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3D Virtual Environments and Corporate Learning: An Empirical Investigation of Benefits

Anne Massey, Mitzi Montoya, and Philip Wu

Abstract

Organizations invest significant resources in learning and development (L&D) to both enhance and protect their human capital. As such, they continue to search for innovative design and delivery approaches that are both cost efficient and learning effective. In this article, we consider one organization's use of a 3D virtual environment (VE) to bring a managerial and leadership development program, informed by collaborative learning principles, to globally distributed participants. To date, there is little empirical evidence that attests to the specific learning benefits of a VE, that is, benefits that derive from distinguishing features such as presence (i.e., the sense of 'being there' in the VE). Given this, and drawing from prior research, we develop and empirically test a model that examines the relationships among organizational participants' perceptions of presence, teamwork quality and outcomes. Our results provide important insights into the mechanisms underlying L&D processes and outcomes in VEs.

1. Introduction

Given the need to identify and prepare future leaders and create opportunities for internal advancement, businesses dedicate substantial resources to learning and development (L&D) [22][45]. According to a recent report by the American Society for Training and Development (ASTD), corporate expenditures globally for L&D reached nearly $290 billion in 2011, with US companies alone spending nearly $175 billion. Nearly 20% of content is focused on managerial training and executive development. Due to advancements in network-based information and communication systems and in light of economic pressures (e.g., reduced budgets, travel constraints) the use of technology to deliver content continues to rise [72]. In 2011, Fortune Global 500 companies set a new high of just over 40% of formal learning hours used being delivered via technology-based methods [3].

Prior research suggests that the application of appropriate *design and delivery* methods for virtual learning environments can help maximize L&D benefits [32]. Traditionally, content design often revolved around instructional packets with delivery methods dominated by synchronous (e.g., Adobe Connect, WebEx) and asynchronous (e.g., on-demand modules) tools to support instructor-led and/or self-paced learning. However, while suitable in some contexts, these methods often fall short relative to the development of managerial and leadership skills (e.g., communication, envisioning the future, team leadership, etc.) [18].

In response, many organizations are exploring approaches designed around *collaborative learning* (CL), broadly defined as a situation in which a small group of individuals work together to complete a problem-solving task designed to promote learning [25]. CL is based on premises of effective learning processes (i.e., active learning and the construction of knowledge, cooperation and teamwork, and learning via problem-solving) (c.f., [2][5][17]). Widely researched, CL is generally accepted as beneficial for critical thinking, learner satisfaction, learning enhancement and performance [31][46].

Ultimately, a key challenge for CL is how to get participants to engage with content *and* each other in ways that are efficient and effective. This challenge is exacerbated when learners are distributed (i.e., organizationally, geographically, and/or temporally). Over the last two decades, communication and collaboration tools have evolved significantly with an expanding array of options available to support dispersed CL, including traditional media (e.g., email, document repositories, web/video-conferencing), groupware and Web 2.0 tools (e.g., wikis, blogs, video sharing, social networking applications, etc.) [1][60]. However, these solutions cannot capture the nuances and dynamics of human interaction, nor do they create truly engaging spaces that encourage individuals to come together to explore, collaborate, and learn [54].

In contrast, graphical three dimensional (3D) virtual environments (VEs) offer unique characteristics to support interaction and engagement. VEs have emerged recently as platforms for a variety of organizational and educational purposes, including distributed and collaborative learning (c.f., [11][12][16][24][35][44][53][58]). A VE may be defined as a 3D space where users, via digital representations known as avatars, can interact with others and digital objects [15]. Research in the education domain suggests that via unique characteristics, VEs offer the potential to produce better learning benefits [20][38][48].

We are specifically interested in the degree to which a VE creates a sense of *presence* in a user. Generally, presence is the sense of "being there" in the space depicted by the VE [49]. Many authors have stressed the importance of presence, suggesting it as a critical feature that distinguishes a VE from other types of computer applications (c.f., [50][58]). Designers of VEs consider presence to be desirable, coupled with a longstanding belief that it is causally related to performance outcomes. To date, however, there is limited empirical evidence to support the view [66, p. 164][69][59]. Because organizations are just beginning to explore the efficacy of VEs to L&D and determine if benefits outweigh costs, the link between presence and CL outcomes is particularly relevant.

