ABSTRACT

Title of Dissertation:	IMPACT OF LEADERSHIP ON CONTINUED PARTICIPATION IN ONLINE GROUPS
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Online groups formed by volunteer members are increasingly recognized as sources of innovative ideas, as producers of information goods, and as a critical component for successful product marketing. Compared to formal organizations, online groups appear as anarchic collections of individuals largely devoid of formal authority. Yet online groups develop strong group norms, successfully generate information goods, and satisfy member needs—outcomes that seem impossible without some form of leadership by influential members. Research on open-membership voluntary online groups has consistently found that contribution to online groups is dominated by a small percentage of participants. The goal of this research is to better understand the role of leadership in online groups and to evaluate the impact of leadership in maintaining online groups by supporting continued participation intentions of existing members.

I explored three related questions regarding leadership in online groups. First, does member interaction with group leaders contribute to continued participation intentions over and above a model based on past participation? Second, do shared context and direct communication with leaders impact continued participation intentions? And third, do group characteristics—group psychological safety, group size, and perceived number of leaders—moderate the relationship between group members and group leaders? I collected 535 survey responses from members of thirty-three different online groups (average of sixteen members per group) and also analyzed group communication history (a total of 135,477 messages). This cross-level analysis furthers our understanding of the relationship between interaction with group leadership, psychological safety, participation role intentions, and turnover intentions.

I found that leadership in online groups is a determinant of online group outcomes. Online group leaders shape the group context, including psychological safety, which encourages or discourages participation. This study shows that leadership processes, group context, and differentiation among dimensions of participation intentions are all important considerations for further understanding of online groups.

IMPACT OF LEADERSHIP
ON CONTINUED PARTICIPATION IN ONLINE GROUPS

By

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Chapter 1: Introduction

The success of open, voluntary, mass collaboration in the production of complex knowledge goods creates both new opportunities and new threats for businesses. Firms are struggling with both how to tap the wisdom of crowds (Surowiecki, 2004) and with how to address the competitive threat of "smart mobs" (Rheingold, 2006). Organizations find that key initiatives are increasingly dependent upon the voluntary contributions of employees and, more critically, non-employees, in the relative anonymity of online settings. For example, intra-, inter-, and extra-organizational networks of practices support (respectively) internal knowledge management initiatives (Wasko & Faraj, 2000), partner communication networks, and industry share groups to serve as sources of competitive advantage through the creation and diffusion of innovation (Alavi, 2000; Hansen, 2002; Lee & Cole, 2003; Tsai, 2001). Once a product is brought to market, potential customers look to online groups for ratings and reviews (Dellarocas, 2003). Post-purchase, questions posted on online technical support forums are more likely to be answered by other customers than by company employees (Microsoft and Dell are two prominent examples). Furthermore, brand-loyal customers who join together in interest groups are critical company assets (Chen & Hitt, 2003). In short, the voluntary participants of online groups can have a major impact on organizational success.

As more attention is focused on the phenomena of online groups, authors are articulating in greater detail how online groups challenge long-held assumptions. Whereas innovation, production, and collaboration have traditionally been assumed to be the providence of small closely knit teams, they can now occur on a mass, global scale. Wikipedia, the online encyclopedia that anyone can edit, is one example of how the once

clear boundaries of mass production by organizations and mass consumption by consumers are now blurred (Tapscott & Williams, 2006). For example, 36 percent of Internet users in the United States having accessed the Wikipedia Web site (Rainie & Tancer, 2007).

Wikipedia, blogs, open source projects, and other mass collaboration by online groups are enabled by non-hierarchical decentralized leadership structures (Brafman & Beckstrom, 2006). As Benkler (2006) advocates in The Wealth of Networks, the unique features of networked computer technology afford new forms of organizing. He challenges the traditional assumption that either markets or hierarchies (firms) are the most efficient method of allocating resources. Instead, Benkler argues "emerging patterns of non-market individual and cooperative social behavior… are internally sustainable… increase information economy productivity… [and] offer defined improvements in autonomy, democratic discourse, cultural creation, and justice" (Benkler, 2006, p. 379). Online groups are changing not just what people do, but also who is doing it, and how they do it.

Despite the recent attention in business and in the general press for successful online endeavors such as Wikipedia and open source software, online group collaboration is not a recent phenomenon. From the earliest days of the Internet, preceding even the World Wide Web, individuals have voluntarily collaborated in open online settings to share their experiences with one another, collaboratively solve complex problems, and jointly generate knowledge (Moon & Sproull, 2002; Rheingold, 1993).

Yet, despite the strong interest in and widespread attention to this phenomenon, fundamental questions remain regarding online groups. What are online groups? What is

an effective online group? What does it mean to be a leader in an online group? In this introduction, we address these questions while outlining our research project. The objective of this project is to better understand the impact of group processes, particularly how online group leadership behaviors influence an individual's continued participation intentions in the group. In the next section we address the questions raised above, describe our research model, and describe the research design and data analysis methods. We first address the scope of our research.

What Are Online Groups?

Over multiple decades researchers have adopted multiple terms, each with different theoretical emphasis, for the study of computer-mediated collective action. These terms include: *electronic group* (Finholt & Sproull, 1990), *virtual community* (Rheingold, 1993), *online communities* (Preece, 2000), *electronic communities of practice* (Wasko & Faraj, 2000), *online social structures* (Butler, 2001), *asynchronous learning networks* (Aviv, Erlich, Ravid, & Geva, 2003), *online interaction spaces* (Jones, Ravid, & Rafaeli, 2004), *electronic networks of practice* (Wasko & Faraj, 2005), and *knowledge networks* (Bush & Tiwana, 2005). In this paper we adopt the term *online groups* not only to encompass a broad range of online collectives but also to specifically distinguish them from the phenomena of virtual teams and online communities. Furthermore, we precisely define online groups to avoid the confusion created by inconsistent usage of similar terms.

As we discuss further in the next chapter, we believe that existing theoretical developments and empirical evidence from distributed work and online community research serve as a useful starting point for the understanding of online groups. Still, we

see online groups as a related, yet distinct phenomenon from virtual teams and online communities. Next we define, compare and contrast these three phenomena: online groups, virtual teams and online communities.

We define *online groups* as voluntary collectives of individuals that meet the following criteria:

i. participants share common interests,
ii. group interaction is predominantly or exclusively online and asynchronous,
iii. group membership is voluntary, unrestricted, and open-ended,
iv. participation is clearly visible, allowing individuals to accurately identify participation status, and
v. the collective is recognized as a group by outside observers,

In this definition the key differences with *virtual teams* are in items *i* and *iii*; the areas of overlap are in *ii*, *iv* and *v*. In addition to the above criteria (*i* through *iv*) *online communities* also cross a higher threshold of group identification where members form emotional connections and participants consider themselves as a social group. In short, online communities are a special case of online groups.

Whereas *virtual teams* engage in distributed work with shared outcomes and interdependent tasks (Cohen & Bailey, 1997), online groups represent a more loosely affiliated set of individuals. Likewise, whereas definitions of *online community* typically stress a felt sense of community encompassing close relationships including belonging, influence, needs fulfillment and emotional connections (Blanchard, 2004; Blanchard & Markus, 2004), our definition of online groups covers a wider range of groups regardless of the strength of participant relationships.

Online groups differ from virtual teams engaged in distributed work in other important ways. Virtual teams are situated within a larger organizational setting, have shared outcomes, engage in inter-dependent tasks, and work together within specific time

frames (Cohen & Bailey, 1997). Online groups exist both inside, outside, and across organizational boundaries; members share similar interests but not necessarily similar objectives; online groups do not exist to perform specific tasks and have open-ended time frames.

We view online groups as both a more general category than online communities and one with a different theoretical and practical emphasis. Some researchers in online communities have developed specific criteria for determining when an online group reaches a state of "community." Although it is not the focus of our study, to the extent that the groups we investigate meet the criteria of feelings of membership, feelings of influence, integration and fulfillment of member needs, and shared emotional connections among participants they could also be considered online communities (Blanchard, 2004; Blanchard & Markus, 2004). More generally, our study is concerned with online groups engaged in complex knowledge sharing and less focused on the relational aspects of online interactions that the online community literature typically emphasizes.

What is an Effective Online Group?

Much as researchers have explored multiple dimension of organizational Information Systems success (DeLone & McLean, 1992; DeLone, 2003), researchers of online groups have explored numerous outcomes (Butler, 2001; Constant, Sproull, & Kiesler, 1996; Cothrel, 2000; Preece, 2000; Wasko & Faraj, 2000). In this study, we study antecedents, moderators, and multiple dimensions of continued participation intentions in online groups. We view continued participation by existing members as an important outcome for three primary reasons. First, as Joyce and Kraut (2006) note in their careful study of continued participation in news groups, online groups experience

high levels of turnover. Understanding reasons for continued participation (the opposite of turnover) is not only of practical relevance for the sustainability of online groups but it is also an understudied area compared to initial motivation to join groups (Joyce & Kraut, 2006).

Secondly, the importance of studying continued participation as a contributor to the sustainability of online groups stems directly from the on-going open-ended nature of online groups themselves. Unlike virtual teams which have a set period of time to accomplish a set of tasks in support of shared objectives, online groups have no inherent time limits. Online groups provide a platform for individuals to pursue common interests around open-ended, ever-changing topics. For example, participants in an online group focused on a complex knowledge topic like research methods have an endless stream of new topics to discuss (Kudaravalli, 2007).

Finally, continued participation is an important outcome to study in online groups because of the importance of membership continuity in online groups. Although it is conceivable that an online group could survive with a series of one-time participants, such a collective would arguably fail to meet important criteria for the development of group processes. People in line together at a bank or fans at a concert aren't groups, but crowds. Continued participation by *at least some participants* develops and propagates group norms, provides institutional memory, leads to shared mental models and common ground that facilitate knowledge creation and sharing, and generally provide for the shared understanding necessary for positive group processes and outcomes to emerge.

What is Online Group Leadership?

Compared to formal organizations, online groups appear as anarchic collections of individuals largely devoid of formal authority. At the same time, online groups develop strong group norms, successfully produce information goods, and satisfy member needs—outcomes that seem impossible without some form of leadership by influential members. Thus there appears to be a leadership paradox at the heart of online groups. We believe the study of leadership in online groups shares key similarities with traditional leadership but has differential emphasis on behaviors, influence processes, attitudes, and outcomes germane to online groups.

The study of online group leadership is a nascent (Butler, Sproull, Kiesler, & Kraut, 2007; Johnson, 2006; Kudaravalli, Faraj, & Wasko, 2007), yet promising arena for research. The biases of traditional leadership research and theory, stressing a single, heroic leader that exerts unidirectional influence to followers (see Yukl, 2002) are not appropriate for online groups. We adopt Yukl's (2002, p.8) definition that "leadership is the process of influencing others to understand and agree about what needs to be done and how to do it, and the process of facilitating individual and collective efforts to accomplish shared objectives."

We view online group leaders are those that other members recognize either for their expertise in topics of interest or for their influence on the nature of interactions among group members. Online group leadership is a shared process with emergent leaders engaged in a deeply embedded social group process. In this study our focus is on how leadership behaviors support influence processes and resulting member attitudes and behaviors.

Research Model

To investigate the impact of leadership on continued participation intentions in online groups, we incorporate conceptual frameworks, research theories, and empirical results regarding leadership processes, online group participation and communication networks. The simplest answer —and our starting point—for predicting future participation intentions in an online group, is the amount and nature of past participation in an online group. Next, recognizing that participation intentions are also shaped by the influence of group leadership, we add interaction with group leadership to our prediction model. Finally, we consider how group characteristics—structural and emergent group properties—reinforce or substitute for leadership processes. Figure 1 summarizes our research model.
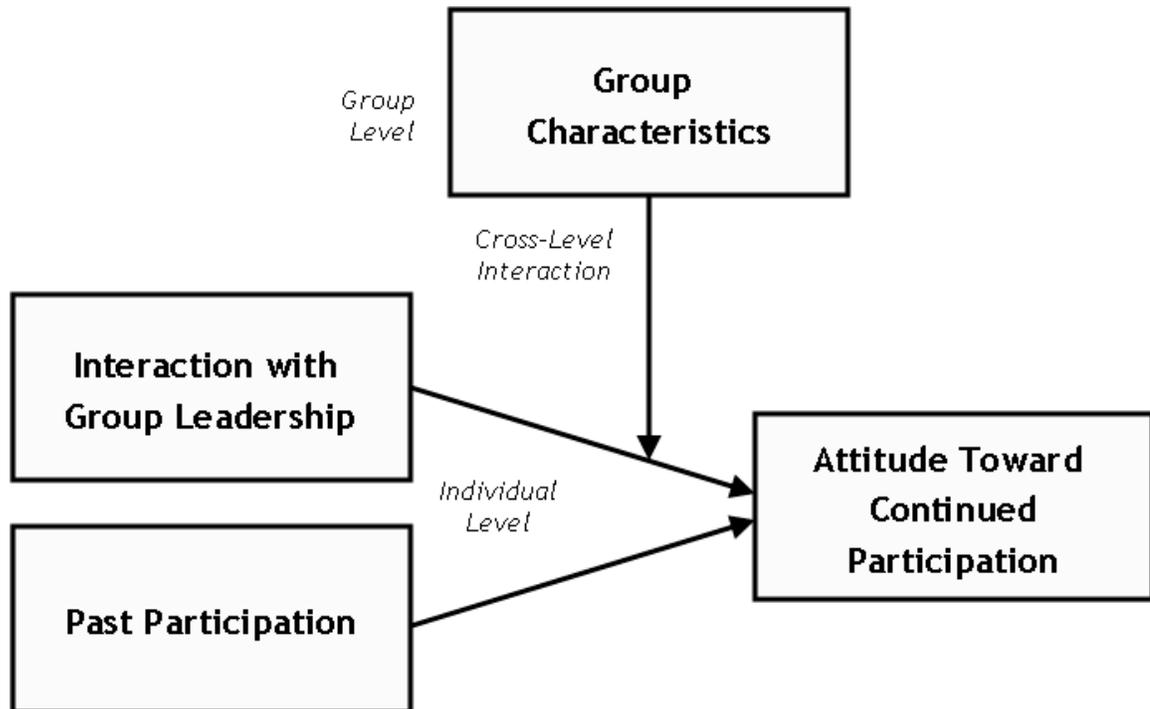
Figure 1: Overview of Research Model

To empirically test these relationships, this study combined data from individual survey data and online archival messages to perform cross-level analyses using hierarchical linear modeling (HLM), a multi-level regression technique. We tested our hypotheses with data from 535 survey responses from members of thirty-three different online groups along with online group communication history spanning 135,477 messages.

