December 2001

Understanding the Role of Information Technology in Supporting Geographically Dispersed Teams

Gary Baker
University of Northern Iowa

Maha El-Shinnawy
Texas A&M University

Follow this and additional works at: http://aisel.aisnet.org/amcis2001

UNDERSTANDING THE ROLE OF INFORMATION TECHNOLOGY IN SUPPORTING GEOGRAPHICALLY DISPERSED TEAMS

Gary Baker
University of Northern Iowa
bakerg@uni.edu

Maha El-Shinnawy
Texas A&M University
Mel_Shinnawy@hotmail.com

Abstract

Globalization and the changing structures of organizations have created work groups that are distributed across space (different sites) and time. As organizations become more geographically dispersed, the individuals increasingly rely on multimedia technologies and Internet-based systems to enhance their communication. Collaboration among workers is vital to both ongoing organizational activities and project-based activities. In examining the impact of communication media on groups, researchers have compared groups utilizing electronic technology to groups meeting without any technological assistance. The underlying assumption of these studies is that groups have the alternative to meet in either a face-to-face or a computer mediated setting. This study compares the performance of distributed teams utilizing different communication technologies. The results of the study found the addition of video to audio only communication result in significant improve in the quality of the group's strategic decisions.

Keywords: Computer mediated communication, group decision-making, decision support systems

Introduction

Political, economic and technical forces have an ever-increasing impact on individuals, groups, organizations and societies. As economies become more interconnected and competitive, the problems and issues have become more complex. Organizations are structured as a network of intertwined processes where communication and collaboration among workers is a vitally important factor contributing to the success of individuals, project teams, and overall growth. Improved connectivity together with the increase in group and teamwork is extending the usefulness of IT to support both individual and group work.

Communication among group members increases the incidences where group members will make more cooperative choices and sacrifice self-interest (Orbell, et al., 1988). Continuing developments in desktop multimedia technologies and Internet-based systems that include support of video communications are providing tools to enhance the work of geographically dispersed work groups. In a 1993 study at Sun Microsystems Laboratories, Isaacs and Tang reported a significant reduction in the usage of their desktop conferencing prototype (DCP) when the video was removed. A 1994 study by Andersen Worldwide comparing the value of non-video desktop conferencing with desktop videoconferencing reported that while 75% of subjects using Desktop Video Conferencing (DVC) said that they would prefer video, only 33% reported that the ability to see the other members enhanced communication. Researchers at the University of Michigan's Collaboratory for Research on Electronic Work (CREW) have also investigated the value of video. A study by Olson, Olson, and Meader (1995) concluded that "adding video to remote work has some value in terms of the work accomplished by the groups, and has a clearer effect on the satisfaction of the group members." When compared to phone conversations, video provides benefits such as allowing individuals to indicate their understanding, augmenting verbal communications with gestures, conveying attitudes by expressions and posture, and interpreting the significance of conversational pauses. In this paper we investigate the impact of communication mode, text versus audio, together with the marginal effect of video on geographically dispersed groups' decision making.

Theoretical Background

Empirical studies comparing computer mediated and face-to-face groups have examined the varying effects of technology on group processes, performance, and user satisfaction. Research on groups using computer-mediated communication has provided evidence of the impact which technology can have on different aspects of group decision making (Hiltz, Johnson and Turoff, 1986; DeSanctis and Gallupe, 1987; Gallupe and DeSanctis, 1988). A few studies of communication media have shown a negative impact on information exchange (Hollingshead, McGrath and O'Connor, 1993; Hightower and Sayeed, 1996). Other studies have found that communication media can have both positive and negative effects on tasks that involve conflict (Poole, Holmes and DeSanctis, 1991).

Recent work by Dennis et al., (1998) presents an approach of media synchronicity theory (MST) described as: "the extent to which the environment encourages individuals to work on the same activity, with the same information, at the same time" (p. 48). MST proposes that communication effectiveness results from matching the communication capabilities of concurrence and feedback to the communication processes of conveyance (the exchange of information) and convergence (the development of a shared meaning about information), see Figure 1.

Selected Media	Concurrency	Feedback
GSS (Text Only)	High	Low-Medium
Telephone (Audio Only)	Low	Medium
Enhanced GSS (Text Video)	High	Medium
Video-Conference (Audio Video)	Low	Medium-High

Figure 1. Feedback and Concurrency Saliency of Selected Communication Media
(Adapted from Dennis et al., 1998)

Successful performance of a task requires not only that group members convey their ideas and understanding of the dilemma, but also that members develop a common shared understanding of the issues and the group's strategy. As members share and exchange information, the conveyance process is enhanced by the capability of multiple concurrent communications while feedback plays a minor role. Convergence is the development of a shared meaning about information. High levels of feedback are needed in the give and take process of comparing views and negotiating a shared meaning. Media which have a low concurrency focus communication on a single issue to support the convergence process. Using a media synchronicity approach, the addition of video to both audio-only and text-only communication was used to analyze the impact of media on the work of dispersed groups.

