

# A SOCIO-TECHNICAL MODEL FOR GEOGRAPHICALLY DISTRIBUTED COLLABORATION

## **Abstract**

*The increasing value of distance collaboration in academic, industrial, governmental and non-profit organizations supports the continuous development of virtual organizations (VOs). Accordingly, the study of VOs has proliferated to investigate not only the technical but also the social factors shaping VOs. Typically, research has focused on the technical and social factors separately. For this reason, this detailed literature review intends to encourage a more comprehensive understanding of the social and technical factors affecting VOs, and propose a far-reaching integrative model for their study and implementation. We provide a comprehensive review of the current literature on social and technical factors and their relation to VOs. Based on this work, we propose a ten-factor sociotechnical model to guide future research and implementation of VOs. Finally we provide some recommendations for empirical testing of the relations among factors.*

## **1. Introduction**

Modern work and social life are characterized by information collection, exchange, collaboration and communication mediated by computer technology. Individual as well as work-team activities are facilitated by the ease of access to information and networked people across long distances; co-location is no longer a constraint to collaborate. Despite the rapid growth of the field and the increasing adoption of geographically distributed organizational structures, research on their social and technical characteristics is limited. Their informational and social functions, social interactions, and maintenance requirements, and outcomes within VOs are still to be explored. It is our objective to draw attention to theoretical relationships and empirical findings from the social and information sciences to understand how VOs operate. Our literature review across disciplines (i.e. psychology, sociology, management, and information science) facilitated the development of a conceptual

model to explain VOs function that accounts for social and technical factors as well as their mutual influences.

## **2. Virtual organizations, an inclusive definition**

We assume that social, organizational, communication, information, and computer science collectively influence the function of the organization. Thus we argue the study of VOs should be done from a multidisciplinary perspective. Toward this end, we adopt Cumming's [1] definition of VOs as our organic starting point: "a group of individuals whose members and resources may be dispersed geographically and institutionally, yet who function as a coherent unit through the use of cyberinfrastructure (CI)." In this respect, we regard VOss as having two main characteristics, (1) they maintain their structure without sharing a physical space and, (2) they use technology-mediated communication to function.

## **3. A five point underpinning model**

The Theory of Remote Scientific Collaboration (TRSC), derived from National Science Foundation (NSF) studies in the fields of collaborative communication and the sociology of science as well as from the Science of Collaboratories (SOC) project identifies five major clusters of socio-technical components that are important for successful remote collaboration [2]. (1) The nature of work, (2) level of common ground, (3) collaboration readiness, (4) management, planning and decision-making and (5) technology readiness. These factors highlight distinct but inter-related areas that can be used in designing and evaluating VOss.

The nature of the work being conducted; refers to the coordination of workflow. Coordination can be categorized in three basic phases [3]: (1) standardization implies that consistent routines are established to organize work in modular or autonomous working groups; (2) coordination by

plan is based on the assumption that work groups coordinate and readjust work based on scheduled meetings and evolving task goals; and, (3) coordination by mutual adjustment, requires ongoing feedback and adjustment. The latter, also called reciprocal interdependence means that “the actions of each position in the set must be adjusted to the actions of one or more others in the set;” also, it “involves the transmission of new information during the process of action [3]. Olson et al. also refer to this third type of work as “tightly coupled,” emphasizing such work is vulnerable in virtual collaborations because distance poses an obstacle in accommodating quick, rich communication, contextual understanding, and firm grounds for decision making.

Level of common ground, which can be thought of as the shared mental models that team members have about their work; this component provides the means to standardize group expectations and consists of experience gained through previous collaboration, a common vocabulary, and similarities in working style [2]. Workers succeed by orienting themselves to the group norms, and by developing common ground, “collaborators gain mutual knowledge, beliefs and assumptions and know that they have this” [2]. Ultimately common ground is a cognitive framing device for each collaborator to make sense of his or her role in the context of the group’s work. Collaboration readiness, based on both work and social dimensions of the collaboration, reflects the extent to which collaborators are motivated to work together and are aligned in work processes and goals [2]. The work dimension refers to working styles and behaviors, and how team members reconcile their differences to take advantage of emerging opportunities or sort out obstacles. The social dimensions of collaboration readiness focus on concepts of motivation, trust, and efficacy [2]. Collaborators are motivated if they have something to gain, in terms of making an individual contribution and in perceiving the value of leveraging disparate skills towards a common goal. Efficacy includes both self-efficacy, group efficacy, as well as the ability to surmount obstacles. Aspects of trust include whether others can be trusted to keep their promises, whether the quality of collaborators’ work will be high, and whether collaborators can be trusted to not take advantage of others’ vulnerabilities [2].