In this article, we consider one organization's use of a 3D VE to bring a managerial and leadership development program – informed by CL principles – to globally distributed participants. Specifically, the objective of our study is to examine the relationship between participants' perceptions of presence, teamwork quality and outcomes (learning and task performance). In the following sections, we review the relevant literature and develop our research hypotheses. We then describe our research context and methodology. Lastly, we discuss the findings and implications of our empirical study, concluding with a discussion of directions for future research.

2. Background

2.1 Organizational L&D

Learning and development (L&D) expenditures, particularly for managerial and leadership training, are often considered important investments for organizations regardless of the economic climate. Prior research suggests that the effectiveness of training varies depending on delivery method and the skills being developed (e.g., interpersonal, leadership, psychomotor) [1]. Meta-analyses of the benefits of managerial leadership development demonstrate positive effects when compared to no training [18][19]. As such, organizations continue to search for new and innovative design and delivery approaches that are both cost efficient *and* learning effective – with learning defined as the acquisition of work-related new skills and knowledge. Thus, it is perhaps not surprising that organizations are interested in approaches, including technology-supported collaborative learning (CL), that engage learners in meaningful learning processes [62].

Collaborative learning (CL) is grounded in social constructivism, a theory wherein groups construct knowledge by collaboratively creating shared artifacts with shared meanings [39][57]. The broadest definition of CL is a situation in which two or more people learn something together [25]. As a learning strategy, CL involves: (1) active (vs. passive) construction of knowledge; (2) cooperation (vs. competition) and teamwork to motivate, share and develop perspectives, and provide social support; and, (3) learning through relevant problem-solving tasks that call for the testing and refinement of domain elements and interrelationships [2]. CL is particularly applicable as a strategy for the development of managerial and leadership skills (e.g., situational awareness, planning, conflict resolution) [18][28[55][65]. In addition to enhancing individual knowledge, skills, and abilities, CL can also facilitate development activities aimed at building and fostering broader network relationships that may lead to, for example, the transfer of organizational best practices [22][43].

When information and communication technology is added to the L&D strategy, the central question is whether the technology enhances the learning process or resultant skills [2][25][42][43]. Interaction through many traditional technologies (e.g., email, document repositories, groupware, etc.) as well as Web 2.0 and social tools is largely constrained to written language. Likewise, web-based and videoconferencing technologies are limited in their ability to provide a 'place' where something happens. Consequently, communication typically lacks the rich (visual and auditory) referential field (e.g., cues, gestures, speech intonations, locus of attention) of the physical world that is present in face-to-face (FtF) interactions. For CL, the reality is that building a common ground is essential to participants' engagement and learning outcomes – technology can either facilitate or hinder this process. Given all this, 3D virtual environments (VEs) may help overcome the constraints of earlier technologies. To date, while applications of VEs have been limited and by and large in higher education settings [44], early results suggest that VEs may advance corporate L&D efforts [23][24][53].

2.2 Virtual environments and learning

VEs grew from virtual reality (VR) technologies, but possess key differences. VEs are persistent (i.e., they continue to exist event when users are not logged in) and, as multi-user spaces, they are social in nature [51]. They are enabled by computer simulation technologies that model or parallel the real world, thus providing a locus for interaction. For example, a VE can visually simulate a business environment (e.g., meeting room, sales floor). Participants act within the space generated by the computer most often through the use of an avatar (a digital representation of self) [6]. One's avatar can be customized to portray (actual or desired) self-image. Importantly, with the ability to customize one's avatar-self and use it to interact with others, VEs offer a new way to assert one's embodied subjectivity [59]. As a result, communication is evolving from disembodied text-dominated 2D technologies to the physical, non-verbal gestures and expressions realized through the body language of an avatar [68].