Combining a solid theoretical framework with novel, yet rigorous, methods of online data collection and analysis, this dissertation makes three major contributions to the study of online groups. First, it breaks new ground in the under-studied area of leadership in online groups, providing empirical evidence for the impact of group leadership. Second, it establishes group psychological safety as a contextual factor influenced by group leadership, one that impacts individual participation intentions. This demonstrates the importance of a multi-level approach to studying online group participation. Finally, it identifies a clear differentiation between participation role intentions and turnover intentions. All together, the improved understanding of continued participation in online groups provided by this study extends theories of online groups and expands practitioner knowledge of this important phenomenon.

The rest of this dissertation is organized as follows. In Chapter 2 we review literature on the study of online groups. Then, in Chapter 3 we detail our research model and proposed hypotheses. In Chapter 4 we discuss of the study design and data analysis strategy. Next, we present the study results in Chapter 5. Finally, we conclude in Chapter 6 with a discussion of results and summary of our study.

Chapter 2: Online Groups

In this chapter we review literature related to online groups. First, starting from individual participation perspective we summarize literature that addresses the questions regarding involvement in online groups and what motivates individuals to participate. Next, we focus on the online nature of interaction and summarize literature with a technology artifact perspective. Third, we look at online groups from the network perspective. As group members come together to share their knowledge and experiences about common interests in an open, online setting, they use communication networks to generate public information goods. We summarize literature on collective action in generation of private and public goods as well as the new science of networks. Finally, we close with a discussion of the relatively limited amount of group-level research on online groups.

Individual Perspective

Perhaps the largest and most fruitful set of research results related to online groups are studies that have focused on individual differences in involvement in online groups. Indeed, this study begins with the individual level (while also adding cross-level interactions). Coming from a variety of theoretical perspectives, studies that adopt an individual perspective provide a rich picture of both how and why individuals participate in online groups.

Models of individual motivation for involvement in online groups have generally focused on two categories of activities: invisible, passive participation called lurking and more active, visible participation such as providing content. Although these activities

have been considered as different levels of involvement along a continuum of interest

(Ridings, Gefen, & Arinze, 2006; Yeow, Johnson, & Faraj, 2006), empirical studies in

particular usually focus on one or the other. We will discuss the literature on motivation

for the passive activity of lurking first and then move to the active participation of

contributing content.

Peripheral Participation

Lurking is the term used to describe participants who do not visibly participate in

a group (for example, those who read but do not contribute content). Although the term

has been long part of the lexicon of online groups--lurking was a topic in online groups as

far back as the early 1990s (The Well, 1992)--only recently have researchers developed

strong empirical evidence regarding why people choose to peripherally participate in

online groups. Theoretical rationales for lurking are divided into two major schools of

thought (see Yeow et al., 2006). In the first, lurking is an anti-social activity motivated by

free-riding (in economic terms) or loafing (in social terms). In the second, lurking is a

form of legitimate peripheral participation and serves as a valuable initial step in the

socialization process of potential participants. The empirical work of Yeow, et al. (2006)

provides some evidence in support of both views. In their longitudinal analysis of 548

online groups, they found that the negative impact of lurking is more pronounced for

transactional-commercial groups than for relational-interest groups.

Empirical studies of online groups have found that anywhere from 40 percent to

90 percent of online group members restrict their participation to merely reading content

(Mason, 1999; Nonnecke & Preece, 2000). In a study of MSN online discussion boards,

Preece, Nonnecke, and Andrews (2004) identified specific reasons for lurking (defined as

readers who never posted a message). Some lurkers reported that they felt that serving as an audience was enough to be an active participant in the group. Another set felt that they needed to learn more about the group before they felt comfortable posting messages. Others had made up their minds that they either had no intention to contribute (and felt no requirement to do so) or had already achieved the objective from the group and had happily discontinued participation altogether. The last two sets of responses reported by Preece et al. (2004) were those with negative experiences. Some participants did not like the group dynamics and therefore preferred to remain anonymous, while the final set faced technical difficulties that precluded them from posting.

A study by Nonnecke, Preece, Andrews and Voutour (2004) found similar rationale including that lurkers felt reading was enough of a contribution and lurking was a way for newcomers to learn about a group. This provides further support for the idea that lurking contributes to the complex and multi-faceted socialization process in online groups (Ahuja & Galvin, 2003).

In summary, research on lurking shows that participation patterns continue along a continuum of commitment with even long-time members remaining as passive participants. The same impediments to greater levels of active participation in a group may exist for active participants as well. Thus, motivation considerations also remain germane to the consideration of continued participation in online groups.

Individual Motivation to Contribution

What makes an online group attractive for active participation? At a basic level, it needs to hold participant interest. As noted by Preece (2000) "a community will be perceived as worth joining only if there are sufficient people and enough activity to make

it interesting and worthwhile" (p. 171). Wellman and Gulia (1997) argue that the stronger your attachment is to an online group, the more likely you are to participate in that group. Similarly, in a survey of news group participants Wasko and Faraj (2000) found that greater interest in a group increases participation.

In research on organizationally focused online groups one of the primary areas of interest is individual participation motivation related to knowledge sharing outcomes. For example, Wasko and Faraj (2000) combined the analysis of archival messages and collection of participant surveys to understand participant motivations and knowledge sharing outcomes. Other studies have focused strictly on observable individual behaviors in online groups (Joyce & Kraut, 2006). The latter approach is congruent with the view that individual roles within communication networks are a stronger predictor of outcomes than individual characteristics (Ahuja, Galletta, & Carley, 2003).

In research of an online forum for members of a national legal professional association, Wasko and Faraj (2005) studied an online forum and found that a key motivator is the desire to improve professional reputation. Just as a performer will naturally seek a larger audience, this reputation motivation suggests that all else being equal larger groups are more desirable than smaller ones.

Wasko and Faraj (2005) also found that many participants believe in norms of reciprocity. Reciprocity refers to the idea that if someone provides you with something of value, you owe that person something back directly in return. The norm of direct reciprocity identified by Wasko and Faraj (2005) is just one type of social exchange norm. Indirect reciprocity, also referred to as generalized exchange, occurs when a favor is returned to a third-party ("pay it forward") instead of directly back to the original

favor-provider (Ekeh, 1974; Flynn, 2005). In a study of two year's history of communication in six technology-focused online groups, Faraj and Johnson (2005) found evidence of both reciprocity and generalized exchange norms. A common outcome of both reciprocity and generalized exchange–webs of social exchange involving obligation formation and obligation fulfillment–is that interaction begets even more interaction.

In a study of knowledge contributions to a practice-oriented online group supporting a professional legal organization, Wasko & Faraj (2005) found that the amount of participation increased for members with higher centrality, longer tenure in the field, and a greater inclination toward reciprocity. Kankanhalli, Tan, & Kwok-Kee (2005) found that members with higher expectations of organization rewards, with higher knowledge self-efficacy, and who had increased levels of enjoyment in helping others were more likely to make contributions to an electronic knowledge repository.

Constant, et al. (1996) found that information provided through weak ties—ties from other knowledge-sharing participants with backgrounds dissimilar to the information seeker—did in fact provide useful information. Consistent with this perspective of social creation of knowledge, larger communication networks with more active participants are more valuable than smaller ones.

Together, these studies provide a multi-faceted view of participation motivation to contribute to online groups. One commonality is that participation begets participation. The more frequently a participant has contributed to a group in the past or the longer he or she has been a member, the more likely is active participation in the future.

Technology Artifact Perspective

Unsurprisingly, an area of great interest in the study of online groups is the nature of being online. Some of the earliest studies related to online groups focused on technology mediation and technology characteristics. This technology artifact perspective remains germane to our study of online groups by informing the scope of our inquiry and helping to identifying potential sources of both desirable and undesirable variation for the empirical study design. A solid understanding of research that adopts the technology artifact perspective is also necessary for accurately assessing how prior research in myriad related technology-supported settings may (or may not) apply to the setting of interest in this study.

We discuss four categories of research that give primacy to technology differences related to online groups. The first category is the categorization of online groups. The second category is the domain effectiveness of specific types of online groups. The third category, media richness, focuses on the impact of computer-mediation of communication, using face-to-face interactions as a reference point. The fourth category, human-computer interaction, describes research related to the design of computer systems.

Categorization of Groups

Some of the most influential early works on online groups focused on describing and categorizing the emerging phenomenon of online communities. In The Virtual Community, Rheingold (1993) provides a rich description of the positive possibilities of online community building. In Online Communities, Preece (2000) summarizes human-computer interaction, social psychology, and organizational studies research to describe

the best practices for forming and supporting online groups. Most recently, Butler, Sproull, Kiesler, and Kraut (2007) describe roles typically found in online groups. They categorize online group participation in the four distinct roles of infrastructure maintenance, member recruitment, social management, and content generation.

Another line of phenomenon-centered research is the attempt to develop a typology for online groups. Lazar and Preece (1998) categorize online groups by four schema: group attributes, supporting technology, relationship to offline groups, and boundedness. Preece (2000) categorizes groups by content type. The typology proposed by Burnett (2000) highlights differences in online groups based on their ability to support information exchange. Stanoevoka-Slaveba and Schmid (2001) suggest a typology of online groups rooted in differences in group purpose. The four types they propose are discussion, task and goal-oriented, virtual worlds, and hybrid. They further advocate using a media reference model to identify the supporting technology most appropriate for a group's purpose. Extending beyond a typology, de Souza and Preece (2004) develop a framework for sociability in online groups.

Synthesizing these earlier typologies, Porter (2004) characterizes groups by five major attributes. He proposes the group purpose, the place of communication (the extent of computer mediation), the technology platform, interaction patterns, and the profit model as the most important dimensions for differentiating between different types of online groups. As the objective of our research project is to understand the dynamics of online groups that are universal among multiple types of online groups, we adopt Porter's typology to help identify the exogenous group differences to control for within our measurement models. Within the scope of this research project, we do not specifically

hypothesize regarding differences between groups that may cross boundaries within these typologies.

Domain Effectiveness

Two specific application domains for online groups have inspired productive streams of research on application effectiveness. These are online learning groups and online health support groups. In both cases, a primary research interest is comparing the effectiveness of new forms of online groups versus traditional, in-person approaches. Unlike the groups of interest in this study, both of these group types tend to have closed membership, be time-bound, have institutional sponsorship (e.g., an educational institution or a health-care provider), and defined leadership roles (e.g., an instructor or facilitator). As such, they are more akin to virtual teams than online groups. Therefore, studies on both the use of online groups in support of or as alternative to classroom learning as well as studies on health support groups are generally beyond the scope of this research effort (see Eysenbach, Powell, Englesakis, Rizo, & Stern, 2004 for a representative meta-analysis of online health support groups). Nonetheless, to the extent that a particular online learning group or health support group shares meets our definition of an online group, the conclusions of this study regarding online group processes may still be applicable.

Media Richness

An early stream of research related to online interactions is the difference between communication in online settings and communication in offline settings (typically referred to as face-to-face or F2F). One of the most influential theories (despite limited

empirical support) is media richness theory. In media richness theory, Daft and Lengel (1986) view computer-mediated communication (CMC) as a lean media severely lacking in the multi-channel cues of F2F communication. They propose that the effectiveness of CMC directly relates to how closely it approximates the multiple verbal and non-verbal cues provided by physical presence. As an extreme example, media richness theory predicts that using an immersive virtual reality to communicate will be more effective than merely an alphanumeric text chat.

Channel expansion theory provides a significant enhancement to media richness theory. Carlson and Zmud (1999) suggest that groups with common experience readily overcome the limitations of lean media. For example, groups of friends and co-workers who frequently use text chat often develop idiosyncratic communication patterns to express nuanced emotions or share complex information, such as a vocabulary of emoticons, jargon, and lingo. Maruping and Agarwal (2004) extend the concept of channel expansion further by exploring the task-technology fit afforded by the use of multiple communication technologies in parallel. They provide examples of technology characteristics--for example, rehearsability and immediacy--affording complementary capabilities that do not move in a simple linear fashion as predicted by media richness theory.

Other critiques of media richness theory stress the unique nature of the online setting for providing a differential interaction experience. For example, the relative anonymity of online interactions allows participants to be more forthcoming of their "true" self than in face-to-face settings, leading to more intimate relationships (McKenna,

Green, & Gleason, 2002). This allows participants in online groups to develop common bonds more rapidly (McKenna et al., 2002).

Finally, in perhaps the most intriguing critique of media richness theory, Kock (2004) invokes a Darwinian evolutionary perspective to develop a psychobiological model of computer-media communication. This approach completely upends media richness theory, arguing that the higher level of abstraction required for symbolic communication (e.g., written communication) makes it a rich and valuable communication channel. Because sound (speech and hearing) are more basic, less evolutionary advanced, biological characteristics, Kock argues that they are less important than written text for effective communication. This argument provides new insights into the wide-spread adoption of asynchronous written communication as a preferred method of communication despite alternative technology choices that more closely approximate F2F communication. Although there are few, if any, empirical tests of these alternative theories, the weight of practical evidence (what we see around us each day in practice) provides support for more nuanced views than the simplistic media richness theory.

