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Alanah Davis

*University of Nebraska at Omaha*

Deepak Khazanchi

*University of Nebraska at Omaha*

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# Mutual Knowledge and its Impact on Virtual Team Performance

**Alanah Davis**

College of Information Science & Technology  
University of Nebraska at Omaha  
alanah.davis@mail.unomaha.edu

**Deepak Khazanchi**

Information Systems & Quantitative Analysis  
College of Information Science & Technology  
University of Nebraska at Omaha  
khazanchi@unomaha.edu

## ABSTRACT

This paper describes the notion of mutual knowledge and its potential impact on virtual team performance. Based on a review of the literature, including proponents and opponents for the concept of mutual knowledge in group interaction, we suggest that there is a gap in our understanding of what is known about mutual knowledge as it impacts team dynamics and ultimately virtual team performance. We conclude the paper by discussing the importance of mutual knowledge for virtual team performance and the research issues that need to be addressed in this domain.

## Keywords

Mutual knowledge, common knowledge, common ground, information sharing, shared understanding, computer-mediated communication, virtual teams, team performance.

## INTRODUCTION

Many of the problems faced by decision makers today are exceedingly complex and generally require the collaborative efforts of individuals from many different areas of expertise. The challenges of team work and collaboration are further exacerbated by the increasingly dispersed nature of teams today, particularly in terms of geography, time, and culture. One approach to facilitating collaboration is the use of computer-mediated communication (CMC) technologies to support virtual teams. Virtual teams have been described as teams whose members are separated by time and space and who have been brought together to accomplish a goal by conducting communication predominately through technology (Lipnack and Stamps, 1997). Further, virtual team members interact through independent tasks guided by a common purpose (*ibid.*, pp 7).

The ability to effectively communicate and then share knowledge can become a daunting task in virtual settings because of the complex nature of both the virtual context and the technology used to support them. Developing a shared understanding is critical for ensuring that any semantic differences caused by the inherent characteristics of virtuality are minimized. Furthermore, given the enormous challenges of managing a virtual project, it becomes even more important that virtual team communications are noise-free. In view of this, some authors have argued that common knowledge or mutual knowledge is an important factor in engendering effective virtual team interactions and ultimately team performance (Tan et al, 2000; Warkentin, Sayeed, and Hightower, 1997).

One of the reasons people talk is to exchange information (whether this happens face-to-face or virtually). It is this basic premise that emphasizes the importance of mutual knowledge. Mutual knowledge researchers have debated its efficacy for many years, particularly with regard to whether some form of mutual knowledge is necessary for effective communication (Brown, 1995). In this paper it is our goal to develop the notion of mutual knowledge and argue that it is important for effective communication and in consequence can have an impact on virtual team performance.

## MUTUAL KNOWLEDGE

In the literature, mutual knowledge has been described by many different terms. For example, Clark (1992) claims that "mutual knowledge is the same as shared knowledge" (pp 16). Additionally, Barr (2004) claims that "common ground and common knowledge are both forms of mutual knowledge: knowledge that is shared and known to be shared" (pp 939). Clark (1992) also asserts that that the concept of mutual knowledge was originally devised to handle coordination problems. For the purposes of this paper, we will assume common ground, common knowledge, and shared knowledge to be equivalent to the phrase mutual knowledge. The term mutual knowledge was originally introduced by both Karttunen and Peters (1975) and Stalnaker (1978). Karttunen and Peters (1975) introduced mutual knowledge with a description of group communication.

“Imagine a group of people engaged in an exchange of talk. At each point in their conversation there is a set of propositions that any participant is rationally justified in taking for granted, for example, by virtue of what has been said in the conversation up to that point, what all the participants are in a position to perceive as true, whatever else they mutually know, assume, and so on. This set of propositions is what we call the common ground or the common set of propositions” (pp 13).

Stalnaker (1978) then used the term to describe speaker propositions.

