Journal of the Association for Information Systems

Volume 9
Issue 10 *Special Issue in Honor of Gerry DeSanctis*

Article 1

November 2008

The Structure of Collaboration in Electronic Networks

Srinivas Kudaravalli
University of Maryland, skudarav@rhsmith.umd.edu

Samer Faraj
McGill University, samer.faraj@mcgill.ca

Recommended Citation
Kudaravalli, Srinivas and Faraj, Samer (2008) "The Structure of Collaboration in Electronic Networks," *Journal of the Association for Information Systems*, 9(10), .
DOI: 10.17705/1jais.00172
Available at: https://aisel.aisnet.org/jais/vol9/iss10/1

Journal of the Association for Information Systems
JAIS

Special Issue

The Structure of Collaboration in Electronic Networks*

Srinivas Kudaravalli
University of Maryland
skudarav@rhsmith.umd.edu

Samer Faraj
McGill University
samer.faraj@mcgill.ca

Abstract

Many electronic networks, such as forums, provide interaction spaces where participants collaborate on complex issues over extended periods of time. However, while inter- and intra-organizational collaboration has been widely studied, collaboration practices in electronic networks need further investigation. Extant research on electronic networks has mainly emphasized availability of expertise, by focusing on factors such as individual resources and participant diversity. We call for a closer examination of the collaboration practices that allow such expertise to be leveraged for successful outcomes. We argue that an examination of collaboration practices in different technology-enabled contexts is essential to the study of knowledge work, which increasingly occurs in electronic networks. Therefore, in this paper, we provide a starting point by investigating the structure of collaboration that enables one group to engage in "deep discussion" and sense-making, develop perspectives, and create knowledge. Specifically, in the context of discussion threads, which are the locus of collaboration in many electronic networks, we explore the structure of interaction that leads to effective collaboration. We propose that two dimensions—initiating dialogue and sustaining dialogue—predict the effectiveness of collaboration in discussion threads. The hypotheses are tested on six months of message data collected from an electronic network focused on methodological issues in the social sciences. We find that the proposed interaction variables contribute to knowledge work over and above the traditional variables that have been studied in the literature such as individual resources and participant diversity.

Keywords: *online communities, computer-mediated communication, collaboration*

---

* Marshall Scott Poole and Jonathon Cummings were the accepting guest editors.

Volume 9, Issue 10/11, pp. 706-726, Special Issue 2008

The Structure of Collaboration in Electronic Networks

1. Introduction

Electronic networks, traditionally called online communities, help users with a variety of purposes and motivations overcome limitations of space and time to gather in virtual spaces (Cummings et al. 2002; Preece 2000; Sproull 2004). Electronic networks represent new ways of collaborating and organizing knowledge work across the boundaries of firms. Researchers have noted that virtual organizing within and across firms creates "forms that are more reconfigurable," "boundaryless," and "flexible" (DeSanctis and Monge 1999) as well as affordances for "visualizing entire work processes" and engaging in "mass collaboration" (Zammuto et al. 2007). But work accomplished in electronic networks, especially those that are practice-based, calls for an extension of these ideas due to the voluntary nature of the work as well as the potential scale and diversity of the participants. For instance, prominent collaborative accomplishments, such as the widely studied development of the Linux operating system, involves loosely coordinated, self-organizing, and voluntary work by thousands of developers from all over the world (Lee and Cole 2003; Moon and Sproull 2000). Examples of other "collaborative work communities" such as the distributed proofreaders project (Sproull 2004) and the creation of online encyclopedias and other collaborative content (Wagner and Majchrzak 2007) also provide interesting case studies. However, beyond the fact that threads play an important organizing role in coordinating work (Yates et al. 2003), we know very little about the structure of collaboration in electronic networks.

In particular, despite the interest in new organizational forms enabled by IT (Fulk and DeSanctis, 1995; McPhee and Poole, 2001), studies on electronic networks have mainly focused on individual-level motivations, resources, and participant diversity (Constant et al. 1996; Wasko and Faraj 2005). While this research has yielded valuable insights, the underlying assumption in these studies tends to be that the most important predictor of success is locating and motivating individuals with the right expertise and resources to participate. The need for groups to develop structures of communication, especially what DeSanctis et al. (2001) refer to as "routines" that support "deep communication," has not received enough attention. In addition, researchers have not yet examined the collaboration practices that enable knowledge work in electronic networks. While inter- and intra-organizational collaboration has been widely studied (Hardy et al. 2005; Levina 2005; Faraj and Xiao 2006), the role of electronic networks as collaboration settings has also not received enough attention. Due to the voluntary nature of the work in online communities and the lack of face-to-face interaction, we can expect that collaboration practices in electronic networks differ from those in traditional organizational settings. The increasing prevalence of electronic networks in accomplishing collaborative work, especially within professional communities, makes the study of such practices more important than ever before. These practices include initiating conversations, establishing the context to enable collaborative learning, and developing complex ideas "through dense dialogue" (DeSanctis et al. 2003; Kraut et al. 2002).

In this study, we examine collaboration practices that support knowledge work in electronic networks. Our principal contention is that even when resources such as individual expertise and participant diversity are mobilized, they cannot be leveraged for knowledgeable outcomes without effective collaboration. Specifically, we investigate the structure of interaction that supports effective collaboration online and suggest that it has two dimensions: initiating dialogue and sustaining dialogue. We test this hypothesis in the context of discussion threads in one electronic network—a professional practice-related, email-based listserv. We investigate whether the hypothesized structure of interaction leads to successful discussion outcomes, over and above the mere presence of individual resources and participant diversity, which has been studied in the literature. To answer this question, we gather messages exchanged over a period of six months in an electronic network focused on methodological issues in the social sciences. In addition to gathering demographic and status data on the members of this online network, we also analyze the content of the messages.

This study contributes to our understanding of electronic networks by highlighting the importance of collaboration to electronic groups and investigating its structure. We argue that it is essential to study not only group inputs, such as resources and diversity, but also collaboration processes in order to

understand how electronic groups succeed and achieve sustainable outcomes. In addition, we make a theoretical contribution by proposing the constituent dimensions of online interaction that support collaboration in electronic networks. Finally, our suggestion that successful discussions are characterized by this interaction structure can be used to guide efforts to improve knowledge work in electronic networks.

2. Theory and Hypotheses

Researchers have long been interested in studying the new organizational forms enabled by information and communication technologies (DeSanctis and Monge, 1999, Fulk and DeSanctis, 1995, McPhee and Poole, 2001). It has been recognized that such technologies have had a wide-ranging impact on hierarchical control within organizations and have also affected intra- and inter-organizational coordination. Moreover, based on the idea that information technology leads to other flexible and emergent forms, researchers have suggested that a conceptual shift from "organizational form" to "forms of organizing" is needed (Zammuto et al. 2007). However, the recent creation of extra-organizational electronic networks on the Internet calls into question our revised understanding of coordination in the organization of work.

If, as suggested, IT has flattened hierarchies and increased innovation in knowledge work by connecting diverse actors within and across traditional organizations, these effects are even more pronounced in Internet-enabled electronic networks. These networks allow diverse groups to engage in voluntary collaboration without any hierarchical or formal controls and are mostly characterized by open membership and diverse organizational affiliation. The larger question this raises for research on new organizational forms enabled by IT is: how do participants in electronic networks collaborate in the absence of traditional coordination mechanisms? Although studies in areas such as open source (Kuk 2006), computer supported cooperative work (Churchill et al. 2001) and computer supported collaborative learning (Stahl et al. 2006) have focused on aspects of this question, it has received limited attention in the research on new organizational forms enabled by IT (Constant et al., 1996; DeSanctis and Monge, 1999; Sproull and Kiesler, 1991). We take the initial step by undertaking a study of one electronic network based on professional practice that is engaged in performing complex knowledge work through collaborative discussions.