The management, planning and decision making component governs physical and logistical working procedures that contribute to successful VOs. It addresses issues related to time planning, communication, project management preferences, team composition, and management styles. This

component stresses the need for developing governance documents, doing contingency, communication and strategic planning, practicing knowledge management and implementing appropriate leadership and decision making models according to the collaborative needs and characteristics [2].

The technology readiness component on one side concentrates on the organizational technological infrastructure and information and communication technology (ICT) suitability. The user side of technology readiness addresses user efficacy and assumes that collaboration tools provide optimal functionality and benefit, they are easy to use, user-centered and reliable, it also assumes there is agreement about which technologies are most useful. On the management side, technology readiness requires a networking infrastructure, interoperability assurance, available technical support, coordination, and policies for data sharing, access certification, and security [2].

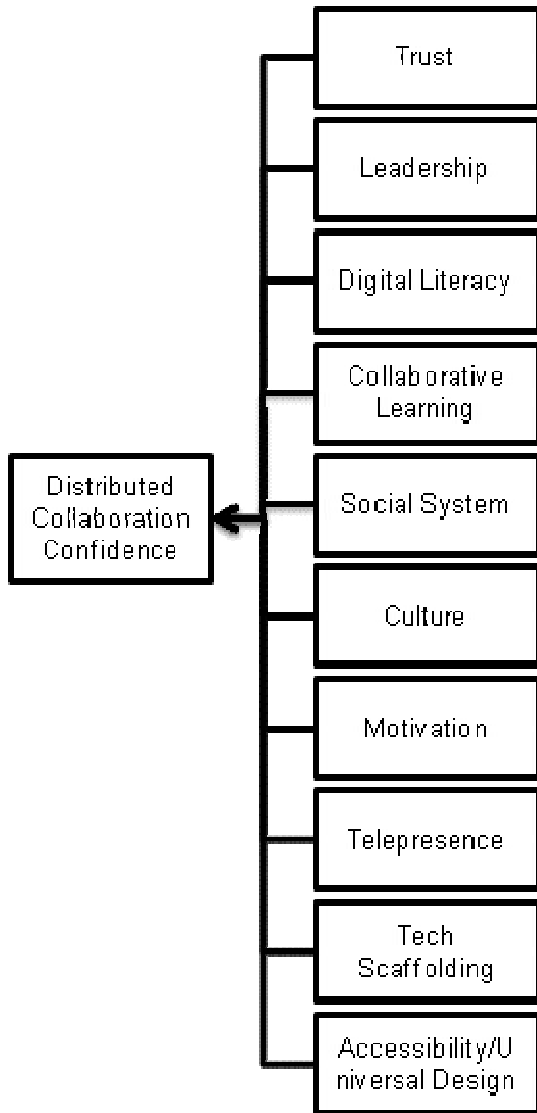
Although the Olsen et al. model helps to organize important functions of VOs, we find the definition of the five components to lack some specificity. The components within the model seem to merge several distinct constructs that have been examined as exclusive concepts in the social, information, and organization sciences. For example, different subtypes within the nature of work category have different implications for the effectiveness of VOs. These instances of differential prediction would be masked by the Olsen et al. model. Shifting focus to more specific and empirically corroborated aspects to the function of VOs might better serve an understanding of the specific conditions under which VOs succeed. Also, utilizing the constructs from recent empirical research will bolster the continued empirical testing and development of theoretical models of VOs effectiveness.

We propose a 10-factor model that builds upon the model proposed by Olsen and colleagues by 1) specifying more precisely defined variables, 2) adopts terminology that allows for connection to an interdisciplinary audience, and 3) incorporates issues related to accessibility--one variable that might be more controllable in VOs as compared to organizations that rely on shared physical space.

#### **4. A ten-point multidisciplinary model**

The proposed conceptual model includes ten interdependent socio-technical factors. For the purpose of classification, these factors are labeled as technical and social-organizational factors.