“Roughly speaking, the presuppositions of a speaker are the propositions whose truth he takes for granted as part of the background of the conversation. A proposition is presupposed if the speaker is disposed to act as if he assumes or believes that the proposition is true, and as if he assumes or believes that his audience assumes or believes that it is true as well. Presuppositions are what is taken by the speaker to be the common ground of the participants in the conversation, what is treated as their common knowledge or mutual knowledge. The propositions presupposed in the intended sense need not really be common or mutual knowledge; the speaker need not even believe them. He may presuppose any proposition that he finds convenient to assume for the purpose of the conversation, provided he is prepared to assume that his audience will assume it along with him” (pp 321).

Based on Krauss and Fussell (1990), we define mutual knowledge as *knowledge that communicating parties share and that each party knows that they both possess*.

In the discussion that follows, we further analyze the literature regarding mutual knowledge in group communication and describe two opposing views regarding this issue. The first view is based on researchers who argue that mutual knowledge does affect group communication (Cramton, 2001; Dennis, 1996; Krauss and Fussell, 1990; Frey and Sunwolf, 2005) whereas the second view is based on others who argue that mutual knowledge does not affect communication (Barr, 2004; Holgraves, 2002; Sperber and Wilson, 1986). This inconsistency raises questions that still need to be addressed in research.

### Proponents of Mutual Knowledge

Cramton (2001) argues that mutual knowledge is necessary for group communication. A study by her reported several reasons for a failure in communication due to a breakdown in mutual knowledge. These reasons include 1) failure for one party to perceive the context and situation the other party had intended, 2) failure to distribute information to all team members, 3) failure in communication media, such as undelivered or undeliverable e-mail messages, 4) difficulty in communicating and understanding the salience of information, 5) time lag caused by access and transport speeds, and 6) misinterpretation of the meaning of silence. In conclusion, these breakdowns in mutual knowledge result in a number of communication problems. Specifically these problems can include poor decision quality (Dennis, 1996) and extra time spent correcting failures of mutual knowledge (Krauss and Fussell, 1990). The processes involved in the breakdown of mutual knowledge and its subsequent consequences studied by Cramton (2001) are shown in Figure 1.

Figure 1 shows the degree of integration required due to task requirements, context, and group composition at point 1. The characteristics of the available communication technologies and how the team decides to use them are shown at point 2. The actual exchange in information is shown at point 3 and then interpreted by the receiver at point 4. Also at point 4, tension can develop due to a breakdown of mutual knowledge. The result from this is either to request more information in the form of feedback (i.e. point 5) or to attribute the breakdown in communication to a particular cause such as failure in technology or the ineptitude of the sender (i.e. point 6). Again at point 6 feedback (i.e. point 5) may be requested. The alternative is to set into motion the in-group/out-group dynamics shown by point 7. The final outcome of this process will be reflected in the subsequent viability and performance of the group. It can also lead the group to re-address the structure of the group and use of communication media (*ibid*).

Frey and Sunwolf (2005) support Cramton’s view by stating that the “construction of mutual understanding is a central task of group work, and communication has long been assumed to rest on a foundation of shared understanding” (pp 210). Frey and Sunwolf (2005) reference Clark and assert that “successful relational communication requires complex perspective taking, in which participants are able to identify their mutual knowledge and develop an awareness of the shared knowledge of relevant others.” However, Frey and Sunwolf (2005) also conclude that communication in group discussions is more complex and requires a more complex perspective taking than dyadic relationships.

