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Abstract

This longitudinal field study (three work sessions plus an initial training session) investigates the efficacy of a new technology—desktop videoconferencing (DVC)—in support of collaborative telelearning (i.e., collaborative learning among non-proximate team members). Two types of collaborative telelearning environments are con-

sidered: One involves local groups (i.e., students on the same campus), and the other involves non-proximate distant groups (i.e., students on two separate campuses). The collaborative telelearning environments are compared to each other and to a traditional face-to-face collaborative learning environment.

The study found that the three environments are equally effective in terms of student knowledge acquisition; however, higher critical-thinking skills were found in the distant DVC environment. The subjects in the three learning environments were equally satisfied with their learning process and outcomes. At the conclusion of the longitudinal assessment, the distant students using DVC were more committed and attracted to their groups compared to local students who worked face-to-face or through DVC.

Keywords: Collaborative telelearning, technology mediated learning, desktop videoconferencing, collaborative work systems, IT in business education

ISRL Categories: AA06, HA11, HA12, HA0802

Introduction

The information technology (IT) revolution, or even evolution, has not really impacted the core processes of learning and teaching in business schools. Business schools stand in stark contrast to organizations where IT (information computing and communications technologies) form the new infrastructure for communication, decision making, product development, and service delivery. Although our corporations, industries, and economy have made a transition into the information age, our educational system has been left behind in the industrial age. As one administrator put it, "... the problem is that those factory jobs don't exist anymore" (Soloway, 1993, p. 28). Transformation from an industrial economy to an information economy is changing the way organizations are structured, managed, and operated. Structures that enable rapid response to unique customer requests, changes in government policies and regulations, continuous technological innovations, and development of

strategic alliances are keys to success in today's global business environment.

The emerging organizational structures have been characterized as flexible networks of knowledge nodes (i.e., an individual or a team of knowledge workers) interconnected with powerful computer and communication technologies that span departments and divisions as well as organizational boundaries (Ives and Jarvenpaa, 1993). These emerging structures are further characterized as those in which knowledge workers operate in self-directed teams, information is shared freely, and suppliers and customers are coproducers of products and services (*Business Week*, 1993). As organizations increase the information content of their products, services, and processes of doing business, IT assumes a more prominent role in the design, development, and delivery of products and services. These changes suggest that organizations need a new breed of workers—flexible and knowledgeable individuals who can work effectively and efficiently with others and also understand the role of modern information technologies in knowledge creation, collaboration, and communication.

Given the volatility of the global business environment, continuous learning via collaboration with remote team members through sophisticated information technology is becoming increasingly important to the organizations. For example, AT&T's learning strategist, Marc Rosenberg, criticizes using classrooms just for dumping information. He sees the "classrooms" as places for teams to work together on problem-solving tasks (Perelman, 1994, p. 94). At Hewlett Packard (HP), Susan Burnett, manager of worldwide sales force development, states that "we are constantly pushing to blur the lines between learning and doing the job" (Perelman, 1994, p. 88). Just a few years ago nearly all of HP sales seminars were conducted in classrooms. Lately, the classroom instructions are replaced by two-way video instructions carried over the Hewlett Packard Interactive Network (HPIN). The new technology-enabled learning environment has not only reduced the cost of new product seminars by 98 percent (from \$5 million to \$80,000), it is even becoming a profit center by providing services to other companies. Alan Nowakowski, director of training at Andersen Consulting's education center in St.

Charles, Illinois, states, "We're working to reengineer the entire learning process" (Perelman, 1994, p. 89). The company is relying on its numerous LANS, as well as propriety client/server WAN and interactive multimedia, to operationalize the new learning processes.

The new vision of technology-enabled anytime-anyplace learning is changing the recruiting practices of some companies (Perelman, 1994). For example, Allstate Insurance is one of the growing numbers of employers that screens job applicants' skills by using the same multimedia technology originally created for training. The company feels that this approach to applicant assessment is more accurate than relying on resumes and school transcripts. Similarly, the Canadian office of Andersen Consulting uses job simulations software to evaluate recruits' problem-solving and critical thinking abilities.

Thus, business schools—and educational institutions in general—are under increased pressure to produce qualified workers adept at working in the emerging organizational structures. The new job demands, the emerging corporate recruiting practices, and the increased competition among the business schools have motivated broad-based re-examination of basic pedagogical assumptions, curriculum, and learning processes. In this context, advanced and emerging information technologies are increasingly viewed as a key resource in enabling new and effective learning processes and educational innovations. IT applications to the learning process need to be developed with an understanding of what is required to promote effective learning. Otherwise, there is a risk of making an ineffective process more efficient—but less effective—through automation and IT applications.

In the following section, contemporary learning theories and empirical research are reviewed, including a detailed discussion of the collaborative learning process. Next, the role of a new technology, desktop videoconferencing, in support of collaborative telelearning (collaborative learning among non-proximate team members) is described. The efficacy of collaborative telelearning (CT) was investigated and is reported herein. The article concludes with a discussion of the findings and suggestions for future research in the area of IT applications to the learning process.

Conditions for Effective Learning: A Theoretical Perspective

A review of the literature and research in the area of cognitive learning theory reveals that no single or unified theory exists (see Leidner and Jarvenpaa's article in this issue). Despite lack of a single model of learning, three attributes of effective learning processes can be identified (Alavi, 1994):

1. Active learning and construction of knowledge,
2. Cooperation and teamwork in learning, and
3. Learning through problem solving.

Active learning and construction of knowledge

Cognitive learning theory emphasizes learning as an active, goal-oriented, and constructive process (Shnell, 1986; Wittrock, 1986). Individuals do not learn by "copying" the presented information, but by constructing meaning from information by processing it through existing mental models. The processed information is then stored in long-term memory for future access and possible reconstruction (Johnson, et al., 1991). From this theoretical perspective, learning is best accomplished by *actively* involving students in construction of knowledge and understanding through acquisition, generation, analysis, and manipulation of information.

Cooperation and teamwork in learning

Some learning theories view learning as a social process that occurs more effectively through cooperative interpersonal interactions. For example, one learning theory argues that learning and development are social activities, initially shared between people but gradually internalized and personalized by the individual (Vygotsky, 1978). Another shows that social interactions promote learning by "decentering" an individual's thinking and shifting it away from an ego-centric perspective (Piaget, 1967). This in turn enables the learner to consider multiple perspectives. An individual's exposure to alterna-

tive points of view can challenge his/her initial understanding, which in turn motivates learning (Glaser and Bossak, 1989). Numerous studies have established the positive motivational and effective cognitive aspects of social learning process (see Brown and Palincsar, 1989, for an extensive review of relevant work in this area).

Learning through problem solving

Problem solving is a mental activity leading from an unsatisfactory state to a more desired "goal state" (Kurfiss, 1988). Problem solving implies the lack of a known route from the current state to the goal state, which requires search through a space of possibilities. Learning through problem solving results from a process of building and transforming mental models (i.e., cognitive representations of elements comprising a domain and their interrelationship (Ansari and Simon, 1979; Neches, 1978; Siegler, 1986). Research has shown that both knowledge of a domain and general problem-solving strategies are acquired through solving domain-relevant problems (Pellegrino and Glaser, 1982; Resnick and Glaser, 1976).

Recently, learning strategies that encompass these three attributes of effective learning have been promoted over traditional strategies that involve passive (versus active), competitive (versus cooperative), and individualistic (versus group-oriented) learning.

This paper focuses on one such strategy—collaborative learning—that embodies the three attributes of effective learning just described.

Collaborative Learning

Collaborative or group learning involves interpersonal processes by which a small group of students work together cooperatively to complete a problem-solving task designed to promote learning (Alavi, 1994). Thus, the collaborative learning concept is based on the three premises of effective learning—active, cooperative, and group problem solving.