**Figure 1. Emerging conceptual socio-technical model for geographically distributed collaboration**



**Built collectively on previous interdisciplinary work on VOs, the model incorporates ten constructs: (1) trust (2) leadership (3) ICT experience/digital literacy (4) collaborative (5) group maintenance and social systems; (6) culture; (7) motivation, curiosity and innovation; (8) telepresence; (9) technology scaffolding; and (10) accessibility and universal design.**

#### 4.1. Technical factors

In the discussions of technology and technological factors that contribute to organization performance, the term *cyberinfrastructure* is very commonly used. Though cyberinfrastructure is generally used to refer to the technological support within an organization to support its functions, the technological infrastructure depends highly on social and organizational factors.

**4.1.1. Telepresence.** Telepresence is an environment by means of a communication medium; as opposed to the concept of presence, which is defined as “the sense of being in an environment” [4], Telepresence is the extent to which one feels present in the mediated environment, rather than in the immediate physical environment [4]. The earliest formal use of this term is attributed to Minsky [5]: Telepresence emphasizes the importance of high-quality sensory feedback and suggests future instruments that will feel and work so much like our own hands that we won't notice any significant difference. Thus the communication medium could take the form of any number of technologies, such as telephone, video, virtual reality, a robotic arm, etc.

Telepresence implies an extremely close approximation of presence, but in fact, telepresence also implies a good bit of other elements that can impact communications and ultimately the success of a virtual collaboration. The “tele” aspect of telepresence is comprised of the specific communication technologies, as well as their idiosyncrasies, pros and cons, suitability, functionality, and modes of use. Presence, as explained by Lombard and Ditton [6], has two characteristics. The first one is presence as social richness, or “the extent to which a medium is perceived as sociable, warm, sensitive, personal or intimate when it is used to interact with other people” (Lombard and Ditton online [7]). The second characteristic is the degree to which a medium can produce a “seemingly accurate” representation of the world, or presence as realism. Lombard and Ditton [6] emphasize that there are two distinct types of realism: social realism, the extent to which events in a portrayal seem “true to life;” and, perceptual realism, where the objects portrayed seem “true to life.”

When perception is mediated by a communication technology, one is forced to perceive two separate environments simultaneously: the physical environment in which one is actually present, and the environment presented via the medium. In the context of VOs, telepresence impacts

the way in which people interact and the way work is accomplished. Minsky [5] suggests though, that (pending the use of well-designed tools) “we won’t notice any significant difference” between the natural state and the mediated state. It is in this idea where the relation of telepresence to VOs rests.

**4.1.2. Digital literacy.** This term is closely related to life-long learning, the ability to use information, and the use of information technology. There is an information component to digital literacy and a technology component. The American Library Association (ALA) defines information literacy as the ability to recognize when information is needed and the ability to locate, evaluate, and use effectively information.”[8] In this sense the technical aspect of digital literacy would refer to individuals’ information literacy while using specifically digital technology

**4.1.3. Technology scaffolding.** Scaffolding is a classic education technique that allows students to progressively build skills by executing a task with the help of a more knowledgeable guide or facilitator Jackson, Krajcik, and Soloway [9] suggest that scaffolding can be an effective training method to build the skills of basic and advanced users of digital information systems. Scaffolding consists in engaging a student/trainee in a task above his/her skill level, an instructor would intervene to help through the task when necessary with decreasing frequency as student’s knowledge increase and until he/she is comfortable using the technology independently[10]. Gupta and Bostrom [11] go on and suggest that when scaffolding is used in concert with observational modeling, a technique where a user observes and imitates behaviors of an instructor while s/he completes a task, a number of benefits can come as a result. (1) It increases student confidence in their ability to use technology (self-efficacy), which will allow them to expend more effort than their counterparts to fill recognized skill gaps[12]. (2)It improves understanding of the use of information technology to achieve objectives [13]. (3) It can quickly develop a user’s ability to use novel collaboration and communication technologies effectively with minimal support from instructors. Having a critical mass of users who can independently use information technologies to access people, resources, and facilities is essential to the success of a VO.

**4.1.4. Accessibility/Universal Design.** One of the key advantages of a VO is its ability to provide a group of geographically distributed people access to

information, resources and other people. Cyberinfrastructure designed with accessibility in mind allows all individuals including those with disabilities to have access to the assets and resources mentioned above, directly or through the use of assistive technology[14][15].