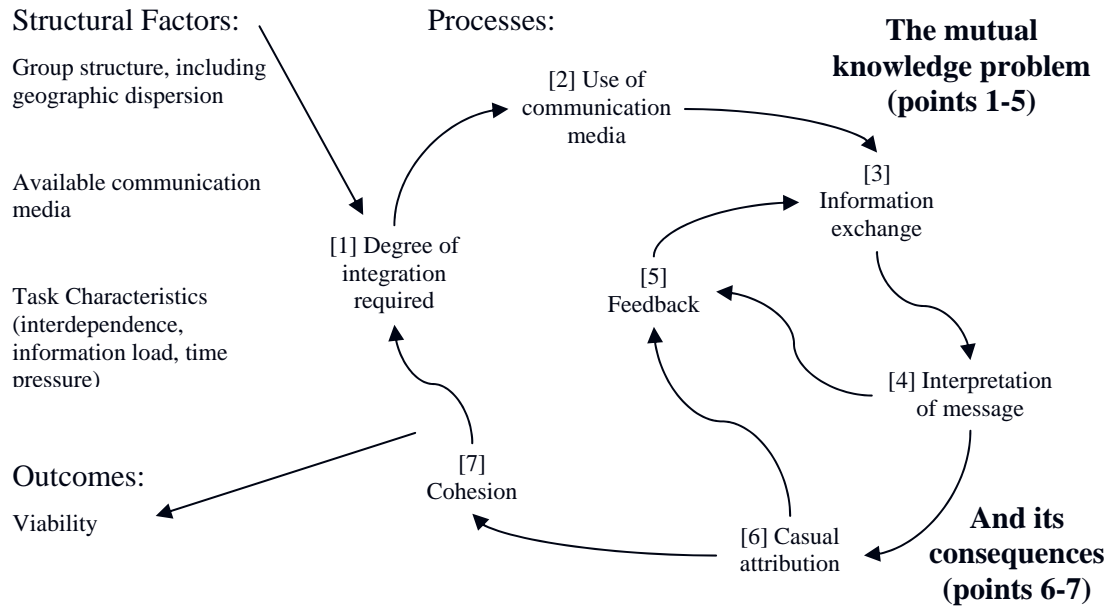


Figure 1. The Mutual Knowledge Problem and its Consequences for Dispersed Collaboration (Excerpted from Cramton, 2001)

### Opponents of Mutual Knowledge

Although some of the reasons for a breakdown in mutual knowledge have been illustrated by Cramton (2001), other researchers argue that mutual knowledge is not even necessary for communication. The first group of opponents recommends alternatives to mutual knowledge. For example, Holgraves (2002) contends that alternatives can “deemphasize the importance of mutual knowledge as a prerequisite for successful communication” (pp 127). He refers to an argument from Sperber and Wilson (1986) that says what underlies communication is *mutual manifestness* rather than *mutual knowledge*. Holgraves continues by saying “a proposition is manifest if a person is capable of representing it mentally (it need not be currently represented as is the case with mutual knowledge. A speaker is responsible for ascertaining the extent to which a proposition might be manifest for a hearer, but not with whether the hearer is aware of this awareness (i.e. the mutuality of mutual knowledge.)” According to Sperber and Wilson (1986) communication is achieved with the communicator providing evidence of their intentions. The audience can then infer the communicator’s intentions through the evidence.

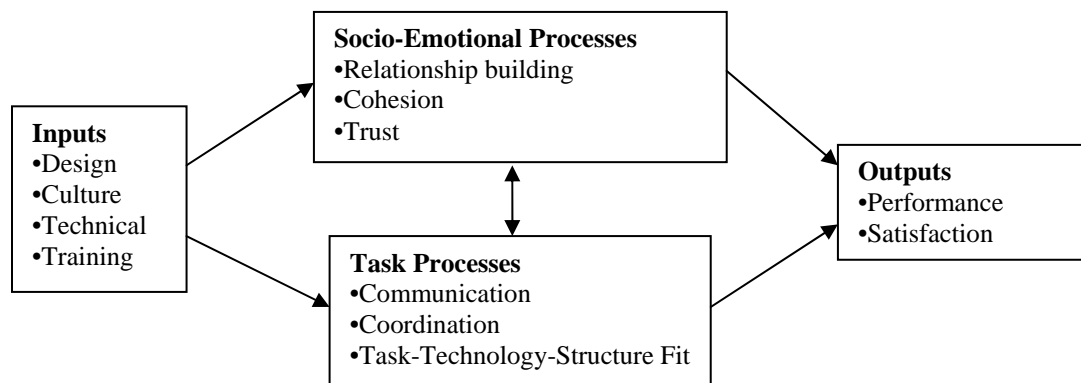
In a similar vein, Barr (2004) argues that “common knowledge (or mutual knowledge) is not necessary for the emergence of symbolic conventions, proposing instead that semantic representations are coordinated through use; that is, as a by-product of individual attempts at coordination among speakers and listeners which are distributed over time and across the language community” (pp 939). Barr then asks “if we remove mutual knowledge’s guarantee of successful communication, why don’t people constantly misunderstand one another?” A study is referenced by Garrod and Doherty (1994) which observes virtual community interactions in a laboratory setting. Barr suggests that it is possible to argue that the conventions in the Garrod and Doherty study emerged without common knowledge.