It should be noted that just as different types of collaboration exist in traditional organizational forms, not all electronic networks engage in the kind of collaboration that is the focus of this study. For example, synergistic collaboration in multiparty information systems development has been shown to involve reflecting on, adding to, and challenging the work produced by others (Levina 2005). On the other hand, IT use sometimes turns collaborative "community-like" relationships into transactive, "market-like" relationships (Levina and Vaast 2006). Electronic networks also vary in their collaboration practices. For example, DeSanctis et al. (2003) studied 40 online communities and concluded that there appeared to be three primary types of online communities, which they labeled information kiosks, associations, and communities of practice. They described information kiosks as spaces that are suited for efficiently exchanging declarative and procedural knowledge, where members are less likely to start discussions. In contrast, associations are characterized by a shared interest in building a professional social network by exchanging transactive knowledge. The third type — communities of practice —operates through "dense interactions" that "promote shared understandings and practices associated with sense-making." Participants in these communities seem to value their "culture of knowledge exchange" more than their diversity and they suggest that increased collaborative learning can be achieved by aiming for dense, "deep discussion." We are interested in this type of collaborative electronic discussion network, since the literature has yet to explore the kinds of collaboration that can support such "deep dialogue" in knowledge work, by means of which "a common view of the world is interactively produced, challenged, and reproduced over time" (DeSanctis et al. 2003).

In this section, we develop our theoretical model to investigate how such collaboration is structured in electronic networks. In doing so, we draw from findings in several different areas of the extant literature on collaboration in organizational settings. We also discuss the applicability of these findings

to electronic networks and what constitutes effective collaboration in these settings. But first, we discuss the individual resources and diversity view that has been the main focus of the literature examining electronic networks.

2.1. Individual Resources and Diversity View

Members and the expertise they bring to discussions are considered the primary resources of electronic networks (Butler 2001). Participants' experience, expertise, and access to a diverse pool of resources has been shown to be effective in generating useful ideas and solving the problems of information seekers in electronic networks (Constant et al. 1996; Wasko and Faraj 2005). The literature on knowledge work in electronic networks relies on explanations that focus on resources and diversity, a focus that can be supported by arguments based on the importance of group composition to performance. The study of the effect of group composition and demography on group outcomes has a long history (van Knippenberg et al. 2004). However, despite the vast number of studies on this topic, the effect of diversity on group performance has been surprisingly equivocal (Van der Vegt and Bunderson 2005).

Many of the arguments about the impact of diversity on performance are based either on task-related/informational aspects or relational/social-categorization perspectives (van Knippenberg et al. 2004). A widely used argument about access to information is drawn from the "weak tie" theory, which suggests that diverse ties bring access to non-redundant information (Granovetter 1973). The social-categorization or identity argument is that the more similar the group members are to one another in terms of certain characteristics, the more they identify with the group (Abrams et al. 2005). Increased identification leads to increased motivation to participate in the group to ensure its success. The coordination argument is that homogenous groups achieve better communication due to their shared characteristics. Just as in knowledge work in science, having a shared paradigm and perspective increases efficiency within the practice (Boland and Tenkasi 1995; Brown and Duguid 2001; Kuhn 1970).

In the context of online forums, we suggest that diversity has an overall positive impact on knowledge work for differing reasons. The Internet and newer communication technologies make it easier to locate and interact with individuals who have diverse experiences and backgrounds. Access to diverse resources is beneficial in electronic networks since it has been widely documented that individuals, even if they are strangers to one another, tend to share information and know-how and volunteer to solve problems for others (Constant et al., 1996; Lakhani and von Hippel, 2003). On the other hand, since the Internet also makes finding like-minded people easier, there may be a tendency for some groups to become too narrow or restrictive. Therefore, in such contexts, we suggest that diversity in electronic networks has a positive effect by making specialized and local knowledge more explicit and accessible to diverse audiences (Griffith et al. 2003). This process in itself may lead to increased knowledge creation. Therefore, we propose:

> *H1: Resource and participant diversity in electronic networks is positively related to effective collaboration.*

2.2. Collaboration in Electronic Networks

Information technology-enabled collaboration has been studied extensively in intra- and inter-organizational contexts (Kraut et al., 1999, Levina and Vaast, 2006, Schultze and Orlikowski, 2004). An important theme that has been explored in these contexts concerns the impact of technology on inter-personal and inter-organizational relationships. A complex picture of the link between technology and relationships has emerged from this research. For example, use of IT has been linked to increased dependence on both inter-personal relationships and markets (Kraut et al., 1999, Levina and Vaast, 2006). A second theme in this literature concerns the effect of collocation and proximity on collaboration. Many studies have attested to the advantages of face-to-face interaction and the negative effects of mediated communication (Kiesler and Cummings, 2002, Nardi and Whittaker, 2002, Olson et al., 2002). Specific factors such as visibility, copresence, contemporality and sequentiality have been proposed as some of the reasons why it is difficult to replace face-to-face interaction with mediated communication (Clark and Brennan 1991).

How, then, does collaboration unfold in settings where there is no expectation of face-to-face interaction, the work is voluntary and loosely coordinated, and there are no social or organizational linkages between participants? Researchers have suggested several strategies to mitigate the effects of the lack of physical proximity in mediated communication. One such strategy is to use technology appropriately to maintain awareness of tasks, teams, and events in their environment, and another is to employ structured management techniques (Kiesler and Cummings, 2002, Kraut et al., 2002). For example, Kiesler and Cummings (2002) suggested that modularization and "standardized procedures for coordination" explain how the Linux group was able to overcome "social distance and lack of cohesion" arising from the absence of co-located interaction to achieve successful collaboration. However, most electronic networks lack the Linux group's advantages of clear role structures and an identifiable work product. The kinds of structures that support collaboration in such settings have yet to be investigated.

One fundamental structure of collaboration in electronic networks that has received attention is the organization of communication into conversation threads (Lewis and Knowles 1997). Threading helps organize conversations in complex and elaborate ways to coordinate work (Yates et al. 2003). Our focus in this study is on examining how collaboration unfolds in threaded collaboration spaces to lead to successful outcomes. We characterize such interaction within the thread as effective collaboration. Collaboration has been defined in various ways, but, generally, it refers to voluntary cooperation among participants (Gray 1989; Hardy et al. 2005). To characterize effective collaboration within the context of collaborative electronic discussion networks, we adapt the definition developed by Hardy et al. (2005) for the inter-organizational setting. We define effective collaboration in threads as a structured, iterative process that leverages the differences among participants to generate suggestions and solutions to address issues relevant to the participants. In electronic networks, especially those that are practice-based, threads start with a seed message in which participants attempt to enroll other members and their expertise to address specific problems (Constant et al., 1996, Galegher et al., 1998, Lakhani and von Hippel, 2003). Through the process, diverse individuals are able to collaborate on issues related to common interests.

2.2.1. The Structure Of Collaboration In Electronic Networks

The emphasis on individual resources and participant diversity in online groups has several limitations. First, in terms of practical implications, it may not be possible to control demographic diversity in electronic networks, since membership tends to be open. Second, the emphasis on group composition and characteristics such as demographic diversity may come at the expense of inadequate attention to group collaboration. While the strength of electronic networks is in their access to geographically dispersed expertise, which fills in the gaps in local resources (Constant et al., 1996, Lakhani and von Hippel, 2003), increased coordination is needed to organize the distributed expertise (Boh et al. 2007). Similarly, researchers have suggested that structured management is needed to mitigate the negative effects that technology-mediated communication may have on collaboration (Kiesler and Cummings 2002). What kinds of interactions can overcome the limitations that computer mediated communication imposes on collaboration in electronic networks? In this study, we suggest one specific type of interaction structure, drawing from the extant literature on collaboration in traditional organizational settings.

When people collaborate in traditional settings, face-to-face conversations play an important role in coordinating activity. Grounding—the establishment of common ground, or information of which participants are mutually aware—plays an important role in such coordination (Clark and Brennan 1991). Generally, this proceeds in two phases that have been labeled the presentation phase and the acceptance phase. Once the speaker makes an utterance, the listener provides evidence of understanding, either implicit or explicit. Since mediated communication lacks the affordances provided by face-to-face interaction, grounding is especially difficult in electronic networks (Kraut et al. 2002). Conversations in electronic networks are structured as a series of interactions between different members in the discussion thread, in a process that progressively elicits relevant details that are used to interpret the issues and suggest solutions. We suggest that these interactions can be usefully conceptualized as being organized in two distinct phases—initiating and sustaining dialogue.