## 4.2. Social factors

**4.2.1. Trust.** Much of the recent work has been devoted to developing a clear and relevant definition of trust. Trust is generally accepted to be a factor that functions at multiple levels within a social system [16]. For instance, individuals might hold general tendencies to trust people. Also, trust might differ across one-on-one relationships. At a higher level of organization, members of a group or organization might develop a sense of trust of the leadership or organization as a whole. We take into consideration the implications of trust in organizational effectiveness and goal achievement. As a starting point we employ Mayer, Davis, & Schoorman’s definition of trust [17]: “the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party (p.712)”.

From Davenport [18] we incorporate the conception that trust encourages individual contributions to team and organizational goals. Considering that at some extent trust is traditionally built based on physical interaction [19], we also draw from the work of other authors who stress that the long-distance status of virtual teams makes trust between members a very important factor for effectiveness [20]. Jarvenpaa’s et al.’s [21](1998) study on trust in global virtual teams is used to ponder the importance of face-to-face interaction and its effect on the trust dynamics and effectiveness. In this sense Olson and Olson [22] suggest trust is a function of the cues provided by social partners, thus contexts that closely resemble face-to-face interaction in which more social cues can be exchanged will more likely foster more trust. And finally Davenport’s [23] argument that trust encourages individual contributions to team and organization goals helps to identify trust as a limiting or facilitating factor in VOs.

**4.2.2. Leadership.** The literature on leadership indicates perceived leadership characteristics as determinants for effectiveness in distributed teams [24]. We draw from these factors as guiding

principles. According to Yamaguchi [25] leaders of effective distributed teams take early initiative in tasks; maintain a positive outlook and communicate regularly with other members. On the other side in unsuccessful distributed teams “email questions go unanswered, important process questions are never addressed, and other leadership functions are unfulfilled” [25]. The effectiveness of communication in virtual teams is also positively associated with the number and quality of informal relationships that colleagues have with one another [26]. In terms of challenges faced by leaders of virtual teams, Cascio & Shurygailo [27] identified six: (1) Keeping tight and loose controls on intermediate progress toward goals; (2) Promoting cooperation among teams and team members in order to integrate deliverables; (3) Encouraging and recognizing emergent leaders. Yamaguchi’s [25] study on emergent leadership scales based on Stogdill’s leadership behavior descriptor questionnaire ([28], [29])[30]. The first classification was “task-focused leadership” and the second was “relationship-focused leadership”; (4) establishing explicit processes for archiving important written documentation; (5) establishing and maintaining norms and procedures early in a team’s formation and development; (6) establishing proper boundaries between home and work. To address some of these challenges, Cascio [27] suggests that leaders should (1) set initial face to face meetings and team-building exercises, (2) establish norms for the frequency of communication and reasonable deadlines for task completion, and (3) schedule standing status (checkpoint) meetings to check on the progress of tasks. The effectiveness of a VO hinges greatly upon the presence of leadership and his/her ability to promote and engage in practices that establish team norms, facilitate relationship building and develop trust.

**4.2.3. Social System.** Social system refers to the way in which individual members within an organization relate to each other and to the organization as a whole. Social systems within VOs share many characteristics with organizations that exist in physical space. However, social systems within VOs demonstrate some unique characteristics that accommodate communication in virtual or long-distance collaboration.

**4.2.4. Collaborative learning.** Computer Supported Collaborative Learning (CSCL) surfaces from several areas of research; Hsiao [31] points out it is the convergence of Computer Supported Cooperative Work (CSCW) and Collaborative Learning theories.

From this perspective then CSCL can be defined as computer-based network system that supports group work providing a shared interface for them to work [32]. Hsiao [31] highlights the differences are based on the setting; while CSCL takes place on a learning/teaching/educational setting, CSCW does it on a professional setting. However beyond the setting, there are educational principles on which CSCL is founded. First of all, CSCL draws from constructivist approaches to learning: “Collaborative Learning”, “Problem-Based Learning” and “Communities of Inquiry” in which students engage actively in a discovery process and “collaboratively construct meaningful and worthwhile knowledge” [33]. CSCL also draws from cognitive psychology research, which affirms the proliferation of knowledge is the result of a “constructive and collaborative process by which two or more individuals collectively focus attention, thus collectively construct and relate episodes” [34]. It’s important to point out that CSCL intends to scaffold and support student learning, group processes and group dynamics in ways that are not achievable by face-to-face. CSCL does not intend to replace face-to-face communication.[31]. Cogburn [35] regards CSCL as a mechanism to facilitate global knowledge, which would not only complement face-to-face collaboration, but would enable global communities of practice and learning communities to emerge. CSCW researchers argue that online learning may have an advantage in supporting collaboration and creating a sense of community, however incorporating the principles of the community of inquiry model to the computer-supported educational experience implies the inclusion *design, facilitation and direction* [31] elements in the design of the cyberinfrastructure.