A final category of mutual knowledge opponents present arguments of communication difficulties. Oakhill and Garnham (1996) emphasize that “it is a lack of mutual knowledge, and hence an asymmetry between speaker/writer and listener/reader, that typically prompts a linguistic interchange. Thus, both the speaker/writer’s and the hearer/reader’s knowledge (and their knowledge of each other’s knowledge) determine how individuals ought to be described, and how descriptions will be understood” (pp 37). Halpern and Moses (1984) have shown that common knowledge (or mutual knowledge) cannot be attainable if communication is not guaranteed or if there is uncertainty in message delivery time. An example of this is the famous “coordinated attack problem,” where two troops want to attack the enemy, but neither would attack unless the other troop would attack too (*ibid*). Galegher and Kraut (1990) question mutual knowledge in the context of e-mail. They believe that e-mail responses are likely to be sent to the original sender, which undermines the level of mutual knowledge within the

group as a whole (Galegher and Kraut, 1990). Finally, McCarthy, Miles, and Monk (1991) concluded that Clark's common ground (i.e. mutual knowledge) was found hard to achieve in a text based only communication environment.

## VIRTUAL TEAM PERFORMANCE

In order to identify the current state of virtual team research, Powell, Piccoli, and Ives (2004) reviewed 43 papers regarding past virtual team research based on a life cycle model shown in Figure 2. It is apparent from the figure that communication is an element of the task process phase in virtual team interactions. Powell, Piccoli, and Ives (2004) go even further and argue that communication is at the core of any virtual team process. Khazanchi and Zigurs (2006) agree, stating that "communication is fundamental to teamwork" (pp 19). They define communication as "the process by which people convey meaning to one another via some medium through which they exchange messages and information in order to carry out project activities" (pp 22). The researchers identify culture, trust, and leadership as the three main issues that affect virtual team projects. As a sub-level of trust, Khazanchi and Zigurs (2006) mention common ground, or mutual knowledge as an important component for building trust.



**Figure 2. Focus of Early Virtual Team Research**  
(Excerpted from Powell, Piccoli, and Ives, 2004)

In their review of past research, both Powell, Piccoli, and Ives (2004) and Khazanchi and Zigurs (2006) cite a number of research studies that impress the importance of team member communication in the virtual context. For example, Suchan and Hayzak (2001) conducted an in-depth analysis of virtual teams in a large consulting firm. The teams developed knowledge repositories as a way to deal with the need for information sharing. The development of a common language for the repositories was a challenging database problem; but, via the process of resolving those issues, the teams ended up with a shared communication language. Their repositories became a common ground—a shared understanding of their domain. Similarly, in their research on quick-response teams, McKinney et al. (2004) found that even though team members were not geographically dispersed, that the members who do not know one another can get up to speed very quickly—a phenomenon that is common in virtual projects. Explicit sharing of communication values was the key factor in the success of these teams. These studies reinforce the idea that values have to be communicated and shared in order to build the common ground required for effective teams.

Balthazard, Potter, and Warren (2004) found that communication is one determinant of virtual team performance. Similarly, Hightower and Sayeed (1996), Tan et al. (2000), and Warkentin, Sayeed, and Hightower (1997) found evidence linking information exchange on a given task and shared norms/expectations of task processes with distributed team performance.