In summary, both media richness theory and its critiques agree that media characteristics do matter. From a theoretical and empirical standpoint we hold media richness as a constant—it is not a variable of primary interest in this study. As discussed further below, in our empirical tests we intentionally seek to sample online groups with similar features and functions to control for similar levels of potential media richness effects.

Human-Computer Interaction

Human-computer interaction literature is primarily concerned with how individual computer users interact with the computer interface. As social computing applications have increased in popularity and relevance, HCI research has also extended into issues of group social support. Multiple researchers have explored how technology differences affect participation in online settings.

Researchers have studied online groups supported by a variety of technology platforms including email-based listservs and USENET discussion groups (Constant et al., 1996; Hiltz & Turoff, 1985; Joyce & Kraut, 2006; Subramani & Hahn, 2003; Wasko & Faraj, 2000); private email-based mailing lists (Ahuja & Carley, 1998); and private message boards (Adamic, Buyukkokten, & Adar, 2003) and public message boards (Schoberth, Preece, & Heinzl, 2003). While there are no doubt strong similarities in dynamics among groups supported by different types of technology platforms there are also some fundamental technology differences that affect important participation patterns.

Online groups that formed through email-based subscription lists rely a "push" model whereby communication is pushed out to all members whenever new content exists (either by message or, perhaps, in a digest format). In sharp contrast, public message boards use a "pull" model where participants actively seek out content (they figuratively "pull" it down to their computer). When members interact exclusively through a site-provided Web interface to view and post content (the "pull" model), it gives online group managers significantly more control over the structuring of content then in the "push" model. Complicating this distinction, however, is the emergence of hybrid forms. The original USENET newsgroups have evolved into Google! groups. A

member can join the group as either a "push" email subscriber or forgo the emails to visit at-will as a "pull" Web-based participant. Furthermore, some Web-based bulletin boards now provide email alerts for members to learn when new content is posted.

Nonetheless, the essential point remains. As researchers, we need to be aware of these differences and make informed judgments regarding construct validity as well as application and ability to generalize results across settings with technology differences. These are not distinctions without a difference. For example, Subramani and Hahn (2003) studied the impact of conversation interfaces and found differences in outcomes based on user interface differences. Likewise, Meyer (2004) found that different forms of "triggering questions" generate different patterns of responses based on a participants' level of conceptualization and associated preferred communication style.

The technology features available for group appropriation to structure content may be an important determinant in the success of a group. The irony of growing online groups is that success, in terms of increased participation intensity (more messages and more participants), also brings negative consequences. A potential negative consequence of increased participation intensity is information overload, incoming communication stimuli exceeding a receiver's processing ability (Rogers & Agarwala-Rogers, 1975). Jones, Ravid and Rafaeli (2004) propose that increases in cognitive demands are responsible for differences in communication patterns in higher volume groups. Lewis and Knowles (1997) found that responding to a single message incurs less cognitive demands than reading an entire message thread. One mechanism to lessen cognitive burdens of increased participation intensity is through participation structures (Butler, 2001). In a study of 576 online groups, Johnson and Faraj (2006) found support for the

use of participation structures (messages threads and grouping of messages into forums) as associated with membership size.

In a fully computer-mediated communication environment, HCI is an important factor. In this study, one of our assertions is that leadership interactions enabled by a participation structure (in this case, messages grouped by topic into threads) differ from direct leadership interaction. Technology itself is an important contributor to structuring and impact of influence processes within an online group.

Network Perspective

Ibarra, Kilduff, and Tsai (2005) have recently noted the emerging trends of connecting individuals and collectives through organizational network research. Researchers adopting a network perspective view online groups through the lens of social communication networks. The network perspective of online groups gives primacy to the relationships among group members. Online groups are social communication groups and, as such, share characteristics, structural and otherwise, with other social networks (Monge & Contractor, 2003).

Collective Action

Online groups typically rely on a small core of participants, usually referred to as the critical mass, for a disproportionate percentage of participation. Like other large-scale networks (e.g., technical, informational and biological networks), many communication patterns in online groups follow power-law distributions (Newman, 2003). In Marwell and Oliver's theory of critical mass (see Oliver & Marwell, 2001 for retrospective overview), the term was borrowed from physics to refer to a minimum group size after which collective action becomes self-sustaining. This concept has intuitive appeal to

online groups where participation is highly skewed. Empirical studies to date show online groups have large numbers of participants that are passively involved, a smaller number with peripheral involvement, and an even smaller core of highly committed members, the critical mass.

As mentioned above, we view online groups as platforms for the production of social information goods with public goods characteristics (see Wasko & Faraj, 2000 for a similar view). Public goods, being non-rivalrous and non-excludable, are prone to significant breakdowns in collaboration (Marwell & Oliver, 1993; Oliver & Marwell, 2001). Significantly, an economically rational actor is likely to free-ride on the efforts of others, knowing they can wait until the good is produced to enjoy the fruits of others' labors. Marwell and Oliver (1993) theorize that a small group of committed collaborators, the critical mass, may overcome this problem when they have above-average access to resources and a belief in the success of the effort.

Identifying the assumptions implicit to economic goods, researchers have extended critical mass theory to the unique qualities of information goods (Fulk, Heino, Flanagin, Monge, & Bar, 2004; Peddibhotla & Subramani, 2007) and goods generated in communication networks (Monge & Contractor, 2003). These updates provide additional insight into the generalizability of critical mass theory, demonstrating its salience to information goods.

New Science of Networks

With the ability to support large-scale interactions, one view of electronic knowledge networks is through the lens of the new science of networks (see Newman, 2003). There are two characteristics in particular that network scientists have focused on

as evidence of emergent network properties: scale-free and small world networks. A scale-free network occurs when node degree, a measure of actor centrality, follows a power-law distribution (Barabasi & Albert, 1999). In a test of more than 30,000 messages by more than 8,000 active participants in a online discussion forum, Ravid and Rafaeli (2004) found the resulting communication network to be scale-free (based on in, out, and total degree distributions), as well as a small world network. A scale-free network exhibits unique characteristics related to its vulnerability and robustness (Barabasi & Bonabeau, 2003).

For example, like many other information goods, electronic knowledge networks formed through message boards may generate positive externalities. "Network effects lead to demand side economies of scale and positive feedback" (Shapiro & Varian, 1999, p. 14). Once a site develops a reputation as the premier location for a particular topic, it may be difficult for competing sites to attract the incumbent's members. In the extreme case of first-move advantage, a winner-take-all model, the first entrant would be the preferred option for all future users. In more common scenarios, where there is a strong but not complete preference for new entrants in a system to follow the preferences of existing users (a.k.a. preferential attachment), the rank order distribution of size will follow a power law (Barabasi & Albert, 1999). Examples of power-law distributions related to online groups include the frequency distribution of links to Web sites (Adamic & Huberman, 2000), recipients of email (Wu, Huberman, Adamic, & Tyler, 2004), participants on message boards (Adamic et al., 2003; Ravid & Rafaeli, 2004) and message board size (Faraj, Wasko, & Johnson, 2008). These studies demonstrate the validity of using network characteristics to differentiate online groups.

Group Perspective

In contrast to studies that consider the characteristics of message content or individual group member differences, some studies have looked at very large sets of groups and focused instead on the structural differences among those groups. For example, in one of the few studies focused on online group sustenance, Butler (2001) found that as groups grow in size and communication activity they attract more members but also have higher rates of turnover. In the largest study of USENET messages to date, Jones, Ravid and Rafaeli (2004) found users cope with high levels of communication activity through a preference for shorter messages. That is, as communication frequency increases participants tend to post shorter messages. Once a group's participants reach a state of information overload they also demonstrate a preference toward responding to shorter messages over longer ones.

Jones et al. (2004) analyzes the structural characteristics of 600 online groups (Usenet newsgroups). Focusing on the relationship between the volume of group member interaction and message complexity, they theorize that groups have a maximum stress point where a high volume of group interaction creates cognitive information overload for its group members. They find that group members prefer to send and receive shorter messages at a point of information overload. Also, they find that group members are more likely to cease participating at the maximum stress point, a finding consistent with Butler's (2001). In summary, although larger online groups may be more attractive to new participants than smaller ones, participating in a very large online group is a qualitatively different experience than participating in a much smaller one.

Butler, Smith and Turner (2004) relate cross-posting patterns in USENET news groups to the dynamic tensions arising between reduced group distinctiveness and increased external visibility. This tension is similar to that between the growth of an

online group, where a diffused sense of group identity may decrease group attractiveness, versus the ability of a larger online group to be visible to more potential new members. A way of overcoming this problem is to expand the group boundaries either through the addition of more general topics or through subdivision to more specific topics. Increased participation structures can achieve both of these objectives.

The concept of critical mass was first applied to use of computers as communication devices almost forty years ago by Licklider and Taylor (1968). They conceptualize computer-mediated communication systems as a supporting environment for creative endeavors. They propose that collective problem-solving efforts require at least a minimum number of experts to be self-sustaining. Likewise, as electronic knowledge networks are meeting places for participants who share common interests, site sponsors need to attract and retain a minimum number of active participants (a critical mass) to sustain on-going discussions.

Chapter 3: Research Model and Hypotheses

This chapter is organized as follows. First we describe existing research that supports our hypotheses with regard to past participation leading to continued participation intentions. Next we describe how group leadership influences continued participation intentions. We also hypothesize how different types of interactions with group leaders impact continued participation intentions. Finally, we hypothesize that group characteristics of group psychological safety, perceived number of leaders and group size all impact leadership processes.

Continued Participation Intentions

We begin our hypotheses with the basic premise that past participation predicts continued participation intentions. To provide a nuanced view of continued participation intentions, we theorize two closely related dimensions. The first dimension, *participation role intentions*, represents *what* roles a participant intends to fulfill in an online group. The second dimension, *turnover intentions*, characterizes *how long* a participant is likely to remain a member. Together these constructs provide a multi-dimensional view of continued participation intentions.

Continued Participation Intentions Dimension	Membership Role	
	Transactional	*Loyal*
Participation Role Intentions	Limited	Extensive
Turnover Intentions	High (leaving soon)	Low (plan to stay)

Table 1: Example of Continued Participation Intentions Dimensions

Table 1 provides an example of how these dimensions might map to two different archetypal forms of participation in an online group. First, consider an anti-social participant, a "troll", who happens across a group and plans to join in order to post a single inflammatory message. This person would have limited participation role intentions (merely posting a message) and would intend to leave the group soon. Next, consider a long-time "loyal member" of an online group. This person would be more likely to intend to engage in multiple participation roles (e.g., reading messages, replying to others) and to have low turnover intentions. These archetype forms demonstrate a close correlation between these two constructs. Indeed, given the close conceptual inter-relationship among these constructs, we theorize that they share the same antecedents. For conceptual clarity we describe both of these dimensions of participation intentions in more detail below.

Participation Role Intentions

Integrating two viewpoints—participation as distinct roles and participation as progressing along a continuum—we define *participation roles* as the multiplex behaviors of an individual at an online group. *Participation role intentions* represent a participant's intention to engage in these behaviors in the future.

Like any form of complex group collaboration, the sustainability of online groups requires role specialization. Butler et al. (2007) identify four primary roles within online groups: infrastructure maintenance, member recruitment, social management and content generation. In a complementary view of online group commitment, Bateman, Gray & Butler (2006) further delineate the community citizenship role as including both social encouragement and social control activities. In empirical studies of peripheral

participation—the study of lurkers in online groups—both Ridings et al. (2006) and

Yeow et al. (2006) conceptualize online group participation as progressing along a

continuum of involvement. The phases of individual involvement with a group include a

range of activities such as reading group content, joining the group, posting messages and

supporting group maintenance activities.

Turnover Intentions

Turnover intentions reflect a group member's intention to remain a member of a

group. Individuals with low turnover intentions plan to remain in a group longer than

those with high turnover intentions. We know of no studies that have investigated

turnover intentions in the context of online groups.

<div align="center">

Past Participation

</div>

Existing research has identified a variety of motivations for individuals to

contribute to online groups. Participation tenure, participation level and group

responsiveness are three participation characteristics identified in a growing body of

empirical evidence associated with continued participation. *Tenure with a group* is the

length of time a member has been an active participant in a group. *Participation in a*

group refers to the number of contributions the participant has made to the online group.

In their analysis of reference data for a simulation of online group growth, Johnson and

Faraj (2005) found that both participant tenure and number of contributions are

associated with a greater likelihood of continued participation. In a study analyzing the

relationship between message response patterns and continued participation, Joyce and

Kraut (2006) identify the importance of *replied to messages*. Participants who receive

responses to their messages are more likely to continue participating than those who do not (Joyce & Kraut, 2006).

H1a: Tenure with a group is associated with the continued participation intentions of participation role intentions and turnover intentions.

H1b: Participation in a group is associated with continued participation intentions of participation role intentions and turnover intentions.

H1c: Replied to messages is associated with the continued participation intentions of participation role intentions and turnover intentions.

Interaction with Group Leadership

Online groups are voluntary forums with open, transient membership. The emergence of influential participants who provide a group with leadership is essential to successful mass collaboration. Organizations increasingly find that the success of key initiatives is dependent upon the contributions of voluntary participants in online settings. The nature of online groups limits an organization's ability to manage these processes. On one hand, online groups are leaderless groups where no one individual is indispensable. On the other hand, participation is far from equally distributed. No one person is critical to success, yet some people are clearly more influential within the group than others; the most prominent emergent leaders can exert significant influence over other group members. We believe that leadership in online groups is an overlooked determinant of online group success.