These are analogous to the presentation and the acceptance phases in face-to-face conversations. In the first phase, the dialogue is initiated by the seed message, in which the participant describes the issue and supplies several different types of contextual details. Very often, other participants then clarify these details for the community and offer solutions through a series of exchanges, which we call sustaining dialogue. While the specific form these two phases take may differ, they are repeatedly employed in threaded conversations to mitigate the lack of face-to-face interaction and to accomplish collaborative knowledge work. The repeated use of these specific situated communicative practices is analogous to the concept of a language game, which has also been applied to the study of linguistic interaction in online communities (Fayard and DeSanctis 2005). We describe these two components in more detail below.

Initiating Dialogue

Face-to-face interaction facilitates grounding by allowing paralinguistic and nonverbal behaviors that help in the development of common ground, precise timing of cues, coordination of turn-taking and easier repair of misunderstandings (Kraut et al. 2002). In their absence, developing common ground in mediated communication is effortful and challenging and has consequences for distributed collaboration (Clark and Brennan 1991). For example, in geographically distributed teams, the failure to establish common ground or mutual knowledge has been shown to lead to failures of information exchange, failures of interpretation, and incorrect attribution, thus creating roadblocks to effective collaboration (Cramton 2001). In the discursive approach to knowledge work adopted here (Corman and Poole, 2000; Hardy et al., 2005; Putnam and Fairhurst, 2001), contextual details are especially important, since it is presumed that all discourse is situated (Bakhtin 2004). For example, texts can only be interpreted in relation to other texts or what is already known. Utterances depend for their meaning on such details as who is speaking, the history of the speaker, and the environment. Therefore, utterances must be contextualized to a communicative context (Morson and Emerson 1990).

Therefore, the first dimension of the structure of interaction in electronic networks refers to the establishment of common ground by supplying different types of contextual details. The diverse backgrounds and experiences of participants in electronic networks amplify the difficulties that researchers have noted in other settings. Participants who post questions may, consequently, include a variety of relevant information in their posts to communicate the issue effectively, generate interest in it, and prepare the ground for subsequent dialogue. For example, the questioner, or the person posting the seed message in a thread, may initiate a conversation by: (i) describing an issue or problem in relevant detail ("I am currently engaged in making a contribution to a debate about the dimensionality of the Cognitive Style Index of…the scale is founded on the notion of a single bipolar scale…is there an approach that will deal with the nonnormality of the items without recourse to parceling?"), (ii) outlining possible solutions that have been explored ("I know that ML estimation and 2SLS estimation procedures are well suited for…but, I am not very convinced…"), and (iii) noting details about times and places that may be relevant ("Approximately three months after the baseline data collection…"; "In this company, managers typically assign tasks by…").

The importance of contextual details for communication has been studied in relation to technology and distributed work in different settings. For example, the movement of people between different physical settings or contexts such as the manufacturing plant and the lab, in order to gain understanding of different types of situated information and tools for problem solving, was found to have a positive influence on organizational learning (Tyre and von Hippel 1997). Research on distributed teams has found a positive relationship between individuals' perception of information technology support for contextualization and collaboration know-how development, when the tasks are non-routine (Majchrzak et al. 2005b). Similarly, contextual details assume greater significance in relation to interactions in knowledge-intensive discussion threads in electronic networks than they might in other contexts. Problem solving in such practice-related discussions is often not a matter of applying systematic rules but of discovering the uniqueness or "essential particulars" of each case (Morson and Emerson 1990). However, supplying too many details may lead to information overload, causing participants to simply ignore the information or reduce participation (Butler, 2001, Jones et al., 2004). For this reason, it is important during this process to extract only the relevant details. Since

discussion of unusual problems in discussion threads often involves understanding related to specialized professional practice, contextual information can play a critical role in solving them. Therefore, we propose:

H2: The extent of initiating dialogue, involving relevant contextual details, is positively related to effective collaboration.

Sustaining Dialogue

Sustaining dialogue builds on the details supplied in the initiating dialogue phase. Since the participants in electronic networks are physically dispersed and very often do not share a common background or experience, participants must interpret contextual details in light of their own experience and background. But the details in the initial message are often not readily interpretable by other members. Therefore, in many cases the accuracy of other members' understanding of such details has to be confirmed. This process unfolds as a series of clarifying questions, feedback, and references to other posts. Since this process extends the conversation started during the initiating dialogue phase, we call this phase sustaining dialogue. This dimension of the interaction in collaborative electronic discussion networks is analogous to the acceptance phase of grounding in face-to-face conversations, as well as to the concept of dialogue traditionally used in the literature.

Others have studied the kind of interaction that underlies sustaining dialogue in relation to learning and knowledge creation in other organizational settings. For example, one kind of dialogue between information systems developers and clients, called collaborative elaboration, has been found to be associated with greater client learning (Majchrzak et al. 2005a). Knowledge work in organizations involves interaction among various communities with specialized expertise. However, this is often problematic, given the incommensurability or incompatibility between different perspectives and paradigms in knowledge work (Kuhn 1970). Boland and Tenkasi (1995) describe the processes within such knowledge communities as "perspective making" and "perspective taking." It is suggested that knowledge work involves both the creation of strong perspectives within communities and taking into account the perspectives of others. Further, the use of dialogue as well as boundary objects plays an important role in overcoming the incompatibility between different perspectives. In managing the diverse expertise in information systems development projects in organizations, how participants use specific practices such as adding to, ignoring, and challenging the work of others has been studied (Levina 2005).

Similarly, in electronic networks in practice-based professional work, deeper, denser interaction is essential to overcoming such incompatibilities (DeSanctis et al. 2003). Specifically, different interaction elements may comprise sustaining dialogue such as: (i) participant seeking clarification from the questioner ("What are the two count variables you used? I just wanted to be clear about the point because…"), (ii) questioner asking a follow-up question ("You suggested using SEM…do you have a good reference for using LISREL to do cross-equation constraints…"), (iii) referring to and adding to others' posts ("John is right -- the adjustment from the Spearman-Brown prophecy formula gives…"), and (iv) identifying paradigm-related issues ("It is interesting to notice that if you are an economist, you will use 2SLS but if you are a management scholar or an industrial psychologist, you will prefer ML estimation procedure…"). These elements help knowledge-intensive discussions in electronic networks unfold at many different levels among people with different backgrounds, experiences and perspectives. The concept of sustaining dialogue is especially relevant to online settings since Internet-enabled communication technologies have now made possible the interplay of voices and views on a scale not seen before. Members of many electronic networks may be said to be involved in joint meaning making of complex technical and social problems with thousands of other individuals. This leads us to propose:

H3: The extent of sustaining dialogue, involving questions and clarification, is positively related to effective collaboration.

A theoretical model incorporating the three hypotheses we have proposed is shown graphically in Figure 1.

