretical approach to using HCI factors to more comprehensively meet the learner's psychological and cognitive needs, and to assemble a more complete model for the appropriate use of HCI factors in the developing VLE.

The following sections offer an overview of some of the most relevant concepts and theories in the education, communication and computer science literatures relating to HCI factors in the VLE, and a synthesis of these literatures in the form of technological guidelines and perceptual and learning measures for the optimal use of HCI factors in the VLE. The sections are offered, likewise, to promote a discussion between and among the different theoretical schools of thought, in order to build a solid intellectual framework for the enhancement of the VLE.

Touchstones in education

Arguably, throughout civilization, but assuredly since the earliest philosophical debates about the written word of the 5th Century BCE between Socrates and Phaedrus, there has been concern about the appropriate use of technologies to engage the senses and promote interaction in learning (Plato, trans. 1966). "The gardens of letters," Plato suggested through the voice of his teacher Socrates, may "produce forgetfulness in the minds of those who learn to use it … Serious discourse is far nobler, when one employs the dialectic method" (Plato, trans. 1966, p. 46). The debate over the cognitive responses to technological cues and the interaction through them has endured in the education literature, leading to some basic theories and guidelines that have directed the evolving classroom through the centuries. The following sections highlight the most widely used of these theories and guidelines.

Bloom's taxonomy of educational objectives

At the height of the instructivist era in the mid-1950s, when Socrates' and Plato's dialectic approach, and the potential of a learner's cognitive response to it, were often less addressed than the instructor's objectives, theorist Benjamin Bloom drew primarily on popular principles of precision teaching, mastery learning and standardized assessments to interpret the value of the traditional classroom (Bloom, Englehard, & Furst, 1956; Reeves & Reeves, 1997; Rosen, 1998). Bloom et al. (1956) emphasized that teacher direction is fundamental to learning achievement. At the same time, he began to discover that behavioral responses could vary based on the method of presentation and the material. He theorized that learning should occur in distinguishable units to optimize a teacher's impact. He further suggested that the success of the sequential units was proportionate not only to the precision of a teacher's direction but also to the investment of effort of the individual or group in accomplishing the learning objectives. Bloom began to recognize the importance of feedback and sought to provide this to students through diagnostic tests and corrections (Mastery Learning, 2001; Rosen, 1998). Even within a highly instructor-focused period, the relationship of the learner's response to the form and content of the curriculum and the method of its delivery began to emerge.

Bloom's theory is best captured in his Taxonomy of Educational Objectives, still a widely used model in education today (Bloom et al., 1956; Harrow, 1972; Kemp & Smellie, 1994; Krathwohl, Bloom, & Masia, 1964; McGrath & Noble, 1993). In it, Bloom took his associations between and among teaching materials, feedback and learner effort a step further. He identified a relationship between levels of learner effort and levels of learning achievement. Specifically, he associated high levels of learner effort with the achievement of high-level or more complex learning objectives, for example, to interpret; and low levels of learner effort with the achievement of low-level or simpler learning objectives, for example, to memorize (Bloom et al., 1956). Bloom categorized learning objectives as mental (cognitive), emotional (affective), and physical (psychomotor) behaviors and ranked them hierarchically in a taxonomy of educational objectives also referred to as learning "domains." Learning objectives are classified as high or low based on descriptive verbs in the cognitive and affective levels of the taxonomy (Bloom et al., 1956).

Dale's cone of experience

During this period, researcher Edgar Dale (1954) began to narrow in on the potential of the teaching materials, supporting Bloom's contention that they can encourage a learner's effort and enhance learning achievement. Dale proposed that materials could evoke "experiences" that are motivating and educational. In his "Cone of Experience," he dissected materials that could be categorized as technologies in the broadest sense of the word – human-made mediations in the learning process. His cone itemized and ranked the form and content factors of the "technologies" available in the day, from text to TV to live dramatization. Form factors focused primarily on sensory outputs or cues and a learner's interactivity with these, which Dale associated with types of sensory and interactive "experiences," levels of learner interest and involvement, and the achievement of low- and high-level learning objectives. Dale called the more sensory and interactive experience "concrete" and the less sensory and interactive experience “abstract.” In the narrowest parts of his cone, he documented the ability of learners to receive “abstract” verbal and visual symbols, for example, text, pictures, and diagrams of subject matter in a passive, low-interactive, experience (Dale, 1954, p. 42). In the next layers of the cone, he depicted the ability of learners to receive slightly more “concrete” listening/observing materials, for example, recordings, radio, still pictures (photos), motion pictures, and TV (Dale, 1954, p. 47). In the middle layers of his cone, Dale forecast the ability of learners to interact with materials, for example, exhibits, field trips, and demonstrations, in a more active or “participating” learning experience (Dale, 1954, p. 47) that could “supply a concrete basis for conceptual thinking” (Dale, 1954, p. 65). Finally, at the widest part of his cone, he forecast the ability of learners to engage the senses in and interact most with the materials, for example, a dramatization, in order to create the most active, simultaneously immersive (sense-surrounding) and interactive or “doing” experience possible. Importantly, Dale supported Bloom’s association of learner effort with high-level thinking, proposing that, at the widest levels of his cone, “observation combined with participation brings higher meaning,” (Dale, 1954, p. 49).

Communication and computer science advances

In the subsequent decades in the communication and computer science literatures, several concepts and theories emerged to strengthen and expand the suggestion in the education literature that the learner’s interest and effort could be encouraged through exposure to socially and psychologically satisfying types of media. Likewise, the theories supported the hypothesis that combinations of sensorially immersive and socially interactive experiences are associated with high-level learning, especially at the “participating” level of Dale’s cone. Uses and Gratifications Theory (Katz, 1959, 1973) set the stage for technology measures that focused on learner motivation and control by defining the technology user as a psychologically motivated, active player, seeking out certain types and content of mass media to connect or disconnect with the world. Social Presence Theory (Short, Williams, & Christie, 1976) and Media Richness Theory (Daft & Lengel, 1984) then proposed more specific form and content factors that might enhance illusions of non-mediated connectedness and social interaction and, ultimately, lead to the better accomplishment of tasks. The concepts of visual literacy (Messaris, 1994), data richness (Tufte, 2001) and the “anchor” (Levie & Lentz, 1982) focused more precisely on the form factors of the visual sense and the techniques necessary to ensure an association of all sensory cues with appropriate content.