In collaborative learning situations, through conversations, discussion, and debate, participants

offer explanations, interpretations, and resolutions to problems. This leads to active and social construction of knowledge and development and internalization of meaning and understanding. Furthermore, group discussions reveal different views and enable a more comprehensive conception and understanding to emerge.

Numerous empirical studies have demonstrated the superiority of collaborative learning over traditional modes of learning (i.e., individual or competitive learning situations). Since the late 1800s, over 500 experimental and about 100 correlational studies of collaborative learning involving different subject matters and subject types (adults and children) have been conducted (see Johnson and Johnson, 1989, for a complete review of the studies and the meta-analysis of results) (Johnson, et al., 1991). These studies and the meta-analysis of their findings provide compelling evidence to the relative effectiveness of collaborative learning in terms of learning achievement, student satisfaction with the learning process and outcomes, and quality of interpersonal relationships and the emotional climate in the learning environment.

A meta-analysis of 375 studies of collaborative learning involving both adult and child subjects indicates that the learning achievement (i.e., knowledge acquisition and critical thinking skills) of students in collaborative learning situations is at about two-thirds of a standard deviation above the average student learning achievement within a competitive or individualistic situation (effect sizes of 0.67 and .64 respectively) (Johnson, et al., 1991). When only studies involving college students and adult subjects are included in the meta-analysis, collaborative learning again promotes higher learning achievement than does competitive or individualistic learning (effect sizes = .59 and .62, respectively) (Johnson, et al., 1991).

Collaborative learning procedures have also been shown to enhance student satisfaction with the learning process and classroom experience. Several studies investigating college-level learning found that students who follow in-class collaborative learning procedures and actively interact with each other are more satisfied with their learning process and evaluate their courses more favorably than students who are exposed to traditional lectures (Bligh, 1972).

Kulik and Kulik (1979), in their review of literature on college-level learning, reach a similar conclusion. Specifically, they report that students who are exposed to collaborative methods (e.g., discussion groups) have a more favorable evaluation of their classroom experience.

Research has shown that compared to traditional classrooms (the lecture mode of instruction), collaborative learning situations promote considerably more liking among students (effect size = .60) (Johnson and Johnson, 1989; Johnson, et al., 1983). Furthermore, students in collaborative learning situations develop considerably more commitment and caring for each other, when compared with students in competitive learning environments (effect size = .80) and individual learning environments (effect size = .62) (Johnson and Johnson, 1989; Watson and Johnson, 1972). A positive emotional climate in a learning environment is important in fostering increased learning productivity and achievement.

Thus, the positive outcomes of collaborative learning (enhanced learning achievement, student satisfaction with the learning process and outcomes, and a positive emotional learning climate) make it a desirable mode of instruction and learning. However, costs and practical considerations in educational institutions and business organizations (e.g., the need for training an increasing number of part-time working adults, and requirements for continuous on-the-job learning) are making it more difficult to implement face-to-face collaborative learning approaches. These considerations have fueled interest on the part of academic institutions as well as private firms to explore the application of advanced and emerging information technologies in the creation of collaborative telelearning environments. For example, New York University offers a graduate teleprogram course in which students at remote locations work together to interview clients, conduct analysis, solve problems, and complete projects all within a computer network. The students' collaboration and interactions are supported by Lotus Notes software and networked personal computers. There are no on-campus sessions for the course. In another example, Hewlett Packard uses its corporate-wide interactive video network to deliver collaborative courses to the em-

employees. The network courses are used to convey highly volatile information and primarily take the form of interactive group meetings. In fact, the company anticipates that these courses delivered over the network will gradually be absorbed into groupware systems that will evolve to support on-demand collaborative learning across the company (Perelman, 1994).

Despite some early successes in the creation of IT-enabled collaborative telelearning infrastructure, little is known about the effectiveness of those environments relative to the face-to-face environments. Before making large investments in the technical infrastructures (i.e., collaborative software, computerized course materials, and the communication links), the learning efficacy of collaborative telelearning environments needs to be investigated.

Research Objectives and Hypotheses

The prior research reviewed above has demonstrated the effectiveness of face-to-face collaborative learning. Cost-effective, advanced, and emerging information technologies are creating opportunities to use technology-enabled environments for collaborative telelearning. The objective of our study is to investigate the efficacy of collaborative telelearning environments. In this section, media richness and TIP (Time, Interactions, and Performance) theories are used to develop a theoretical framework for the study. Then, research hypotheses derived from the theoretical framework are presented.

Theoretical framework

Desktop videoconferencing systems with fully integrated interactive collaborative software have recently emerged as a viable technology (*PC Magazine*, 1994). These systems represent a merging of several technologies that have existed independently, but not in a fully integrated fashion. Desktop videoconferencing systems represent a convergence of videoconferencing, collaboration-support software, and audio all packaged in a familiar personal computer. The

most unique feature of these systems is the collaboration-support software that allows remote parties to jointly (and synchronously) work on documents, spreadsheets, and graphics (i.e., any Microsoft Windows-compatible software) via an increasingly common ISDN (Integrated Services Digital Network) telephone call. Through the collaboration support software, either party can control the application program, and any changes are immediately reflected on both screens.¹ This capability is designed to mimic how students working face-to-face would work using the tools of a shared personal computer.

Although the DVC environment is designed to provide a communication environment that is similar to face-to-face communication, past theory and research suggests that these two environments are clearly not the same. Specifically, desktop videoconferencing systems, because of limitations in display screen size and quality, video speed, and audio delays, represent a "leaner" communication and interaction environment relative to traditional face-to-face communication (Daft and Lengel, 1986). Yet, relative to other forms of electronic media (e.g., telephone, voice mail, e-mail, computer conferencing), desktop videoconferencing of the form employed in this study, supports faster feedback, greater personal focus, and a greater variety of information cues. Thus, from a normative media richness perspective, desktop videoconferencing environments present the richest communication environment relative to other electronic communication environments for support of remote group interactions (c.f. Fulk, et al., 1987).

The reason why the communication environment plays such a critical role in most group activities, including collaborative learning, is that the effectiveness of exchanging information and gaining consensus on information meaning is tightly linked to the ability of the communication environment to convey different types of information (Daft and Lengel, 1986). Additionally, research has found that performing different tasks requires the exchange of different types of infor-

¹ We acknowledge that key features of desktop videoconferencing systems—jointly controllable software and PC video—have existed in some experimental and commercial local area network environments for some time. However, the emergence of commercially available desktop videoconferencing systems for ISDN represents a new era of technology convergence with widespread availability.

mation (see Dennis and Valacich, 1994, for a review and discussion). In other words, media richness theory suggests and past research has found that group task performance (in terms of uncertainty and equivocality reduction) and other outcomes should improve when task requirements are matched to a communication environment's ability to convey information. Of course, other factors are also important (e.g., relationship between individuals, personality, etc.).

Learning at all levels involves both uncertainty and equivocality reduction. Declarative learning (also referred to as factual knowledge acquisition or lower-level learning) refers to knowing and understanding the facts and or procedures (Bloom, 1956). It thus involves uncertainty and equivocality reduction in terms of information acquisition, processing, and interpretation as well as knowledge construction. Learning at the critical thinking level (also referred to as higher-order learning) consists of cognitive processes of transfer, analysis, synthesis, and evaluation (Bloom, 1956). Transfer involves using currently or previously acquired information and facts in new situations. Analysis and synthesis processes involve breaking down and aggregating information to diagnose and solve problems. Evaluative processes consist of developing and/or applying criteria for assessing ideas and alternatives. These processes involve high levels of uncertainty and equivocality reduction in thinking about, creating, or developing solutions to problems outside the domain of facts, rules, or procedures (Rice, 1992).