In contrast to more structured groups, such as organizational teams, online groups are characterized by voluntary participation, minimal formal leadership structures, open membership, and an absence of systemic external constraints on member participation. In organizations, managers are expected to be leaders. In online groups, there are few, if any, designated management roles with formal authority. Substantial research exists on

leadership in organizational settings yet little is known about the impact of leadership on participant attitudes toward online groups. We believe the study of leadership in online groups shares key similarities with traditional leadership but has differential emphasis on behaviors, influence processes, attitudes, and outcomes germane to online groups.

The research on online group leadership is nascent (Butler et al., 2007; Johnson, 2006; Kudaravalli et al., 2007), yet a promising arena for future study. The biases of traditional leadership research and theory (Yukl, 2002), stressing a single, heroic leader that exerts unidirectional influence on followers are not appropriate for online groups. We adopt Yukl's (2002, p.8) definition that "leadership is the process of influencing others to understand and agree about what needs to be done and how to do it, and the process of facilitating individual and collective efforts to accomplish shared objectives."

The purpose of online groups is to facilitate member communication on topics of shared interests. We view online group leaders are those that other members recognize for their expertise in topics of interest or influence on the nature of interactions among group members. Online group leadership derives from the ability to influence *what online groups do*—communicate on topics of interest—or *how they do it*. Thus, online group leadership is a shared process with leaders engaged in a deeply embedded social group process. Leadership is emergent, not mandated.

Interactions with online group leadership may influence other group members in a variety of ways. Most simply, familiarity developed through frequent interaction tends to engender positive attitudes (Cartwright & Zander, 1953). The more frequently that individuals interact with one another in online settings, the more likely they are to form lasting relationships with one another (McKenna et al., 2002). Positive relationships with

other group members is one basis of developing a strong identification with a group (Ren, Kraut, & Kiesler, 2007).

H2a: Interaction with leadership is associated with the continued participation intentions of participation role intentions and turnover intentions.

We further differentiate between two different types of interactions germane to our specific setting of online groups. Communication in online groups is open, public, and visible to all group members. Thus, when a group member posts a response their communication has a dual nature. It is both a direct interaction with a single group member as well as an indirect interaction with all other group members.

Online groups use conversation interfaces and participation structures including message threads and topic forums to organize group communication (Butler, 2001; Johnson & Faraj, 2006). This leads to a further distinction between direct communication and shared context. We define *direct communication* as occurring between two group members when messages are posted in sequential order within a participation structure (e.g., subsequent messages in the same message thread). We define *shared context* as two participants who both post a message in the same message thread, but not necessarily in direct communication with one another.

H2b: Direct participant interaction with leadership has an even stronger effect than shared context on the continued participation intentions of participation role intentions, identification with group and turnover intentions.

Group Level Antecedents

Psychological Safety

An important aspect of the social maintenance role of online group leaders is establishing a group climate for communication norms (Butler et al., 2007).

Psychological safety is a shared belief that a group is a place where it is safe to take interpersonal risks (Edmonson, 1999). It describes a group climate "characterized by interpersonal trust and mutual respect in which people are comfortable being themselves" (Edmonson, 1999, p. 354). In a longitudinal study of members of Internet USENET groups, McKenna and colleagues (2002) found that expressing one's "true self" via the Internet was the strongest predictor of long-term relationship formation via online groups. Their study provides a strong empirical suggestion of the importance of psychological safety to continued participation.

There is further reason to believe that psychological safety moderates the relationship between interaction with leadership and continued participation intentions. When group leadership promotes positive norms of psychological safety it provides a basis to strengthen individual identification with a group. Also, an individual can be expected to be more willing to engage in a variety of participation roles when they feel supported by group leadership than when they feel psychologically threatened. A group member has little incentive to "stick out their neck" in a voluntary activity if they fear it "will get chopped off" by group leadership.

H3: Group psychological safety moderates the relationship between interaction with leadership and the continued participation intentions of participation role intentions and turnover intentions.

Group Size

As a group grows in size the importance of group leadership also increases. In a study of 576 online groups, Johnson and Faraj (2006) find the number of formally designated leaders (e.g., moderators and administrator) is associated with online group membership size. As noted above, increases in group size have both positive and negative

effects for groups. As groups grow larger it is more difficult to maintain a cohesive group climate. Larger online groups attract more members yet also have higher levels of turnover (Butler, 2001). When participation intensity reaches a particular threshold (presumably, a state of information overload) group interaction changes (Jones et al., 2004). Therefore, interactions with group leadership will have a more pronounced on group members.

H4: Group size strengthens the association between participant interaction with leadership and the continued participation intentions of participation role intentions and turnover intentions.

Number of Leaders

Another measure of the leadership processes in a group is the number of perceived leaders in a group. Participants who feel there are more individuals providing leadership in a group are also more likely to believe in the overall efficacy of the group. Thus, they are more likely to believe that the group can meet the needs of its members, a belief consistent with an intention to participate in the future and to continue remaining a member. Previous studies have uncovered a variety of motivations for participating in online groups, including the desire to solve problems (Kankanhalli et al., 2005) and to improve professional reputation (Wasko & Faraj, 2005). These motivations are enhanced by a belief that a group has a larger, rather than a smaller, number of influential members to support those objectives.

H5: The number of leaders in a group strengthens the association between participant interaction with leadership and the continued participation intentions of participation role intentions and turnover intentions.
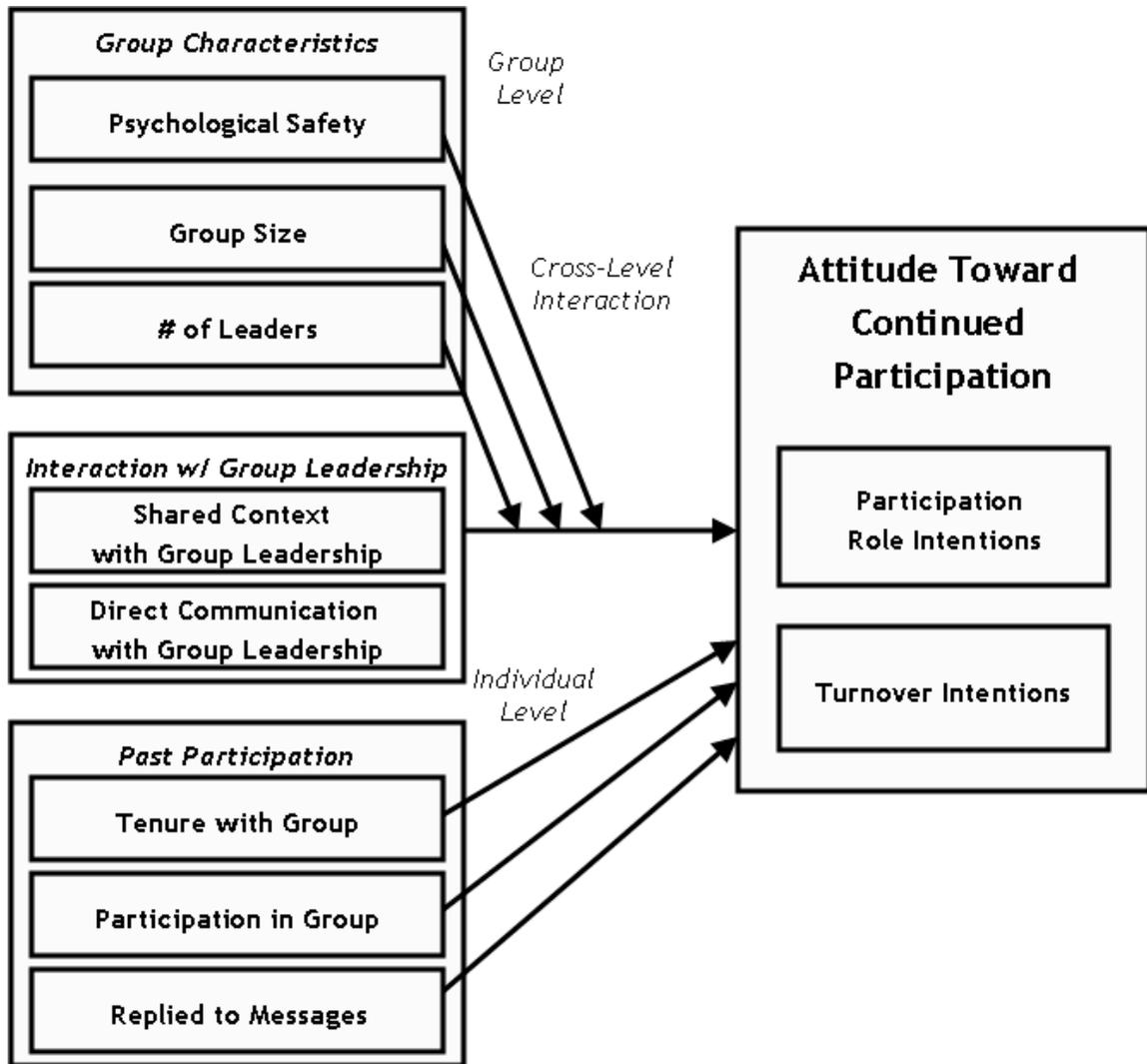
Figure 2: Research Model

In summary, Figure 2 shows our detailed research model. The base model, past participation, is the starting point for predicting continued participation based on existing literature and theories of online group participation. Additional independent variables of greater interest are labeled interaction with group leadership. The survey results were used to identify nominated group leaders. All leadership measures were based on archival online participation data and communication network analysis.

The group characteristic variables group psychological safety and number of leaders were emergent group properties assessed through aggregated survey responses for all respondents from the same online group. Group size was calculated based on archival online participation data. Collectively, these three variables are used for cross-level analyses.

The individual level dependent variables of participation role intentions and turnover intentions were collected via individual survey responses. Although it is beyond the scope of the data collection for this dissertation, we note our theoretical model, our research design, and future research plans support the collection of actual (future) behaviors. Thus, in addition to collecting survey responses about respondent attitudes, as time passes actual behaviors will be observable in public forums and those attitudinal measures can be further analyzed for consistency with actual behaviors.

Chapter 4: Research Methodology

Testing a complex set of cross-level group relationships requires robust data collection and advanced statistical methods. The lowest level of data for our study was an individual participant at a Web-based message board. Individual responses were nested within groups: shared communication networks and leadership structures of Web-based message boards. Because we are interested in understanding *continued participation* in these online groups, we restrict our sample to message board members who participated in the online group prior to the beginning of the survey period.

In addition to individual level survey responses we analyzed emergent group properties aggregated from individual survey responses, individual archival participation history, archival communication history between the respondent and online group leadership, and archival group properties.

We sent individual survey invitations to 9,566 members of sixty-two Web-based message boards. We received a total of 760 complete, valid responses. Our detailed analysis focuses on 535 of those responses from thirty-three groups. Each of these thirty-three groups had at least five or more responses from members who had participated in the group prior to the survey period and who provided full valid survey responses.

The remainder of this section begins with a description of the research setting and our measurement model. Next we describe each of the study measures in detail. We close with a discussion of the data collection process.

Research Setting

We choose Web-based group discussion boards as our research setting. They are among the most popular forms of online groups, yet are firmly in line with the heritage of other technologies. Researchers have studied online groups supported by a variety of technology platforms including email-based listservs and USENET discussion groups (Constant et al., 1996; Hiltz & Turoff, 1985; Joyce & Kraut, 2006; Subramani & Hahn, 2003; Wasko & Faraj, 2000), private email-based mailing lists (Ahuja & Carley, 1999), private message boards (Adamic et al., 2003) and public message boards (Schoberth et al., 2003). Online discussion forums such as Web-based bulletin boards, community forums, and group blogs have emerged as one of the most popular classes of websites for open participatory communication (e.g., Horrigan, Rainie, & Fox, 2001; Petersen, 1999). In contrast to the closely related to the phenomenon of open innovation communities, where participants engage in closely coordinated tasks including as software development (e.g., Kuk, 2006) and standards setting (e.g., Fleming & Waguespack, 2007), online groups are interest-oriented, rather than task-oriented. Web-based online groups trace a direct lineage to earlier technologies as news groups and listserv technologies "migrated" to Web-based bulletin boards (Rothaermel & Sugiyama, 2001). Early Web-based forums were primarily geared toward social support groups and hobby-related interests such as gaming clubs (Armstrong & Hagel, 1996).