Methodology

The task used for this study has virtual teams communicate using one of the four different communication media. The problem domain consisted of a group resource dilemma using a fishing simulation program. Tasks such as this group resource dilemma, often result in conflicts between personal and collective interests where individuals must cooperate with members of a larger group to effectively pursue their own goals and objectives. The experimental procedures were preset and differed only based on the type of communication media used by each of the fifty-six groups. The experimental design consisted of 2 x 2 factorial design text versus audio, and video versus no video communication. The communication between group members in this study was conducted using the *CU-SeeMe* software. Different features of the software were used to support groups in each of the four conditions. The audio feature was disabled for the text-only and the text feature was disabled for the audio-only groups. Likewise the use of video was disabled and hidden from the non-video groups. The number of groups per cell were sufficient to detect a 20 percent difference in effect between the conditions.

The resource dilemma task used in the study required the group to develop a strategy for maximizing income based upon limited information. A graphics-based simulation of a common dilemma situation based on fisheries was utilized for the experimental task. The FISH program developed by Gifford and Wells (1991) simulates the harvesting process of fisheries stock by multiple fishers and a renewal of stock through the natural reproduction process. The performance of groups using different media was measured using the quality of the group's strategy decision. While the specific features of the communication media were different, groups were given the same set of instructions regarding the task and allotted the same five minute time period to develop their group strategy. This experimental study examined the following research hypotheses:

> **H(1)** Text only communications results in better strategy decisions than audio only communications
> **H(2a)** The addition of video results in better strategies for text based communication.
> **H(2b)** The addition of video results in better strategies for audio based communication.

The quality for each group strategy was calculated based on each group's planned pattern of resource utilization. In reviewing each group's discussion transcript, two key variables in the simulation, the number of fishers leaving port in each round and the number of fish each individual fisher was to harvest before returning to port were documented. The simulation for each group consisted of a predetermined number of fishing seasons. A fishing season is defined as one round of fishers leaving and returning to port. The replenishment of the resource, i.e. the number of fish added to the pool, takes place at the end of each fishing season. The replenishment of fish at the end of a season was equal to one-half of the number of fish remaining at the end of each round, up to a maximum of the initial pool size.

Each group's session began with an initial pool size of one hundred fish. The optimal strategy would be to catch thirty-three fish during each fishing season leaving sixty-six fish remaining in the pool at the end of each season. These fifty percent of the remaining sixty-six fish, i.e. thirty-three fish would be added to the pool and the resource could be maintained in perpetuity. Groups generally stated their strategy in terms of the number of fishers leaving port and the number of fish each fisher should catch before returning to port. Using the replenishment calculation discussed above, these two factors from each group's strategy were entered into a spreadsheet designed to calculate the number of fish caught each season, the replenishment of the resource pool each season, and the number of seasons fished before the resource would be depleted. The income potential for the group was then calculated assuming they faithfully implemented their agreed upon strategy.

The task placed each group member in charge of their own fishing boat where they decided how many fish they would catch from the common pool of fish and when they would return to port. As in real fishing decisions, a fixed cost is associated with the decision to leave port and a variable cost is associated with the total fishing time. The simulation program tracks for each fisher in the group, the number of times the fishers leave port, the number of casts the fishers made, the time fishers spent out of port, and the fish caught by the fishers. A fixed cost of $15 is assessed every time a fisher leaves port. A variable cost of $60 per hour ($1 per minute) is incurred for the time each fisher is away form port. Each fish caught generates $10 of income. Individual income is based on the number of fish harvested and profit is calculated as the difference between income and expenses. The performance for the group is calculated by adding up the individual fishing profits of the group members.

Results

This study was designed to examine the impact of media, text versus audio and the addition of video to both of these media. The resource dilemma task required group members to develop a strategy decision that was to be executed via a simulation program. The strategic plan developed during group discussion was used to test the underlying MST dimensions of conveyance (high concurrency and low feedback) and convergence (low concurrency and high feedback). The mean income potential for each group's strategy decision across the different communication media are presented in Table 1.

Table 1. Group Strategy Decision by Treatment

	Text	Audio
No Video		
Mean	1350	1273*
Standard Deviation	(388)	(392)
Video		
Mean	1402	1585*
Standard Deviation	(326)	(285)

Note: *denotes significant difference in means at 0.10 level

The overall results from the study were generally in the predicted direction across the different communication media. Text-only communication, which is high in concurrency and low in feedback, resulted in better strategies (1350 versus 1273) than audio-only communication, which is low in concurrency but provides a medium level of feedback. The addition of video to audio-only communication, which maintains the low level of concurrency but increases the feedback, resulted in significantly better strategies (1585 versus 1273). The addition of video to the text-only communication also resulted in slightly better strategies (1402 versus 1350).