**4.2.5. Culture.** Culture is regarded as the glue between people, an essential context common between groups of people that facilitates communication and knowledge sharing. Hofstede [36] defines culture as ‘the collective programming of the mind which distinguishes one group or category of people from another. Hall’s [37] research on culture led to the discovery of national cultures that have high or low context communication styles. Hall affirms that people from high context cultures depend on nonverbal signals and cues to communicate, while those who prefer low context styles focus on rely heavily on verbal or written communication. Ardichvili [38] has studied how culture affects knowledge sharing in a physical and a virtual context using Hall and Hofstede’s frameworks. Ardichvili [38] argues that individuals from a culture with a

preference for high context communication will tend to prefer rich media to interact with their colleagues; and people from cultures with a preference for low context communication styles may gravitate toward leaner media (chat, e-mail, discussion boards) in computer mediated environments. Studies have also shown that the use communication tools with high media richness facilitates the creation of common ground with visual cues and gestures, thus helping bridge cultural differences or language barriers amongst different groups [39]. We think that taking account for cultural differences could lead to increased participation and knowledge sharing in virtual environments.

**4.2.6. Motivation.** Motivation refers to the reason for people to engage in a particular behavior. The management, psychology, and lately information science literature identify motivation as an important social aspect to organizations and learning. Most cognitive-based literature distinguishes two sources of motivation: internal (intrinsic) and external (extrinsic). Intrinsic motivation is related to informational rewards; or the satisfaction to learn something new; whereas external motivation is related to “controlling” rewards, achieving recognition or advancing a career. Small [40] argues that John Keller’s Attention, Relevance, Confidence and Satisfaction (ARCS) model [41, 42] can be applied to instructional design in work and collaborative environments. Therefore organizational design should incorporate elements to increase: (1) Attention: to increase curiosity and interest, (2) Relevance: likelihood that a task satisfies needs, motives or values, (3) Confidence: feeling of competence and confidence (need to share control over tasks, facilitate access to information), and (4) Satisfaction: Extrinsic and intrinsic reinforcement. Similarly, Small and Venkatesh [43], in a later study indicate, based on problem solving learning theory, that the satisfaction a person obtains from making a decision is an intrinsic motivation to learning. Drawing from Stewart [44] they claim instructional methods and technologies should encourage information process and analysis in order to foster better decision-making skills, improve learning outcomes and promote intrinsic motivation. Motivation has implications in team building, trust, collaborative learning and management, leadership, and digital literacy; which have been identified by Hollan and Stornetta [45] as crucial for understanding and designing VOs. The authors recognize motivation through people’s participation in organization, use of technology, appetite for learning, and other individual difference factors such as

curiosity and engagement. Correspondingly, they talk about incorporating into the organizational structure the necessary elements to motivate people intrinsically and extrinsically to continue to be involved in VOs.

### 4.3. Relationship amongst factors

The relationship of all these concepts in the study of VOs lays primarily on the complexity of the social and technical factors that come into play in VOs, and the need to fill the socio-technical gap [46] between what people need to collaborate and what technology can provide. The literature cited here addresses team building, management, leadership, and digital literacy as, identified by Hollan and Stornetta [45], crucial for understanding and designing VOs. In addition we included literature from the social and information sciences on interrelated social and technical factors (Called in this paper concepts: trust, leadership, collaborative learning, social systems, culture, motivation, technology scaffolding and universal design) that have an fundamental impact in the way people collaborate virtually.

For organization purposes we initially divided the concepts in two groups, technical factors and social factors. From our examination we found clear relations amongst technical factors. For instance, digital literacy, as the ability to find, retrieve, and evaluate information, is closely related to the abilities technology scaffolding provides people to be digitally literate. Another relation we identified is the relation between universal design and the amount of training people may need to use a technology.