Uses and gratifications, learner motivation, satisfaction and control

Uses and Gratifications Theory (Katz, 1959, 1973; Severin & Tackard, 1997) reflected the first major shift in the communication literature from an interpretation of the user as a passive recipient of information, consistent with the instructivist perspective, to an active participant in the gathering of information. The theory emphasizes a technology user's need to choose socially and psychologically satisfying types of media relative to the content and context of subject matter (Arbaugh, 2000; Hacker & Wignall, 1997; Hiltz, 1986). Researcher Elihu Katz (1973) placed emphasis on the technology user's internal motivations, categorizing these similarly to Bloom's (1956) categorization of learning objectives, but delving more deeply into their origins:

a) cognitive (acquiring information, knowledge, and understanding);
b) affective (emotional, attitudinal, or persuasive);
c) personally integrative (credibility, confidence, and status);
d) socially interactive (contacts with family and friends); and
e) tension relieving (escape and diversion) (Katz, 1973; Severin & Tackard, 1997).

Katz identified three social and psychological "needs" as the primary forces behind every objective:

a) to be goal-directed,
b) to seek social interaction with others, and
c) to seek social and psychological gratification.

Most importantly, the researchers began to associate the user's satisfaction of social and psychological needs with different media and media exposure patterns in the categories of

a) media content, for example, an educational lesson;
b) media type, for example, a television program; and
c) social context; for example, entertainment (Katz, 1973).

Social presence, media richness, and the development of social media measures

Social Presence Theory offered the first detailed set of technology form factors that focused on perceptual illusions of non-mediated interaction (Short et al., 1976). The theorists offered a scale to measure "the degree to which a medium is perceived to convey the actual presence of communicating participants" (Ware, 2000, p.160). They hypothesized that "communications media vary in the degree of social presence that they evoke, and that these variations are important in determining the way individuals interact" (Short et al., 1976, p. 65). In the social presence scale, the greater the presence of social cues in a technology, for example, a glance, a smile, a voice inflection, or a laugh, the greater the potential for a perceived socially real and meaningful communication. The theory emphasizes that greater levels of social presence are necessary for more complex tasks, whereas lower levels of social presence are sufficient for simpler tasks. An audio-video conference capable of displaying facial expressions, transmitting voice sounds and facilitating two-way conversation, therefore, may have the potential of being more effective than a textbook for debating; whereas a notebook may be sufficient for outlining an assignment.

Media Richness Theory (Daft & Lengel, 1984) further expanded the communication research by relating technology form and content factors to both perceptual responses and levels of cognitive and affective performance. Specifically, the researchers itemized form and content factors and related these to synchronous (real-time) and asynchronous (delayed) social interaction and levels of task accomplishment. Their work in an era of burgeoning electronic and digital technologies, such as audio-video conferencing and the computer, helped to transform traditional learning and work environments into distance-learning and work environments. Daft and Lengel suggested that effective leaders make rational choices matching a particular communication medium to a specific task or objective and to the degree of richness required by that task (Daft & Lengel, 1984; Trevino, Lengel, & Daft, 1987). The researchers proposed a technology scale built on four form and content factors of a medium’s perceptual “richness” that can contribute toward “resolving ambiguity, negotiating varying interpretations, and ultimately achieving understanding” (Scott, n.d., para. 3):

a) instant feedback,
b) transmission of multiple cues such as body language and voice tone,
c) use of natural language, and
d) personal focus.

The theory rated those technologies that included instant feedback as synchronous and those that did not as asynchronous. Synchronous face-to-face communication was considered the highest in perceptual richness, followed by the synchronous telephone, and the asynchronous electronic mail, letter, note, memo, special report, and finally, flier or bulletin (Scott, n.d.). The theory proposed using the richest of media when there is equivocality or multiple possibilities for interpreting the information transmitted, necessitating high-level thinking, for example, consideration and reflection of a topic. The theory, further, proposed that less rich media were appropriate when there is uncertainty or a lack of information to process a communication but a predetermined framework for understanding it, requiring low-level thinking, for example, the memorization of facts. Based on this theory, a teacher attempting to accomplish high-level learning objectives, for example, to consider and reflect, might choose a medium that allows an exchange of information, for example, a conferencing system; while a teacher attempting to realize a low-level learning objective, for example, to describe, might choose a medium that promotes little exchange, for example, a bulletin or flier.

Visual 'literacy': Making the illusion meaningful

Fueled largely by the Media Richness research on the potential of technologies to use rich and relevant sensory form and content factors to evoke meaningful illusions, communication scholars began to hone in on the power of technologies to appeal to specific senses. Much emphasis was placed on the visual sense and the creation of the visual illusion, as it was an increasingly prevalent means of communicating in the developing VLE. In his research on visual communication, researcher Paul Messaris (1994) offered evidence to suggest that certain technologies could work together to reproduce natural visual cues that could help technology users perceive a "real" visual illusion. He contended that the key to making an image influential to the viewer may lie in the very unobtrusiveness or invisibility of a technology's design, and on the viewer's lack of "visual literacy" (Messaris, 1994, p. 3) or lack of awareness of the editing techniques used in the presentation. Messaris identified camera positioning, editing and spatial juxtapositions as key form factors, and the use of narrative (visual storytelling) as a key content factor, in evoking both effective and meaningful visual illusions. Through this vantage, the most influential virtual environments are those that present a visual so "realistic" and "natural" that there is no explicit awareness of the editing techniques (Messaris, 1994, pp. 5, 31, 39). The technology, in essence, disappears in the illusion, and the learner may more effectively construct an understanding of the subject matter through a more natural exposure to it.

Making the visual data-rich

Like Messaris, Edward Rolf Tufte, professor emeritus of statistics, information design, interface design and political economy at Yale University and a leading researcher in the computer science literature, focused greatly on the visual factors that are both necessary and unnecessary to building an understanding of the subject matter through a meaningful and natural exposure to it. In his research on informational graphics, Tufte (2001) explored the concepts of visual literacy and the meaningful communication of information. He called non-informative or information-obscuring content factors "chartjunk" and referred to the term data-ink ratio in his argument against the inclusion of non-informative decoration in visual displays of quantitative information (Tufte, 2001). He claimed that ink should only be used to convey and display significant data. He encouraged the use of data-rich illustrations in which all the available data is presented and each data point has value. He further stressed the importance of a well-functioning and well-designed technology that is not clouded and does not prompt hesitation. Tufte suggested that the technology user best absorbs the material when it is presented through such form factors as high resolution, comprehensive and non-linear graphics, good typography and fluid chart layout. In sum, Tufte supported the use of visual form factors that promote a seamless exposure to a technology only when they are combined deliberately and completely with relevant content (Tufte, 2001). In this way, the visual may evoke an accurate and clear illusion of the subject matter.