Group interactions for task performance and learning consist of a complex and dynamic nesting of task and socio-emotionally focused processes (Dennis and Valacich, 1994). More specifically, according to McGrath's (1991) Time, Interactions, and Performance (TIP) theory, groups engage in three concurrent functions: production, member support, and group well-being. The production function refers to the formally assigned task for which the group is formed (e.g., solving a problem or learning a skill or concept, etc.). Member support contributes to the individual members of the group and their satisfaction. Group well-being contributes to the group's emotional climate and viability as an intact social structure. According to TIP theory, groups engage in both socio-emotional and

task-oriented behaviors that can operate simultaneously during group interactions. Thus, the collaborative learning group "task" (i.e., learning) outcomes involve consideration of both the learning achievement (the production function) as well as the socio-emotional group outcomes (i.e., member satisfaction with the group process, and the perception of the emotional climate of the group).

Research hypotheses

Informed by established theories of media and social interaction (e.g., media richness and TIP theory) and given that face-to-face collaborative learning environments will allow the conveyance of a broader range of task and social-emotional information (information richness) relative to desktop videoconferencing learning environments, it is hypothesized that:

H1: The learning effectiveness of students who collaborate face to face will be greater than the learning effectiveness of students who collaborate via desktop videoconferencing.

The following specific subhypotheses were tested:

H1a: Students' *learning achievement* will be greater in *face-to-face* environments than in *distant CT* environments.

H1b: Students' *satisfaction* with the learning process and outcome will be greater in *face-to-face* environments than in *distant CT* environments.

H1c: Students' perceptions of the *emotional* learning climate will be more positive in *face-to-face* environments than in *distant CT* environments.

In contrast to the primary use of DVC between distant parties (referred to as *distant collaborative telelearning*), an alternative and likely use will be for collaborative telelearning within an organization, e.g., different floors of the same building or adjacent buildings (referred to as *local collaborative telelearning*). Since the students in the local groups have opportunities for richer face-to-face interactions outside the learning sessions, it would be expected that the use of DVC in local settings would be perceived less favorably—and therefore be less conducive to

effective learning—than in distant settings. Therefore, a second hypothesis contrasts different conditions for *collaborative telelearning environments*.

H2: The learning effectiveness of students who collaborate via distant desktop videoconferencing will be greater than the learning effectiveness of students who collaborate via local desktop videoconferencing.

The following specific subhypotheses were tested.

H2a: Students' *learning achievement* will be greater in *distant CT* than in *local CT* environments.

H2b: Students' *satisfaction* with the learning process and outcome will be greater in *distant CT* than in *local CT* environments.

H2c: Students' perceptions of the *emotional learning climate* will be more positive in *distant CT* than in *local CT* environments.

Research Design

The research methodology was a field experiment in MBA programs employing a quasi-experimental design with nonequivalent control groups (Cook and Campbell, 1979). The data was collected in 1994.

Subjects

One hundred twenty MBA students from two major state universities participated in the study. The subjects were divided up into 30 four-person teams. The subjects from one of the universities were drawn from two sections of an MIS course and participated as part of several experiential class activities. The subjects from the other university participated on a voluntary basis.² The average age of the subjects participating in the experiment was 28.1 years with 5.4 years of full-time work experience. T-tests indicated that there were no significant differences

between the subjects in terms of age, work experience, or self-reported computer skills.

Experimental manipulation

The experimental manipulation involved use of desktop videoconferencing PCs to create a collaborative telelearning environment for some of the student teams while others interacted face-to-face. All subject teams participated in three sessions and were assigned to only one of the three treatments for all sessions. The primary treatment of interest, *Distant Collaborative Telelearning (DCT)*, involved 20 distant teams (about 600 miles apart) composed of two dyads, with each dyad representing one of the two universities (Figure 1). Each dyad had a different part of the business case (described below). The DCT treatment was based on the primary role envisioned for desktop videoconferencing systems—collaboration between geographically distant parties (i.e., students from different campuses). The learning effectiveness of the DCT environment was compared with the learning outcomes of two smaller baseline treatments. The *Local Collaborative Telelearning (LCT)* treatment involved five teams of two dyads from the same university. In this treatment the two dyads were physically separated during the learning sessions (Figure 2), but had chance opportunities for face-to-face interactions outside the learning sessions (i.e., students on the same campus). The second baseline treatment also used five teams of two dyads from the same university who collaborated face-to-face (FtF). These dyads also received the same level of task support via the collaboration software between the two PCs as did teams in the other treatments (Figure 3). The two smaller treatments were necessarily conducted with students from the same university and were designed to serve as baselines for comparison to the DCT treatment. Subject availability and curricular constraints necessitated fewer participants in the baseline treatments.³

² Differences in the curricular structures of the two universities necessitated this arrangement. The volunteer students were paid \$35 for their participation in the study.

³ The subjects were drawn from two sections of a required introductory IS class. Since their participation was a graded requirement, it was deemed necessary to ensure academic fairness by having all of one class communicate across distance and the other class communicate locally. This constraint minimized the differences within each class for grading, but resulted in unequal cell sizes.