We also identified strong relations amongst social factors. For instance, Small’s articles on motivation have a strong tie to Collaborative Learning, several of the Motivating techniques she proposes are to promote intrinsic motivation (satisfaction with decisions, learning as a reward, etc) , which is the most important type of motivation that people in communities of practice have to join them. Another example is Jarvenpaa and Leidner [20] observation on teams exhibiting high levels of swift trust had rotating or emergent leadership. Teams with lower measurements of swift trust showed little or no leadership, and communicated with less frequency and effectiveness than the high trust teams. In terms of trust and culture Jarvenpaa and Leidner [20] argue that people from individualistic cultures are more likely to be trusting of people who share their national culture. Ardichivli [38] makes a similar assertion that individuals from

collectivist cultures like China and Russia will be more likely to share with individuals from similar cultures.

More importantly though, were the relations the literature made across our two broad categories. For instance, Davenport and Hall,[23] make a very strong connection between Collaborative Learning, motivation to participate in communities of practice and the role of technology in the infrastructure to promote motivation and learning. Another tie found is the relation between collaborative learning and problem –based learning to digital/information literacy. The authors argue that those are the most effective methods to teach and motivate information literacy learning [8]. Motivation was linked to collaborative learning. The literature on these subjects argues their model could be implemented in the design of VOs that enhance judgment and decision-making skills that will increase motivation and learning satisfaction. Olson, Teasley, and Bietz [47] argue that if a user has little or no familiarity with "simple" collaboration technologies (data repositories and group calendars), then s/he will not be able engage in more advanced processes (e.g., the creation of a data repository and handoff collaboration [47]). We find this statement to closely relate motivation to digital literacy, technology scaffolding, and trust.

VOs and communities require their users to have a working knowledge of the simple and advanced communication and collaboration technologies for the organizations' efforts to be successful. In return the organizational structure should also be designed so that people can easily make use of it and have access to people, resources, and facilities [35].

The diffusion of collaboratory and virtual VOs innovations has been limited by the difficulty for subject-matter experts to acquire the knowledge resources required in information and communication technology, information retrieval and management, and other social and technical skills necessary to support virtual organizations.

## **5. Discussion and conclusions**

Currently scholars studying VOs draw upon a wide range of disciplines, including: information systems; computer-supported cooperative work; human computer interaction; computer mediated communication; computer-supported collaborative learning; economics; management; sociology; and organizational psychology using a wide variety of methodological approaches such as: surveys, field

studies, ethnographies, experiments, quasi-experiments, and action research. In spite of this diversity of influences, much of the previous research has taken a somewhat techno-centric approach, focusing mostly on the design and uses of the systems that support collaboration. The empirical knowledge base for VOs is based largely on data from scientific laboratories, industry collaborations, and software development teams. While clearly these are all important demographic sectors, unfortunately, this approach has left a significant gap in our comparative understanding of diverse interdisciplinary virtual organizations. Because of the socio-technical complexity of VOs; a more comprehensive understanding can only be obtained through collaborative interdisciplinary research approaches.

The conceptual socio-technical model for the study and design of virtual organizations we present in this paper, is clustered around ten themes that we believe will contribute to an enhanced understanding of the factors and dynamics influencing the study, design and effectiveness of virtual organizations. This model will foster the development of a repeatable methodology for collecting empirical data to analyze virtual organizations and networks. As a next step it is our objective to develop, test, and disseminate a consensual model for analyzing, categorizing, and evaluating VOs.

Considering the potential impact of VOs on broadening participation in scientific research around the world, enhancing employment and research opportunities for people with disabilities, and increasing economic competitiveness; we propose further research to be pursuit around the following questions: (1) universal design and accessibility in the study of virtual organizations that still need to be explored; (2) the interdisciplinary skills and knowledge of the technologies necessary to support them new VOs ; (3) The socio-technical factors most significantly influence the diffusion of VOs (4) the types of activities are most common and unique amongst VOs (5) the impact of the VO on effectiveness and productivity; (6) integration of VOs to the larger organizational ecosystem; (7) the role of leadership in the acquisition of digital literacy; (8) and the socio-technical dynamics of knowledge sharing and socialization for virtual collaboration. Answering these questions would advance the identification of social and technical dynamics that influence the design, development, and evaluation of VOs.