VEs offer a number of affordances relevant to learning, especially CL which involves collaboration, 'learning by doing', and the generation of artifacts as outputs of the effort [23][44][56]. Due to the use of 2D representations, 2D platforms lack support for deep engagement with objects. In contrast, VEs allow dispersed users to explore a 3D space concurrently and use 3D objects to support a variety of tasks [21]. In addition avatars, VEs also offer many other visual and spatial cues essential to coordinating activities and knowledge sharing. In concert, representational fidelity (e.g., realistic display of the environment, user representation) and learner interaction (e.g., embodied actions such as object manipulation, embodied verbal and non-verbal communication) constitute unique characteristics of a VE as a learning space [20].

In principle, users experience varying degrees of *presence* in a VE. Presence is often described as the subjective sense of "being there" in the virtual place rather than in the physical space where one's body is really located (c.f., [63][64]). Of relevance to CL, the notion of "being there" is enhanced by the possibility of "being there together" as avatars can occupy space simultaneously and "doing there" as avatars can interact with 2D and 3D objects [20] [71].[1] Presence is considered by many researchers and practitioners to be a critical and distinguishing feature of VEs. Moreover, partially due to the belief it is positively related to outcomes (e.g., task performance), it a considered by designers to be a desirable element. However, there is little evidence to support this view [59]. Overall, early findings are mixed regarding whether there is a correlation or causal relationship between presence and outcomes [4][52][69]. Findings by Stanney et al. (1998) suggest that the relationship may be dependent on task and/or the communication requirements placed on the user.

While VEs may hold promise for corporate L&D (and other corporate use settings), a review of the literature suggests that research on how VEs actually support learning is limited and remains equivocal. In fact, there is little empirical evidence that attests to the specific learning benefits of a VE, that is, benefits that derive from distinguishing features such as presence or application to specific pedagogical approaches like CL [20][48]. To address these questions, in the following section, we develop specific hypotheses regarding the relationships between perceptions of presence and the quality of teamwork, learning and task performance.

3. Model and Hypotheses

In principle, when an individual's attention is allocated to the VE *vs.* the real world, an individual experiences presence as the space surrounds them with ever-changing sensations, while simultaneously responding to their actions via an avatar.

We hypothesize that one's sense of presence – the ability to both *be* and *do* in a 3D space – is positively related to desired outcomes. More specifically, in the context of collaborative learning (CL), active participation with others and objects in the VE, coupled with focused attention on VE task stimuli, will influence learning and performance [17][37]. Learning is defined as the acquisition of knowledge or skills. Moreover, with the ability to *do* and *be there together*, presence will enhance individual perceptions of teamwork quality, defined as how well a team works together towards its goal. For example, awareness of visual and spatial cues will enable better collaboration (e.g., visual information can be used to monitor work progress) [8]. Similarly, avatar embodiment can also motivate individuals to participate more because they are unable to hide in the shared space [37]. Constructivist theory assumes outcomes are influenced by *how* a participant engages in activities [17]. We propose that the efficacy of VEs to CL hinges on individual acceptance of the representational fidelity of the VE as an authentic representation of reality and participation in embodied actions to support dynamic social relationships. Stated formally:

[1] While immersion and presence are often used interchangeably, we agree with Dalgarno and Lee [20] and Slater et al. [64] that presence is context-dependent and draws on an individual's subjective psychological and physiological response to the VE. In contrast, immersion relies on the technical capabilities of the VE to render sensory stimuli leading to a sense of presence.

H1: Collaborative virtual presence is positive related to (a) perceptions of learning, (b) perceptions of teamwork quality, and (c) team performance.

An extensive body of literature offers strong evidence for the importance of teamwork to the success of collaboration processes in a variety of contexts (e.g., innovation, learning, business process modeling) (c.f., [14][41][47][67]). Drawing from prior research, an individual's perceptions of teamwork quality encompasses both process quality (e.g., the ability to reach consensus) and work quality [26][36]. Broadly, success is indicated by team-produced outputs *and* the consequence a team has for its individual members [33]. In the context of CL, the purpose of teamwork is to engender interactions that trigger individual learning mechanisms [2][25]. Success is reflected in both individual learning and problem-solving effectiveness. As such, the quality of teamwork is assumed to influence individual learning as well as team task performance. For example, high teamwork quality leads to satisfaction with the work condition and provides an opportunity for learning, skill acquisition, and the construction of knowledge [26]. Stated formally:

H2: Perceived teamwork quality is positively related to (a) perceptions of learning, and (b) team performance.