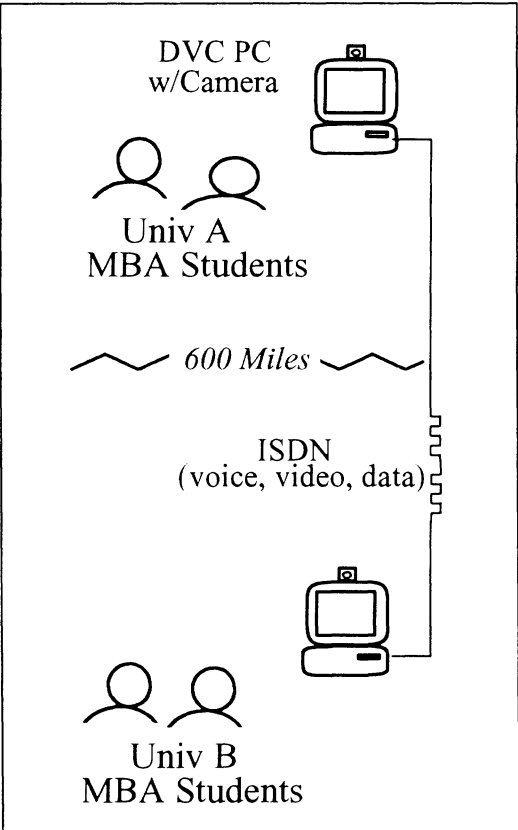


Figure 1. Distant Collaborative Telelearning (DCT) Treatment

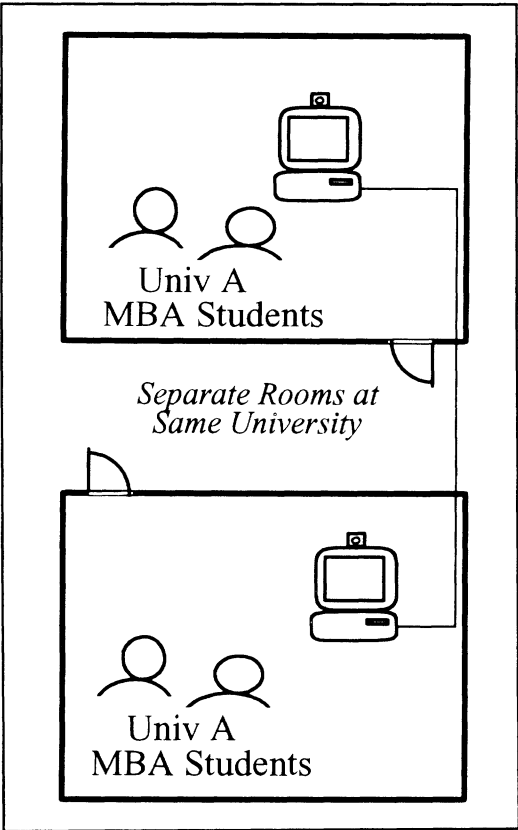


Figure 2. Local Collaborative Telelearning (LCT) Treatment

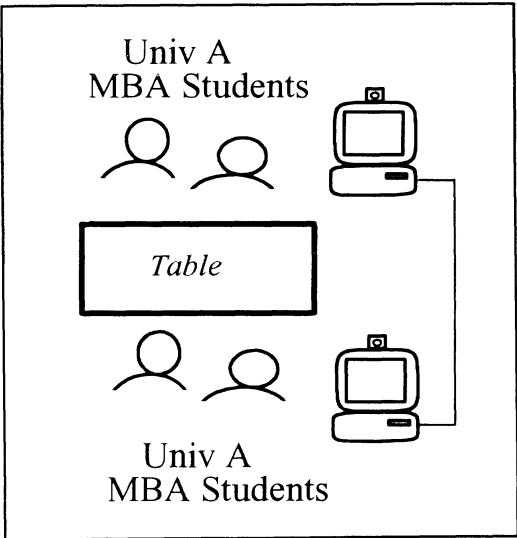


Figure 3. Face-to-Face (FtF) Treatment

Learning task

One of the important features of collaborative learning is learning through cooperative conversation, debate, analysis, interpretation, and information sharing. To maximize learning appropriate for MBA-level studies, extensive efforts were made to increase the contextual realism of the collaborative learning task. Two versions of a Harvard Business School-style case (though fictional) were written that involved the manufacturer-distributor relationship in the grocery industry.⁴ One version of the three-part case took the perspective of the manufacturer, which was described as a large *Fortune 100* food manufacturing company that operated on a national basis. The second version of the case took the perspective of a food broker, a regional sales organization. A central issue in the case was the feasibility of forming an interorganizational technology linkage between the two companies.

In each student team, one dyad received the manufacturing firm version of the case, and the other dyad received the broker version of the case. Within the FtF and LCT conditions the dyads were randomly assigned to represent either the manufacturing or the broker firm. For the DCT condition, the students at one university represented the manufacturer perspective, while the other university's students represented the broker.

The subjects completed three collaborative learning sessions, with each corresponding to one of the three parts of the manufacturing-food broker cases. For the first two learning sessions, the two versions of each case each contained both common and unique information. The third session of the case represented a joint decision that had been made by upper management in both companies, and thus was identical for both dyads. The first session involved a decision-making task that required the subjects to prioritize a joint set of 10 objectives for the proposed interorganizational linkage. Some objectives favored the joint good of both companies, while others only benefitted one firm. The second session required the subjects to choose from various configurations of hardware and software to

support the interorganizational linkage. These options included purchasing various levels of personal computers and creating various types of interorganizational linkages for e-mail or real-time data access. Anticipated costs and benefits were enumerated for each set of alternatives. In the third session, the subjects rated the extent to which a chosen technology configuration in session 2 would achieve a set of business objectives.

The case materials (in hardcopy form) were distributed to each subject one week in advance of his or her scheduled sessions. Subjects were asked to analyze the case (outside of class) and complete prespecified worksheets on an individual basis prior to each session. Subjects were also told that they would be tested on the case materials at the outset of each session. This was done to ensure that each student was thoroughly prepared for the case discussion during the collaborative learning session.

Dependent measures

Consistent with the research literature in the area of collaborative learning summarized in a previous section, the learning effectiveness was measured in terms of three sets of variables: (1) learning achievement, (2) satisfaction with the learning process and outcome, and (3) the emotional climate of the learning environment (defined in terms of individual attraction to and feeling toward his/her group).

Learning achievement was measured at two levels: acquisition of declarative knowledge and critical thinking skills. Declarative knowledge refers to the concepts, principles, issues, and facts presented in a learning situation. Information is not stored exactly as it is presented; what is stored in memory is an understanding of the information as constructed by the learner (Kurfiss, 1988). Thus, students' declarative knowledge acquisition was measured in terms of their learning about the other dyad's case through the interactive sessions (i.e., learning information unknown to them prior to the session). More specifically, declarative knowledge acquisition was measured as the change in the students' pre to postsession scores on multiple-choice quizzes for sessions 1 and 2, where each of these versions of the cases contained some

⁴ The cases were developed by the researchers for the course and this experiment, and are available from the authors.

unique information. A different quiz was developed for each of the collaborative learning sessions to tap into students' understanding of the task-relevant concepts, issues, and facts needed for a particular session.

Learning in terms of critical thinking was measured via a three-item questionnaire administered pre and postsession in the third session only.⁵ These questions went beyond declarative knowledge acquisition and involved analysis, synthesis, reasoning, interpretation, and induction—thus, tapping students' higher-order learning. For example, using Nolan's model of technology assimilation, the students were asked to identify the stage that would best describe the technology assimilation of the firm described in the case. Another example was asking the students to assess the importance of an issue to strategic positioning of the firm described in the case.

Since the collaborative learning sessions involved a group problem-solving task, satisfaction with the learning process and outcome (i.e., solution to the case) was measured via Green and Taber's (1980) satisfaction questionnaire. The questionnaire consisted of nine five-point Likert scales (four items for satisfaction with process and five items for satisfaction with outcome). The questionnaire was administered at the end of each of the three learning sessions.

The emotional climate of the learning environment was measured by a 20-item questionnaire developed by Evans and Jarvis (1986) to gauge individual attraction to and feelings toward his/her group. For each session, the questionnaire items were subjected to a principal component factor analysis followed by varimax rotation. Results across the sessions indicated the presence of five factors (66.4 percent of variance explained). From these factors, two coherent scales with acceptable alpha reliabilities were obtained. The first scale, labeled commitment to the group, consisted of three items: a desire to remain a group member; liking the group; and looking forward to coming to the group. The second scale, labeled desire to

leave the group, consisted of four items: a desire to drop out of the group; dreading to come to the group; a desire to end the group; and being dissatisfied with the group.

Means, standard deviation, and alpha reliabilities of the dependent measures are presented in Table 1.

Procedure

The collaborative learning process for each team was extended over three sessions in order to allow the subjects' technology appropriation patterns to stabilize and to form established (versus ad hoc) teams with both a history and future of working together. The collaborative learning sessions were scheduled three weeks apart, and each session lasted an hour and 15 minutes.⁶

AT&T Vistium PCs, interconnected via ISDN lines, were used to provide video, audio, and data links between the two dyads (one team) in the DCT and LCT treatments. In addition to the video and communication software, each PC was equipped with spreadsheet templates designed to provide task support for the teams' case analyses. The video communication and the spreadsheet software operated in Microsoft Windows, which allowed simultaneous display of both the video image (DCT and LCT treatments) and a collaborative workspace (e.g., the spreadsheet templates for all treatments) on the PC screen. The shared workspace could be accessed, altered, and manipulated by either dyad. A small clip-on video camera sat conspicuously on the top of each monitor. FtF subjects sat across the table from each other in the same room during all three sessions (Figure 3). The face-to-face groups also had access to a PC equipped with a spreadsheet template for the teams' case analyses, provided in the DCT and LCT treatments.

The procedures for each session (Figure 4) were identical for each team. Subjects arrived at the facility, turned in their completed worksheets reflecting their individual solution to the case,

⁵ Research has shown that declarative knowledge is a prerequisite for critical thinking. Therefore, critical thinking was measured in the third session after all the pertinent case information was presented to the subjects.