## 6. References

- [1] J. Cummings, T. A. Finholt, I. Foster, C. Kesselman and K. A. Lawrence, "Beyond Being There: A Blueprint for Advancing the Design, Development, and Evaluation of Virtual Organizations," *Final Report from the Workshops on Building Effective Virtual Organizations*, 2008.
- [2] J. Olson, E. Hofer, N. Bos, A. Zimmerman, G. Olson, D. Cooney and I. Faniel, "A theory of remote scientific collaboration (TORSC)," *Science on the Internet*, 2008.
- [3] J. D. Thompson, "Organizations in action," *New York*, 1967.
- [4] J. Steuer, "Dimensions of virtual reality: Dimensions determining telepresence." *Journal of Communication*, vol. 4, pp. 73-93, 1992.
- [5] M. Minsky, "Telepresence," *Omni*, vol. 2, pp. 45-52, 1980.
- [6] M. Lombard and T. Ditton, "At the heart of it all: The concept of presence," *Journal of Computer-Mediated Communication*, vol. 3, pp. 20, 1997.
- [7] M. Lombard and T. B. Ditton. (2000, The presence project. 2009(05/05),
- [8] R. V. Small, N. Zakaria and H. El-Figuigui, "Motivational aspects of information literacy skills instruction in community college libraries," *College and Research Libraries*, vol. 65, pp. 96-122, 2004.
- [9] S. L. Jackson, J. Krajcik and E. Soloway, "The design of guided learner-adaptable scaffolding in interactive learning environments," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1998, pp. 187-194.
- [10] A. de Antonio Jiménez and B. T. Pantoja. (2008, Scaffolding tutoring strategy on virtual environments for training scaffolding. *Ingeniare.Revista Chilena De Ingeniería* 16(1), pp. 220. Available: [http://www.scielo.cl/pdf/ingeniare/v16n1/ART1\\_2.pdf](http://www.scielo.cl/pdf/ingeniare/v16n1/ART1_2.pdf)
- [11] S. Gupta and R. P. Bostrom, "End-user training methods: What we know, need to know," in *Proceedings of the 2006 ACM SIGMIS CPR Conference on Computer Personnel Research: Forty Four Years of Computer Personnel Research: Achievements, Challenges & the Future*, 2006, pp. 172-182.
- [12] D. R. Compeau and C. A. Higgins, "Application of social cognitive theory to training for computer skills," *Information Systems Research*, vol. 6, pp. 118, 1995.
- [13] J. Y. Mao and B. R. Brown, "The effectiveness of online task support vs. instructor-led training," *Contemporary Issues in End User Computing*, pp. 77, 2007.
- [14] J. Mankoff, H. Fait and T. Tran, "Is your web page accessible?: A comparative study of methods for assessing web page accessibility for the blind," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 2005, pp. 41-50.
- [15] S. Hackett, B. Parmanto and X. Zeng, "Accessibility of internet websites through time," in *ACM SIGACCESS Conference on Assistive Technologies: Proceedings of the 6 The International ACM SIGACCESS Conference on Computers and Accessibility: Atlanta, GA, USA*, 2004,
- [16] J. A. Simpson, "Psychological foundations of trust," *Current Directions in Psychological Science*, vol. 16, pp. 264-268, 2007.
- [17] R. C. Mayer, J. H. Davis and F. D. Schoorman, "An integrative model of organizational trust," *Academy of Management Review*, pp. 709-734, 1995.
- [18] E. Davenport and H. Hall, "New knowledge and micro-level online organization: Communities of practice as a development framework," in *PROCEEDINGS OF THE ANNUAL HAWAII INTERNATIONAL CONFERENCE ON SYSTEM SCIENCES*, 2001, pp. 92-92.
- [19] C. Handy. (1995, *Harvard Business Review* 73pp. 44-50.
- [20] S. L. Jarvenpaa and D. E. Leidner, "Communication and trust in global virtual teams," *Organization Science*, pp. 791-815, 1999.
- [21] S. L. Jarvenpaa, K. Knoll and D. E. Leidner, "Is anybody out there?: antecedents of trust in global virtual teams," *J. Manage. Inf. Syst.*, vol. 14, pp. 29-64, 1998.
- [22] G. M. Olson and J. S. Olson. (2000, Distance Matters. *Hum. -Comput. Interact.*

15(2), pp. 139. Available:  
[http://www.informaworld.com.libezproxy2.syr.edu/10.1207/S15327051HCI1523\\_4](http://www.informaworld.com.libezproxy2.syr.edu/10.1207/S15327051HCI1523_4)

[23] E. Davenport and H. Hall, "Organizational Knowledge and Communities of Practice." *Annual Review of Information Science and Technology (ARIST)*, vol. 36, pp. 171-227, 2002.