'Anchoring' the illusion

While illusions may depend on the seamlessness or "invisibility" of technologies (Messaris, 1994), they may depend equally on the "visibility" of content factors. Keying in on the content factor's ability to fix or hold a learner mentally in a context relevant to and instructive of the subject matter, researchers Levie and Lentz (1982) labeled the content factor an "anchor" (Levie & Lentz, 1982), a textual, verbal, visual and/or other sensory factor that assigns meaning to an illusion of subject matter.

Levie and Lentz suggested that "anchored" illusions help create "mental models" – frameworks of understanding or bodies of relevant knowledge – that make learning possible (Levie & Lentz, 1982). Technologies that are not "anchored" appropriately in subject matter are merely "decorative (meaning they do not depict actual events from a story) and fail to aid comprehension because they do not help … construct mental models of the story situation" (Ramsey, 1996, p. 10). "On the other hand, pictures that illustrate actual scenes … or help organize complex scenes that may be difficult to imagine improve the … memory of the story" (p. 10). In their research on children's books, the researchers contended that learners sometimes fail to make effective use of or comprehend form factors correctly, if they are not "anchored" in guiding textual, verbal and/or visual references, for example, a visual of an ancient king may be misinterpreted if it is not anchored in a picture of his kingdom, or if the king's title and name are not anchored beneath the visual (Levie & Lentz, 1982).

Other researchers have begun to explore the value of acoustic or audible space as a valuable anchor, as it can permit a combined sensory, cognitive and social experience (sounds from the subject matter amid discussion, for example, sounds of battle amid a discourse between Cortes and an Aztec king) (Carpenter, 1973; Carpenter & Heyman, 1970; Carpenter & McLuhan, 1960; McLuhan, 1962, 1964; Ong, 1967, 1982; Schwartz, 1974). "Visual space situates the individual on the outside looking in, as a voyeur gazing objectively at only a fragment of the total scene at any given time. Acoustic space places its subject in the center of the action, surrounded by an aural environment that is heard holistically" (Strate, 1999, para. 39).

Emerging recent research on "anchors" has supported suggestions in the education, communication and computer science literatures that, when sensory form factors work together with content factors in a "senses communis," taking up combinations of "acoustic space, tactile, thermal, and kinesthetic space, and even olfactory space" (Strate, 1999, para. 38), learners may experience the most meaningful sensory and interactive illusions and the most enriching and high-level learning experiences. A 1999 study of visual, aural, verbal, and textual prompts in a highly immersive electronic learning theater called the CAVE, for instance, confirmed the contention. Researchers Roussou et al. (1999) found evidence that, when multiple form factors evoked anchored illusions of subject matter, the learning environment was most effective. Without the anchors, the illusions were sometimes ineffective (Roussou et al., 1999).

Integrating technology guidelines with presence for enhanced learning in the VLE

With varying degrees of emphasis on learning, communication, and perception, researchers have found strong evidence in their investigation of the rapidly evolving electronic and digital technologies of the traditional and distance learning classrooms and the VLE that the transformation of a “virtual” experience into a “real” teaching and learning experience requires the creation of a perceptual space in which the senses work together to foster meaningful illusions of the subject matter (Daft & Lengel, 1984; Dale, 1954; Kearsley & Shneiderman, 1999; Messaris, 1994; Strate, 1999; Tufte, 2001; Wright, 1970). A preponderance of the research, further, has suggested that the experience of meaningful sensory and interactive illusions of subject matter will correlate with the achievement of low- and high-level learning constructs, respectively, and enhance satisfaction (Bloom et al., 1956; Blumler, 1979; Daft & Lengel, 1984; Dale, 1954; Hiltz, 1986; Katz, 1959, 1973; Kearsley & Shneiderman, 1999; Severin & Tackard, 1997; Short et al., 1976; Tufte, 2001; Wright, 1970). A detailed definition of the meaningful illusions that the highly advanced and increasingly prevalent VLE can evoke, however, has remained elusive. Further, precise sets of measures to define and associate form and content factors of the VLE with meaningful sensory and interactive illusions, learning and satisfaction remain absent. The research on presence offers detailed descriptions of the form and content factors capable of evoking meaningful illusions in the VLE. Equally important, the presence literature reflects a synthesis of the relevant education, communication and computer science research, providing the VLE designer with a simultaneously specific and comprehensive tool for creating meaningful illusions and enhancing learning and satisfaction in the VLE (International Society for Presence Research, 2008; Lombard & Ditton, 1997; Selverian, 2005).

Defining spatial and social presence: The illusion of non-mediation in the virtual world

Telepresence, or presence, is “a psychological state or subjective perception in which even though part or all of an individual’s current experience is generated by and/or filtered through human-made technology, part or all of the individual’s perception fails to accurately acknowledge the role of the technology in the experience” (International Society for Presence Research, 2008, para. 2). The presence “experience” is often called an “illusion.” While presence researchers have classified presence and the technological form and content factors that evoke it in different ways, researchers have generally concurred that these fall into two main categories: spatial, immersing a learner’s sensory “space”; and social, involving perceptions of interaction with sensory stimuli. The presence spatial (sensory) and social (interactive) classifications are in many theoretical premises and practical considerations consistent with aspects of Bloom’s, Englehard’s and Furst’s (1956), Dale’s (1954), Katz’s (1959, 1973), Short’s, Williams’ and Christie’s (1976), Daft’s and Lengel’s (1984), Messaris’ (1994), Tufte’s (2001) and Levie’s and Lentz’s (1982) concepts and theories relating to form and content factors that can engage and interact with the senses to evoke meaningful illusions. The following sections offer an overview of the relationship of the multidisciplinary concepts and theories to the form and content factors of presence.

Spatial and social presence form factors

The presence literature defines spatial presence as the illusion of seeing, hearing, tasting, touching or smelling a perceived person, place or thing in the subject matter; and social presence as the illusion of being together/interacting with a perceived person, place or thing in the subject matter (International Society for Presence Research, 2008). Spatial presence form factors focus largely on multi-sensory outputs, visual and aural dimensionality, image size and quality, viewing distance, use of motion and color, and audio volume and fidelity (International Society for Presence Research, 2008), which are greatly reflective of Dale’s (1954) “concrete” (high-sensory) and “abstract” (low-sensory) classifications, Daft’s and Lengel’s (1984) multiple media-rich cues, Messaris’ (1994) vivid visual stimuli and Tufte’s (2001) high resolution graphics. Additionally, spatial presence form factors key to subjective or first-person camera techniques, navigation controls, technology size and shape, and obtrusiveness of the technology (International Society for Presence Research, 2008), echoing Daft’s and Lengel’s (1984) emphasis on personal focus, Messaris’ (1994) attention to camera positioning and spatial juxtaposition, and Tufte’s (2001) prioritization of data-rich and seamless presentations of sensory cues.