A trend over recent years is the growth of online discussion boards either sponsored by organizations or geared specifically to organizational audiences (Jeppesen & Frederiksen, 2006; Kenny & Marshall, 2000; Muniz & O'Guinn, 2001). In 2004, the Pew Internet & American Life Project (Lenhart, Horrigan, & Fallows, 2004) estimated

that more than 12 million Americans had posted to online groups. One of the largest sites (IGN Boards) has more than 1.2 million registered memberships while the ten largest sites encompass 10.9 million user registrations and 1.1 billion messages (http://www.big-boards.com, 2006). According to the latest Annual Gadgets Survey by the Pew Internet and American Life Project (2007), posting comments in online groups remains a popular online activity among Internet users--even more popular (18%) than the activity of working on Web pages or blogs (8% - 12%).
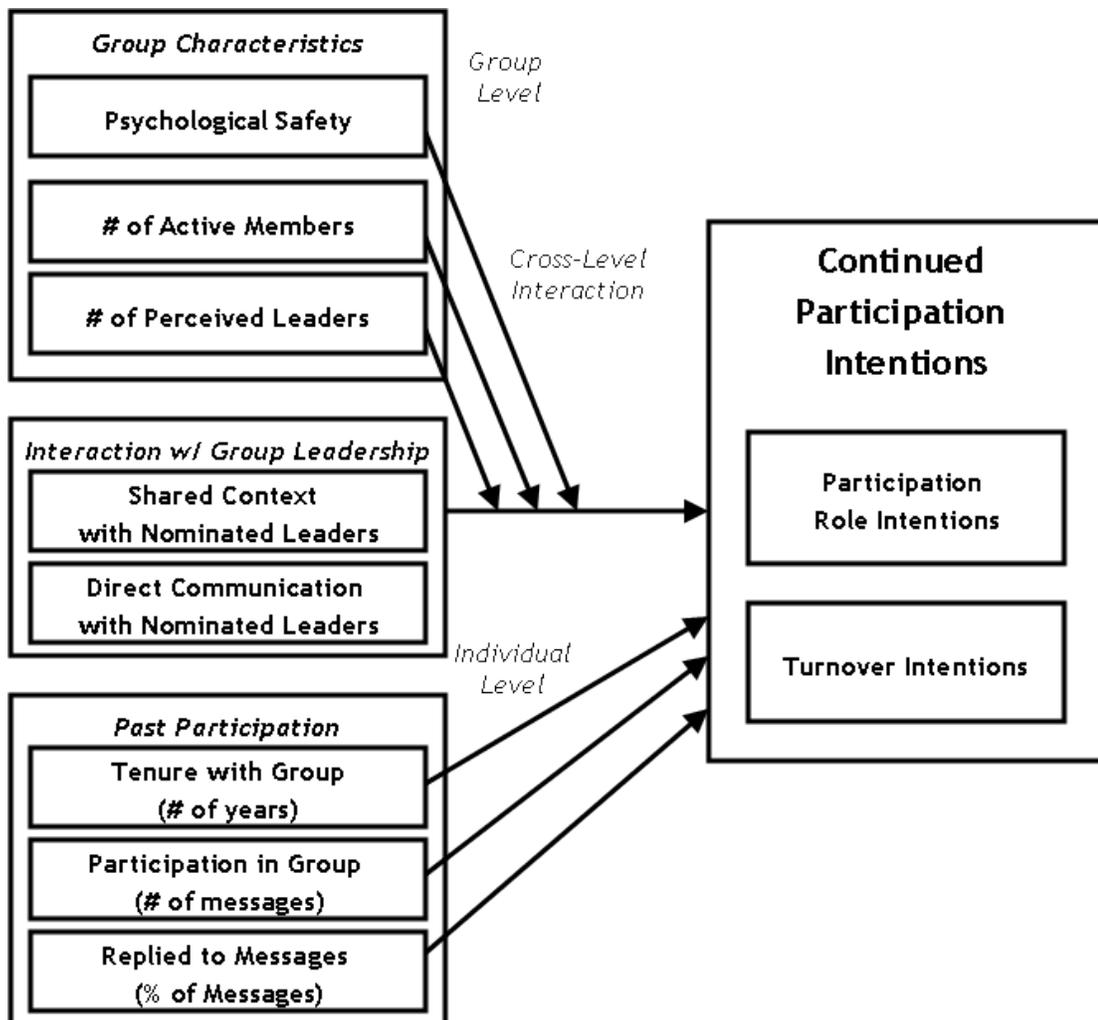
Figure 3: Measurement Model and Levels of Analysis

Measurement Model

The variables of interest in this study were measured through two primary sources: a survey of online participants and archival data of online participation. The full measurement model is shown in Figure 3. In this section we describe how we collected and calculated these measures. The discussion begins with the measures of the dependent variables, continues with measures of past participation and follows with measures of interaction with group leadership. Finally, we conclude with the description of measures of group level characteristics.

Dependent Variables

Survey responses were used to measure the dependent variables: participation roles intentions and turnover intentions. Both of these measures were comprised of multiple survey items. They are described below.

Participation Role Intentions

To measure participation role intentions in online groups we developed a new multi-item scale. The focus of our study is to understand the range of roles—conceptualized as representing deepening levels of commitment to a group. The participation role intentions construct was loosely related to Organizational Citizenship Behaviors (OCB). In the setting of online groups, the closest adaptation is the study by Bateman et al (2006) that includes a two-factor measure of Citizenship Behaviors.

Our measure is similar to existing OCB measures and the Bateman et al. (2006) measure in that it focuses on tangible behaviors. It differs from traditional OCB measures in that it measures intentions for on-going behaviors (rather than past or current behaviors). It differs from the Bateman et al. measure in that it encompasses a more

comprehensive range of behaviors related to online group membership. The response

scale for these items was a five-point Likert-type scale where 1 = Strongly disagree and 5

= Strongly agree. The prompt was: "Thinking about your on-going participation related

to this online group, choose the response that most closely matches your level of

agreement with the following statements:"

Survey item
1. I expect to regularly read others' content in this online group.
2. I intend to regularly post messages at this online group.
3. I plan to tell others about this online group
4. I intend to praise members of this group when they are supportive towards others
5. I plan to reprimand other members' inappropriate behaviors.

Table 2: Measure of Participation Role Intentions Prepared for Online Groups

Turnover Intentions

To measure individual turnover intentions in an online group we adapted the

organizational turnover intentions measure developed by Kelloway, Gottlieb, & Barham

(1999). The original four-item measure and our adaptation are shown in Table 3. The

response scale for these questions was a five-point Likert-type scale with anchors of 1 =

Strongly Disagree; and 5 = Strongly Agree.

Original – Kelloway et al. (1999)	Adaptation to online groups
1. I am thinking about leaving this organization.	1. I am thinking about leaving this online group.
2. I am planning to look for a new job.	2. I am planning to look for other online groups.
3. I intend to ask people about new job opportunities.	3. I intend to ask people about new online groups.
4. I don't plan to be in this organization much longer.	4. I don't plan to be in this online group much longer.

Table 3: Measure of Turnover Intentions Adapted to Online Groups

The major wording change is from "organization" or "new job" in the original scale to "online group" in the adapted scale. Although the fourth item includes negative wording "do not plan," it was not reversed scored. Like all other items in the scale, it measures intent to leave the group or participate in another group. The entire measure measured an opposite intention compared to participation role intentions. That is, turnover intentions and participation role intentions will typically be negatively correlated.

Past Participation

Next we describe the measurement approach for the three individual level independent variables related to past participation. The three past participation variables themselves were gathered from archival participation data, not participant surveys. We use the respondent's user ID for the message board, as provided on the participant survey, to match past participation to other survey responses. The user ID is a name participation uses on a bulletin-board. As a self-selected pseudonymous "handle," the member name uniquely identifies a participant's bulletin board posts.

Tenure with Group and Participation in Group

To calculate the variables participation tenure with group and participation in group, we gathered archival data of observable online participation. The tenure with group variable captured the duration of an individual's membership in an online group. We calculated this measure based on 30-day-month equivalents. Specifically, we measured the number of days between the date of the first observed message for a survey respondent and the beginning of the survey collection period for the respondent's online group. We divided that number of days by 30 to derive the person's tenure with group.

To measure the level of participation in the group, the respondent's experience with the group, we measured the total number of visible messages the respondent posted to a group. To gather the message history for a respondent we performed the following steps:

(a) We visited the user's profile at the online group

(b) We performed the "search for all messages by this user" query

(c) We counted the number of message with a message date *prior* to the beginning of the communication network observation period (e.g., 21 days prior to the beginning of the survey response period). The distinction between the archival period history and the observation period is described in more detail below in the final section of this chapter.

The sampling frame for this study guarantees that all data items will have a non-zero value for the tenure value. It is possible, however, for a respondent to post no messages prior to the beginning of the network observation period and, therefore, have a participation in group value of zero.

Replied to Messages

In vBulletin, all user messages are organized into message threads. Messages appear sequentially in a single-threaded message stream organized by threads. (Threads are further organized in topic-oriented forums.) To create a new thread a member posts a message that is designated as the start of a new thread--in other ways, the message appears just like any other post. By reading posts post-date order within a thread, we could identify which posts were responded to and which are not. (Simply put, all posts

but the last generate a response, keeping in mind the first post may not receive any responses and, therefore, end up being both the first and last post in a thread.)

We calculated the frequency of replied to messages as a measure of the *percentage* of total messages a user posted that were replied to. Table 4 shows multiple scenarios of scoring for this variable based on example number of messages and number of replies.

Total Messages	Number of Replies	Calculation	Measure
1	0	0 / 1	0%
1	1	1 / 1	100%
3	2	2 / 3	66%
5	4	4 / 5	80%
10	8	8 /10	80%
10	9	9 / 10	90%
10	10	10/10	100%

Table 4: Measure of Frequency of Replied to Messages (Example)

We measured replied-to messages based on all messages posted by a user from the person's join date through the beginning of the network observation period. If a user posted no messages during this time period, the replied to percentage was zero.

Interaction with Group Leadership

To measure interaction between survey respondents and leadership of their online group, we combined data gathered via surveys with the group communication history gathered from archival data. The unique user name for a survey respondent and the list of nominated leaders for a group were both provided via survey responses. The interaction data was collected from publicly visible messages displayed in the message archives for each group. One of the criteria for selection in this study is that an online group maintains visible message history. Both measures of interaction with group leadership require a list of group leaders and the message history for the observation period. After discussing the

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method of identifying group leaders we describe the calculation of shared context with group leadership and direct communication with group leadership variables.

Group Leadership

We used participant survey responses to identify one or more leaders for each online group. The specific survey prompt was as follows: "Name (by user name) up to three group members that you feel have the most influence on what the group does and how it does it." If a group member was nominated by more than one respondent, he or she was considered a nominated group leader.

Shared Context with Leadership

The shared context with leadership measure was based on the number of message threads that a respondent posts messages to where group leaders also posted a message during the observation period. It was calculated as the percentage of total messages threads someone posts to during a specific time period that also include a message from one or more nominated group leaders during that same time period. The values can range from 0% to 100%. The specific calculation was performed as follows:

(a) Identify all messages by participant A during time period t. If no messages were found, the variable was set to 0.

(b) Identify all messages threads that include one or more messages by participant A during time period t. Count the number of threads, TOTAL-THREADS(A).

(c) For each message thread identified in step (b), review all messages posted during time period t. Count the number of threads identified in step (b) that

include one or messages posted by a leader during time period *t*, LEADER-

THREADS(A).

(d) Calculate the value of Shared Context with Leadership for participant *A*

during time period *t* as:

$$\text{LEADER-THREADS(A)} / \text{TOTAL-THREADS(A)}$$

The valid range for this variable is 0 to 1. The minimum value of zero occurs either when

a respondent posted no messages during the observation period or when all posted

messages were at message threads with no messages by a nominated group leader. The

maximum value of 1 occurred when every message posted by the respondent during the

observation period was in a thread that also included a post by a nominated group leader.

Direct Communication with Leadership

The direct communication with leadership measure was based on the number of

direct interactions that a respondent had with nominated group leaders. It was calculated

as the percentage of total messages that someone posts during a specific time period that

were sent to or responded to by a nominated group leader during the same time period.

The specific calculation was performed as follows:

(a) Identify all messages by participant A during time period t. If no messages

were found, set the variable to 0.

(b) For each message, identify if the message was sent to a leader ($\text{SENT}_{\text{lead}}$) or

sent to a non-leader ($\text{SENT}_{\text{non-lead}}$).

(c) For each message, identify if the message was replied to and, if so, if the reply

was made by a leader ($\text{REPLY}_{\text{lead}}$) or non-leader ($\text{REPLY}_{\text{non-lead}}$).

(d) Calculate the value of direct communication with leadership for participant *A* during time period *t* as:

$$(SENT_{lead} + REPLY_{lead}) / (SENT_{lead} + REPLY_{lead} + SENT_{non\text{-}lead} + REPLY_{non\text{-}lead}).$$

The valid range for this variable is 0 to 1. The minimum value of zero occurs either when a respondent posts no messages during the observation period or when none of their posts were sent to or responded to by a nominated leader. The maximum value of 1 occurs when every message posted by the respondent during the observation period was both sent to and responded to by a nominated group leader.

Group Characteristics

Psychological Safety

To measure psychological safety, we adapted the team psychological safety measures of Tucker, Nembhard & Edmondson (2007) (a shortened version of the Edmondson's (1999) measures). Both their original measures and our adaptation are shown in Table 5. The major adaptation of our measure was from "unit" to "online group." For consistency with other questions we use a 5-point Likert-type scale with anchors of 1 = Strongly Disagree; and 5 = Strongly Agree. The group level measure was calculated as the average value of individual level responses for respondents from that group.

Original – Tucker et al. (1999)	Adaptation to online groups
1. People in this unit are comfortable checking with each other if they have questions about the right way to do something	1. Members of this online group are comfortable checking with each if they have questions about the right way to do something
2. The people in our unit value others' unique skills and talents	2. The members of this online group value others' unique skills and talents
3. Members of this NICU are able to bring up problems and tough issues	3. Members of this online group are able to bring up problems and tough issues.

Table 5: Measure of Team Psychological Safety Adapted to Online Groups

Number of Active Members

We measured the second group level control, number of active members, based on observed participation data. The number of active members reflects the size of the online group. It is measured as the number of unique participants who posted at least one message during the observation period.

Number of Perceived Leaders

The number of perceived leaders is an emergent group property based on individual level survey responses. The specific survey prompt for this item was: "How many different members do you feel regularly provide leadership to this online group?" The group level measure was calculated as the average value of individual level responses for respondents from that group.