[24] R. Hogan, G. J. Curphy and J. Hogan, "What we know about leadership: Effectiveness and personality," *Am. Psychol.*, vol. 49, pp. 493-493, 1994.

[25] R. Yamaguchi, N. Bos and J. Olson, "Emergent leadership in small groups using computer-mediated communication," *Computer Support for Collaborative Learning*, pp. 138, 2002.

[26] M. E. Warkentin, L. Sayeed and R. Hightower, "Virtual Teams versus Face-to-Face Teams: An Exploratory Study of a Web-based Conference System\*," *Decision Sciences*, vol. 28, pp. 975-996, 1997.

[27] W. F. Cascio and S. Shurygailo, "E-leadership and virtual teams," *Organ. Dyn.*, vol. 31, pp. 362-376, 2003.

[28] R. M. STOGDILL, "Personal factors associated with leadership; a survey of the literature," *J. Psychol.*, vol. 25, pp. 35-71, Jan. 1948.

[29] R. M. Stogdill, "VALIDITY OF LEADER BEHAVIOR DESCRIPTIONS 1," *Person. Psychol.*, vol. 22, pp. 153-158, 1969.

[30] R. M. Stogdill and A. E. Coons, *Leader Behavior: Its Description and Measurement*. Ohio State University College of Administrative Science, 1957,

[31] J. W. D. L. Hsiao. (2003, CSCL theories. [Dhsiao/theories.Html# Vygot 2009\(04/05\)](#),

[32] C. "Ellis, S. "Gibbs and G. "Rein, "Groupware - some issues and experiences.," *Communications of the ACM*, 34 (1): 38 {58, 1991.

[33] D. Garrison, "Online collaboration principles," *Journal of Asynchronous Learning Networks*, vol. 10, pp. 25-33, 2006.

[34] M. A. D'Eredita and C. Barreto, "How Does Tacit Knowledge Proliferate? An Episode-Based Perspective," *Organ. Stud.*, vol. 27, pp. 1821, 2006.

[35] D. "Cogburn and N. S. "Levinson, "Help me, help you: A triple track approach to maximizing collaborative learning in complex cross-national virtual teams," in Anonymous Information Science Reference, 2007, pp. 257.

[36] G. H. Hofstede and G. J. Hofstede, *Cultures and Organizations*. McGraw-Hill New York, 1991,

[37] E. T. Hall, "Beyond Culture. New York: Anchor," 1976.

[38] A. Ardichvili, M. Maurer, W. Li, T. Wentling and R. Stuedemann, "Cultural influences on knowledge sharing through online communities of practice," *Journal of Knowledge Management*, vol. 10, pp. 94-107, 2006.

[39] E. S. Veinott, J. Olson, G. M. Olson and X. Fu, "Video helps remote work: Speakers who need to negotiate common ground benefit from seeing each other," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: The CHI is the Limit*, 1999, pp. 302-309.

[40] R. V. Small, "Motivation in instructional design," *EDUCATIONAL MEDIA AND TECHNOLOGY YEARBOOK*, pp. 89-92, 1999.

[41] J. M. Keller, "Strategies for stimulating the motivation to learn," *Performance Instruction*, vol. 26, 1987.

[42] J. M. Keller, "Motivational design of instruction," *Instructional Design Theories and Models: An Overview of their Current Status*, pp. 386-434, 1983.

[43] R. V. Small and M. Venkatesh, "A cognitive-motivational model of decision satisfaction," *Instructional Science*, vol. 28, pp. 1-22, 2000.

[44] W. J. ". "Stewart, *Improving the Teaching of Decision-Making Skills*. , vol. 63, 1989, pp. 64-66.

[45] J. Hollan and S. Stornetta, "Beyond being there," pp. 119-125, 1992.

[46] M. S. Ackerman, "The intellectual challenge of CSCW: The gap between social requirements and technical feasibility," *Hum. - Comput. Interact.*, vol. 15, pp. 179-203, 2000.

[47] G. M. Olson, S. Teasley, M. J. Bietz and D. L. Cogburn, "Collaboratories to support distributed science: The example of international HIV/AIDS research," in

*Proceedings of the 2002 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists on Enablement through Technology*, 2002, pp. 44-51.