Presence form factors capable of evoking social presence are intended to enable “real” and natural responses to/interaction with the user (International Society for Presence Research, 2008; Selverian, 2005). Social presence form factors focus largely on the speed of receipt of information, the range (number) of possible responses, the synchronous nature of the exchange of information, and the ability to map or chart out control over physical changes experienced (understanding/anticipating responses of the tools) (International Society for Presence Research, 2008). These factors correlate with and expand upon Bloom’s (1956) and Dale’s (1954) focus on the value of feedback, Katz’s (1959, 1973) emphasis on user control and socially and psychologically satisfying interactions; Short’s, Williams’ and Christie’s (1976) association of face-to-face social cues with meaningful communication; and Daft's and Lengel's (1984) attention to synchronous communication.

Spatial and social presence content factors

Comparable to the contextual references explicated in the education, communication and computer science literatures, presence researchers have developed content factors essential to evoking meaningful illusions through spatial and social technologies (International Society for Presence Research, 2008; Selverian, 2005). The factors include the quality/nature of writing, quality/nature of acting, relevant physical appearance of actors, fame or notoriety of actors, relevant use of media conventions, and the nature of the task or the activity in the context of the subject matter. The focus on the quality of the communication and the relevance to the subject matter is reflective of Daft's and Lengel's (1984) use of natural language and personal focus, Messaris' (1994) reliance on relevant editing, Tufte's (2001) emphasis on the meaningful presentation of data, and Levie's and Lentz's (1982) focus on descriptors or "anchors."

The presence literature further draws on the Uses and Gratifications (Katz, 1959, 1973) and Social Presence (Short et al., 1976) theories to consider media user characteristics that may impact the effectiveness and satisfaction of spatial and social presence, including a user's willingness to suspend disbelief (to be engaged in the technology-mediated activity) and level of knowledge of or experience with the medium (Lombard & Ditton, 1997). Other psychological motivations that might help evoke spatial and social presence are considered, including seeking social interaction with others, seeking social and psychological gratification (Katz, 1959, 1973), and perceiving a sense of intimacy (psychological closeness) and immediacy (currency) with persons, places, or things in the technology-mediated experience (Short et al., 1976).

Presence and learning

While a growing number of presence researchers work to confirm and improve the definitions of spatial and social presence and the associations of spatial and social technologies with spatial and social presence, respectively, only a few are exploring the relationship of spatial and social presence to quantified assessments of cognitive achievement in the context of teaching and learning experiences (Mania & Chalmers, 2000; Selverian, 2005; Selverian & Hwang, 2003; Picciano, 2002; Roussou et al., 1999; Sponberg, Knudsen, & Handberg, n.d.). This small body of research, nonetheless, offers data to support the strong suggestions in the education, communication and computer science literatures that, when technologies evoke meaningful social illusions, they can enhance the achievement of high-level learning objectives; and when they evoke meaningful spatial illusions, they can enhance the achievement of low-level learning objectives (Mania & Chalmers, 2000; Selverian, 2005; Selverian & Hwang, 2003; Picciano, 2002; Roussou et al., 1999; Sponberg et al., n.d.).

Measuring presence

Presence researchers have used a variety of instruments to measure spatial and social presence, but paper-and-pencil subjective instruments have been the most prevalent. Subjective responses to questionnaires keying to the spatial and social presence form and content factors have been collected in written and verbal forms using Likert scales, e.g., 1 (low) to 5 (high) (Lessiter, Freeman, Keogh, & Davidoff, 2001; Slater & Steed, 2000), and via the Internet using a hand-dial to register the “realness” of the experience (potentiometer) (e.g., Freeman, Avons, Pearson & IJsselsteijn, 1999; IJsselsteijn & de Ridder, 1998). Objective measures have also been used to measure a technology user’s immediate physiological responses to a technology experience, including changes in skin conductance, blood pressure, heart rate, muscle tension, respiration, eye motion, posture, and so forth (e.g., Freeman, Avons, Meddis, Pearson, & IJsselsteijn, 2000). Subjective questionnaire items are more often used “in part because they appear to be valid measures (they request information logically related to what we understand presence to be) and also because the measures are easy and inexpensive to use” (International Society for Presence Research, 2008, para. 4). Arguably one of the most comprehensive subjective measures of presence at the time of this writing is a paper-and-pencil instrument (a questionnaire) compiled through a comprehensive review of measures in the presence literature and tested using a 103-item questionnaire (see Lombard et al., 2000).

Integrating the literatures into VLE technology guidelines, presence and learning measures

The authors of this article have begun to move the presence-learning relationship forward by integrating the presence questionnaire (Lombard et al., 2000) and the presence form and content factors (International Society for Presence Research, 2008) with the relevant technology and learning guidelines in the education, communication and computer science literatures, and applying these to working VLEs. The researchers have developed a set of VLE Spatial and Social Presence Technology Guidelines (Appendix A) and a VLE Presence Questionnaire (Appendix B) to direct the creation and assessment of VLEs capable of evoking spatial and social presence that enhance the achievement of low- and high-level learning objectives, respectively; and that promote satisfaction. The researchers assembled the guidelines and questionnaire through a series of observations of and interviews with 40 elementary-level students studying history and archaeology using 20 combinations of low- and high-spatial and social technologies – from textbooks to 3-D desktop technologies – in five VLEs at The Dalton School in New York City (Selverian, 2005). Examples of technologies used in the Dalton VLEs are as follow: high-spatial/low-social – 3-D visualization of the Alhambra palace of Spain at http://www.mcah.columbia.edu/alhambra/flash/index5.html; high-social/low spatial – two-way discussion about Marco Polo's travels from Venice to China; high-spatial/high-social – "Explorers of the New World" 3-D interactive software allowing visualization of and interaction with an avatar of Cortes at Tenochtitlan; low-spatial/low social – a textbook passage describing the Chinese emperor Kublai Khan. The presence questionnaire was tailored for each of the 20 treatment conditions. The researchers then formed and administered sets of multiple-choice and short-answer learning and satisfaction assessments for each of the conditions (see example, Appendix C).

