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Abstract

Computer-mediated communication systems (CMC) offer alternative means of communication within and across organisational contexts. Collaboration between virtual teams which meet via computer-mediated technologies, often takes place in a context where the teams are geographically distributed and the members in the teams have not met in a face-to-face meeting. In this context promoting effective communication using CMC is a fundamental issue for managers and researchers alike. Prior studies have found that CMC technologies could be used as effectively as face-to-face meetings for group decision making providing group members have the opportunity to build up a shared common understanding. However, CMC does not currently facilitate building a shared basis for effective communication among group members. This paper proposes that a theory-based framework can be adopted to help group members build such a common understanding for effective communication in a CMC environment. Results from an experiment show that groups that used this framework had better group decision outcomes than those that did not in both a face-to-face and a videoconferencing environment. Videoconferencing can be used as effectively as face-to-face meetings for group decision satisfaction. Videoconferencing groups demonstrated greater improvement in group outcomes by using the framework. Therefore, the dialogue technique appears to be a useful framework for group members, especially virtual teams, to build a common understanding and consequently work more effectively via CMC technologies.

Keywords: Computer-Mediated Communication (CMC), Media Richness Theory (MRT), virtual team, group outcomes, videoconferencing.

1. Introduction

With the growth of global organisations, virtual teams, and advances in networks and telecommunications, face-to-face meetings are no longer the sole communication medium used by organisations to facilitate collaborative work. Computer-mediated communication (CMC) systems that have emerged in recent years have revolutionised communication and made possible new and expanded forms of group work. These CMC systems have become an integral component of organisational communication as they are more convenient and less expensive than travelling to face-to-face meetings as well as being integrated into multi-media environments and digital networks (Baltes et al. 2002). CMC media include e-mail, voice-mail and videoconferencing over digital networks. These media have come to be known as the *new media* as opposed to the *traditional* media of face-to-face meetings, telephone and text based documents. There has been much research exploring the use of the new media,

attempting to develop theoretical approaches for explaining media choice and usage in organisational contexts where available media for communication has now been complemented by the new media. However, there has been little work done to investigate how CMC systems can be used as effectively as conventional face-to-face meetings to enhance group performance. This issue must be addressed as CMC is emerging as the preferred medium to facilitate virtual workgroups. The aim of this paper is to address this gap by presenting the results of an experiment investigating the effect of a shared social construction on group outcomes mediated by two media: face-to-face and videoconferencing.

2. Background

CMC systems use computers to structure, manage and process information, images and electronic resources across telecommunications networks to facilitate its exchange. These CMC systems have been shown to reduce delays in information exchange, improve maintenance of records and information received, increase coordination of geographically dispersed groups, and improving users' capabilities to process large amounts of information (Baltes et al. 2002; Kettinger et al. 1997; King et al. 1997). As these new media generally are asynchronous and, involve text and audio modes, they tend to be characterised by a relatively lower information carrying capacity when compared with face-to-face.

The effectiveness or suitability of these new media, as compared to traditional media, for various communication activities, is still debatable and yet to be resolved by research. It is still not well understood how these new media are integrated into users' communication behaviour or which traditional media are displaced by the new media within the users' task environments. To answer these questions there has been research in the many dimensions of CMC usage which emerge from the above characteristics. These dimensions include: changing perceptions of communication media (Schement et al. 1989); the technical and social characteristics of the new media (Huang et al. 2000); the human conceptualisation of the underlying properties, roles and functions of the new media (Katz et al. 2002); the perceived characteristics of the new media (Culnan et al. 1987; Short et al. 1976; Trevino et al. 1990); the affect of context and social influence on the adoption and usage of the new media (Carlson et al. 1999; Rice et al. 1998); structuration examining the adoption and development of new organisational structures and technologies in the domain of communication technologies (Rice et al. 2001). An emerging dimension of research in CMC is the effectiveness of teams using CMC technologies as the medium for all communication and collaboration of virtual teams. A virtual team is a "group of people who collaborate closely even though they are separated by space, time, and organisational barriers" (Lipnacek et al. 1997). Group members work on a specific high-level task or goal, they may work at the same time but at different locations, or they may even work over different time zones and different locations due to geographic and time zone differences. CMC systems are used widely to facilitate virtual teams to communicate and exchange knowledge and information to achieve the team goal. The effectiveness of CMC in supporting the collaboration and successful outcomes of virtual teams is the focus of this paper.