⁶ This schedule and rotation was a necessary constraint due to the limited number of desktop videoconferencing PCs available to the researchers at the universities and the relatively large number of teams involved in the study.

and took a short quiz on the case materials. The subjects received an instruction sheet for the session that described the objective for their collaborative session. Collaboration software and video (for DCT and LCT only) communication links were established between the teams. The

subjects then engaged in a 40-minute collaborative case analysis session. At the end of the session the team turned in a joint worksheet reflecting its group solution to the case. The subjects then completed the postsession questionnaires and a second quiz.

Table 1. Means, Standard Deviations, and Reliabilities of Dependent Variables by Experimental Conditions

| Variables | Experimental Conditions | | | | | | | | |
|--|---|----------------|-----------------|--|----------------|-----------------|---|----------------|----------------|
| | Non-Proximate Distance Collaborative Learning Mean (SD) | | | Non-Proximate Local Collaborative Learning Mean (SD) | | | Face-to-Face Collaborative Learning Mean (SD) | | |
| | Sessions | | | Sessions | | | Sessions | | |
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Knowledge acquisition * | .51 (.92) | 2.04 (1.09) | — — | 1.18 (1.68) | 1.59 (.80) | — — | .42 (.61) | 2.00 (1.16) | — — |
| Critical thinking skills ^{†‡} | — — | — — | 1.11 (.89) | — — | — — | .67 (.59) | — — | — — | .65 (.79) |
| Satisfaction with learning process [§] (<i>p</i> > .84) | 4.03 (.66) | 4.23 (.57) | (3.94) (.38) | 4.0 (.71) | 4.05 (.58) | 4.04 (.74) | 4.06 (.45) | 4.09 (.51) | 4.08 (.67) |
| Satisfaction with learning outcome [§] (<i>p</i> > .79) | 3.82 (.55) | 3.95 (.52) | 3.87 (.52) | 3.73 (.50) | (3.9) (7.1) | 3.87 (.56) | 3.81 (.55) | 3.95 (.65) | 3.87 (.45) |
| Commitment to the group ** (<i>p</i> > .87) | 8.14 (1.19) | 8.11 (1.) | 6.91 (1.68) | 7.65 (1.03) | 7.49 (1.98) | 7.75 (1.07) | 7.84 (1.43) | 8.02 (.97) | 7.37 (1.28) |
| Desire to leave the group ** (<i>p</i> > .82) | 1.45 (.72) | 1.83 (1.02) | 2.14 (1.25) | 1.78 (.74) | 1.96 (1.15) | 3.109 (1.53) | 2.25 (1.27) | 2.10 (1.11) | 2.75 (.98) |

* Variable Range: (0 to 5).

† Variable Range: (0 to 3).

‡ Since declarative knowledge is a prerequisite for critical thinking, critical thinking was measured in session 3, after all the pertinent knowledge and information was provided to the subjects.

§ Variable Range: (1 to 7).

** Variable Range: (1 to 9).

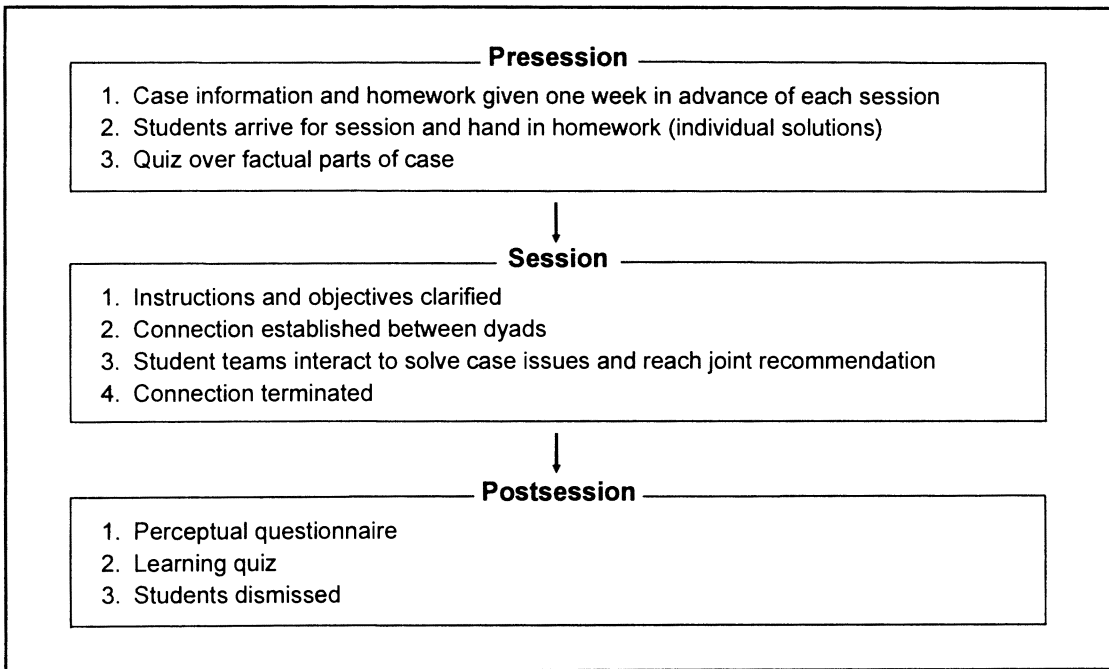


Figure 4. Experimental Procedures

Data Analysis and Findings

Hypothesis testing was done via planned comparisons using the non-parametric Wilcoxon-Mann-Whitney test. Siegel and Castellan (1988) note that the Wilcoxon-Man-Whitney test closely approximates the power of the parametric t-test for tests of independent samples and avoids the problems that unequal cell sizes can create in ANOVA-planned comparisons (Klockars and Sax, 1986).⁷ For each dependent variable, the first planned comparison contrasted the DCT and the FtF conditions (hypothesis 1), and a second comparison contrasted the DCT and the LCT conditions (hypothesis 2).

H1a predicted higher learning achievement in the FtF condition, relative to the DCT condition,

while H2a predicted higher learning achievement in the DCT condition over the LCT condition. There were no statistically significant differences in declarative knowledge acquisition for either comparison at any of the sessions. A significant effect was found, however, for both planned comparisons of the critical thinking measure in the third session ($Z = -1.98$, $p = 0.477$; $Z = 1.95$, $p = .051$, respectively). DCT subjects did display higher levels of critical thinking skills than subjects in the other conditions. Thus, neither hypothesis was supported for declarative knowledge acquisition, while H1a was contradicted and H2a was supported for critical thinking skills. This finding is further discussed in the next section.

H1b predicted greater satisfaction in the FtF condition, over the DCT condition, and H2b expected greater satisfaction in the DCT condition when compared to the LCT condition. Statistical tests of the planned comparisons found no significant differences for either of the process or outcome measures. Thus, H1b and H2b were rejected.

H1c predicted that the emotional learning climate in the FtF condition would be more positive

⁷ To confirm the results of the non-parametric tests for a balanced design, a secondary parametric analysis of the data was performed. All hypotheses were retested using a randomly drawn subset of five groups from the DCT treatment to compare to the five groups in each of the other treatments. ANOVA-planned comparisons were used for the tests. These more conservative tests supported the conclusions of the original non-parametric statistics in all cases.