On the other hand, researchers have also found that virtual teams communicate less effectively than traditional teams (Burke and Chidambaram, 1996; Galegher and Kraut, 1994; McDonough, Kahn, and Barczak, 2001) and face greater obstacles in conducting orderly and efficiently exchange information (Hightower et al, 1997; McDonough, Kahn, and Barczak, 2001). However, virtual teams have been shown to communicate more frequently than traditional teams (Eveland and Bikson, 1988; Galegher and Kraut, 1994). Other studies, such as that by Sarker et al. (2005), have found a correlation between the level of virtual team capability, credibility, communication volume, and culture of knowledge sharing. They argue that a virtual team member who is more communicative (i.e. has a high level of participation in chat sessions and posts a higher volume of text as e-mail or threaded messages visible to remote members) will end up transferring more knowledge to his or her virtual team members (*ibid*).

## MUTUAL KNOWLEDGE AND VIRTUAL TEAM PERFORMANCE

Can (Does) mutual knowledge among virtual team members improve the performance of the team? In our review of the literature relating to mutual knowledge and its affect on group communication behavior, we previously described two opposing streams of thought. In addition, we summarized virtual team research regarding communication that emphasizes the importance of communication in the form of information/knowledge exchange, sharing of norms/expectations as an important factor for improving virtual team performance. Clearly, mutual knowledge in its different forms impacts communication and in turn virtual team performance.

Referring back to figure 2, we believe that mutual knowledge can improve group communication and impact all three stages of virtual team interaction -- input, process (both socio-emotional and task), and output. Challenges to this notion form alternative new concepts such as mutual manifestness (Sperber and Wilson, 1986; Holgraves, 2002), semantic representations (Barr, 2004; Garrod and Doherty, 1994), and other communication difficulties (Oakhill and Garnham, 1996; Halpern and Moses, 1984; McCarthy, Miles, and Monk, 1991; Galegher and Kraut, 1990) can be addressed through better research designs. If the virtual team task is designed with each team member having mutual knowledge, the process of communication will improve in quality and this in turn will improve team performance. Despite the many challenges of achieving mutual knowledge, there is ample evidence from the virtual team and virtual projects literature to support the notion that mutual knowledge among virtual team members will lead to better communication and consequently enhance virtual team performance. Some evidence to this effect already exists; for example, Ocker (2005) found that a lack of shared understanding among virtual team members presents a significant inhibitor to the creative performance of virtual teams. Ocker (2005) concluded that the inability to reach a common conceptualization prevented any synergy to occur within the team and at some point the divergent concepts needed to converge. In their research on global virtual teams, Qureshi, Liu, and Vogel (2006) concluded that it is important for geographically dispersed team members to have mutual knowledge for effective communication and to build shared understanding. Similarly, Khazanchi and Zigurs (2006) assert that engendering shared understanding is a critical practice for effectively managing the complexity of highly dispersed virtual projects.

Furthermore, there is some evidence to indicate mutual knowledge can positively impact virtual team outputs. For example, Stasser and Stewart (1992) found that group decisions often reflect the common knowledge shared among the team members. This suggests that the greater the mutual knowledge within a team, the better the team performance and the quality of the final decision.

In addition, it can be surmised from *a priori* literature that mutual knowledge breakdowns contribute to a lack of semantic fit in dispersed groups. Some studies, such as that by Cramton (2001), have found that misunderstandings regarding the perceptions of context and salience of information are prime causes of breakdowns in mutual knowledge. Other studies, such as that by Sarker et al. (2005), have found a correlation between the level of cultural collectivism and knowledge sharing. However, there has been very little research into the role that semantics plays in this breakdown. Also, further research in this area is needed to address how mutual knowledge can improve the performance of dispersed teams, particularly those impacted by cultural and geographical separation, and whether collocation of teams can potentially increase the possibility of mutual knowledge.

Pinsonneault and Caya (2005) suggest that virtual teams experience difficulties in communication and exchanging information and conclude that face-to-face teams have a higher perceived communication and effectiveness of information exchange. They also conclude that "multiple communication media offer more opportunities for exchanging diverse types of information and appear to provide the necessary flexibility for dealing with the various information processing requirements that characterize the virtual work environment" (pp 11).

## CONCLUDING REMARKS

Despite the challenges of achieving mutual knowledge and variety of research issues addressed in the literature, it is apparent that our understanding of how mutual knowledge can impact virtual team processes and performance needs further investigation.

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