Data collected from the presence and learning instruments were very encouraging. Data from the presence questionnaires confirmed the effectiveness of the VLE Spatial and Social Presence Technology Guidelines' spatial factors at evoking spatial presence ($F(1, 155) = 581.95$) and its social factors at evoking social presence ($F(1, 155) = 1{,}3320.34$). Further, data from the presence questionnaires and the learning assessments strongly supported the hypothesized correlations between spatial presence and the achievement of low-level learning objectives ($\underline{r}(154) = 0.83$, $\underline{p}<0.005$); and social presence and the achievement of high-level learning objectives ($\underline{r}(154) = 0.88$, $\underline{p}<0.01$). Finally, the results were enlightening in regard to the relationship between combinations of high spatial and social presence and high satisfaction ($\underline{r}(154) = 0.71$, $\underline{p} <0.001$). Most importantly, the data provided incentive for continued assessments of the presence technology guidelines and the strong potential for the realization of enhanced learning and satisfaction in the VLE through the perceptual states of spatial and social presence. Additional research is warranted and essential to confirm and strengthen the validity and reliability of the test instruments.

References

Arbaugh, J. B. (2000). How classroom environment and student engagement affect learning in Internet-based MBA courses. *Business Communication Quarterly*, *63*(4), 9-26.

Bloom, B. S., Englehard, M. D, & Furst, E.J. (1956). *Taxonomy of educational objectives. Handbook I: The cognitive domain*. New York: Longman.

Blumler, J. G. (1979). The role of thoery in uses and gratifications studies. *Communication Research, 6,* 9-33.

Card, S. K., Moran, T. P., & Newell, A. (1983). *The psychology of human-computer interaction.* Hillsdale NJ: Lawrence Erlbaum Associates.

Carpenter, E. (1973). *Oh what a blow that phantom gave me!* New York: Holt.

Carpenter, E., & Heyman, K. (1970). *They became what they beheld*. New York: Outerbridge & Dienstfrey.

Carpenter, E., & McLuhan, M. (1960). Acoustic space. In E. Carpenter & M. McLuhan (Eds.), *Explorations in communications* (pp. 65-70). Boston: Beacon Press.

Chaffee, S. H., & Hochheimer, J. L. (1985). The beginnings of political communication research in the United States: Origins of the 'limited effects' model. In Michael Gurevitch & Mark R. Levy (Eds.), *Mass Communication Review Yearbook 6,* 75-104.

Daft, R. L., & Lengel, R. H. (1984). Information richness: A new approach to managerial information processing and organization design. In L. L. Cummings & B. M. Staw (Eds.), *Research in organizational behavior.* Greenwich, CT: JAI Press.

Dale, E. (1954). *Audio-video methods in teaching (revised edition).* New York: The Dryden Press.

Engelbart, D. C. (1963). A conceptual framework for the augmentation of man's intellect. *Vistas in Information Handling, 1*(9).

Freeman, J., Avons, S. E., Meddis, R., Pearson, D. E., & IJsselsteijn, W. A. (2000). Using behavioural realism to estimate presence: A study of the utility of postural responses to motion-stimuli. *Presence: Teleoperators and Virtual Environments*, *9*(2), 149-165.

Freeman, J., Avons, S. E., Pearson, D. E., & IJsselsteijn, W. A. (1999). Effects of sensory information and prior experience on direct subjective ratings of presence. *Presence: Teleoperators and Virtual Environments*, *8*(1), 1-13.

Hacker, K., & Wignall, D. (1997). Issues in predicting user acceptance of computer mediated communication in inter-university classroom discussion as an alternative to face-to-face interaction. *Communication Reports*, *10*(1), 107-114.

Harrow, A. J. (1972). *A taxonomy of the psychomotor domain*. New York: Longman.

Hewett, T., Baecker, R., Card, S., Carey, T., Gasen, J., Montei, M., Perlman, G., Strong, G., & Verplank, W. (1996). *Chapter 2: Human-computer interaction*. Retrieved from http://sigchi.org/cdg/index.html

Hiltz, S. R. (1986, Spring). The "virtual classroom:" Using computer-mediated communication for university teaching. *Journal of Communication*, *36*(2), 95-104.

Hunt, A. D. (1999). *Review of HCI literature – 1990-1999*. Department of Electronics, University of York, UK.

IJsselsteijn, W. A., & de Ridder, H. (1998). Measuring temporal variations in presence. Paper presented at the *Presence in Shared Virtual Environments Workshop*, BT Laboratories, Ipswich, UK.

International Society for Presence Research (2008). *Concept of presence: Explication statement*. Retrieved from http://ispr.info/

Jacko, J.A., & Sears, A. (Eds.) (2003). *Handbook for human computer interaction*. Mahwah: Lawrence Erlbaum & Associates.

Katz, E. (1959). Mass communication research and the study of popular culture: An editorial note on a possible future for this journal. *Studies in Public Communication*, *2*, 1- 6.

Katz, E. (1973). The two-step flow of communication: An up-to-date report of an hypothesis, In B.M. Enis & K.K. Cox (Eds.), *Marketing Classics*, 175-193.

Kearsley, G., & Shneiderman, B. (1999). *Engagement theory: A framework for technology-based teaching and learning*. Retrieved from http://home.sprynet.com/~gkearsley/ engage.htm

Kemp, J. E., & Smellie, D. C. (1994). *Planning, producing, and using instructional technologies (7th ed.*). New York: Harper Collins College Publishers.

Krathwohl, D. R., Bloom, B. S., & Masia, B. B. (1964). *A taxonomy of educational objectives. Handbook II: The affective domain*. New York: David McKay.

Lessiter, J., Freeman, J., Keogh, E., & Davidoff, J. D. (2001). A cross-media presence questionnaire: The ITC sense of presence inventory. *Presence: Teleoperators and Virtual Environments*, *10*(3).

Levie, W. H., & Lentz, R. (1982). Effects of text illustrations: A review of research. *Educational Communication and Technology Journal*, *30*(4), 195-232.

Lombard, M., & Ditton, T. (1997). At the heart of it all: The concept of presence [Electronic version]. *Journal of Computer-Mediated Communication, 3*(2).

Lombard, M., Ditton, T., Crane, D., Davis, B., Gil-Egui, G., Horvath, K., & Rossman, J. (2000). *Measuring presence: A literature-based approach to the development of a standard paper-and-pencil instrument*. Retrieved from http://www.matthewlombard.com

Mania, K., & Chalmers, A. (2000). A user-centered methodology for investigating presence and task performance. Paper presented at the *Presence 2000 Workshop*, Delft, The Netherlands.