In addressing the seminal issue of the information carrying capacity of the new media, Daft & Lengel (1984) proposed Media Richness Theory (MRT), which hypothesises on the information carrying capacity of the new media. Richness is defined as the potential information-carrying capacity of data. Daft and Lengel (1986) proposed that communication media vary in the richness of information processed from highest (face-to-face) to lowest (numeric formal, computer formatted reports).

The literature on media richness theory demonstrates that support for media richness propositions is often mixed at best, especially when new media such as voice and electronic mail are concerned. Part of these inconsistent results may be due to inherent problems with judges' ratings of task equivocality or user ratings of media's richness. Other reasons may be due to poor understanding of individual, positional and organisational differences in media choice.

These inconsistencies of research findings in the literature, however, have encouraged a reconsideration of the descriptive and predictive validity of MRT, especially for CMC systems. Some researchers (e.g. Fulk et al. 1990; Huang et al. 1996) contend that media richness is not a fixed feature of a medium, but could be changed by shared social constructions, which refers to an object that is, at least in part, socially constructed and subjectively generated, as defined by Huang et al. (1996). To choose and use CMC systems effectively for improving group performance, the key issue is, thus. How to develop a shared basis for communicators before they work together as a team to engage in task based activities and frequent communication. This proposition is supported by the findings of recent research into the use of CMC by computer-mediated groups. The effectiveness of computer-mediated teams has been found to improve where: the teams had a shared history (Alge et al. 2003); when training in developing media use and communication-related issues took place (Lurey et al. 2001); teams had the ability to build personal relationships in the mediated environment (Pauleen et al. 2001); the media allowed the team to adapt their behaviour to match the nature of the task and other constraints.

3. Dialogue Technique - Building a Shared Social Construction

Dialogue theory (Bohm 1990) and an operational dialogue procedure proposed by the MIT's Dialogue Project provide a sound theoretical foundation for building up such a shared basis for communicators. The dialogue can help to establish shared meanings and group cohesion. Based on theories of dialogue, learning, learning organisations and alignment, a theoretical framework proposed by Huang et al. (1998) is adapted in this research to develop a shared relationship for users of the new electronic media (Senge 1990). The main premise of this framework is that through dialogue, group members could build a common mental model that facilitates shared understanding (Huang et al. 1998). This model serves as group norms to guide future interaction and activities of the group. The dialogue framework is illustrated in Figure 1.
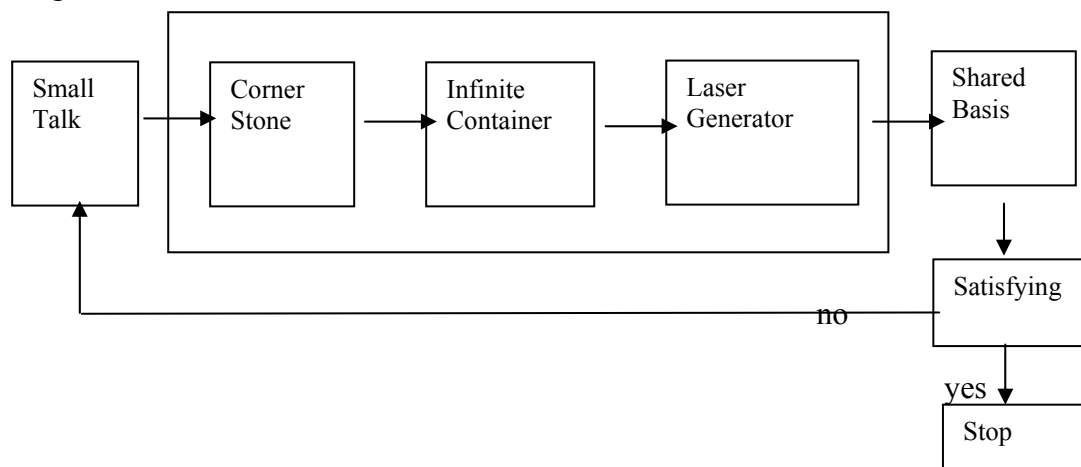

Figure 1. Dialogue Framework

The dialogue technique process includes:

1) Communicators take part in a small-talk session to introduce themselves and get to know the other communication partners (Jarvenpaa et al. 1996).