Data Collection

Our population of interest is online groups using open, asynchronous, Web-based supporting technology. To control for potential differences due to technology platform or topic, our target sample is online groups using the popular vBulletin web-based bulletin board technology. Given that a large amount of archival data collected via automated scripts, by restricting our sample to a single technology platform we benefited from

economies of scale in the study execution. Finally, despite differences in group

appropriation of technology, collecting archival data from online groups that shared a

common technology platforms increased construct validity when comparing measures

between groups.
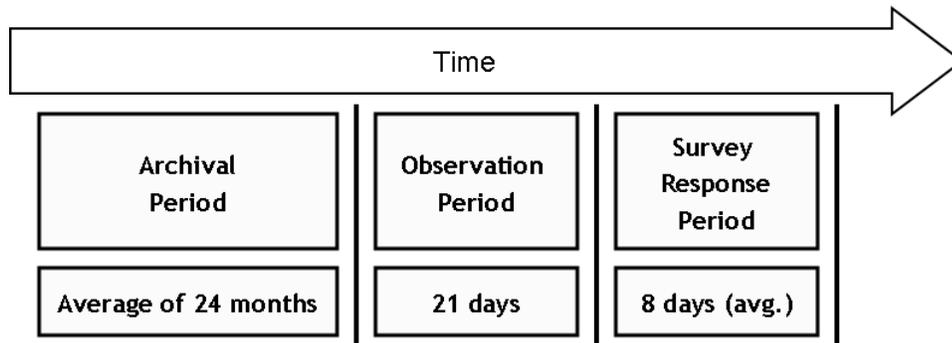
Figure 4: Data Collection Design

As introduced above, the study variables were collected from three non-

overlapping time periods. These time periods were uniquely defined for each group and

were driven by the survey collection period for that group. Figure 4 depicts the data

collection strategy. The study dependent variables, participation role intentions, and

turnover intentions were collected during the survey response period. They capture the

current intentions of a respondent for future actions. The independent variables were

collected through a combination of survey responses and archival data collection. Table 6

summarizes the source of each variable in our measurement model.

Measure	Level	Type	Source
Tenure with group	Individual	# of years	Archival period + observation period
Participation in group	Individual	# of messages	Archival period
Replied to messages	Individual	% of messages (0.00 to 1.00)	Archival period
Shared context with nominated leaders	Individual	% of messages (0.00 to 1.00)	Observation period + survey responses for leader nominations

Measure	Level	Type	Source
Direct communication with nominated leaders	Individual	% of messages (0.00 to 1.00)	Observation period + survey responses for leader nominations
Psychological safety	Group (convergent)	Avg. response on multi-item 5-point scale (referent-shift)	Survey
# of active members	Group	# of authors	Observation period
# of perceived leaders	Group (convergent)	Avg. response to single item, # of leaders	Survey
Participation role intentions	Individual	Multi-item 5-point scale	Survey
Turnover intentions	Individual	Multi-item 5-point scale	Survey

Table 6: Study Measures

Surveys

Selected target groups. The population of interest in this study is members of online groups engaged in asynchronous communication about complex information-intensive topics. In identifying an appropriate sample of online groups, we balanced two competing objectives. The first objective was the need for sufficiently variability between groups in order to achieve variance in study measures. The second objective was the maintain commensurability among groups in order to maintain construct validity. We balanced these objectives by selecting online groups that use the popular vBulletin software package and are focused on a discussion topic in some way related to technology.

In addition to being based on the vBulletin platform, the specific implementation of vBulletin of each web-based bulletin board (e.g., the version, configuration, and any customizations) needed to support all of the following technical features:

- The ability to view the member profile of other registered members. (Some bulletin boards only allow administrators to view registered member profiles.)

- The ability for a newly registered member of the group to send a personal message to other members of the group. (Some bulletin boards only allow messages to be sent to administrators; some only allows members who have already posted a substantial number of posts on the public bulletin board to send personal messages; and, other bulletin boards turn off personal messaging altogether.)

- The ability for registered members of a bulletin board to read old posts. (Some sites only keep a short history of posts online.)

- The ability to view individual posts "one-at-a-time" via a post-specific URL. (This requirement was necessary to support the automated scripts for reading posted content.)

We found no evidence that groups failing to meet the above criteria differed in any other substantive way from groups that remained in our sample.

We used a multi-phase process to identify online groups that met all the above criteria for sample inclusion. In the first phase of identifying target groups we leveraged a previous research effort. As part of this early study, we had identified over one thousand online groups using vBulletin. Those groups were identified from three sources:

1. The website big-boards.com, a directory of the largest web-based bulletin boards.

2. User member profiles at the vBulletin.com customer support message board.

3. Yahoo! search engine results on the string "Powered by vBulletin".

As part of the earlier study, a member of that research team manually visited each online group and categorized each online group by topic. Several dozen were identified as related to technology (e.g., computer hardware, software, or consumer electronics). We began data collection for this study using groups identified from this much smaller sub-sample of the earlier research study. During the survey data collection for the study described in this manuscript, we quickly assessed we would need more candidate groups. Therefore, we embarked on a second phase of identifying appropriate sites.

In the second, we tapped two additional sources:

1. A directory of vBulletin groups provided by the website vBulletin Setup.

2. Targeted web searches at Yahoo! on the strings: "powered by vBulletin" and "hardware" as well as "powered by vBulletin" and "software".

The final selection criteria used in the study was to select groups with the appearance of a vibrant, active, and large enough size to return an adequate number of survey responses. In our early survey solicitations, we found online groups needed to meet two major criteria in order to return at least five usable responses. First, they needed to show evidence of daily content. Second, they needed to have at least 80-100 active members in the previous 4-5 month.

Data collection. During the pilot phase of collecting data from the first six groups, we attempted to contact site administrators to ask for permission and used an invitation offering potential participants a chance to enter a drawing upon survey completion. We found the response rate from administrators was very low--only one responded in a timely manner, with a negative response. No other administrators replied. We then

decided to try an incentive of $5 per completed survey response and $10 per completed

survey response. We tried each of these options at a single group. We received no

responses for the $5 (gift certificate) per response and had a strong response rate for the

$10 per survey invitation. Thereafter, we used the $10-per-completed-survey response for

all other groups.

The final protocol for the survey process is as follows:

(a) Confirm that the site is active and accepting new registrations. Active sites

had new messages posted within the previous 48 hours. Inactive sites were

dropped from the sample.

(b) Register as a new user at the site. The site registration process at a vBulletin

site typically involved agreeing to a user agreement, selecting a user ID and

password, providing (and validating) an email address, and completing a

minimal set of user profile variables. If, during the site registration process,

the user agreement specifically restricted solicitation of members via personal

messages, the site was dropped from the sample. I registered using my actual

name (given name, space, surname) as my user ID. In the few cases where this

user ID violated site naming restrictions or guidelines, I used a variant thereof.

(c) Confirm the site allows registered members to send personal messages (PMs)

to each other. Sites which do not allow PMs to be sent by new members were

dropped from the sample. (Some sites only allow PMs to be sent after a

minimum number of messages have been posted at the site. I did not attempt

to meet this minimum merely to be able to send PMs.)

(d) Confirm the site allows viewing of the contents of a single post via a unique URL. This is a standard feature of vBulletin. Nonetheless, some vBulletin installation turn this feature off, sometimes in conjunction with third-party search engine optimization add-ons. Because the automated data collection routines used during data validation relied on the ability to read single messages via a unique URL, sites which had turned off this feature were dropped from the sample.

(e) Confirm the site allows registered members to view profiles of other members. This is a standard feature of vBulletin. Because the automated data collection routines used during data validation relied on the ability to read user profiles via a unique URL, sites which had turned off this feature were dropped from the sample.

(f) Complete my own profile at the site. I completed my profile with accurate data about my profession ("Researcher"), employer ("U. of Maryland"), and location ("Maryland"). Where allowed, I also loaded a profile picture (typically, a 100x100 or smaller picture) and an avatar picture (typically, a 50x50 or smaller picture).

(g) Collect either a random sample (for large groups) or a complete listing of all posts at the site during the previous four-to-five months. This message listing was used to identify the user names of recently active members and to send study participation invitations.

(h) Collect the list of members who are administrators and moderators. This data was used to prioritize message invitations and as control data. Because the

purpose of the study is to assess the influence of communication by leaders, these users were given lower priority for message invitations.

(i) Prepare site-specific survey at the online survey host (SurveyMonkey.com). The survey title and fix different questions prompts in the survey included reference to the specific site name.

(j) Prepare and test automated routines for sending PMs to site members. The default setting for vBulletin sites is to restrict the sending of PMs to one every 30 seconds.

(k) Send out study participation invitations.

(l) Monitor responses. Respond to PMs, review the site for message threads with questions about the survey, and watch SurveyMonkey responses. Send out Amazon.com gift certificates to participants with fully completed survey responses as soon as possible after completion (no later than twelve to thirty-six hours after submission).

(m) If the initial survey invitations fail to generate enough responses, send out invitations to additional site members who have recently participated (e.g., those identified in step (g) above).

(n) Close survey when the survey invitation period is complete. Closing a survey involves changing the status in SurveyMonkey so it will no longer accept new responses. Surveys were closed for any one of these conditions: (1) enough survey responses were received for the group and the survey had already been open at least 24 hours, (2) no new responses had been received in the previous week, or (3) the survey had been open for a full month.

Archival Data

Only users who provided an accurate user identification name were included in the final data set used for analysis. Furthermore, only groups that met the minimum number of individual responses were included. For the respondents with valid user IDs from the groups included in the study, we collected their full message history. We collected not only summary data about every message they posted to the group, but also every message posted in every thread that they ever posted in. This way we could calculate both the measures related to direct communication and number of replies as well as the shared context measure.

To collect participant communication history we performed the following steps. (We automated each of these steps with scripts written with the WebL Java library.) First, we read the user profile. In vBulletin, the user profile includes a link to a query to "view all messages" for that user. We ran that query and noted the thread number for every message posted by the user. We then prepared a list of threads (eliminating duplicates) containing one or more messages by any of the survey respondents. Next, we collected summary data for every message in each thread. Finally, to calculate specific measures of interest, we limited the summary data to specific observations periods (e.g., the 15-, 30- or 60-day period to the survey start date) for each group.

Response Rate

The nature of the survey recruitment method makes it difficult to calculate a comparable response rate between groups. There were several complications: (a) in some groups the group administrator invited me to post a survey invitation to a message thread in lieu of any additional invitations via personal messages, (b) in some groups, the

participation invitation sent via personal message was posted by a recipient to a message

thread (in addition to invitations I sent via personal message), (c) there is no way to know

how many of the invitations sent by personal message were actually read, and (d) in some

groups, due to budget constraints the survey was closed once the required number of

respondents was received although additional responses might have still been gathered if

they survey had remained open. Still, we can gather some information about the response

patterns of individuals from different groups (see Table 7 below).

There were sixty-two different vBulletin message boards for which we received at

least one survey response. In looking at response rates (the shaded column), the lower

end of the range (0-5%) is consistent with direct mail solicitations, the average (12%) is

consistent with norms for contemporary survey research, and the upper end (20% and

above) was quite good.

Group	Personal Message Invitations	Any Response (Partial or Complete)	Response Rate (Any Response / Invites)	Fully Completed Responses	% Complete Response (Complete / Any Response)	Valid Responses	% Valid Response (Valid / Any Response)
WINX (*)	110	36	**33%**	20	56%	15	42%
UGOPL (*)	60	17	**28%**	15	88%	13	76%
JONNY	118	29	**25%**	26	90%	26	90%
NORTH	116	27	**23%**	25	93%	24	89%
AXIM	140	32	**23%**	26	81%	23	72%
DEVONE	149	32	**21%**	16	50%	22	69%
RCGR	97	19	**20%**	12	63%	14	74%
VDEP	110	21	**19%**	17	81%	19	90%
VJFORM	175	33	**19%**	25	76%	27	82%
MMOCC	133	25	**19%**	21	84%	20	80%
GEAR	157	29	**18%**	21	72%	17	59%
BLEND (**)	148	27	**18%**	25	93%	24	89%
NSIDE	115	20	**17%**	17	85%	18	90%
AGW (*)	245	40	**16%**	32	80%	30	75%
DEVX	135	22	**16%**	18	82%	17	77%
PEPPER	160	26	**16%**	18	69%	15	58%
DOOM	156	25	**16%**	22	88%	23	92%

Group	Personal Message Invitations	Any Response (Partial or Complete)	Response Rate (Any Response / Invites)	Fully Completed Responses	% Complete Response (Complete / Any Response)	Valid Responses	% Valid Response (Valid / Any Response)
DANGER	158	25	**16%**	18	72%	19	76%
LAKE	158	25	**16%**	21	84%	22	88%
NOTEB	128	20	**16%**	19	95%	18	90%
BHAUS	116	18	**16%**	13	72%	13	72%
PCPER	149	23	**15%**	16	70%	19	83%
BREWQ	162	25	**15%**	18	72%	18	72%
WBICY (*)	150	23	**15%**	13	57%	3	13%
GREY	149	21	**14%**	20	95%	21	100%
KIRU	157	22	**14%**	15	68%	15	68%
CMFAM	65	9	**14%**	7	78%	8	89%
SWORD	52	7	**13%**	4	57%	5	71%
SIGNS	119	16	**13%**	12	75%	13	81%
MACOSX	30	4	**13%**	1	25%	1	25%
MACRUM	167	22	**13%**	16	73%	17	77%
OSNN (*)	86	11	**13%**	9	82%	10	91%
BTECH	110	10	**9%**	4	40%	5	50%
FRUGAL	300	27	**9%**	18	67%	17	63%

Group	Personal Message Invitations	Any Response (Partial or Complete)	Response Rate (Any Response / Invites)	Fully Completed Responses	% Complete Response (Complete / Any Response)	Valid Responses	% Valid Response (Valid / Any Response)
SRVR	149	13	**9%**	6	46%	7	54%
STEAM	105	9	**9%**	4	44%	5	56%
LGSOFT	132	11	**8%**	7	64%	7	64%
SCRAP	73	6	**8%**	5	83%	5	83%
TALKF	129	10	**8%**	7	70%	8	80%
GEEKST	142	11	**8%**	8	73%	10	91%
CODEF	264	20	**8%**	9	45%	11	55%
XMODS	27	2	**7%**	2	100%	2	100%
IROSE	138	10	**7%**	8	80%	9	90%
VWNAVI	288	20	**7%**	14	70%	13	65%
FLASH	223	15	**7%**	5	33%	10	67%
ACRE	328	22	**7%**	18	82%	17	77%
QPEN	77	5	**6%**	4	80%	5	100%
ACTS	529	33	**6%**	19	58%	21	64%
TREOC	150	9	**6%**	5	56%	5	56%
PSOFT	389	21	**5%**	13	62%	14	67%
TECHP	101	5	**5%**	4	80%	5	100%

Group	Personal Message Invitations	Any Response (Partial or Complete)	Response Rate (Any Response / Invites)	Fully Completed Responses	% Complete Response (Complete / Any Response)	Valid Responses	% Valid Response (Valid / Any Response)
VBULLS	101	5	**5%**	3	60%	3	60%
SPEED	217	9	**4%**	8	89%	8	89%
CPANEL	149	6	**4%**	2	33%	2	33%
ICRON	129	5	**4%**	3	60%	5	100%
XBOX	79	3	**4%**	1	33%	2	67%
SWEET	351	12	**3%**	9	75%	10	83%
HOSTR	36	1	**3%**	0	0%	0	0%
RAILB	94	2	**2%**	2	100%	2	100%
GRAPH	186	3	**2%**	1	33%	2	67%
RPGH	154	1	**1%**	1	100%	0	0%
ALLNT	246	1	**0%**	1	100%	1	100%
Total	9566	1038	**N/A**	749	N/A	760	N/A
Average	154	17	**12%**	12	70%	12	72%

(*) Invitation also posted on a site thread.