Table 2. Hypotheses and Results

| Hypothesis | Result |
|---------------------------------|--|
| H1a: Learning FtF > DCT | Not supported for declarative, Contradicted for critical thinking |
| H2a: Learning DCT > LCT | Not supported for declarative, Supported for critical thinking |
| H1b: Satisfaction FtF > DCT | Not supported |
| H2b: Satisfaction DCT > LCT | Not supported |
| H1c: Learning Climate FtF > DCT | Contradicted |
| H2c: Learning Climate DCT > LCT | Supported |

than in the DCT condition, and H2c expected that the emotional learning climate in the DCT condition would be more positive than in the LCT condition. The first contrast between DCT and FtF subjects found no statistical differences in terms of commitment to the group. In sessions 1 and 3, however, FtF subjects did report a significantly higher desire to leave the group than DCT subjects ($Z = -3.05$, $p = .0023$; $Z = -2.40$, $p = .0161$, respectively). The second contrast between the DCT and the LCT conditions found a constant pattern of significant effects for sessions 1 and 3. The DCT subjects reported higher levels of commitment to the group than the LCT subjects ($Z = -2.34$, $p = .0194$, $Z = -1.94$, $p = .0523$). Similarly, sessions 1 and 3 also found that the LCT subjects reported a greater desire to leave the group than DCT subjects ($Z = -2.41$, $p = .0162$; $Z = -3.03$, $p = .0025$). There were no significant differences in session 2 for either planned comparison. Therefore, H1c is partially contradicted and H2c is partially supported. Table 2 summarizes the hypotheses and results.

Summary and Discussion

Results

This study investigates the efficacy of distant collaborative telelearning relative to local collaborative telelearning and face-to-face settings. The three environments were equally effective

in terms of acquisition of declarative knowledge. This finding is consistent with previous research on technology-mediated distance learning (Gibbons, 1989). The results, however, indicate that the subjects' learning achievement in terms of critical thinking was different under the three learning conditions. The subjects who participated in the DCT environment demonstrated the highest level of critical thinking achievement. These results are not consistent with current conceptualizations of media capabilities and their effects on human communication performance. The next section discusses possible explanations for these results in terms of each dependent variable. The final section addresses how this work informs theory-building in terms of theory and research design and describes the implications of this research for current practice.

Interpretation

Research that assesses human behavior in relation to new technologies must always consider the possibility that a measured effect resulted from the novelty of doing something in a different way. The real concern with novelty is that an effect might only be transitory in nature and not an enduring outcome of a particular process or technology change. In our experiment, the DCT learning environment presents two distinct, novel elements. The first is the possibility that the *newness* of interacting through an emerging technology that combined audio, video, and software sharing may have heightened students' engagement in the learning process. When familiarity with the technology replaces the newness,

such transitory effects might disappear. The longitudinal design of the field experiment sought to minimize this possibility by giving the students time to become comfortable using the technology (three times over 10 weeks). Implications for technology use more (less) frequently and over longer (shorter) periods of time are beyond the scope of this experiment and represent a necessary limitation. One objective of using a longitudinal research design is to enable the evaluation of phenomena beyond initial encounters. Nonetheless, the possibility of non-steady-state behavior cannot be discounted.

Since critical thinking was measured during the third session—and near the end of a busy graduate semester—it is reasonable to believe that any potential technology-induced novelty effect would be less influential after the students had already completed two sessions. Furthermore, the LCT students, using the same technology as the DCT subjects, did not demonstrate comparable achievement in critical thinking skills. Thus, although we discount the newness of technology as a viable explanation for these results, it may have played a significant role in our outcomes. Future research is needed to clarify this issue.

The second novel element of the DCT learning environment is the *innovation* of enabling rich interactions for collaborative learning with distant students. Desktop videoconferencing and other emerging information technologies are enabling new ways of structuring learning environments that were previously not possible. The effects from this new type of learning environment may be explained in terms of heightened student motivation or the interaction of heterogeneous learners. The students who participated in the DCT environment may have derived higher motivation from the novelty of collaborating with *remote colleagues* and thus may have been more mentally engaged in the learning process. The positive relationship between motivation and learning is well established in the literature.

Alternatively, the DCT condition enabled heterogeneous knowledge sources to interact on the case. The MBA curriculum at each university is somewhat different and undoubtedly teaches students varying skills and perspectives on business problems. The distant collaborative telelearning environment enabled the students to

engage and educate each other through voice, video, and shared software. Thus, while higher motivation is a likely contributor to the significant results, we do not discount the likelihood that facilitating the interaction of heterogeneous knowledge sources enhances the higher-order learning of critical thinking skills. For example, one Maryland student commented, "A particular strength of the project worth noting was the participation of the Indiana University MBA students. Our colleagues at Indiana brought different perspectives to the sessions and added value to this experience of learning a new technology." It may be possible to isolate the effects of team heterogeneity by studying distributed teams from remote branches of a single organization or university. Nonetheless, these preliminary findings and the increasing importance placed on development of students' critical thinking abilities warrant further investigation to pinpoint the specific attributes of how collaborative distance-learning environments—enabled by desktop videoconferencing—might promote critical thinking achievement.

The results indicate that subjects in the three collaborative environments were equally satisfied with their learning process and outcome. Interactivity, immediacy, flexibility, and high integration of communication capabilities (video, data, and voice) seemed to have created an adequate and effective collaborative learning environment. While the DVC systems did not provide as "rich" a communication environment as the face-to-face setting, the students noted that the real-time updating of the shared software screens helped them to communicate effectively. One student commented, "I was particularly pleased with how quickly our group was able to reach a joint decision. I attribute this to the fact that we could quickly make changes in the screen together and see the outcome of these 'what if' actions." While identical task support via the shared spreadsheet screens was available to each dyad in the FtF condition, these students rarely chose to use it for their collaboration and interacted via conventional oral and visual communications. We speculate that the similarity of process and outcome satisfaction may be related to how the shared software in the DVC conditions compensated for the loss of richness found in the FtF condition and the type of learning task. We cannot dis-

count, however, that the lack of differences between treatment were a result of our instrumentation's inability to adequately assess differences. Future researchers are cautioned when using single-encounter measures in longitudinal, multi-encounter settings.

Finally, it appears that the three conditions did differ in terms of the emotional learning climate. The DCT environment engendered equal commitment to stay in the group relative to the FtF environment. Furthermore, subjects in the DCT environment reported less desire to leave their group (and the collaborative learning session). One conclusion could be that the distant students were less willing to leave their group due to the novel *means* of interacting with other students. Alternatively, this finding could be interpreted as evidence of true higher-learning engagement among the *distant students* as they were drawn to collaboratively learn from other students they perceived to be unlike themselves. Again, the lack of similar commitment to the group from the LCT students (described below) supports the attribution of a better emotional learning climate to an interaction between distant learners rather than to technology. Thus, one implication of this finding is that desktop videoconferencing systems appear to be a relatively effective medium for supporting the social and team-building interactions among distant team members. For example, one subject stated that, "The video capability of the technology gave the sessions a 'human' feel. Being able to see the people on the other side made it easier to develop personal relationships . . . you can see the body language of the other meeting participants, and this helps make you feel more connected to them."

Comparisons between the two DVC environments consistently found that the geographically remote subjects had a higher commitment to stay in their group and a lower desire to leave their group than did the locally based DVC subjects. The local subjects knew that they could physically enable a "rich" collaborative learning environment by simply walking to meet their colleagues whom they see at class. Thus, after the first two sessions, when the novelty of the desktop videoconferencing should have diminished—and given that, they could easily and

conveniently interact in a face-to-face mode at other times—they were less committed to and less willing to stay with their videoconferencing groups. This finding implies that, given a choice, individuals may have a preference for face-to-face interactions over the technology-mediated ones, especially if the individuals are colocated. Thus, desktop videoconferencing may not be a suitable surrogate for collaborative learning when face-to-face interactions are perceived to be highly feasible. The systems do, however, appear to offer an effective alternative in those situations where face-to-face interactions may be infeasible.