2) CornerStone: Communicators engage in a dialogue defining and generating shared goals for communication.

3) InfiniteContainer: The core of the framework is a dialogue session adopted from the MIT's dialogue procedure (Schein 1993). Firstly, communicators reflect on their past experience of cooperation in terms of good communications. Secondly, communicators, in concert, disclose and share their past cooperative working experiences, identifying characteristics of their past experience related to experiences of good communication protocols. Thirdly, given the shared goals, communicators exchange feedback to the derived characteristics of good communication. Fourthly, communicators are not allowed to criticise other's input. A dialogue facilitator would intervene, when necessary, to clarify or elucidate on any issue. Fifthly, the dialogue will be closed when no further exchange and clarification from communicators are possible.

4) LaserGenerator Outcomes of the dialogue are described as laser (Bohm 1996) can be produced. Communicators rank the characteristics discussed at step (3). This can result in a specific team mental model of effective communication shared by all members.

5) Verification of an outcome that will support effective communication in a mediated environment.

Figure 2 outlines the proposed research model. The two media to be used in the experiment are face-to-face and videoconferencing. For each medium there will be two treatments: with framework and without framework. Examination of this research model would reveal whether, after group members build up their shared basis, their group outcomes could be improved. Group outcome is a composite variable which includes decision process satisfaction, decision satisfaction and decision quality. These dependent variables are believed to be critical for understanding and predicting the use and usefulness of CMC in organisational settings (Baltes et al. 2002).

Group Outcomes

Face-to-Face	With Framework	Decision Process Satisfaction

Decision Satisfaction

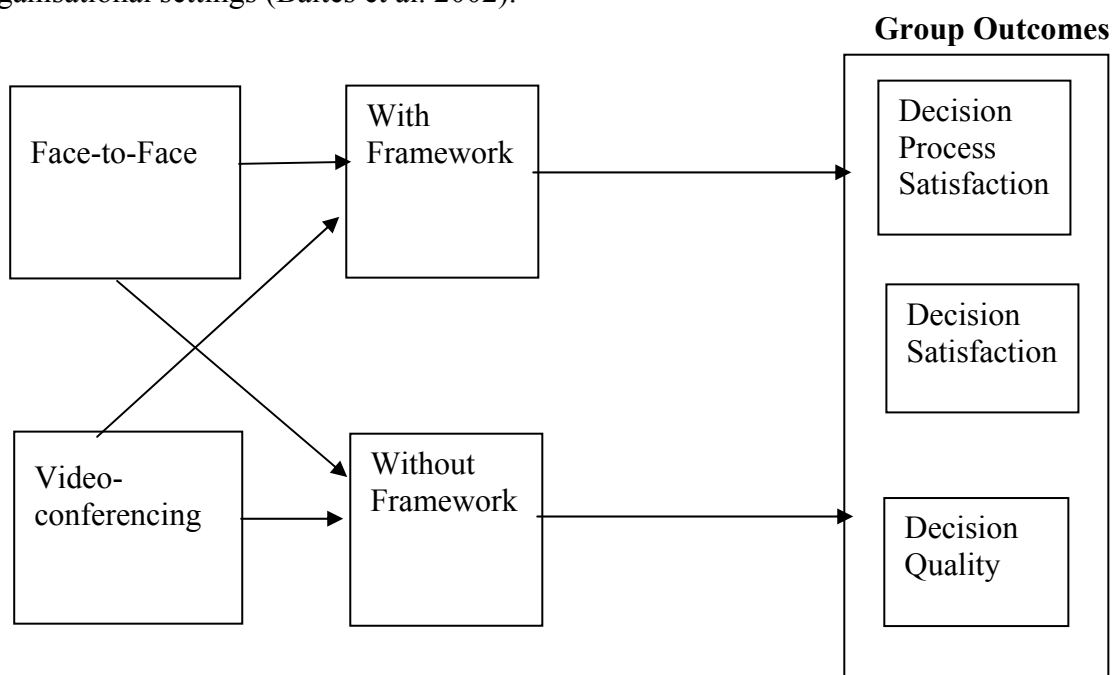| Video-conferencing	Without Framework	Decision Quality

Figure 2. Research Model

The basic proposition of this paper is that those groups with a shared basis will experience higher perceived levels of group outcomes as measured by the dependent variables. This proposition will be investigated by the following three hypotheses:

H1: Groups with a shared basis of effective communication will have higher perceived group outcomes than groups without a shared basis of effective communication, regardless of media used.