(**) Dropped from final sample; website closed before all archival data collected.

Table 7: Response Rates for 62 Groups

The number of personal messages (PMs) sent out to each group varied based on (a) the number of members available to send messages to (larger groups had a larger potential set of members to invite), (b) the responsiveness of initial batch of invitees (which determined if additional invitations were required to meet the minimum number of responses for the group to be viable), and (c) if I was banned by site administrators for sending out "bulk" personal messages (some sites took a very aggressive stance on sending unsolicited personal message even when no posted group policies were violated). The number of PMs ranged from a high of 529 for the group ACTS to a low of twenty-seven for the group XMODS. The average number of PMs per group was 154. At five groups (AGW, OSNN, UGOPL, WINX, and WBICY) an invitation to participate was also posted on a public message thread either by myself (at a moderator's invitation) or by a user to whom I had sent an invitation via personal message.

A respondent is included in the count of "any response" if they completed at least the first screen of survey questions. This means that they had agreed to the online participant consent form and completed one screen with multiple survey questions. The number of "any responses" range from a high of 40 from AGW to a low of 1 from ALLNT, HOSTR, and RPGH. The average number across all sites was seventeen.

A respondent is included in the fully completed responses if he or she completed all of the screens of survey questions, including providing a response to the prompt for a user ID and a nomination of one or more leaders at the site. The number of "fully completed responses" range from a high of 32 from AGW to a low of 0 from HOSTR. The average number across all sites was twelve. Once a respondent completed all survey questions, he or she were provided with the option of receiving the survey completion

incentive (described above). The respondents who choose not to provide a personal email address required for the survey completion incentive but otherwise completed all other survey responses were included in the count of "fully completed responses."

Finally, the count of valid responses includes users who completed at least six of the seven screens of survey data. This includes a valid user ID. Respondents in this category did not need to provide a response to the final screen of the survey data, one which requested nominations for group leaders. Because the group leader nominations were pooled across the responses for the entire group, the lack of a group leader nomination for an individual response does not render it unusable. As long as all other data elements were accurately completed, including a valid user ID for the site in question, the respondent data can be included in the sample. The number of "valid responses" range from a high of 30 from AGW to a low of 0 from HOSTR and RPGH. The average number across all sites was twelve.

Hypotheses Testing Approach

We used regression-based multilevel modeling analysis, hierarchical linear modeling, to test our hypotheses (see Aiken & West, 1991; Cohen, Cohen, West, & Aiken, 2003). This technique allowed us to control for the lack of independence of individual observations within groups while also testing for the consistency of hypothesized relationships across groups. Furthermore, this technique supports statistical tests of cross-level relationships: in this case, the effect of group-level moderators on individual level relationships.

Hierarchical linear modeling was the appropriate statistical method for this study because our data violates assumptions of OLS regression. Hierarchical linear modeling is

also known as random coefficient models, mixed-effects models, covariance structure models, and growth-curve models (Luke, 2004). If we had used OLS regression for our tests of nested and cross-level relationships, it would have resulted in inaccurate parameter estimates and inaccurate significance levels. Different patterns of within-group and across-group similarity and dissimilarity for independent variables and dependent variables determine how extreme the potential problems would have been. The use of hierarchical linear modeling addressed the violation of the lack of independence of observations assumption required for OLS regression.

Hierarchical multiple regression simultaneously estimates a model of the relationship of variables within a group and how those relationships vary between groups. Conceptually, the process is akin to estimating a regression fit for each group and using the resulting parameter estimates as inputs for a group-level regression equation. The term "random coefficient" is applied because the intercept and slope estimates for each within-unit regression equation can vary "randomly" between units. Although hierarchical multiple regression is a novel technique within online groups research it is a well-accepted statistical method in psychology and management journals.

Chapter 5: Results

To analyze this rich data set, we will use a random-coefficient modeling technique, hierarchical linear modeling (HLM), to control for the lack of independence of individual observations within groups while also testing for the consistency of hypothesized relationships across groups. Furthermore, this technique supports statistical tests of cross-level relationships; in this case, the effect of group-level moderators on individual level relationships. As a first step in data analysis, we confirm the validity of our survey instrument, including statistical tests to justify the aggregation of emergent properties to the group level.

Measurement Analysis

As described above, three study variables were measured through multi-item survey responses: participation role intentions, turnover intentions, and psychological safety. Also, two group-level study variables, psychological safety and number of perceived leaders, are group-level variables aggregated from individual level responses. In this section, we report the construct reliability and validity of the measurement of these constructs.

Construct Reliability and Validity

Of the three multi-item survey responses two (turnover intentions and psychological safety) were adapted to our setting from existing measures and the third (participation role intentions) was developed specifically for this study. As a first step, we analyzed the reliability of each construct individually. On the four-item scale for turnover intentions Cronbach's alpha was 0.78, with no improvement by deleting any of the four

items. On the three-item scale for psychological safety, Cronbach's alpha was 0.71, with no improvement by deleting any of the three items.

For the newly created scale for participation role intentions, with all five items included the value for Cronbach's alpha was 0.75. By dropping the fifth item on the scale Cronbach's alpha improved to 0.78. The fifth item had a lower average value (mean = 3.26) than the other four (n = 535; mean = 3.48 to 3.77). The fifth item also had a much lower average correlation with the other four items ($r = .22$) than those four items did with each other ($r = .46$). In light of this evidence, we opted to drop the fifth item ("I plan to reprimand other members' inappropriate behaviors."). All further analyses are presented based on a four-item scale.

Transformation of Variables

Consistent with other studies of online groups we found that two variables collected at the individual level and one collected at the group level (number of messages and number of perceived leaders; number of active members, respectively) followed non-normal distributions. To increase the validity of statistical tests, we performed a natural log transformation on all three of these variables with abnormally high kurtoses. Because the valid range for both number of messages and number of perceived leaders included a minimum value of 0, the constant of 1 was added to the original value prior to the transformation.

Prior to transformation the number of archival messages (n = 535) had a mean of 253.2, a standard deviation of 638.2, and a kurtosis of 72. After the natural log transformation, the mean was 4.0, the standard deviation 2.0, and the kurtosis 1.6. Prior to transformation the number of perceived leaders (n = 535) had a mean of 14.0, a

standard deviation of 47.9, and a kurtosis of 339. After the natural log transformation, the mean was 2.1, the standard deviation 1.0, and the kurtosis 2.0. Prior to transformation the number of active members (n = 33) had a mean of 310.9, a standard deviation of 673.9 and a kurtosis of 22.6. After the natural log transformation, the mean was 4.8, the standard deviation 1.3 and the kurtosis 0.7.

Aggregation to Group Level

The group-level constructs of psychological safety and number of perceived leaders were measured at the individual level and aggregated to the group level. We calculated multiple statistics to justify the aggregation of these measures to the group level. For the three-item survey measure of psychological safety, we calculated ICC(1) = 0.09 and ICC(2) = 0.66 (see Bliese, 2000; James, Demaree, & Wolf, 1993). These values may be interpreted as follows: approximately 9 percent of the variance in the individual level values of psychological safety can be accounted for by group membership. However, groups can be differentiated from one another based on their mean psychological safety value with an estimated reliability of 66 percent. We calculated Rwg(j), a measure of inter-member agreement on the multi-item scale, as 0.88.

For the single item measure of number of perceived leaders, we calculated ICC(1) = 0.09 and ICC(2) = 0.64. Again, although a relatively low amount of individual variance in this value can be explained by group membership, groups may be reliably differentiated based on group means. We calculated Rwg = 0.61 for the number of perceived leaders.

Statistical Power Analysis

A difficult question in performing this study was assessing when we had collected enough survey data to reasonably expect to achieve the statistical power necessary to test the relationships of interest. The nature of nested, cross-level analyses complicated the determination of what an appropriate minimum sample size was for this study. The ability to discern statistically significant effects for the hypothesized relationship depends not only on effect sizes but also on a complex pattern of within-group and across-group similarities and differences on variables of interest. Nonetheless, the general guidance for multi-level research is it is "usually desirable to have as many units as possible at the top level of the multilevel hierarchy" (Snijders, 2005, p. 1570). Furthermore, the number of groups (>30), number of respondents (at least 5) and total number of respondents (average of 16 per group), was consistent with a design considered necessary to find medium to large effects (Raudenbush & Liu, 2000; Snijders & Bosker, 1993). Regardless, in this domain our study encompasses both the largest cross-level data set we know of to date as well as the first to combine subjective survey responses with objective participation data for a large sample.

<div align="center">

Hypotheses Tests

</div>

The specific form of hierarchical multiple regression we used was two-level hierarchical linear modeling (HLM) as implemented in the HLM 6.06 software package (Raudenbush, Bryk, Cheong, & Congdon, 2008). Our hypotheses propose individual-level outcomes with both individual-level predicators and group-level moderators. Because the tests of individual-level outcomes predicted by individual-level variables are subject to non-independence due to common group-level influences, these relationships

are also tested via HLM. All of the presented HLM models allow for both unequal intercepts and unequal slopes across groups.

In OLS regression more commonly used in Information Systems literature, researchers are accustomed to assessing the overall fit of a regression model via the adjusted R-squared value. In contrast to a single-level model, in multi-level models there are multiple components of variance (in a two-level model, both between-group and within-group variance), complicating the calculation of a corresponding value to assess model fit. We report the closest available statistical measure, the pseudo $\sim R^2$ calculation developed by Snijders and Bosker (1993).

Results

Table 8 provides the descriptive statistics and correlations for the study variables. In this table, the team-level variables correlations were based on team-level means assigned down to individual-level respondents. These values are shown merely for descriptive purposes and are not intended to faithfully reproduce the mechanics of HLM regression.

Variable	Mean	SD	1	2	3	4	5	6	7	8	9
1. Tenure (# of years)	2.01	1.76	---								
2. Experience (LN) (# of Msgs)	3.98	2.04	.51**	---							
3. Reply Percentage	.86	.18	.11**	.44**	---						
4. Shared Context w/ Nominated Leaders	.31	.40	.25**	.30**	.18**	---					
5. Direct Interaction w/ Nominated Leaders	.07	.18	.07	.00	-.08	.43**	---				
6. Psychological Safety (group mean)	4.17	.24	.11*	.18**	.09*	.09*	.16**	---			
7. Perceived # of Leaders (LN) (group mean)	2.08	.37	.13**	.37**	.28**	-.02	-.02	.26**	---		
8. Number of Active Members (LN)	4.96	1.17	-.01	.35**	.24**	.00	-.21**	.12**	.58**	---	
9. Participation Role Intentions	3.61	.78	.07	.23**	.14**	.16**	.12**	.26**	.27**	.19**	---
10. Turnover Intentions	2.25	.81	-.05	-.09*	-.12**	-.13**	.01	-.15**	-.18**	-.21**	-.38**

Note. N=535; * $p < 0.05$, ** $p < 0.01$; Statistics are for individual-level variables with group means assigned down to individuals.

Table 8: Descriptive Statistics and Correlations

The HLM analyses testing our proposed hypotheses are reported in Table 9 for

H1-H2 and in Table 10 for H3-H5. Each table shows separate HLM analysis for the

dependent variables of participation role intentions and turnover intentions. HLM

parameter estimates are shown as table entries with standard errors in parentheses. All

individual-level variables were grand-mean centered to reduce potential issues with

group-level parameter estimates due to multicollinearity (Snijders & Bosker, 1999) and to

facilitate interpretation of results (Kreft, de Leeuw, & Aiken, 1995).

The analyses were run for 535 individuals in thirty-three online groups (an

average of sixteen individuals per group). The variables shared context with nominated

leaders, direct interaction with nominated leaders and number of active members were all

measured based on an observation period of 21 days. This period covers group

communication during the 21 days immediately prior to the beginning of the survey

collection for that group. Appendix C provides additional descriptive statistics, means,

standard deviations, minimum values and maximum values for individual-level and

group-level variables used in the reported HLM analyses.[1]

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[1] Appendix C reports the average of group means (N=33). The descriptive statistics reported above provide

the grand mean (N=535). In our case of unequal group sizes, these two values may differ.