Prior research offers evidence of the benefits of training for managers and leaders [18][19]. Benefits consist of knowledge (e.g., skill development, critical thinking) *and* behavioral outcomes (e.g., ability to apply acquired knowledge). When working on a task, particularly an ill-structured one, teams perform better when multiple perspectives are considered and diverse knowledge, skills, and abilities are applied to the problem at hand [33][47]. In the context of CL, a key objective is to further the learning of individuals through interaction with others. Thus, we expect that higher levels of learning by individuals enhance a team's capability to perform. Stated formally:

H3: Perceptions of learning are positively related to team performance.

4. Methodology

4.1 Research Context

BP is a global energy group that employs over 80,000 people and operates in over 80 countries worldwide. Historically, as part of its premier leadership development program, BP ran an annual multi-day forum at its global headquarters to mark the end of the program and give participants (approximately 450/year) an opportunity to hear and learn from senior executives. Due to travel costs and other constraints, only one-third of the global graduates typically attended and some geographic regions were grossly under-represented. BP sought an alternative "virtual" approach to the multi-day forum in response to economic pressures and concerns about the value of the forum itself as a broader platform for learning, As objectives, the planning team determined that the new approach should: facilitate learning needed to ground participants in the company's broader business objectives and qualify them as future managers; extend engagement with senior executives; and, create global networks to allow for the sharing of best practices.

To achieve these objectives, BP designed a capstone project informed by principles of collaborative learning for the leadership development program called the 'Global Graduate Challenge' (GGC). The GGC centered on a relevant decision-making scenario set in the year 2025. The scenario involved a fictitious territory that held immense promise for oil and gas reserves, but was also cold and desolate, hard to access, and home to protected species. The decision dilemma was whether or not to tap the region's energy resources. With this as the learning context, 158 participants (assigned to 17 cross-functional teams) were chosen to participate in the pilot program and play the role of BP executives. Team members were organized within 2 to 3 time zones of each other. Over a 4-week period, participants met with their team and senior leadership (executives, VPs, directors) and subject matter experts to learn about, collect and share information related to the project. The project ended with each team presenting its plan to senior executives.

From a technical perspective, BP examined a variety of, including VEs. BP chose *ProtoSphere®*, a VE that offers a collection of business-focused collaboration, communication, and 3D visualization tools. Participants (as avatars) could interact with each other (voice, text) and data in a variety of forms (e.g., application content, documents, images, video, presentations, and web content). In addition to common meeting spaces (e.g., briefing rooms), each team had its own virtual workroom for both synchronous and asynchronous activities. Ultimately, *all* activities associated with the GGC were conducted in the VE. Figure 1 provides an example of a meeting space. Prior to the actual start of the 4-week GGC, a 2-week beta test was held to train participants on the basics of the VE and resolve any technical issues.[2]

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[2] For additional case details, see [40, pp. 181-189].

Figure 1. Sample 3D meeting space

4.2 Data collection and measures

To test our hypotheses, we developed a survey to capture participant perceptions of their GGC experiences and the VE. In addition, voluntary and anonymous responses were collected during the 2-week period immediately following the end of the program. 91 of the 158 participants (57.6%) provided usable surveys with 15 of the 17 teams represented in the response set. Demographically, 65% were male; 43% were 22-26, 47% were 26-30, and 10% were between 31-35 years old.

Perceptions of collaborative virtual presence (PRESENCE) were measured at the individual level to capture the subjective viewpoint of each participant's felt experience in the VE. Based on a review of the literature and a variety of sources, we adapted 10 measurement items for collaborative virtual presence (c.f., [34][61][70]). Perceptions of team work quality (TEAM) were measured via 6 items adapted from [36]. Individual perceptions of learning (LEARN) were measured via 3 items adapted from [2]. In addition, an open-ended question was offered to gather participants' thoughts about their GGC program experiences and perceived benefits from participating. Lastly, an objective measure of performance (PERFORM) (0 to 100) was derived from evaluations conducted by BP senior executives. Specifically, each team's final recommendation received a score based on evaluations of content, inclusion of desired leadership framework behaviors, demonstrated knowledge sharing, and reflection of BP's key priorities.