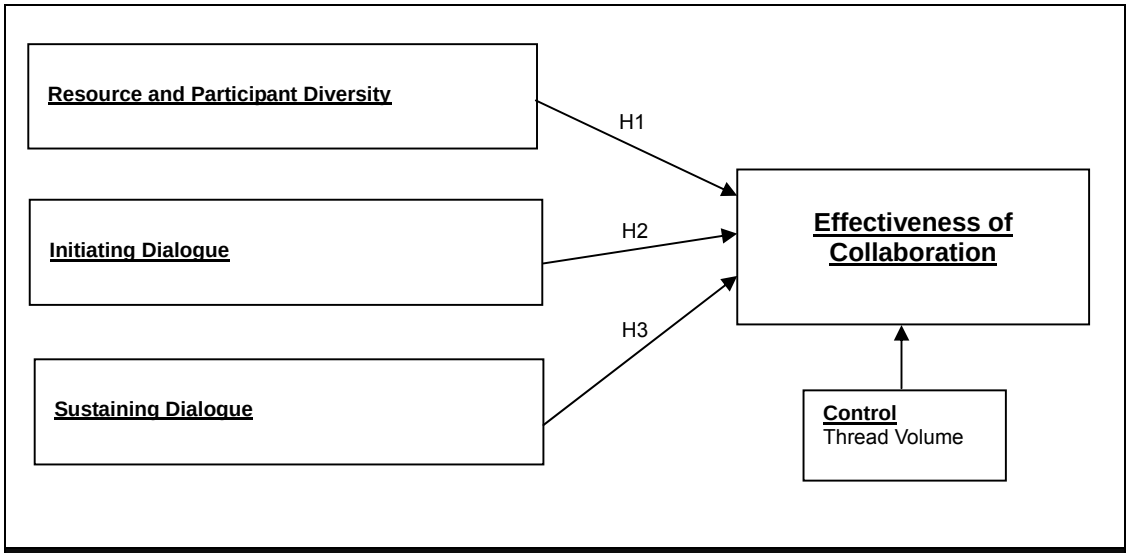

Figure 1: Theoretical Model

3. Research Methodology

3.1. Site Selection

In order to study knowledge creation in electronic networks, we chose to focus on one online network — a listserv focusing on methodological problems in the social sciences, aimed at management scholars. We chose this site for several reasons. First, since we are interested in estimating the broader effect of dense interactions in addition to their individual characteristics, we needed a site that made member attribute data openly available. We concluded that academic electronic networks offered that advantage by including signatures at the end of each email message. Moreover, members of the academic community often have other information on their personal websites, or those of their institutions. Second, given our interest in studying the processes involved in "deep discussions" on complex, unusual problems, we deemed this network an appropriate choice because a large proportion of conversations in it match this description. This network closely resembles what DeSanctis et al. (2003) call a community of practice in their classification of different types of online communities. As in their description, this site is extra-organizational and associated with practice—participants have their primary organizational affiliation elsewhere but participate in this network to engage in discussions with others interested in methodological issues in social science research.

We collected message and member attribute data from the website archives. The site displays threads in descending order by date and time, grouped by subject. We collected approximately six months of archived message data, which totaled 503 email messages. Within each subject (or thread), messages are listed in descending order by date and time. The data are drawn from 137 unique contributors.

3.2. Coding Message Content

Our study used several content analysis measures for the initiating and sustaining dialogue variables as well as the dependent variables measuring effectiveness of collaboration. We used the following procedure in creating the coding scheme for the content analysis of the interaction variables (Krippendorff 1980; Weber 1990). First, once the two dimensions of the interaction structure were identified from theory and observations, we studied messages that were on the site but were not included in our sample in order to observe the various ways of initiating and sustaining dialogue. This resulted in a preliminary coding scheme. The resulting categories for each dimension were evaluated by four Ph.D. students, in addition to the authors. The coding scheme was revised based on these discussions. Subsequently, we dropped the categories that seemed ambiguous, unclear, or hard to

understand. The remaining categories were tested by the author and used them to code all the messages in the sample. To ensure the reliability of the content analysis scores, a second rater who was unaware of the research question in the paper independently rated 100 messages for the same items. We calculated reliability using Cohen's kappa statistic. Kappa is a chance-corrected measure of interrater reliability excluding the number of judgments for which agreement can be expected by chance. It is, therefore, considered to be better than a percent agreement measure (Capozzoli et al. 1999). For the items included in the analysis, the lowest value for the kappa statistic was 0.6 and the highest was 0.9.

3.3. Measures

3.3.1 Independent Variables

In general, individual characteristics such as organizational tenure, experience, expertise, hierarchical level and position have been widely studied in the literature (Constant et al. 1996; Reagans and Zuckerman 2001). However, in the context of electronic networks, tenure may not always translate into community-specific experience, as some may lurk rather than participate. Therefore, member participation has to be taken into account as well. As discussed above, extra-organizational electronic networks lack most kinds of formal controls, so hierarchical levels and position have no clear correlates. Since our setting is an academic forum, we chose academic rank as a proxy for expertise and position. We measured tenure, academic rank, and previous participation. The operational details of these variables are described below and also listed in Appendix A.

Tenure: This variable was operationalized as length of membership in the community. This information was available through the member profile link on the listserv archive website. Tenure was calculated as the number of days from the date the member joined the group.

Rank: Members' academic rank was coded manually using data gathered from message signatures. In some cases, academic rank information was ambiguous or not available in the message signature. The website gave access, through the member profile link, to all previous messages posted by the members. Where rank information was not available, signatures in previous messages were observed. In cases where rank information could not be found in any previous message signatures, the data were collected from the web site of the individual's institution of origin. Rank was coded from 1 through 5 on an increasing scale from student to professor (other, student, assistant professor, associate professor, professor).

Previous Participation: This variable was operationalized as the total number of all messages posted by the member over the lifetime of his or her membership. This information was available on the website.

Using these variables, in the next step, we computed diversity of tenure, rank and previous participation within each thread. The diversity measures were calculated using the Gini index for the thread. Measures based on the Gini coefficient, such as the Gini index and the coefficient of mean difference, are widely used in the literature to measure demographic diversity (Reagans and Zuckerman 2001). The Gini index of a variable such as tenure calculates the relative mean difference of tenure among the participants in a thread.

Initiating Dialogue: Only messages that started new threads (seed messages) were analyzed for initiating dialogue. This is in accordance with the definition of a seed message as one in which relevant contextual details about an issue are provided to initiate a dialogue. Different types of contextual details surrounding history, situations, times, and places are important in establishing the ground for participants to engage in conversations and dialogue (Clark and Brennan, 1991, Morson and Emerson, 1990). Through such details, questioners and information seekers in electronic networks set the stage for the other group members to participate in the discussion. For example, when the seed message includes information about the various procedures followed to find a solution, it allows other members to suggest additional procedures that have not been attempted, without repeating those that have already been tried. Therefore, the initiating dialogue dimension

includes three different items developed to measure contextual details—the amount of detail provided about the issue itself, the details provided about the search for a solution, and situational context. We measured all three items on a five-point scale, from very low to very high. The individual items used for this variable are described in Table 1 with detailed examples, and the operational details are listed in Appendix A.

Table 1: Items for Initiating Dialogue

Item	Description
Issue Details	Describes the context around the problem to be solved. Example: "Some background information …. I have been using a handful of published team process measures over the last couple years. The psychometric properties of these measures are fine (e.g. Cronbach alphas, factor structure, rwg, ICC's). However, I have noticed 2 trends across a couple of samples. (1) The ratings for the teams (i.e. measures aggregated to the team level via the mean) are negatively skewed (i.e. ceiling effect). (2) When the measures are aggregated via the standard deviation, that is to provide a measure to assess variation in team member responses, there is not much variance. I realize this is desirable for team measures, however I am interested in identifying why there is variance within as well as between teams. My feeling is that the lack of variation in this measure may also be a function of the ceiling effect going on in the data."
Search Details	Describes circumstances and outcomes of earlier search efforts for a solution. Example: "Briefly, we are doing a meta-analysis on price elasticities and charitable giving. The field is nascent and there is no previous multivariate model to draw up. Also, even if there was, the available moderators are haphazard and not conducive to testing it. This is consistent with Becker and Schram (1994, p. 374) regarding meta-analysis: 'If an unstudied path is critical to the model, the effects (e.g., standardized regression slopes) estimated for the variables that were studied may be over- or underestimated and the results biased. Such model misspecification can lead to incorrect conclusions, but is hard to avoid when using existing data.' Of note the editor suggested that we seek additional expertise in responding to this issue (this is where you come in)."
Situational Details	Specific occasions, encounters, times and places. Example: "Our Dean has just announced that he wants to establish a School policy on the practice of offering incentives to research study in the form of prize draws. Are there any specific policies in place in the US or elsewhere concerning this practice?"

Sustaining Dialogue: We measured this dimension in all messages except the seed messages. This follows from the distinction made between the phases of conversation – once the speaker initiates a dialogue, the other participants in the conversation achieve understanding through requests for clarification and references to what was said before (Clark and Brennan, 1991, Constant et al., 1996, Morson and Emerson, 1990). Using multiple ways to describe and identify differences between participants was shown to be an integral part of collaborative elaboration (Majchrzak et al. 2005a). In the context of electronic networks, we developed four different items to measure these characteristics and these formed the sustaining dialogue dimension: whether the participant asked for clarification; whether the person referred to what another member said in another message within the thread; whether the questioner asked follow-up questions; and whether the post referred to paradigmatic issues or the disciplinary affiliation of the members in the discussion. All four items were coded either 0 or 1 for each message in the thread. These items represent interaction among members and measure the level of dialogue that the members were engaged in during the course of their participation in the thread. For example, asking follow-up questions and referring to what was said in other posts in the thread indicates a high level of engagement with the discussion. The individual items used for this variable are described in detail in Table 2 along with examples, whereas the operationalization is presented in Appendix A.