Mastery Learning (2001). Retrieved from http://www.funderstanding.com/content/mastery-learning

McGrath, H., & Noble, T. (1993). *Different kids, same classroom*. Melbourne. Longman.

McLuhan, M. (1962). *The Gutenberg galaxy*. Toronto: University of Toronto Press.

McLuhan, M. (1964). *Understanding media: The extensions of man*. New York: Mentor Books.

Messaris, P. (1994). *Visual literacy. Image, mind, & reality*. Boulder, CO: Westview Press.

Ong, W. J. (1967). *The presence of the word: Some prolegomena for cultural and religious history*. Minneapolis, MN: University of Minnesota Press.

Ong, W. J. (1982). *Orality and literacy: The technologizing of the word*. New York: Methuen.

Picciano, A. G. (2002). Beyond student perceptions: Issues of interaction, presence, and performance in an online course. *Journal of Asynchronous Learning Networks, 6*(1), 21-32.

Plato (trans. 1966). Phaedrus. In : *Plato in Twelve Volumes,* Vol. 1, translated by Harold North Fowler. Cambridge, MA: Harvary University Press. [Available: Perseus Project at http://www.perseus.tufts.edu]

Ramsey, T. D. (1996). *The effects of multimedia interface design on original learning and retention*. Master's thesis. Retrieved from http://scholar.lib.vt.edu/theses/

Reeves, T. C., & Reeves, P. M. (1997). Effective dimensions of interactive learning on the WorId Wide Web. In Badrul H Kahn, *Web-based instruction*, Englewood Cliffs, Educational Technology Publications.

Rosen, J. (1998). K-16: *Instructivism, and history of U.S. education*. Retrieved from http://math forum.org/kb/thread.jspa?forumID=206&threadID=477993&messageID=1464948

Roussou, M., Johnson, A. E., Moher, T., Leigh, J., Vasilakis, C., A., & Barnes, C. R. (1999, June). Learning and building together in an immersive virtual world [Special issue]. *Presence*, *8*(3), 247-263, cover.

Salvendy, G. (1984). *Human-computer interaction.* Amsterdam: Elsevier Science.

Schwartz, T. (1974). *The responsive chord*. Garden City, NY: Anchor Books.

Scott, C. (n.d.) *Media choice in library reference communication interactions*. Retrieved from http://www.gslis.utexas.edu/~ssoy/newtechnologies/soypaper1.htm

Selverian, M. E. M. (2005). *Being there in the VLE: A pan-pedagogical model for enhanced learning through perceptual states of 'presence'.* Doctoral dissertation, Temple University. Dissertation Abstracts International-A, 66, 1617.

Selverian, M.E. M., & Hwang, Ha S. (2003, Oct.). In search of presence: A meta-analysis of the evolving VLE. *Presence*, *12*(5), 512-522. Retrieved from http://www.mitpress journals.org/loi/pres

Severin, W. J., & Tackard, J. W. (1997). *Communication theories: Origins, methods and uses in the mass media* (4th ed.). New York: Longman.

Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications.* New York: John Wiley and Sons.

Slater, M., & Steed, A. (2000, Oct.). A virtual presence counter. *Presence: Teleoperators and Virtual Environments*, *9* (5). Retrieved from http://www.cs.ucl.ac.uk/staff/m.slater/Papers/bips.pdf

Sponberg, H., Knudsen, C. J. S., & Handberg, L. (n.d.). *New learning modes in the production of presence – distance techniques for education.* Retrieved from http://kmr.nada.kth.se/ papers/TelePresence/CJKNewLearning.pdf

Steuer, J. (1993). *Defining virtual reality: Dimensions determining telepresence*. Retrieved from http://eprints.kfupm.edu.sa/33854/1/33854.pdf

Stolterman, E. (2006). *The lack of literature in HCI and design theory*. Retrieved from http://transground.blogspot.com/2006/11/lack-of-literature-in-hci-and-design.html

Strate, L. (1999, Summer). The varieties of cyberspace: Problems in definition and delimitation [Electronic version]. *Western Journal of Communication*, *63*, 382-412.

Trevino, L. K., Lengel, R. K., & Daft, R. L. (1987). Media symbolism, media richness and media choice in organizations. *Communication Research*, *14*(5), 553-574.

Tufte, E. R. (2001). *The visual display of quantitative information* (2nd ed.). Cheshire, CT: Graphics Press.

Ware, S. (2000). Communication theory and the design of live online reference services. In A.S. Kasowitz & J. Stahl (Eds.). *The Facets of Digital Reference. Proceedings of the Virtual Reference Desk Annual Digital Reference Conference*, Seattle, Washington. Retrieved from http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/19/51/d7.pdf

Wright, A. R. (1970, Fall). Participative education and the inevitable revolution. *Journal of Creative Behaviour*, *4*(4), 234-282.

Appendix A: VLE Presence Technology Guidelines

The following VLE presence technology guidelines reflect a synthesis of the form and content factors in the telepresence literature with the form and content factors in the education, communication and computer science literatures. They are intended to direct a VLE educator/designer in the comprehensive and precise assignment of high- and low-spatial and social technologies likely to evoke combinations of high- and low-spatial and social illusions that enhance learning and satisfaction in the VLE.

Form Factors

The high- and low-spatial form classifications are based on a technology's high and low potential to bring a learner closer to subject matter through immersive (sense surrounding) sights, sounds, tastes, touches, and/or scents, e.g., high – a 3-D film, and low – a 2-D illustration. High- and low-social form classifications are based on a technology's high and low potential for social interaction about/with subject matter, e.g., high – a synchronous audio-visual electronically mediated or face-to-face exchange involving two-way communication through the senses (seeing, hearing, touching, etc.); and low – a lecture or slide show involving no two-way interaction through the senses). A technology needs to score 3 out of 6 of the spatial characteristics and 2 out of 3 the social characteristics to qualify for a VLE.