The results multiple means comparisons for theses results are shown in Table 2. No significant differences were found for strategy decisions between the audio-only and the text-only conditions. Although the audio-only communication did negatively impact the quality of the strategy decision, when compared to text-only communication, the difference was not significant. The addition of video for the text-only condition had almost no significant impact on the quality of groups' strategy decision. The addition of video for the audio-only condition was found to have a significant positive impact on the strategy decision.

Table 2. Multiple Means Comparison for Strategy Decision

Group	Text Only	Text-Video	Audio-Only	Audio-Video
Text Only				
Difference in Group Means	0	18	152	-184
Significance		.999	.646	.491
Text-Video				
Difference in Group Means	-18	0	133	-202
Significance	.999		.731	.408
Audio Only				
Difference in Group Means	-152	-133	0	-336
Significance	.646	.731		.057**
Audio-Video				
Difference in Group Means	184	202	336	0
Significance	.491	.408	.057**	

Note: Pairs that show significant difference are denoted by **

Conclusion

The purpose of this paper is to examine the impact of communication media on the quality of group decisions. Building on prior work in communication media, the results highlight the positive impact of adding of video to audio-only communication. The finding extends the previous research by focusing only on communication media for disbursed group. Face-to-face communication is not used as the standard by which alternate communication media are measured. The research utilizes a task, which requires individuals to work together as members of a disbursed group and results in quantifiable decision which can be compared across groups. From a pragmatic perspective, the results of this study should be extremely useful for organizations becoming more geographically dispersed. The use of multimedia technologies and Internet-based systems can enhance their communication and the resulting decisions for virtual teams.

This performance of fifty-six groups across the different communication media indicates that the addition of video to audio-only communication results in better strategy decisions by group members. Therefore, if an organization has groups, which do not meet in a face-to-face setting, the addition of video existing audio-based communication can improve their ability to make decisions. This research suggests that communication media play an important role in the success of virtual teams. As problem solving and decision making groups move from face-to-face to virtual environments it is important to re-examine group process characteristics such as the participation level of group members, degree of cooperation and the domination of group processes by members together with interpersonal implementation characteristics collected such as the satisfaction with the process and satisfaction with the outcome. These factors will help to provide a more complete understanding of how the media characteristics of concurrency and feedback impact the underlying communication processes of conveyance and convergence for virtual teams.

References

Dennis, A.R., Valacich, J.S., Speier, C. and Morris, M.G. "Beyond media richness: An empirical test of media synchronicity theory," *Proceedings of 1998 Annual Hawaii International Conference on Systems Science,* Maui, January 1998, pp. 48-57.

DeSanctis, G. and Gallupe, R.B. "A foundation for the study of group decision support systems," *Management Science*, (33: 5), May 1987, pp. 589-609.

Gallupe, R.B. and DeSanctis, G. "Computer-based support for group problem-finding: An experimental investigation," *MIS Quarterly*, (12: 2), June 1988, pp. 277-296.

Gifford, R. and Wells, J. "FISH: A commons dilemma simulation," *Behavioral Research Methods, Instruments, & Computers*, (23: 3), 1991, pp. 437-441.

Hightower, R. and Sayeed, L. "Effects of communication mode and prediscussion information distribution characteristics on information exchange in groups," *Information Systems Research*, (7: 4), December 1996, pp. 451-465.

Hiltz, S.R., Johnson, K. and Turoff, M. "Experiments in group decision making: Communication process and outcome in face-to-face versus computerized conferences," *Human Communication Research*, (13: 2), Winter 1986, pp. 225-252.

Hollingshead, A.B., McGrath, J.E. and O'Connor, K.M. "Group performance and communication technology: A longitudinal study of computer mediated versus face-to-face groups," *Small Group Communication*, (24: 3), August 1993, pp. 307-333.

Isaacs, E.A. and Tang, J.C. "What video can and can't do for collaboration: A case study," *ACM Multimedia '93,* Anaheim, CA, August 1-6, 1993, pp.199-206.

Olson, J.S., Olson, G.M. and Meader, D.K. "What mix of video and audio is useful for small groups doing remote real-time design work," *CHI '95*, Association of Computing Machinery, New York, October 1995, pp. 362-368.

Orbell, J.M., Dawes, R.M. and van de Kragt, A.J. "The limits of multilateral promises," *Ethics*, (100: 3), April 1990, pp. 616-627.

Poole, M.S., Holmes, M. and DeSanctis, G. "Conflict management in a computer-supported meeting environment," *Management Science*, (37: 8), August 1991, pp. 926-953.