Table 2: Items for Sustaining Dialogue	
Item	Description
Ask for Clarification	Participant in the discussion asks for clarification Example: "Did you reverse-code the items back before running factor analysis? Some programs like Stata can recognize reverse-coded items and adjust analysis appropriately, but it is always better to recode the items back manually and only then factor analyze them. That is the first thing that comes to mind in response to your question."
Reference to other's posts	Participant in the discussion refers to what another participant has said in other posts in the thread Example: "I would second Brian's recommendation for the Kline text – have used both the first and the second edition in SEM courses and find it one of the more readable texts out there."
Follow Up Question	Questioner who posted the seed message asks a follow-up question Example: "I agree, this does initially look like an HLM application. However, as an IV, I am interested in what other people in the group thought without allowing that individual's own score to be calculated in that mean. I do control for that individual's T1 score, but my hypotheses are that… Given this, are there other options besides HLM that would be more appropriate? Or does this still sound like an HLM application?"
Reference to disciplinary issues	Participant in the discussion refers to paradigmatic issues or the other person's disciplinary affiliation Example: "Unfortunately, you've just entered one of the long-standing debates in psychology--whether to use unweighted (i.e., equal-weighted) or weighted (using 'importance' weights generated via factor loadings, standardized regression coefficients, etc.) scores."

3.3.2. Dependent Variables

The dependent variables in this study reflect effective collaboration in knowledge-intensive discussions in electronic networks. In this community, this took the form of two measurable outcomes. First, in several cases the questioners acknowledged that their issue has been resolved. For this outcome, we coded a binary variable (1-yes, 0-no) to indicate the questioner's acknowledgment of the value derived from the discussion. Similar variables and coding procedures have been used in prior literature (Constant et al. 1996). In this network, how questioners acknowledged the value of the responses varied in relation to the nature of the query. For example, a questioner may acknowledge that the discussion has corrected her misconception or altered her thinking on a topic, as follows:

> *Thanks to everyone for your very helpful replies. I guess I was overly simplistic in my thinking and automatically equated "nonnormal = bad" and something that might need "fixing" before commencing with the major analysis. I suppose the more one thinks about it, the more you realize that many of our variables of interest are normally nonnormal.*
> *Thanks for putting me on the right track!*
>
> *Jane Doe*

As an additional indication of effective collaboration, we counted the number of different ideas proposed in each thread. These, too, varied in response to the query posed by the questioner. In some cases, participants responded simply with citations, whereas in other cases, a number of long meditations on different topics were offered. In each case, we counted all the unique suggestions or ideas. Together, these two variables show how effective the collaboration in the thread has been in generating suggestions and ideas to solve the problem or the issue faced by the questioner.

3.3.3. Control Variable

We control for thread volume so that the measures of effective collaboration are not simply a

reflection of the length of the thread. Thread volume is a measure of total contributions to the thread topic, and is defined as the total length of all messages in the thread. For the purposes of our study, we believe that the length of the content in the thread, measured as word count, is a more appropriate measure of total contribution than the sheer number of messages the thread contains. Since email messages frequently include the text of the message being responded to, the message length data may contain considerable noise. Very often, multiple email messages are appended at the end. Therefore, we took care to ensure that such appended messages were removed before measuring the message length.

3.4. Analysis

The question of interest is how the effectiveness of collaboration in a thread is determined by the structure of interaction within it. Although both message and thread-level data were collected for this study, we performed the analysis at the thread level. To facilitate this analysis, all the message-level data was aggregated to the thread level. The items used to measure the two dimensions of initiating dialogue and sustaining dialogue at message level were added to obtain thread level measures. We also calculated diversity indices at the thread level. When all the message-level variables were aggregated to the thread level, we obtained a sample size of 142, which corresponded to the number of threads in the original sample.

4. Results

Table 3 presents the means, standard deviations, and correlations for the variables included in the study. The correlations are all well below the levels that would indicate problems with collinearity (the highest VIF statistic was 3.11, below the acceptable limit of 5) (Belsley et al. 1980).

Table 3: Descriptive Statistics and Correlations

	Variable	Mean	S.D	1	2	3	4	5	6	7
1	Thread Volume (LN)	6.33	1.20							
2	Diversity of Tenure	.11	.11	0.52**						
3	Diversity of Previous Participation	.27	.24	0.60**	0.71**					
4	Diversity of Academic Rank	.14	.13	0.55**	0.65**	0.73**				
5	Initiating dialogue	3.40	3.27	0.53**	0.36**	0.42**	0.32**			
6	Sustaining dialogue	.59	1.57	0.41**	0.26**	0.17*	0.24**	0.30**		
7	No. of Different Ideas	1.73	1.98	0.68**	0.55**	0.63**	0.61**	0.65**	0.49**	
8	Issue Resolution	NA	NA	0.38**	0.26**	0.21**	0.25**	0.37**	0.44**	0.41**

N=142
*p<0.05, **p<0.01

4.1. Validity

We analyzed the validity of the interaction measures using factor analysis with varimax rotation. We obtained two factors that explained 73 percent of the total variance. The highest eigenvalue was 3.365 and the lowest was 1.79. No items cross-loaded on the other dimensions at a level higher than 0.33. Overall, the results support the two-dimension solution in our model of online interaction structure as consisting of initiating dialogue and sustaining dialogue.

4.2. Hypothesis and Model Testing

Since our study includes count and dichotomous dependent variables, we used OLS and logistic regression techniques to test our hypotheses. Because our study hypothesizes that the two interaction structure variables contribute to effective collaboration over and above the individual resource and participant diversity variables studied in the literature, we entered the variables in multiple stages in our models. The resulting models for the two dependent variables, number of different ideas in the thread and acknowledgments of issue resolution are presented in Tables 4 and 5.

Model 1 in Table 4 represents the base model with diversity measures of individual resource and participant variables, which include tenure, previous participation, and academic rank of the members. We entered these variables into the regression model as a set. The resulting adjusted R^2 of the model was 54 percent and statistically significant, although the individual variables were not significant, except for diversity of previous participation. Therefore, Hypothesis 1, which predicted that the traditional factors of individual member resources and diversity would be associated with effectiveness of collaboration, receives little support when effectiveness is operationalized as the number of different ideas proposed in the thread.

Table 4: Regression Results for number of different ideas in the thread

	Model 1	Model 2	Model 3	Model 4
Control Variables				
Thread Volume (LN)	.42***	.26***	.30***	.17*
Resources				
Diversity of Tenure	.07	.045	.02	.007
Diversity of Previous Participation	.17*	.11	.25**	.18*
Diversity of Academic Rank	.20	.24**	.18*	.21**
Interaction Structure				
Initiating Dialogue		.38***		0.34***
Sustaining Dialogue			.27***	0.22***
Model Statistics				
N	142	142	142	142
R-Square	0.55	.66	.62	0.69
Adjusted R-Square	0.54	.64	.60	0.68
F	43.22***	52.19***	43.90***	52.13***
∆ R-Square from base model		.11	.07	.14

*p<0.05, **p<0.01, ***p<0.001

Models 2 and 3 in Table 4 show the results of testing whether initiating and sustaining dialogue matter in addition to and apart from the traditional resource and participant diversity factors. First, in Model 2, we entered the initiating dialogue variable in addition to the resource and diversity variables in Model 1. The results provide strong support for Hypothesis 2 (R^2=0.66, R^2_{adj}=0.64, Model F =52.19, p<0.001). Second, in Model 3, we entered the sustaining dialogue variable in addition to the resource and diversity variables in Model 1. The results provide strong support for Hypothesis 3 (R^2=0.62, R^2_{adj}=0.60, Model F=43.90, p<0.001). Finally, in Model 4, we ran a model that included all the diversity variables and the interaction structure variables together. Again, the results provide strong support for Hypotheses 2 and 3 (R^2=0.69, R^2_{adj}=0.68, Model F=52.13, p<0.001). The coefficients for the individual characteristics variables are significant for previous participation and academic rank in the full model.