5. Analysis and results

A three-stage analysis was undertaken to quantitatively evaluate the measurement model and test the hypotheses. First, principle component analysis (PCA) was performed on the data set to assess the unidimensionality of the measurement scales. Then, the data set were subjected to a confirmatory factor analysis (CFA) with maximum-likelihood estimation to assess the overall fit of the measurement model. Finally, we used a Partial Least Square (PLS) method to test the structural model derived from our theoretical hypotheses.

We performed a PCA in SPSS 17 based on the questionnaire items (Table 1) for the three constructs – PRESENCE, TEAM and LEARN. The three-factor solution explains approximately 71% of the variance. All item loadings are greater than .60 with no cross-loadings above .40. The scales also demonstrated high internal consistencies with Cronbach's alpha coefficients ranging between 0.762 and 0.945. To further test the factorial validity of our measurement scale, we conducted a CFA. The results demonstrated an acceptable fit between the data and the model: χ^2= 46.22, *df* = 31, *p* = .039. Three additional indices were used to assess the goodness of fit: GFI = .913, CFI = .970, RMSEA = .074. While the values of GFI and CFI indicate an adequate fit, RMSEA is higher than the cut-off value (.05) suggested by Browne and Cudeck (1993). However, this index is very sensitive to sampling error and model complexity [10]. Given the small sample and a total of 24 estimated parameters in this case, a RMSEA value below .08 is considered acceptable (see [9]). The means and standards deviations for our measures are shown in Table 2.

To assess the hypothesized causal links between the predictors (PRESENCE and TEAM) and the dependent variables (PERFORM and LEARN), a PLS analysis was performed. Compared to covariance-based structural equation modeling in Amos and LISREL, PLS does not require the assumption of multivariate normality and is more robust in estimating complex models with small to medium sample sizes [13]. To ensure the stability of our estimates with PLS, we employed a bootstrapping technique with 500 resamples of the 91 cases.

In PLS, convergent validity and discriminant validity of the measurement scale was evaluated by examining the individual loadings and weights of each item, cross loadings, internal composite reliability, and average variance extracted (AVE) [13][30]. Based on the results from the measurement model (outer model), there was evidence of convergent validity, as all loadings were over 0.70 and the composite reliability of all components were higher than the recommended value of 0.80[29]. In addition, as shown in Table 3, all AVE scores were above the threshold value of 0.50. Discriminant validity is demonstrated by having the square root of the AVE of each construct larger than any correlation between the construct and other constructs [30]. This condition has been met.

The structural model in PLS was assessed by examining the path coefficients, t-statistics, and R^2

values [13]. Figure 2 presents the results of the model testing. As shown, both PRESENCE (β = .449, p < .001) and TEAM (β = .290, p < .05) have a significant positive effect on LEARN. H1a and H2a are supported. Similarly, the model shows that PRESENCE has a strong positive effect on TEAM (β = .590, p < .001), supporting H1b. However, while TEAM is positively related to PERFORM (β = .265, p < .05), thus supporting H2b, neither of the hypothesized paths to PERFORM from PRESENCE or LEARNING (H1c and H3) are supported.

Table 1. Constructs and survey items

Construct	Items
PRESENCE	1. I was deeply engrossed in the project. 2. The project was interesting. 3. I was absorbed intensely in the project. 4. In *Protosphere*, I used nonverbal cue (e.g., gestures) to communicate with others. 5. I noticed others (i.e., my teammates) using nonverbal cues to communicate. 6. I felt in control while I was in *Protosphere*. 7. The *Protosphere* environment was responsive to my actions. 8. I was able to anticipate what would happen next in response to actions I performed. 9. I was able to closely examine the objects I need to in *Protosphere*. 10. I was able to examine objects I needed to from multiple perspectives.
TEAM	1. My teammates and I developed a clear strategy for working on the project. 2. My teammates and I easily reached consensus. 3. I enjoyed working with my team. 4. In my opinion, my teammates and I were successful on the project. 5. I was satisfied with the process by which my team completed the project. 6. There was a feeling of unity and cohesion in my team.
LEARN	1. The project provided me with a significant learning opportunity. 2. I was able to acquire important “know-how” through the project. 3. I learned important lessons by working on the project.