Technology Form Factors for Presence in the VLE

Low- Spatial/Low-Social Factors

Low-spatial – low vividness of spatial sensory outputs depicting subject matter

1) small image size and quality
2) little use of motion and color
3) unclear audio volume and fidelity
4) no visual and aural dimensionality (2-D)
5) no subjective camera techniques
6) high obtrusiveness (cumbersome nature) of the technology, and unmanageable technology size and shape (awkward)

Low-social – low level of interactivity with subject matter

1) slow or no speed of interactive tools and receipt of information (mouse click, conversation)
2) small or no range (number of possible responses) to interactive tools

3) no or low ability to map or chart out control over physical changes experienced in the technology environment in a natural or predictable way, e.g., control the interaction

Examples of low-spatial/low-social technologies by classification and specific type

- Asynchronous, written symbols (low-immersive textual, low-interactive), e.g., a written narrative, a letter, a listserv
- Asynchronous, aural symbols (low-immersive verbal, low-interactive), e.g., a lecture, a recording
- Two-dimensional visual symbols (low-immersive visual, low-interactive), e.g., pictures, paintings
- Two-dimensional still photographic reproductions (low-immersive visual, low-interactive), e.g., photographs, 2-D slides

High-Spatial/Low-Social Factors

High-spatial – high vividness of spatial sensory outputs depicting subject matter

1) large image size and quality
2) use of motion and color
3) clear audio volume and fidelity
4) visual and aural dimensionality (3-D),
5) subjective camera techniques, low or no obtrusiveness (cumbersome nature) of the technology
6) manageable technology size and shape (not awkward)

Low-social –low level of interactivity with subject matter

1) slow or no speed of interactive tools and receipt of information (listserv communication)
2) small or no range (number of possible responses) to interactive tools
3) no or low ability to map or chart out control over physical changes experienced in the technology environment in a natural or predictable way, e.g., control the interaction

Examples of high-spatial/low-social technologies by classification and specific type

- Three-dimensional visual symbols (high-immersive visual, low-interactive), e.g., three-dimensional illustrations
- Three-dimensional still photographic reproductions (high-immersive visual, low-interactive), e.g., three-dimensional photographs or slides
- Two-dimensional movies and TV (high-immersive audio-visual, low-interactive)

- Web TV (high-immersive audio-visual, low-interactive), e.g., movie purchases, bank transactions, shopping
- Three-dimensional audio-visual tools (high-immersive audio-visual, low-interactive), e.g. a three-dimensional video or film
- “Real” demonstrations (high-immersive visual, low-interactive), e.g., plays
- “Real” artifact display (high-immersive visual, low-interactive), e.g., replicas and relics
- Three-dimensional audio-visual tools (high-immersive audio-visual, low-interactive), e.g., a controllable 3-D real-time video on the Web, or an adjustable virtual reality illusion

Low-Spatial/High Social Factors

Low-spatial – low vividness of spatial sensory outputs depicting subject matter

1) small image size and quality
2) little use of motion and color
3) unclear audio volume and fidelity
4) no visual and aural dimensionality (2-D)
5) no subjective camera techniques
6) high obtrusiveness (cumbersome nature) of the technology, and unmanageable technology size and shape (awkward)

High-social – high level of social interactivity with subject matter

1) high speed of interactive tools and receipt of information through sensory response
2) great range (number of possible responses) to interactive tools
3) high ability to map or chart out control over physical changes experienced in the technology environment in a natural or predictable way, e.g., understand how to use the tools of interaction

Examples of low-spatial/high-social technologies by classification and specific type

- Synchronous audio-visual tools (low-immersive audio-visual, high-interactive), e.g. an audio-video conferencing system that displays teachers and students but not subject matter
- Synchronous, written symbols about but not with subject matter (low-immersive textual, high-interactive), e.g., an instant Internet message system, or a real-time interactive artificial intelligence text program

- Synchronous, aural symbols about but not with subject matter (low-immersive aural, high-interactive), e.g., a facilitated discussion, a telephone exchange
- Synchronous 3-D audio-visual tools about but not with subject matter (low-immersive audio-visual, high-interactive), e.g., a 3-D audio-video conferencing system

High-Spatial/High Social Factors

High-spatial – high vividness of spatial sensory outputs depicting subject matter

1) large image size and quality
2) use of motion and color
3) clear audio volume and fidelity
4) visual and aural dimensionality (3-D),
5) subjective camera techniques, low or no obtrusiveness (cumbersome nature) of the technology
6) manageable technology size and shape (not awkward)

High-social – high level of social interactivity with subject matter

1) high speed of interactive tools and receipt of information through sensory response
2) great range (number of possible responses) to interactive tools
3) high ability to map or chart out control over physical changes experienced in the technology environment in a natural or predictable way, e.g., understand how to use the tools of interaction

Examples of high-spatial/high-social technologies by classification and specific type

- Interactive dramatizations (high-immersive multisensory, high-interactive), e.g., an interactive play depicting and enabling multisensory communication with/about subject matter
- Three-dimensional, multisensory desktop tools (high-immersive multisensory, high-interactive), e.g., a 3-D desktop program with interactive avatars depicting and enabling multisensory communication with/about subject matter
- Three-dimensional headsets, theaters (high-immersive multi-sensory, high-interactive), e.g., VR systems or immersive CAVEs depicting and enabling multisensory communication with subject matter
- Three-dimensional free-standing illusions (high-immersive multi-sensory, high-interactive), e.g., holograms depicting and enabling multisensory communication with subject matter

Content Factors

The guidelines for content factors, which define three primary qualities that "anchor" or instruct about subject matter, were extracted from the education, communication and computer science literatures and assembled on a 0-4 rubric table for purposes of rating technologies. A technology needs to score a 2 or above in at least one of the three categories to be considered "anchored" and to qualify for a VLE.

Table A-1. Technology Content Factors for Presence in the VLE ("Anchors")

Content Factors	0	1	2	3	4	Score
	Content not relevant to subject matter	Less than half content relevant to subject matter	Half of content relevant to subject matter	More than half content relevant to subject matter	All of content relevant to subject matter	
Relevance of the written or spoken narrative to the subject matter (a textual or verbal description)						
Relevance of the literary conventions to the subject matter, (the writing style, dialect used, themes, setting)						
Authenticity of the physical appearance of the actors portraying the subject matter (their fame, notoriety, and recognizeability)						
Total						

Appendix B: VLE Presence Questionnaire

Levels of spatial presence and social presence in the VLE were determined through the subsequent question sets, which were delivered on written or verbal questionnaires. Questions on spatial and social presence are based on Lombard and Ditton's (2000) presence measures and factor analysis but modified to reflect subject matter in each of the treatment conditions and to cater to the comprehension levels of the 3rd-grade students. Subject matter from each of the treatment conditions was inserted into each question set. The questions measure spatial presence based on a learner's subjective perception of being together with spatial illusions of subject matter. The questions measure social presence based on a learner's subjective perception of interacting with illusions of subject matter (Lombard & Ditton, 1997; Lombard et al., 2000; Steuer, 1993). Specifically, the spatial presence measures key to the sense of engagement and perceptual realism experienced through exposure to the spatial presence form and content factors (Lombard et al., 2000). The social presence measures key to experiences of parasocial interaction (interaction with an actor in the subject matter), interpersonal communication with any person in or about the subject matter, and rich (realistic) social cues experienced through exposure to the social presence form and content factors (Lombard et al., 2000).