This hypothesis will be considered across the two media and the three dependent variables.

H2a: The face-to-face group and video conferencing group with a shared basis for effective communication will have equal perceptions of group outcomes.

H2b: For groups without a shared basis of effective communication, group outcomes will be higher for face-to-face groups than video conferencing environments.

Hypotheses 2a and 2b will be considered across the two treatments and the three dependant variables for the two media.

4. Methodology

The study will adopt a 2x2 factorial design. Communication medium varies between face-to-face and videoconferencing. Group structure varies with the presence or absence of the theoretical framework as shown in figure 2. A pilot study was carried out before the formal experiments to modify and fine-tune formal experimental tasks, settings, and procedures.

The 88 postgraduate students chosen for this study were undertaking a course in decision support systems and information decision technologies. They were briefed on the experiment and the importance of what was being investigated with respect to decision making, virtual groups, and the use of computer mediated communication in organisations. An assignment was also set for these students which required them to reflect on the experience in the experiment. Subjects were randomly assigned into groups of three each. The random assignment of subjects to groups helped to control for differences due to subject characteristics. The average age of participants was 23, and 44.3% of the group was female. T-tests showed that subjects under both treatments (with and without framework) did not differ significantly in terms of age, gender, experience of using media, and experience working in project teams. Also, there is no significant difference in perceptions of media richness between the treatments, with framework and without framework.

Committee rooms and staff offices were selected and used for the face-to-face meetings. Participants involved in the face-to-face meetings met together to have the experiment explained in detail and to complete the pre-experiment questionnaire. After completing the questionnaire the individual groups met to engage in dialogue (if they were part of the "with dialogue framework" group) and/or complete the experiment and finally the post experiment questionnaire.

For those participants involved in the videoconferencing treatment there was an initial meeting at which the experiment was explained and the pre-experiment questionnaire completed. For the experiment itself participants were assigned to staff offices equipped for videoconferencing. The equipment consisted of a PC, video camera, and microphone/headset. The software used in the experiment was an installation of Lotus Notes sameTime®. After the initial meeting the only contact made between group members was via the technology. The Lotus Notes sameTime server enabled the opportunity to record each session. The meeting metaphor adopted by Lotus Notes is that the speaker is the focus, i.e. when a group member is speaking only his/her image is viewed by the other group members. This is different from the boardroom approach whereby all participants are visible to each other throughout the meeting.

In summary, the procedure that was followed for those participants involved in the 'with dialogue framework' treatment was as follows:
1) After a brief explanation of the experiment a pre-experiment questionnaire was completed
2) Each group met for a small talk session of about 15 minutes duration
3) Following this "get to know you" session each group participated in a dialogue session which lasted for approximately one hour. The purpose of this session was for the groups to develop a foundation for effective communication upon which they agreed.
4) The experiment itself required the participants to solve an open-ended group problem. Depending on the treatment to which they were assigned the resolution of the problem had to be made using only one of the mediated environments: face-to-face or videoconferencing. On completion of the task each group member was asked to complete a post-experiment questionnaire.
5) A debriefing session was held to conclude the experiment.

For those groups participating in the experiment without the framework step three above was omitted.

Past research showed especially mixed results in terms of the role of "rich" media for equivocal tasks. Therefore, we chose a task that has no clear decision-making criteria and no demonstrably correct answer – the task chosen was the "van management" task (Mennecke et al. 1993).

The two dependent variables of decision process satisfaction and decision satisfaction were measured by using Green and Taber's (1980) scales and decision quality was measured by using Gouran et al. (1978). The reliability of the scales was high: decision quality, alpha = 0.87; decision process satisfaction, alpha = 0.89 (one item was dropped here to achieve this alpha score); and, decision quality, alpha = 0.82.