Table 2. Construct values

Construct	Mean	Standard Deviation
PRESENCE	4.787	0.950
LEARN	4.693	1.578
PERFORM	56.872	9.870
TEAM	5.312	0.992

Table 3. Average variance extracted, composite reliability, and Cronbach’s alpha

Construct	AVE	Square Root of AVE	Composite Reliability	Cronbach’s Alpha
PRESENCE	0.530	0.728	0.816	0.762
LEARN	0.900	0.949	0.964	0.945
PERFORM	1.000	1.000	1.000	1.000
TEAM	0.589	0.767	0.895	0.858

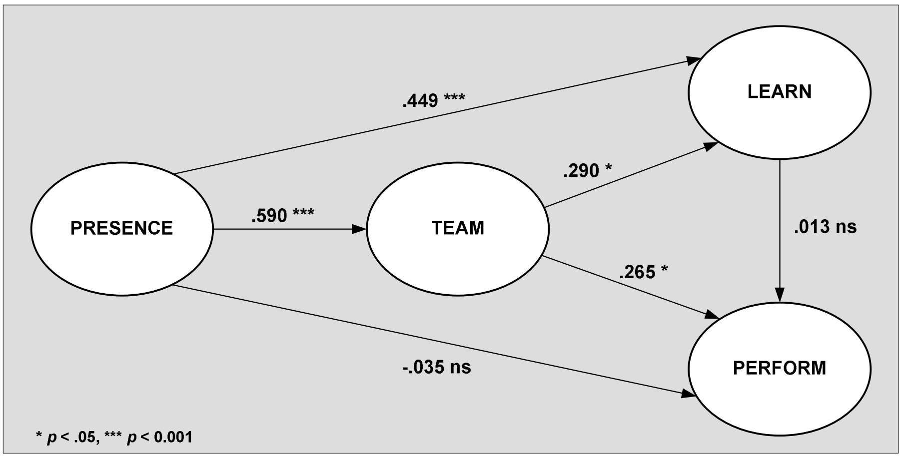

Figure 2. Results of PLS Structural Model Analysis

6. Discussion and implications

Our study developed and empirically tested a model in a corporate L&D context to examine the relationships among participants' perceptions of presence, teamwork quality and outcomes in a virtual learning environment. Prior L&D studies have not considered the relationships among teamwork, learning and performance in VE contexts. In addition, the nascent research on VEs has not linked the concept of presence to outcomes. Our results have important implications regarding the effects of perceived presence on teamwork quality and individual learning and team performance outcomes in 3D VEs.

The results shown in Figure 2 provide important insights into the mechanisms underlying L&D processes and outcomes in VEs. In particular, our empirical analysis indicates that perceived collaborative virtual presence has a direct positive effect on individual perceptions of learning and teamwork quality in a VE. Recent advances in global network connectivity and information technologies are creating new opportunities for lower cost and highly effective distributed L&D programs. 3D VEs present the opportunity to develop simulated visual space for collaborative learning that is a major advance beyond current web/teleconferencing. VEs have been well-studied in military applications and gaming contexts, but no prior research has examined the role of VEs in organizational L&D collaborative learning contexts. Our results suggest that perceived collaborative virtual presence is a critical enabler of collaborative learning and team processes in VEs for collaborative learning activities.

This field study in a corporate L&D setting demonstrates the importance of perceived presence in a 3D VE. The effects of presence on teamwork quality and individual learning suggest that decision makers who are considering VEs to support L&D need to carefully consider the features and capabilities of any given VE to make sure it supports the desired collaborative learning activities and team member needs. Although VEs offer new possibilities, L&D managers must be careful to map VE capabilities to specific desired learning outcomes and team processes. The BP implementation is a good illustration of the need for demonstration projects to validate learning outcomes, provide training for users in advance of launch, and capturing feedback from users throughout the process to identify strengths and weaknesses of the VE as a learning environment.