In the next set of models, we operationalized our dependent variable as a binary variable, indicating whether the questioner acknowledged that his or her question had been answered or that his or her issue had been resolved. The logistic regression results for the questioner's acknowledgement of issue resolution are presented in Table 5. We followed the same methodology that we followed for the previous sets of models in the regression for the first dependent variable. The traditional factors

model is shown in Model 1, including the diversity measures of individual-level resources. It has a likelihood ratio of 26.55 and is statistically significant. However, none of the coefficients for the variables in this model is significant. Next, we tested whether initiating and sustaining dialogue variables are associated with effectiveness of collaboration, over and above the traditional factors. First, in Model 2, we entered the initiating dialogue variable in addition to the resource and diversity variables in Model 1. The overall model is significant; however, the initiating dialogue variable is only significant at the level of p<0.10. Second, in Model 3, we entered the sustaining dialogue variable in addition to the resource and diversity variables in Model 1. The results provide strong support for Hypothesis 3 (likelihood ratio = 32.50 and significant). Finally, in Model 4, we ran a model that included all the diversity variables and the interaction structure variables together. Again, the results provide strong support for Hypotheses 2 and 3 (likelihood ratio = 38.54 and significant).

Table 5: Logistic regression results for issue resolution

	Model 1	Model 2	Model 3	Model 4
Control Variables				
Thread Volume (LN)	1.12***	.98**	.79*	.52
Resources				
Diversity of Tenure	4.02	4.01	2.98	2.7
Diversity of Previous Participation	-1.74	-2.44	-.60	-1.35
Diversity of Academic Rank	1.79	1.77	1.04	.83
Interaction Structure				
Initiating Dialogue		.20+		0.09*
Sustaining Dialogue			.45**	0.56*
Model Statistics				
N	142	142	142	142
LR chi2	26.55	30.52	32.50	38.54
df	4	5	5	6
Pseudo R-Square	0.21	0.24	0.26	0.31
p	0.00	0.00	0.00	0.00

+p<0.10, *p<0.05, **p<0.01, ***p<0.001

5. Discussion

Researchers have observed that not all electronic networks perform the same in promoting learning among participants. It has been suggested that, even though most distributed communities provide access to useful resources, some are better at promoting learning among knowledge workers, depending on how "their electronic environments are structured and, more importantly, on how participants manage their interaction processes" (DeSanctis et al. 2003). In this study, we explored the interaction processes that allow members in electronic networks to collaborate effectively and achieve greater learning. Currently, very little is known about the processes that lead to successful collaboration in discussions in electronic networks. We proposed the variables of initiating and sustaining dialogue to explore these processes and hypothesized that such interaction in discussion threads predicts the effectiveness of collaboration. We analyzed more than 500 messages covering a six-month period in one online network, using content analysis data from the messages as well as demographic and diversity data for the participants.

5.1. Discussion of Results

In this study, we argued that in the context of threaded discussions in practice-based electronic networks, the presence of diverse expertise (which we label the individual resources and participant diversity hypothesis) is not enough to lead to effective collaboration in suggesting ideas and solutions for the questions raised in the threads. We argued that two dimensions that structure interaction predict the effectiveness of collaboration over and above the presence of expertise in the threads. To test this argument, we ran two separate analyses for the two independent variables—a regression

analysis for the number of different ideas in the thread and a logistic regression analysis for the questioner's acknowledgement that the issue had been resolved. Both analyses show that the proposed variables are significant and that the addition of these variables improves model statistics. This provides strong support for our main argument that interaction structure matters over and above individual resource and participant diversity.

We found some support for the individual resources and diversity hypothesis when the dependent variable is operationalized as the number of different ideas in the thread, but not when it is operationalized as the questioner's acknowledgement that the issue had been resolved. Specifically, diversity of previous participation appears to be important for the number of ideas generated in the thread. We think that this can be explained as follows: When only the participants with longer experience with the group, as measured by a higher number of lifetime posts to the network, are included in the conversation, a significant degree of common knowledge is assumed, resulting in only the most significant ideas being contributed to the thread. When there is strong perspective making in the community due to a long shared history, much information may not have to be made explicit. On the other hand, when the conversation includes members who do not share a long history of participation in the group and may not be familiar with past debates and conversations, there is a greater need for the more experienced participants to clarify issues and make explicit suggestions.

In the base model that predicted that the number of different ideas in the thread would be determined by diversity variables, academic rank was not found to be significant. However, in the models where interaction variables are included, academic rank does predict the number of different ideas in the thread. We think that a similar argument can be made for this finding. When there is a mix of expertise in the group, as represented by the different academic ranks of members, those with less expertise may ask clarification questions that elicit more ideas, resulting in greater and deeper interaction. We think that this is the reason that academic diversity is only significant in the presence of such interaction. To put it another way, deeper interaction may be a precondition for members with diverse academic expertise to collaborate effectively and generate ideas. A similar argument can be made for a related finding — diversity of previous participation is significant in the presence of sustaining dialogue but not in the presence of initiating dialogue alone. When participants in the thread vary in their previous experience with the group, there are a greater number of clarification questions and references to other posts.

5.2. Contributions

Our study makes two primary contributions. First, we highlight the importance of focusing on collaboration practices in the discussions in electronic networks. Traditionally, the literature on knowledge work in electronic networks focused principally on how the characteristics of the participants were related to the generation of useful responses. Therefore, previous studies have focused on understanding how a greater number of responses can be generated from participants in electronic networks. For example, research has found that weak ties often contribute useful advice to electronic networks (Constant et al. 1996). In this view, once the individuals with the expertise to provide the solution are identified, their contribution is itself assumed to be unproblematic. While this may be true in situations where the problem being addressed is relatively trivial or where there is considerable homogeneity in the group, we suggest that in the context of groups with diverse membership who face complex, unusual, or unclear problems, the nature of the participants' engagement is at least as important as the expertise of the contributing individuals (Faraj and Xiao 2006). We suggest that even after individuals with the right expertise are recruited to work on the solution to a problem, the nature of their interaction determines the effectiveness of the collaboration.

Our second contribution is unpacking the concept of online collaboration practices by revealing its constituent dimensions of initiating dialogue and sustaining dialogue and providing an empirical test for the importance of these components to the effectiveness of collaboration. Our study is one of the first to explore this aspect of the structure of online collaboration. In the context of electronic networks, these specific behaviors are used to structure effective collaboration. Just as organizational routines provide templates for repeatable action to achieve organizational tasks (Feldman and

Pentland 2003), so too do these dimensions provide a template for repeatable virtual interaction to perform knowledge work online. Furthermore, these dimensions represent a distinctive characteristic of the way in which knowledge work is organized in a virtual, practice-based, and voluntary setting using a specific technology. In this context, the virtual interaction among members is patterned such that the degree of problem-related, situational, and historical contextual details provided in the seed message play an important role in enrolling the expertise in the network to collaborate on a specific, often unusual, problem. Other members choose to participate in the collaborative effort and decide whether the details provided are sufficient and interpretable. For complex issues, the degree to which the participants seek clarification, ask follow-up questions, and explicitly refer to other parts of the conversation predicts how successful this temporary collaboration within a thread will be in suggesting ideas and solutions. Just as the processes used to accomplish work in traditional settings have been investigated, the structures used to accomplish work in online settings need to be studied. We provide the initial step in that direction.

5.3. Limitations and Future Research

Our research has some limitations. First, our study is based on data from one online network and, therefore, the generalizability of the findings is limited. Admittedly, our choice of this listserv was a convenience sample—we selected this forum since it exemplifies the kinds of knowledge creation contexts we are interested in studying, involving "deep discussions." Future research could extend these results to different types of electronic networks that may show very different member behavior. We may find that larger electronic networks show fewer deep interactions in their discussions, with different implications for their outcomes. Second, our study proposes new constructs for the structure of interaction in electronic networks. Although we have verified the validity of these dimensions, future research could confirm these findings in different online settings.