Spatial Presence

Please rate how you felt when you were using the technology. 1 means Not Much; 5 means Very Much

1) How much did it seem as if [e.g., the 15th Century armor] that you saw/heard came to your classroom? 1-2-3-4-5
2) How much did it seem as if you could reach out and touch [insert subject matter]? 1-2-3-4-5
3) How often did you want to get out of the way of [insert subject matter] that seemed to be headed toward you? 1-2-3-4-5
4) How much did it seem that sounds [insert subject matter] came from different places? 1-2-3-4-5
5) How often did you want to or try to touch something you saw/heard from [insert subject matter]?
6) How much did you feel as if [insert subject matter] that you saw/heard did something back to you? 1-2-3-4-5
7) How much did you feel like you were mentally immersed or "dropped into" the [insert subject matter]? 1-2-3-4-5
8) How involved did you feel in [insert subject matter]? 1-2-3-4-5

9) How completely were your senses of sight, hearing, touch, taste, and smell engaged or a part of [insert subject matter]? 1-2-3-4-5
10) How much did you feel like [insert subject matter] were real? 1-2-3-4-5
11) How relaxing or exciting was the experience with [insert subject matter], (from very relaxing to very exciting)? 1-2-3-4-5
12) How engaging was the story relating to [insert subject matter], i.e., how much did it hold your attention? 1-2-3-4-5
13) Overall, how much did touching [insert subject matter] feel like it would if you had experienced them directly? 1-2-3-4-5
14) How much did the heat or coolness (temperature) of the [insert subject matter] you saw/heard feel like it would if you had experienced it directly? 1-2-3-4-5
15) Overall, how much did [insert subject matter] smell like they would have had you experienced them directly? 1-2-3-4-5

Social Presence

16) How often did you have the sensation or feeling that [insert subject matter] you saw/hear could also see/hear you? 1-2-3-4-5
17) To what extent did you feel you could interact with [insert subject matter] you saw/heard? 1-2-3-4-5
18) How much did it seem as if you and [insert subject matter] both left the places where you were and went to a new place? 1-2-3-4-5
19) How much did it seem as if you and [insert subject matter] were together in the same place? 1-2-3-4-5
20) How often did it feel as if [insert subject matter] were talking directly to you? 1-2-3-4-5
21) How often did you want to or did you make eye-contact with [insert subject matter]? 1-2-3-4-5
22) During the media experience, how well were you able to observe the facial expressions of [insert subject matter]? 1-2-3-4-5
23) During the media experience, how well were you able to observe the changes in tone of voice of [insert subject matter]? 1-2-3-4-5
24) During the media experience, how well were you able to observe the style of dress of [insert subject matter]? 1-2-3-4-5
25) During the media experience, how well were you able to observe the body language of [insert subject matter]? 1-2-3-4-5
26) How often did you make a sound out loud (e.g., laugh or speak) in response to [insert subject matter] you saw/heard? 1-2-3-4-5

27) How often did you smile in response to [insert subject matter]? 1-2-3-4-5
28) How often did you want to or did you speak to [insert subject matter]? 1-2-3-4-5
29) Rate how distant or close [insert subject matter] felt (from distant to close)? 1-2-3-4-5
30) Rate how emotional [insert subject matter] made you feel (from not emotional at all to emotional)? 1-2-3-4-5
31) Rate how much [insert subject matter] responded to you (from not responding at all to responding)? 1-2-3-4-5
32) Rate how dead or lively [insert subject matter] seemed to you (from dead to lively)? 1-2-3-4-5
33) Rate how impersonal (not warm) to personal (warm) [insert subject matter] seemed to you? 1-2-3-4-5
34) Rate how insensitive (not intuned to you) to sensitive (intuned to you) [insert subject matter] seemed? 1-2-3-4-5
35) Rate how unsociable (not friendly) to sociable (friendly) [insert subject matter] seemed to you? 1-2-3-4-5
36) Rate the following statement: [Insert subject matter] that I saw/heard could occur in the real world? 1-2-3-4-5
37) The way in which [insert subject matter] occurred is a lot like the way they occur in the real world? 1-2-3-4-5

Appendix C: VLE Learning Assessment Example

High Spatial/High Social

3-D Web Site and

Two-Way Facilitated Discussion

Name ____________________________

Section 1 (Circle the letter next to the best answer)

1) Where was Kublai Khan's summer palace?
   a) Xanadu
   b) Venice
   c) Tibet
   d) Rome
2) Venice was at war with what Italian province in the 1200s?
   a) Genoa
   b) Venice
   c) Sicilia
   d) Lombardia
3) One group of people that traveled from Venice to Asia in the Middle Ages was:
   a) villains
   b) servants
   c) vassals
   d) merchants
4) Another group of people who traveled from Venice to Asia in the Middle Ages was:
   a) serfs
   b) midwives
   c) monks
   d) architects
5) When did Marco Polo return from China?
   a) 1050
   b) 1101
   c) 1295
   d) 1492

Section 2 (Circle the letter next to the best answer)

1) How might Asian architecture have become an influence on medieval Venetian architecture?
   a) people traveled between the two nations
   b) people sent things back and forth
   c) a and b
   d) architects from both cultures were Christian
2) What features did Gothic architectural buildings have?
   a) tall
   b) large stained glass windows
   c) bright
   d) all of the above
3) Who do you think was more powerful in medieval Venice?
   a) a duke
   b) a priest
   c) an archbishop
   d) a bishop
4) Why do you think Kublai Khan hired Marco Polo to work for him?
   a) A king forced him to hire Polo.
   b) He needed an explorer who could speak many languages to explore his lands.
   c) He wanted to take all of Polo's riches.
   d) b and c
5) How do you think Marco Polo found Asia compared to Europe in the Middle Ages?
   a) less advanced
   b) thriving with many cities
   c) uneducated
   d) little technology

Section 3 (Identify/Describe)

What are two architectural features of a mosque in Turkey?

Section 4 (Evaluate)

Why do you think a cathedral in Venice in the 1300 might look like a mosque?

Section 5 (Circle 1, 2, 3, 4, or 5, with 1 the least and 5 the most)

How much did you enjoy viewing VR (Virtual Reality) of Venice and discussing its architecture with Dr. Marcus in the computer lab?

1 – 2 – 3 – 4 – 5

Thanks for your great work!