The results in Figure 2 also indicate that the effect of presence on team performance is partially mediated by teamwork quality. Both presence and teamwork have positive direct effects on individual learning, but neither presence nor learning have a direct effect on performance (as measured objectively by senior BP management). Of the variables included in our model, team performance is predicted solely by teamwork quality. On the one hand, this is a key finding that suggests the potential of VEs to replicate FtF collaborative learning environments in L&D contexts. This finding confirms the constructivist view of learning as a social activity in which group based learning and motivational processes contribute positively to interactions, cooperation and ultimately outcomes [7]. Our results suggest that it is not the VE itself nor the user's perceived presence in the VE, but rather the quality of teamwork that the VE enables is the key driver of performance. Likewise, the lack of significant effect of individual learning on team performance suggests that the collaborative learning effects outweigh individual effects in this context. It may be that the nature of the collaborative learning exercise in this context masked the role of individual learning. The team performance evaluation by BP management did not assess individual development, but rather looked solely at the quality of the decision the team made.

The positive effect of perceived presence on individual learning speaks to the importance of the affordances provided by VEs to the learner. These affordances include the facilitation of interaction, improved contextualization of communications, and enhanced spatial awareness. The results suggest that the VE may capitalize on natural aspects of human perception by extending information flows visually and spatially in three dimensions such that individuals are able to interact with other team members and objects. The positive effect of perceived presence on individual learning suggests that that the pedagogic potential of 3D VEs is significant.

The effect of presence on teamwork suggests that presence enables team members to explore, debate, and iterate toward a decision as they would typically in a FtF setting through discussion and information exchange. Some further analysis of participant feedback provides some additional insight into this finding. Comments from participants in BP's GGC activity indicate that while they did not consider the VE a full replacement for FtF programs, given daily workloads and time/travel constraints, the VE was deemed a viable alternative to traditional mediated solutions. For example, a participant reflected that the VE facilitated richer communication than would have been possible with leaner media: "*In general, I find conference calls hard because I can't easily distinguish who is speaking. In this way Protosphere was better than a conference call because you could see who was speaking*." Or, stated another way, the functionality afforded by the VE (e.g., avatar embodiment) created a closer functional equivalence to FtF than traditional alternatives.

7. Limitations and research directions

Our results must be interpreted in light of certain strengths and limitations. While our sample is rich in terms of being an applied organizational task and setting with objective and independent performance outcome measures, it is simultaneous limited in generalizability beyond the focal company and collaborative learning task. BP is a global firm and the program studied is representative of a well-designed L&D program for high potential young managers, but future research is needed to determine the stability of our findings across settings.

Second, while this study provided an important assessment of the relationships among presence, teamwork quality and learning, future research could explore the evolution of these constructs over the course of a collaborative learning experience. This could be achieved by collecting additional data at repeated intervals during the exercise to examine the dynamic nature of the interrelationships over time. From a learning perspective, this would allow us to deconstruct the learning process for the sake of developing interventions that enhance individual and team learning over time. Further testing via both controlled experiments and field studies would lend to developing a rich understanding of the value of VW interventions to learning. And, research is needed using different and larger populations that would allow for further empirical testing and validation of the hypotheses and model structure reported here.

8. Conclusion

Organizations are just beginning to explore the potential of VEs, particularly in the workplace. While use is still largely in a nascent stage, early results from diverse fields (e.g., health, military) are encouraging. Due to unique characteristics, the ability to bring dispersed individuals together, along with falling costs, VEs offer great potential for corporate L&D – particularly as platforms for constructivist learning approaches like collaborative learning. Yet, there remains a great need for empirical research on how these technologies support learning processes and benefits, as well as validation of assumptions about what transfers theoretically and practically from one type of learning environment to another. We hope that the ideas and findings offered here contribute to this growing area of research and practice.

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