It is interesting to note that there were no differences among the three conditions for the session 2 emotional learning climate. Issues related to group history and development offer one possible explanation (Mennecke, et al., 1992). We believe that the nature of the collaborative learning exercise for session 2 produced a different perceived learning environment than the other sessions. The problem-solving tasks in sessions 1 and 3 largely relied on exchanging information, rational argument, and persuasion among the students to find a group solution to that session's part of the case. In session 2, however, the students had to choose between various configurations of hardware and software, which the students perceived to be more subject to an evaluation for correctness than the exercises from sessions 1 and 3. Student comments overwhelmingly reflect that session 2 was the most challenging. A second uniqueness of session 2 is that the shared spreadsheet provided a higher level of task support by calculating the cost implications of various hardware or software choices. The number of calculations would have been tedious if done by hand. We draw two insights from the session 2 results and our observations from conducting the study. First, perceptions of the learning environment are likely moderated by the perceived difficulty of the collaborative learning task, with more difficult tasks diverting awareness from the learning environment to the task. Second, a tighter integration of the collaborative learning task requirements with the task support capabilities of the information technology diverts awareness from the learning environment to the learning task. Our interpretation of these results needs confirmation by further research.

Limitations

The results presented in this paper should be considered in light of the limitations associated with field research and this particular experiment. As a field experiment, experimental controls were less stringent than under laboratory conditions. Students in the LCT condition and those in the face-to-face condition might have interacted with one another in the course of conducting the study, although the project "ground-rules" asked them not to do so. These interactions might have influenced learning and student perceptions. A second limitation is that students in this experiment worked on a dyad-to-dyad basis (i.e., four-person teams). Technology use and learning behavior may be different in one-to-one collaborative telelearning sessions. A third limitation, the multiple differences between the DCT treatments and the other control conditions (e.g., geography, different universities and student populations, novelty of distant communications, etc.), cannot be ignored or discounted as a rival explanation for our treatment differences. Interestingly, a primary motivation of deploying DVC is to connect distant, heterogeneous communicators. Controlling all potential validity threats during empirical assessments is a significant challenge for researchers. Finally, the 10-week nature of the project with three collaborative sessions should be considered when attempting to generalize these results to other learning situations of a longer or shorter duration.

Study Implications and Conclusions

This study represents early work in the application of an emerging technology—desktop videoconferencing—in support of collaborative telelearning (i.e., technology-mediated collaborative learning across distance). The findings of this study suggest some preliminary insights and provide guidance for future research and practice in this area.

Implications for future research

Future research needs to develop and investigate the relationship between media charac-

teristics, capabilities, and the learning process. This can be accomplished by first specifying the cognitive, affective, and social processes by which learning occurs and then mapping these processes onto the structures and characteristics of various media. This direction for future research is consistent with the media synchronicity theory (Dennis and Valacich, 1994) that views media richness theory as being inadequate for predicting group performance and advocates a redefinition of media in terms of media capabilities, task requirements, group communication processes, and group performance. Normative views of media on perceptions (e.g., Daft and Lengel, 1986) or task performance (McGrath and Hollingshead, 1993) may prove to be inadequate for predicting the complex behavior of collaborative learning.

An effective and productive research program investigating the role of electronic media in learning may consist of the following steps:

- Grounding a theory of media in the cognitive and social processes involved in acquisition and construction of knowledge (i.e., learning),
- Designing media in ways that are compatible with and complementary to these processes, and
- Investigating the mechanisms by which media characteristics might interact with and influence these processes.

Both field- and laboratory-based methodologies should be employed in future research efforts. The contextual richness of field-based settings will be vital to understanding the implications of emerging technologies to support collaborative telelearning. Additional longitudinal, field-based experiments set in the context of real graduate and undergraduate courses or activities are desirable. Experimental manipulations in these contexts whenever possible are valuable for measurement and interpretation against baseline and other technology conditions (e.g., comparison of various types of communication media). Instrumentation capable of measuring learning motivation and cognitive engagement in the learning process would also be helpful to more precisely understand causality. However, the difficulties of coordinating projects, courses, and curricula across multiple university environments

are formidable barriers to this type of research (Wheeler, et al., 1995). Qualitative methods that rely on journaling or observation could be helpful when experimental and baseline manipulations are not possible. Beyond the university course context, theory-driven research on technology-enabled collaborative learning activities in organizations, such as corporate training programs and executive education, may help to better understand the potential of alternative learning contexts in organizational settings.

While laboratory-based experiments often suffer from contextual leanness, greater control will be needed to test theorized relationships between specific media and learning activities. One obvious next step is to unbundle the video and software-sharing features of desktop videoconferencing and test them independently in a rigorously controlled learning context. The significant cost increases for adding additional communication media—especially high quality video—argue for assessment of costs and benefits regarding the creation of collaborative telelearning environments.

Implications of the findings for practice

Considering the findings of the study regarding the efficacy of collaborative telelearning and the relatively lower operational cost of telelearning (cost of long-distance ISDN lines compared to staff travel costs associated with face-to-face collaborative learning environments) make it a desirable approach for situations in which the students are not colocated. Large and geographically dispersed organizations may be well-advised to start investing in and experimenting with technical infrastructures that enable collaborative telelearning approaches to training and staff development. This will become increasingly more important with the rapid rate of change in business and technological volatility which leads to increase in training requirements of corporations.

Collaborative telelearning may not be a desirable strategy for colocated students who have the opportunity and the ability to meet face to face. Findings of this study suggest that colocated students do not seem to be as committed to maintaining the learning interactions over the

electronic media, possibly leading to a high drop-out rate. This may be attributed to the "artificiality" of a desktop collaborative learning environment relative to more "natural" and readily available face-to-face collaborative interactions.

The learning efficacy of "new electronic media" in the form of integrated videoconferencing and program-sharing environments can lead to the creation of information rich environments for routine telelearning and delivery on demand of education to remote students in both university and corporate settings. This will have important implications for the educational institutions in terms of globalization, competition for remote students, and policy development. For example, for state universities, the rights to deliver distant education to remote sites might be divided and regulated among the different state universities. Furthermore, the new and emerging electronic media can lead to new structural forms in terms of IT-enabled alliances between universities, faculty, and corporations for telelearning and distance course delivery (Alavi, et al., 1995).

Concluding remarks

It is important to continue the inquiry into the effectiveness of collaborative telelearning environments. With the declining cost and continued convergence of computing and communication technologies and the subsequent increase in prevalence of networked, multimedia computers, collaborative telelearning will be an increasingly viable educational alternative. Furthermore, the increase in requirements for continuous learning and the growth in the number of adult, part-time students will create a "demand-pull" for going beyond the four walls of the classroom. Research should aim at addressing some important questions such as: What technical resources do we use? How do the learners respond to these new experiences? How effective are the new experiences? And perhaps the biggest question is: How do educators create curricular content for these collaborative telelearning environments?

Provision of IT-mediated learning experiences to business students is important for two reasons. First, advanced information technologies provide opportunities for implementing new, potentially more effective learning paradigms, such as those that incorporate enhanced collaboration,

individualization, and students' engagement and active construction of knowledge. Second, the business students' educational experience should reflect the current and emerging technology-intensive corporate settings, thus preparing them for—and giving them the skills necessary to manage—their future workplace.

Because IT can lead to the creation of alternative learning environments does not mean that it will. As the variety, power, and availability of IT expand, its application to the learning process requires thoughtfulness and extensive experimentation. Our study takes a first step in gaining an improved understanding of how one advanced technology can be used for collaborative telelearning. In conclusion, given the limitations of this research design, the first-generation nature of the technology, and the tendency of technology users to adapt their communication to the capabilities of the new media (Dennis and Valacich, 1994), the *practical significance* of our qualitative and quantitative analysis is that desktop video conferencing is a viable medium for collaborative distance learning. Of course, much more work remains before all benefits and constraints of these environments are clearly understood.