The group from which we have drawn our sample thread data has some unique characteristics that should also be acknowledged for their implications. Even among professional practice-based networks, this network stands out, both for the complexity of the topics discussed and the related issue of the way in which they are discussed. First, since this group is an academic listserv, the issues draw on significant accumulated research and involve deep expertise of methodological issues, in contrast to, say, a forum related to knowledge management technologies. Therefore, the higher complexity may mean that initiating and sustaining dialogue have greater effect on successful outcomes in this sample than in others. Reduced complexity in other forums may also mean fewer discussions involving non-routine information (Majchrzak et al. 2005b), thereby increasing the importance of the availability of expertise alone, relative to collaboration processes. In addition, many members of this network also gather for an annual conference. While a large percentage of the group may be strangers to each other, there is a core group that has greater familiarity with each other and may reiterate group norms about being helpful and staying focused on the issues with their active participation. In groups where members have less offline familiarity with each other, participation may be more diffuse and discussions less focused. Such samples may offer greater variation and, therefore, opportunities for more accurate testing of the hypotheses proposed here.

Although electronic networks have been classified into different types based on various characteristics (Sproull 2004), sufficient attention has not been paid to how they differ in collaboration practices. In the only study to do this, DeSanctis et al. (2003) note that some online communities are closely related to practice and differentiate themselves by engaging in collaboration practices such as dense dialogue, deep discussion and sense-making. Such collaboration practices are yet to be studied in the research on electronic networks. We have taken an initial step by examining the structure of such collaboration processes. Although prominent examples such as Wikipedia have made the concept of online collaboration popular, research into the details has been lacking. While online collaboration is often painted with a broad brush, we would argue that differing contexts of technology and local situated practices make it necessary to examine them in their specific contexts. There is a need to investigate the kinds of collaboration practices employed in other kinds of forums and in entirely different technological contexts, such as wikis and blogs.

6. Conclusion

In conclusion, although there has recently been significant interest in examining knowledge work in electronic networks, this study is one of the first to focus attention on the importance of group collaboration to the creation of knowledge in electronic networks. In doing so, we depart from the focus on individual resources and diversity that has been predominant in the literature. The development of new kinds of electronic networks such as blogs and wikis, which may involve thousands of members, shows the need for varied approaches to investigate the large-scale, polyphonic nature of technology-enabled communication in the creation of knowledge. This study provides a starting point by suggesting two dimensions that structure online interaction to study collaboration in these settings, and investigates the importance of this concept for discussions in electronic networks.

References

Abrams, D., Hogg, M. A., Hinkle, S., and Otten, S. 2005. "The Social Identity Perspective on Small Groups," in: *Theories of Small Groups: Interdisciplinary Perspectives,* M.S. Poole and A.B. Hollingshead (eds.). Sage Publications.

Bakhtin, M. M. 2004. *The Dialogic Imagination: Four Essays*. Austin, TX: University of Texas Press.

Belsley, D. A., Kuh, E., and Welsch, R.E. 1980. *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity* New York: John Wiley & Sons.

Boh, W. F., Ren, Y., Kiesler, S., and Bussjaeger, R. 2007. "Expertise and Collaboration in the Geographically Dispersed Organization," *Organization Science* (18:4), p 595.

Boland, R. J., and Tenkasi, R.V. 1995. "Perspective Making and Perspective Taking in Communities of Practice," *Organization Science* (6:4).

Brown, J. S., and Duguid, P. 2001. "Knowledge and Organization: A Social-Practice Perspective.," *Organization Science* (12:2), pp 198-213.

Butler, B. S. 2001. "Membership Size, Communication Activity, and Sustainability: A Resource-Based Model of Online Social Structures," *Information Systems Research* (12:4), Dec, pp 346-362.

Capozzoli, M., McSweeney, L., and Sinha, D. 1999. "Beyond Kappa: A Review of Interrater Agreement Measures," *The Canandian Jounal of Statistics* (27:1), pp 2-23.

Churchill, E.F., Snowdon, D.N., and Munro, A.J. (eds.). 2001. *Collaborative Virtual Environments: Digitial Places and Spaces for Interaction*. New York: Springer-Verlang.

Clark, H.H., and Brennan, S.E. 1991. "Grounding in Communication," in: *Perspectives on Socially Shared Cognition,* L. Resnick, J. Levine and S. Teasley (eds.). Hyatsville, MD: American Psychological Association, pp. 127-149.

Constant, D., Sproull, L., and Kiesler, S. 1996. "The Kindness of Strangers: The Usefulness of Electronic Weak Ties for Technical Advice," *Organization Science* (7:2), Mar/Apr 1996, pp 119-135.

Corman, S. R. and M. S. Poole. 2000. *Perspectives on Organizational Communication: Finding Common Ground*. New York: The Guilford Press.

Cramton, C.D. 2001. "The Mutual Knowledge Problem and Its Consequences for Dispersed Collaboration," *Organization Science* (12:3), pp 346-371.

Cummings, J.N., Butler, B., and Kraut, R. 2002. "The Quality of Online Social Relationships," *Communications of the ACM* (45:7).

DeSanctis, G., Fayard, A.L., Roach, M., and Jiang, L. 2003. "Learning in Online Forums," *European Management Journal* (21:5), pp 565-577.

DeSanctis, G., and Monge, P.R. 1999. "Communication Processes for Virtual Organizations," *Organization Science* (10:6), pp 693-703.

DeSanctis, G., Wright, M., and Jiang, L. 2001. "Building a Global Learning Community," *Communications of the ACM* (44:12), pp 80-82.

Faraj, S., and Xiao, Y. 2006. "Coordination in Fast Response Organizations," *Management Science* (52:8), pp 1155-1169.

Fayard, A.-L., and DeSanctis, G. 2005. "Evolution of an Online Forum for Knowledge Management Professionals: A Language Game Analysis," *Journal of Computer-Mediated Communication*