5. Results
The data collected was first analysed using General Linear Model (GLM) for detecting both main and interaction effects. If an interaction effect is found, an in-depth analysis of the interaction effects is performed as an interaction effect takes precedence over a main effect (Keppel 1991). Considering the exploratory nature of this study, the criterion level of $p < 0.1$ was accepted as support for a hypothesis. Some dependent variables did not meet the homogeneity requirement. Accordingly, nonparametric tests were conducted to significant results for confirmation. Table 1 summarises the descriptive statistics for the dependent variables. Table 2 reports the results of ANOVA tests on the dependent variables.

Table 1: Descriptive Statistics for the Dependent Variables

Treatment	Communication Medium	Decision Process Satisfaction (DPS)		Decision Satisfaction (DS)		Decision Quality (DQ)		Sample Size
		Mean	S.D.	Mean	S.D.	Mean	S.D.	
With Framework	FtF	6.24	0.50	5.55	0.64	6.02	0.45	21
	V-C	5.58	0.61	5.40	0.68	5.45	0.58	23
Without Framework	FtF	5.88	0.47	5.49	0.77	5.85	0.51	25
	V-C	4.63	1.59	4.89	1.05	4.71	1.55	19

FtF: Face-to-Face; V-C: Videoconferencing

Table 2: Results of ANOVA Tests for Dependent Variables

		DPS	DS	DQ
	df	F-value	F-value	F-value
Framework (DT)	1	12.2***	2.8*	6.35**
Communication Media (CM)	2	26.2***	4.81**	22.01***
DT x CM	2	2.46	1.77	2.5

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

While no significant interaction effects between framework and media were detected across three dependent variables, main effects were found for all variables due to framework and media. A follow-up t-test was performed along media and framework for each dependent variable respectively. Tables 3 and 4 show the results. Each of the dependent variables is discussed below.

Table 3: T-tests of Dependent Variables along Media

Medium	Treatment	DPS T-value	DS T-value	DQ T-value
FtF	With Framework Without Framework	2.50**	0.273	1.197
V-C	With Framework	2.448**	1.898*	1.992*

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	Without Framework		

*** p<0.01, ** p<0.05, * p<0.1

Table 4: T-tests of Media Differences on Dependent Variables along Framework

	DPS	DS	DQ
	T-value	T-value	T-value
With Framework (FtF vs. V-C)	3.91***	0.73	3.61***
Without Framework (FtF vs. V-C)	3.32**	2.18**	3.09**

*** p<0.01, ** p<0.05, * p<0.1

5.1 Decision Process Satisfaction (DPS):

The significant main effect on framework was confirmed by a Mann-Whitney test (χ^2=4.863, p=0.027). The significant main effect on media was also confirmed by a Mann-Whitney test (χ^2=19.086, p<0.001). Table 3 shows that significant differences were found between groups with and without framework in face-to-face and videoconferencing communication environments. Table 4 shows that for both groups (with and without framework), subjects who communicated via face-to-face had higher perceptions of group decision process satisfaction than subjects in the videoconferencing environment.

5.2 Decision Satisfaction (DS):

The significant main effect on media and framework were not confirmed by Mann-Whitney tests. As shown in Table 3, only a marginal difference was found between groups with and without the framework in the videoconferencing environment. For groups without the framework, the face-to-face environment demonstrated higher perceived decision satisfaction than groups via videoconferencing systems.

5.3 Decision Quality (DQ):

The main effect on framework was not confirmed by a Mann-Whitney test (χ^2=1.032, p=0.310). The significant main effect on media was confirmed by a Mann-Whitney test (χ^2=17.807, p<0.001). As shown in Table 3, only a marginal difference was found between groups with and without framework in the videoconferencing environment. Table 4 shows that for both groups (with and without framework), subjects who communicated via face-to-face had higher perceptions of group decision quality than subjects in the videoconferencing environment.

5.4 Summary of Findings:

Table 5 summarises the findings. Hypothesis 1 was supported in the videoconferencing environment across the three dependent variables, and in the face-to-face environment, it was only significant for decision process satisfaction, therefore H1 is partially supported. Hypothesis 2a was supported for DS, while hypothesis 2b, was supported for the three dependent variables.