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References

- Alavi, M. "Computer-Mediated Collaborative Learning: An Empirical Evaluation," *MIS Quarterly* (18:2), June 1994, pp. 159-174.
- Alavi, M., Vogel, D., Briggs, R.O., and Yoo, Y. "Transforming Higher Education Through IT-Enabled Value-Added Partnerships," working paper, College of Business and Management, University of Maryland, College Park, MD, 1995.
- Ansari, Y. and Simon, H.A. "The Theory of Learning by Doing," *Psychological Review* (86:2), 1979, pp. 124-140.
- Bligh, D.A. *What's the Use of Lectures*, Penguin, Harmondsworth, England, 1972.
- Bloom, B.S. (ed.). *Taxonomy of Educational Objectives: The Classification of Educational Goals—Handbook I: Cognitive Domain*, David McKay, New York, 1956.
- Brown, A.L. and Palincsar, A.M. "Guided, Cooperative Learning and Individual Knowledge Acquisition," in *Knowing and Learning: Essays in Honor of Robert Glaser*, L.B. Resnick (ed.), Erlbaum, Hillsdale, NJ, 1989, pp. 393-451.
- Business Week*. "The Virtual Corporation," Number 3304, February 8, 1993, pp. 99-103.
- Cook, T.D. and Campbell, D.T. *Quasi-Experimentation: Design and Analysis Issues for Field Settings*, Houghton Mifflin, Boston, MA, 1979.
- Daft, R.L. and Lengel, R.H. "Organizational Information Requirements, Media Richness and Structural Design," *Management Science* (32:5), 1986, pp. 554-571.
- Dennis, A.R. and Valacich, J.S. "Rethinking Media Richness: Towards a Theory of Media Synchronicity," working paper, University of Georgia, Athens, GA, 1994.
- Evans, N.J. and Jarvis, P.A. "The Group Attitude Scale: A Measure of Attraction to Group," *Small Group Behavior* (17:2), 1986, pp. 203-216.
- Fulk, J., Steinfield, C.W., Schmitz, J., and Power, J.G. "A Social Information Processing Model of Media Use in Organizations," *Communication Research* (14), 1987, pp. 529-552.
- Gibbons, M.P. "The Effectiveness of Technology Applied to Instructions: A Summary of the Research Literature," Center for Communications, San Diego State University, San Diego, CA, 1989.
- Glaser, R. and Bassok, M. "Learning Theory and the Study of Instruction," *Annual Review of Psychology* (40), 1989, pp. 631-666.
- Green, S.G. and Taber, T.D. "The Effects of Three Social Decision Schemes on Decision Group Process," *Organizational Behavior and Human Performance* (25), 1980, pp. 97-106.
- Ives, B. and Jarvenpaa, S. "Competing with Information: Emerging Knowledge Networks with Information Technology," in *The Knowledge Economy: The Nature of Information in*

- the 21st Century*, Annual Review of the Institute for Information Studies, Wye Center, Queenstown, MD, 1993, pp. 53-87.
- Johnson, D.W. and Johnson, R.T. *Cooperation and Competition: Theory and Research*, Interaction Book Co., Edina, MN, 1989.
- Johnson, D.W., Johnson, R.T., and Smith, K. *Cooperative Learning: Increasing College Faculty Instructional Productivity*, ASHE-ERIC Higher Education Report (4), Clearinghouse on Higher Education, The George Washington University, Washington, D.C., 1991.
- Johnson, D.W., Johnson, R.T., and Maruyama, G. "Interdependence and Interpersonal Attraction Among Heterogeneous and Homogeneous Individuals: A Theoretical Formulation and a Meta-Analysis of the Research," *Review of Educational Research* (53), 1983, pp. 5-54.
- Klockars, A.J. and Sax, G. *Multiple Comparisons* Sage, Beverly Hills, CA, 1986.
- Kulik, J.A. and Kulik, C.L.C. "College Teaching," in *Research on Teaching: Concepts, Findings, and Implications*, P.L. Peterson and H.J. Walberg (eds.), McCutcheon, Berkeley, CA, 1979.
- Kurfiss, J.G. *Critical Thinking: Theory, Research, Practice, and Possibilities*, ASHE-ERIC Higher Education Reports, The George Washington University, Washington, D.C., 1988.
- McGrath, J.E. "Time, Interaction, and Performance (TIP): A Theory of Groups," *Small Group Research* (22), 1991, pp. 147-174.
- McGrath, J.E. and Hollingshead, A.B. "Putting the 'Group' Back in Group Support Systems: Some Theoretical Issues About Dynamic Processes in Groups with Technological Enhancements," in *Group Support Systems: New Perspectives*, L.M. Jessup and J.S. Valacich (eds.), Macmillan, New York, 1993, pp. 78-96.
- Mennecke, B.E., Hoffer, J.A., and Wynne, B.E. "The Implications of Group Development and Group History for GSS Theory and Practice," *Small Group Research* (23:4), 1992, pp. 524-572.
- Neches, R. "Learning Through Incremental Refinement of Procedures," in *Production System Models of Learning and Development*, D. Klahr, P. Langley, R. Neches (eds.), MIT Press/Bradford Books, Cambridge, MA, 1978.
- PC Magazine. "Desktop Videoconferencing, Seeing is Almost Believing," (13:11), 1994, pp. 233-251.
- Pellegrino, J.W. and Glaser, R. "Analyzing Aptitudes for Learning: Inductive Reasoning," in *Advances in Instructional Psychology* (2), R. Glaser (ed.), Erlbaum Associates, Hillsdale, NJ, 1982, pp. 269-345.
- Perelman, L.J. "Kanban to Kanbrain," *Forbes ASAP*, June 6, 1994, pp. 84-95.
- Piaget, J. *Biologie et Connaissance* [Biology and Knowledge], Gallimard, Paris, France, 1967.
- Resnick, L.B. and Glaser, R. "Problem Solving and Intelligence," in *The Nature of Intelligence*, L.B. Resnick (ed.), Erlbaum Associates, Hillsdale, NJ, 1976, pp. 205-230.
- Rice, R.E. "Task Analyzability, Use of New Media, and Effectiveness: A Multi-Site Exploration of Media Richness," *Organization Science* (3:4), 1992, pp. 475-500.
- Shnell, T.J. "Cognitive Conception of Learning," *Review of Educational Research* (56), 1986, pp. 411-436.
- Seigel, S. and Castellan, N.J., Jr. *Nonparametric Statistics for the Behavioral Sciences (Second Edition)*, McGraw-Hill, New York, 1988.
- Siegler, R.S. "Unities Across Domains in Children's Choices," in *Minnesota Symposium on Child Psychology*, M. Perlmutter (ed.), Erlbaum, Hillsdale, NJ, 1986.
- Soloway, E. "Technology in Education," *Communications of the ACM* (36:5), May 1993, pp. 28-29.
- Vygotsky, L.S. *Mind in Society: The Development of Higher Psychological Processes*, Harvard University Press, Cambridge, MA, 1978.
- Watson, G. and Johnson, D.W. *Social Psychology: Issues and Insights*, Lippincott, Philadelphia, PA, 1972.
- Wheeler, B. C., Valacich, J. S., Alavi, M., and Vogel, D. R. "A Framework for Technology-mediated Inter-institutional Telelearning Relationships," *Journal of Computer-Mediated Communication* (1:1), 1995.
- Wittrock, M.C. "The Cognitive Movement in Instruction," *Educational Psychologist* (13), 1986, pp. 15-29.

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