(10:4).
Feldman, M.S., and Pentland, B.T. 2003. "Reconceptualizing Organizational Routines as a Source of Flexibility and Change," *Administrative Science Quarterly* (48), pp 94-118.
Fulk, J. and G. DeSanctis. 1995. "Electronic Communication and Changing Organizational Forms," *Organization Science* (6) 4, pp. 337-349.
Galegher, J., L. Sproull, and S. Kiesler. 1998. "Legitimacy, authority, and community in electronic support groups," *Written Communication* (15) 4, pp. 493-530.
Granovetter, M. 1973. "The Strength of Weak Ties," *American Journal of Sociology* (78), pp 1360-1380.
Gray, B. 1989. "Collaboration: The Constructive Management of Differences," *Collaborating: finding common ground for multiparty problems*).
Griffith, T.L., Sawyer, J.E., and Neale, M.A. 2003. "Virtualness and Knowledge in Teams: Managing the Love Triangle of Organizations, Individuals, and Information Technology," *MIS Quarterly* (27:2), pp 265-287.
Hardy, C., Lawrence, T.B., and Grant, D. 2005. "Discourse and Collaboration: The Role of Conversations and Collective Identity," *Academy of Management Review* (30:1), pp 58-77.
Jones, Q., G. Ravid, and S. Rafaeli. 2004. "Information Overload and the Message Dynamics of Online Interaction Spaces: A Theoretical Model and Empirical Exploration," *Information Systems Research* (15) 2, pp. 194-210.
Kiesler, S., and Cummings, J.N. 2002. "What Do We Know About Proximity and Distance in Work Groups? A Legacy of Research," in: *Distributed Work,* P. Hinds and S. Kiesler (eds.). Cambridge, MA.: MIT Press.
Kraut, R., C. Steinfield, A. Chan, B. Butler, and A. Hoag. 1999. "Coordination and Virtualization: The Role of Electronic Networks and Personal Relationships," *Organization Science* (10) 6, pp. 722-740.
Kraut, R.E., Fussell, S.R., Brennan, S.E., and Siegel, J. 2002. "Understanding Effects of Proximity on Collaboration: Implications for Technologies to Support Remote Collaborative Work," in: *Distributed Work,* P. Hinds and S. Kiesler (eds.). Cambridge, MA.: MIT Press.
Krippendorff, K. 1980. *Content Analysis: An Introduction to Its Methodology*. Beverly Hills: Sage Publications.
Kuhn, T. 1970. *The Structure of Scientific Revolutions, Second Edition*. Chicago: The University of Chicago Press.
Kuk, G. 2006. "Strategic Interaction and Knowledge Sharing in the Kde Developer Mailing List," *Management Science* (52:7), pp 1031-1042.
Lakhani, K. and E. von Hippel. 2003. "How Open Source software works: "free" user-to-user assistance," *Research Policy* (32) 6.
Lee, G.K., and Cole, R.E. 2003. "From a Firm-Based to a Community-Based Model of Knowledge Creation: The Case of the Linux Kernel Development," *Organization Science* (14:6), Nov/Dec, p 633.
Levina, N. 2005. "Collaborating on Multiparty Information Systems Development Projects: A Collective Reflection-in-Action View," *Information Systems Research* (16:2), pp 109-130.
Levina, N., and Vaast, E. 2006. "Turning a Community into a Market: A Practice Perspective on Information Technology Use in Boundary Spanning," *Journal of Management Information Systems* (22:4), pp 13-37.
Lewis, D.D., and Knowles, K.A. 1997. "Threading Electronic Mail: A Preliminary Study," *Information Processing and Management* (33:2), pp 209-217.
Majchrzak, A., Beath, C.M., Lim, R.A., and Chin, W.W. 2005a. "Managing Client Dialogues During Information Systems Design to Facilitate Client Learning," *MIS Quarterly* (29:4), pp 653-672.
Majchrzak, A., Malhotra, A., and John, R. 2005b. "Perceived Individual Collaboration Know-How Development through Information Technology-Enabled Contextualization: Evidence from Distributed Teams," *Information Systems Research* (16:1), pp 9-27.
McPhee, R. D. and M. S. Poole. 2001. "Organizational Structures and Configurations," in F. M. Jablin and L. Putnam (Eds.) *The New Handbook of Organizational Communication: Advances in Theory, Research, and Methods*: Sage Publications Inc.
Moon, J.Y. and Sproull, L. 2000. "Essence of Distributed Work: The Case of the Linux Kernel," *First Monday* (5:11), November.

Morson, G.S., and Emerson, C. 1990. *Mikhail Bakhtin: Creation of a Prosaics*. Stanford: Stanford University Press.

Nardi, B. A. and S. Whittaker. 2002. "The Place of Face-to-Face Communication in Distributed Work," in P. Hinds and S. Kiesler (Eds.) *Distributed Work*, Cambridge, MA: MIT Press.

Olson, J. S., S. Teasley, L. Covi, and G. Olson. 2002. "The (Currently) Unique Advantages of Collocated Work," in P. Hinds and S. Kiesler (Eds.) *Distributed Work*, Cambridge, MA: MIT Press.

Preece, J. 2000. "What Is an Online Community," in: *Online Communities: Designing Usability and Supporting Sociability,* J. Preece (ed.). New York, NY: John Wiley & Sons, pp. 8-19.

Putnam, L. L. and G. T. Fairhurst. 2001. "Discourse Analysis in Organizations: Issues and Concerns," in F. M. Jablin and L. Putnam (Eds.) *The New Handbook of Organizational Communication: Advances in Theory, Research, and Methods*: Sage Publications Inc.

Reagans, R., and Zuckerman, E.W. 2001. "Networks, Diversity, and Productivity: The Social Capital of Corporate R&D Teams," *Organization Science* (12:4), pp 502-517.

Schultze, U. and W. J. Orlikowski. 2004. "A Practice Perspective on Technology-Mediated Network Relations: The Use of Internet-Based Self-Serve Technologies," *Information Systems Research* (15) 1, pp. 87-106.

Sproull, L. 2004. "Online Communities," in: *The Internet Encyclopedia,* H. Bidgoli (ed.). John Wiley & Sons.

Sproull, L. S. and S. B. Kiesler. 1991. *Connections: New ways of working in the networked organization*. Cambridge, MA: The MIT Press.

Stahl, G., Koschmann, T., and Suthers, D. 2006. "Computer-Supported Collaborative Learning: An Historical Perspective," in: *Cambridge Handbook of the Learning Sciences,* K. Sawyer (ed.). New York: Cambridge University Press, pp. 409-426.

Tyre, M.J., and von Hippel, E. 1997. "The Situated Nature of Adaptive Learning in Organizations," *Organization Science* (8:1), pp 71-83.

Van der Vegt, G.S., and Bunderson, J.S. 2005. "Learning and Performance in Multidisciplinary Teams: The Importance of Collective Team Identification " *The Academy of Management Journal* (48:3), pp 532-547.

van Knippenberg, D., De Dreu, C.K., and Homan, A.C. 2004. "Work Group Diversity and Group Performance: An Integrative Model and Research Agenda," *Journal of Applied Psychology* (89:6), pp 1008-1022.

Wagner, C., and Majchrzak, A. 2007. "Enabling Customer-Centricity Using Wikis and the Wiki Way," *Journal of Management Information Systems* (23:3), pp 17-43.

Wasko, M.M., and Faraj, S. 2005. "Why Should I Share: Examining Social Capital and Knowledge Contribution in Electronic Networks of Practice," *MISQ* (29:1), pp 35-47.

Weber, R.P. 1990. *Basic Content Analysis*. Sage Publications.

Yates, J.A., Orlikowski, W.J., and Woerner, S.L. 2003. "Virtual Organizing: Using Threads to Coordinate Distributed Work," *Proceedings of the 36th Annual Hawaii International Conference on System Sciences, 2003.*), p 10.

Zammuto, R.F., Griffith, T.L., Majchrzak, A., Dougherty, D.J., and Faraj, S. 2007. "Information Technology and the Changing Fabric of Organization," *Organization Science* (18:5), pp 749-762.

Appendix A: Constructs and their Operationalization

Construct/ Dimension	Measures	Operationalization
Resource and Participant Diversity	Diversity of Tenure in the Thread	Gini index of Tenure. Tenure is number of months in the group.
	Diversity of Rank in the Thread	Gini index of Rank . Rank is an ordered variable (1-Other, 2-Student, 3-Asst. Prof., 4-Asso. Prof., 5-Prof.)
	Diversity of Previous Participation in the Thread	Gini index of previous participation. Previous participation is measured as total number of posts contributed over the lifetime of membership.
Initiating Dialogue	Issue Details	The extent to which questioner describes the problem. (Five-point scale – very low to very high)
	Search Details	The extent to which questioner describes the attempts to search for a solution. (Five-point scale – very low to very high)
	Situational Details	The extent to which questioner provides situational details – involving time and place. (Five-point scale – very low to very high)
Sustaining Dialogue	Ask for Clarification	Whether participant asks for clarification (0, 1)
	Reference to others' posts	Whether participant refers to what the person has said in other posts within the thread (0, 1)
	Follow Up Question	Whether questioner asks follow up questions (0,1)
	Reference to disciplinary issues	Whether participant refers to someone else's disciplinary affiliation (0,1)
Effectiveness of Collaboration	Number of different ideas suggested in the thread	Count Variable
	Questioner acknowledges Resolution of issue	Binary Variable

About the Authors

Srinivas Kudaravalli is a Doctoral Candidate in the Smith School of Business at the University of Maryland. He has more than a decade of IT consulting experience with public and private sector organizations. His research interests relate to the role of information technology in distributed knowledge work, online communities and social networks. His work has been presented at several conferences where it has been nominated for or won awards.

Samer Faraj holds the Canada Research Chair in Technology, Management & Healthcare. He joined the Desautels Faculty of Management at McGill University in 2007. Previously, he was associate professor at the Smith School of Business at the University of Maryland. His current research interests include: how IT transforms work and the provision of health care, the coordination of expertise in settings such as trauma care and software development teams, and the participation dynamics of online knowledge communities. He is currently senior editor at *Organization Science* and serves on the editorial board of the *Journal of AIS* and *Information and Organization*.

Journal of the Association for Information Systems

ISSN: 1536-9323