Table 5: Summary of Experimental Results

Hypothesis	Dependent Variable	Prediction	Findings	Support of Hypothesis
H1	DPS	Framework Effect	FtF: yes V-C: yes	Supported
	DS	Framework Effect	FtF: no V-C: yes	partially supported
	DQ	Framework Effect	FtF: yes V-C: yes	supported
H2a	DPS	FtF=V-C	FtF>V-C	not supported
	DS	FtF=V-C	FtF=V-C	Supported
	DQ	FtF=V-C	FtF>V-C	not supported
H2b	DPS	FtF>V-C	FtF>V-C	Supported
	DS	FtF>V-C	FtF>V-C	Supported
	DQ	FtF>V-C	FtF>V-C	Supported

6. Discussion

The basic proposition of this paper is that those groups with a shared basis will experience higher perceived levels of group outcomes as measured by the dependent variables, viz, decision process satisfaction, decision satisfaction, and decision quality. This proposition is supported following the analysis of the data collected. Table 5 above, which summarises the results of the data analysis, shows that the decision process satisfaction and decision quality were both supported on the framework effect. Both face-to-face and videoconferencing media showed positive benefit, reflected in improved perceptions of decision process satisfaction and decision quality for groups developing a shared understanding of "good communication practices". Improvement in perceptions of decision satisfaction was found only for the videoconferencing treatment – there was an improvement in perceptions of decision satisfaction for the face-to-face groups but this was not statistically significant at the $p<0.1$ level. Generally speaking, however, improvement can be seen between those groups having a shared understanding and those who do not, regardless of media used.

When considering the comparison within frameworks – face-to-face and videoconferencing media where both sets of groups developed a shared understanding; and where neither developed a shared understanding; the results were not as anticipated. We predicted that when the data collected for face-to-face groups and videoconferencing groups was compared for the

treatment where a shared understanding was developed, that the dependent variables would demonstrate no difference between the two media. This was only the case for perceptions of decision satisfaction. The results showed that perceptions of both decision process satisfaction and decision quality were higher. Groups using face-to-face media reported greater satisfaction with decision process and decision quality than did those using videoconferencing. This may be explained by the face-to-face groups and the videoconferencing groups being given the opportunity to develop a shared understanding and the greater perceived satisfaction for process and quality may be a consequence of the greater information carrying capacity of the face-to-face groups compared to the videoconferencing groups, i.e. they were more able to reach consensus, develop group cohesion etc over the short time span. This finding may lend some support to media richness theory. On the other hand we predicted that where no shared understanding was developed, that the groups using videoconferencing media would show a lesser improvement in perceptions than the face-to-face groups. This was found to be the case for each of the dependent variables. The change in reported perceptions of decision process satisfaction, decision satisfaction and decision quality were all greater for the face-to-face groups than for those using videoconferencing.

The implication of these findings with respect to virtual groups is quite clear. Some time and effort spent in developing a shared understanding of what makes good communication will have beneficial effects in terms of group perceptions. These effects should translate into improved group outcomes. Another interesting observation is that the improvement noted is greater for groups using videoconferencing media than for those using face-to-face media. This suggests that the employment of the shared experience may help increase the information carrying capacity of videoconferencing media, moving it closer to face-to-face in this regard. The use of the shared experience for virtual teams may move the group satisfaction with videoconferencing closer to the expectations of face-to-face media. Some of the group members involved in the experiment stated in their assignment, which called on them to reflect on the experience, that they found the technology, in particular the meeting metaphor used in sameTime® interfered with their groups ability to reach a decision. Improved technology and/or a different meeting metaphor (say the boardroom approach) may have a more positive effect on the dependent variables. This should be the subject of some future work in this area.

The findings reported here may be limited by the following issues:
1) The approach adopted was experimental and therefore generalisability of the results may be limited.
2) The sample was entirely composed of post-graduate students and limited in size.
3) The technology used to facilitate the video-conferencing group may have confounded the user's perception of the outcomes.

7. Conclusion
This research recognises the need to fill the gap that exists in theoretical approaches explaining media choice. The major contribution is the extension of media richness theory by including and measuring the influence of a shared social construction of communication behaviour. The results of this research have significant implications to the operations of virtual teams, and the adoption of computer-mediated communication systems. This research indicates that organisations using virtual teams may benefit from appropriate training programs. Training will have to be provided to develop an understanding of communication behaviour, communication tasks and the match between the medium and the communication task. Organisations must develop an understanding of the attributes of the new media and

how these attributes may or may not "match" organisational needs and tasks. The Dialogue process proposed here is one technique that may be used by organisations to learn and understand communication behaviour and thereby use CMC more effectively.

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