	DV: Participation Role Intentions		DV: Turnover Intentions		Related Hypothesis
Predicator	**Model 1**	**Model 2**	**Model 1**	**Model 2**	
Intercept	3.59 (.09)**	3.57 (.10)**	2.27 (.08)**	2.30 (.08)**	
Individual-Level Past Experience					
Tenure (# of years)	-.04 (.02)	-.04 (.02)*	-.00 (.02)	-.00 (.02)	H1a: Not supported
Experience (LN) (# of Msgs)	.10 (.03)**	.09 (.03)**	.00 (.02)	.01 (.02)	H1b: Partial support
Reply Percentage	-.04 (.24)	-.02 (0.21)	.04 (.21)	.00 (.21)	H1c: Not supported
Interaction with Nominated Leaders					
Shared Context w/ Nominated Leaders	---	.18 (.07)*	---	-.19 (.10)	H2a: Partial support
Direct Interaction w/ Nominated Leaders	---	-.48 (.22)*	---	.15 (.20)	H2b: Not supported
Pseudo ~R^2	.43**	.46*	.30**	.31**	

Note. * $p < .05$, ** $p < .01$; N=535 individuals in 33 groups (avg. of 16 ind. per group); 21 day observation period; individual-level variables are grand-mean centered; HLM parameter estimates shown as table entries with standard errors in parentheses.

Table 9: Hierarchical Linear Modeling Results for H1 and H2

Table 9 records the results of two HLM models, run separately for the participation role intentions and the turnover intentions dependent variables. Model 1 shows tests for three variables representing individual-level measures of past participation. Model 2 includes two measures of interaction with group leadership. H1a, H1b, and H1c stated that the three measures of past participation are associated with increased participation role intentions and decreased turnover intentions.[2] H2a stated that interaction with group leadership, in the form of shared context with nominated leaders, was associated with increased participation role intentions and decreased turnover intentions. H3a stated that direct interaction with leadership would have a stronger impact on those outcomes over and above shared context.

We begin with a discussion of the results shown in Table 9 related to H1a-H1c. Model 1, including only individual-level past experience variables, was calculated as a baseline. At .46 ($p < .05$), the pseudo $\sim R^2$ for Model 2 for participation role intentions shows a modest improvement from Model 1 ($\sim R^2 = .43, p < .01$). Likewise, Model 2 for turnover intentions ($\sim R^2 = .31, p < .01$) shows a slight improvement over Model 1 ($\sim R^2 = .30, p < .01$). The calculation of pseudo $\sim R^2$ takes into consideration the complexities of multi-level regression model estimation. Even when a model has multiple additional statistically significant parameter estimates, a corresponding increase in pseudo $\sim R^2$ may be slight if there are less favorable changes in estimated covariance components (Hofmann & Gavin, 1998).

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[2] Through additional analyses we confirmed the direction and magnitude of parameter estimates are not sensitive to order of entry effects.

As reported in Table 9, tenure was a statistically significant predictor of participation role intentions ($\beta = -.04$, $p < .05$), but *not* in the hypothesized direction. Tenure was not a statistically significant predictor of turnover intentions. The HLM results provided no support for H1a.

The parameter estimate for experience as a predictor of participation role intentions (Model 2) was statistically significant ($\beta = .09$, $p < .01$) and in the hypothesized direction. It was not statistically significant for turnover intentions. H1b was partially supported by the HLM results.

The HLM results provided no support for H1c. The parameter estimates for reply percentage were not significant for either participation role intentions or turnover intentions. Although there was a statistically significant correlation between both reply percentage and participation role intentions ($r = .14$, $p < .01$) and reply percentage and turnover intentions ($r = -.12$, $p < .01$), our HLM analysis provided no evidence of a statistically significant relationship after controlling for effects of group membership and the impact of other individual-level variables. This lack of statistical significance demonstrates the peril of directly interpreting correlations between variables and the value of performing multi-level analysis such as HLM on multi-level data.

Next we turn to the test of hypothesis H2a and H2b dealing with variables measuring interaction with leadership. For the test of H2a, the HLM analysis in Model 2 showed shared context with nominated leadership was a statistically significant predictor ($\beta = .18$, $p < .05$) of participation role intentions. No significance was found for the turnover intentions. Therefore, we conclude H2a was partially supported.

In H2b, we proposed that direct interaction with nominated leadership would have a greater effect (in the same direction) than shared context with nominated leadership. To support this hypothesis, three conditions needed to be met:

(i)   There needed to be a statistically significant relationship between direct interaction and each DV,

(ii)   The parameter estimates needed to be in the hypothesized direction, and

(iii)   If the parameter estimates for shared context were statistically significant and in the expected direction, the parameter estimates for direct interaction needed to be of greater magnitude.

As shown in Table 9, the parameter estimate (β = -.48, p < .05) for the relationship between direct interaction and participation role intentions was statistically significant but not in the hypothesized direction. Therefore, although condition (i) was met, condition (ii) was not. The parameter estimate for direct interaction as a predictor of turnover intention was not significant. In summary, there was no support for H2b.

Next, we present the results of the HLM tests for hypotheses H3, H4, and H5. These results are shown in Table 10. Model 3 is shown for reference. It is the same as Model 2 in Table 9 with addition of three group-level predictors: group mean psychological safety, group mean perceived number of leaders, and number of active members (during the twenty-one-day observation period). Model 4 was used for the test of H3-H5. These hypotheses predicted that the three group-level predictors moderated the relationship between the two variables measuring interaction with nominated leaders (shared context and direct interaction) and the two outcome variables (participation role intentions and turnover intentions).

Predictor	DV: Participation Role Intentions		DV: Turnover Intentions		Related Hypothesis
	Model 3	Model 4	Model 3	Model 4	
Intercept	.44 (.91)	.19 (.95)	3.96 (.94)**	4.91 (1.14)**	
Group-Level					
Psychological Safety (group mean)	.66 (.25)*	.68 (.26)*	-.26 (.22)	-.43 (.23)	
Number of Active Members (LN)	-.08 (.05)	-.06 (.06)	-.08 (.06)	-.11 (.06)	
Perceived # of Leaders (LN) (group mean)	.40 (.19)*	.39 (.19)*	-.09 (.17)	-.14 (.23)	
Individual-Level Past Experience					
Tenure (# of years)	-.05 (.02)*	-.05 (.02)*	-.00 (.02)	-.00 (.02)	
Experience (LN) (# of Msgs)	.09 (.03)**	.08 (.03)**	.02 (.02)	.02 (.02)	
Reply Percentage	-.04 (.21)	-.05 (.22)	-.01 (.21)	.05 (.22)	

Predictor	DV: Participation Role Intentions		DV: Turnover Intentions		Related Hypothesis
	Model 3	Model 4	Model 3	Model 4	
Interaction with Nominated Leaders					
Shared Context w/ Nominated Leaders	.18 (.07)*	.26 (1.60)	-.19 (.10)	.71 (1.76)	
Moderator: Psychological Safety	---	-.16 (.32)	---	.09 (.43)	No support for H3
Moderator: Number of Active Members (LN)	---	.14 (.20)	---	-.24 (.12)	No support for H4
Moderator: Perceived # of Leaders (LN)	---	.06 (.08)	---	-.05 (.49)	No support for H5
Direct Interaction w/ Nominated Leaders	-.43 (.18)*	-5.56 (4.30)	.03 (.22)	-1.61 (3.8)	
Moderator: Psychological Safety	---	.96 (1.05)	---	-.31 (.98)	No support for H3
Moderator: Number of Active Members (LN)	---	.48 (.55)	---	-.11 (.19)	No support for H4
Moderator: Perceived # of Leaders (LN)	---	.06 (.20)	---	1.67 (.75)*	No support for H5
Pseudo ~R^2	.44**	.44**	.30**	.30**	

Note. * $p < .05$, ** $p < .01$; *N*=535 individuals in 33 groups (avg. of 16 ind. per group); 21 day observation period; individual-level variables are grand-mean centered; HLM parameter estimates shown as table entries with standard errors in parentheses.

Table 10: Hierarchical Linear Modeling Results for H3, H4 and H5

The results of Model 4 in Table 10 provided <u>no support for H3</u>, <u>no support for H4</u>, and <u>no support for H5</u>. As a test of H3, no support was found of a moderating relationship of psychological safety on the slope of shared context with nominated leaders with either participation role intentions or turnover intentions. As a test of H4, no moderating effect was found for number of active members. Finally, as a test of H4, no moderating effect was found for perceived number of leaders.

The HLM tests showed no support for H3, H4 or H5. Nonetheless, Model 3, an HLM test of all the individual-level and group-level model variables, shows several statistically significant results of note. The individual-level variables previously found significant remained statistically significant predictors of participation role intentions: tenure ($\beta = -.05$, $p < .05$), experience ($\beta = .09$, $p < .01$), shared context with nominated leaders ($\beta = .18$, $p < .05$) and direct interaction with nominated leaders ($\beta = -.43$, $p < .05$). Also, two group-level variables were found to be significant: group mean psychological safety ($\gamma = .66$, $p < .05$) and group mean perceived number of leaders ($\gamma = .40$, $p < .05$). (We discuss these findings in more detail in a later section.)

Additional Analyses

To gain additional insight into the pattern of relationships seen in the hypothesis testing, we performed two additional analyses. In the first, we analyzed an alternative model predicting the dependent variable turnover intentions. In the second, we tested a model predicting the individual perception of group psychological safety. We present the results of these two tests next.

Predicting Turnover Intentions

Predictor	DV: Turnover Intentions
Intercept	3.57 (.72)**
Individual Participation Role Intentions	-.23 (.06)**
Group-Level	
Psychological Safety (group mean)	-.16 (.16)
Number of Active Members (LN)	-.11 (.04)*
Perceived # of Leaders (LN) (group mean)	-.06 (.13)
Individual-Level Past Experience	
Tenure (# of years)	-.00 (.03)
Experience (LN) (# of Msgs)	.04 (.02)
Reply Percentage	-.14 (.08)
Interaction with Nominated Leaders	
Shared Context w/ Nominated Leaders	-.14 (.08)
Direct Interaction w/ Nominated Leaders	-.04 (.19)
Pseudo ~R^2	.32**

Note. * $p < .05$, ** $p < .01$; *N*=535 individuals in 33 groups (avg. of 16 ind. per group); 21 day observation period; individual-level variables are grand-mean centered; HLM parameter estimates shown as table entries with standard errors in parentheses.

Table 11: Additional HLM Results for Turnover Intentions

In Table 9 and Table 10, four different HLM models predicted turnover intentions. In those models, no statistically significant parameter estimates were identified that directly predicted turnover intentions. (One statistically significant parameter estimate, for a moderator in the HLM Model 4, is associated with a variable moderating the slope of a non-significant predictor.) As noted in Table 8, participation role intentions and turnover intentions are significantly correlated ($r = -.38$, $p < .01$). This

motivated us to test an additional HLM model, shown in Table 11, adding participant role intentions as a predictor for turnover intentions.

In Table 11, the HLM model included all of the predictors in Model 3 of Table 10 plus participation role intentions. In contrast to the earlier model, where no predictors where significant, two estimated parameters were statistically significant. The parameter estimate for the individual-level variable, participation role intentions was statistically significant ($\beta = -.23$, $p < .01$). Also, the parameter estimate for the group-level measure number of active members was statistically significant ($\gamma = -.11$, $p < .05$). This HLM model provides evidence that (after controlling for the all other variables in the model), the higher the level of an individual's participation role intentions and the higher the number of active members in the group in which an individual participated, the lower their reported turnover intentions were.

Predicting Psychological Safety

As a second additional analysis, we sought to identify the antecedents of group mean psychological safety. Table 12 reports an HLM model of individual-level predictors of the individual-level variable measuring group psychological safety (this is the variable aggregated to create the group mean psychological safety measure). As shown, we found the parameter estimates for both experience ($\beta = .04$, $p < .05$) and shared context with nominated leaders ($\beta = .19$, $p < .01$) were statistically significant. The estimated psuedo-R^2 for the model was significant ($\sim R2 = .16$, $p < .01$). This model suggests that participants who posted more messages, and participants who posted more of their messages to message threads where nominated leaders also posted, were more likely to report a higher score for their group for psychological safety.

Predictor	DV: Psychological Safety
Intercept	4.15 (0.05)**
Individual-Level Past Experience	
Tenure (# of years)	-.01 (.02)
Experience (LN) (# of Msgs)	.04 (.02)*
Reply Percentage	-.15 (.17)
Interaction with Nominated Leaders	
Shared Context w/ Nominated Leaders	.19 (.07)**
Direct Interaction w/ Nominated Leaders	-.28 (.21)
Pseudo ~R^2	.16 **

Note. * $p < .05$, ** $p < .01$; N=535 individuals nested in 33 groups (avg. of 16 ind. per group); 21 day observation period; individual-level variables are grand-mean centered; HLM parameter estimates shown as table entries with standard errors in parentheses.

Table 12: HLM Results for Ind. Measure of Group Psychological Safety

Summary of Findings

Next, we summarize the results of the hypotheses tests. No support was found for predicting turnover intentions. Surprisingly, statistically significant relationships were found between participation role intentions and the IVs of tenure and direct interaction with nominated leadership--but, both in the opposite direction than was expected (counter to H1a and H2c, respectively). As hypothesized, the relationship between experience (as measured in participation tenure) and participation role intentions and between shared context with nominated leaders were supported (H1b and H2a). No support was found for reply percentage as a predictor of continued participation (H1c). No support was found for group characteristics serving as moderators of the relationship between interaction with leadership and the dependent variables (H3, H4 and H5).

Additional analyses suggested that turnover intentions decreased based on an increased number of active members and increased participation role intentions. Also, we found support for psychological safety being predicted by experience and shared context with leadership. Finally, the full model test of the direct relationships between the independent variables and participation role intentions (Model 3 in Table 10) showed multiple statistically significant predictors. The individual-level variables, experience and shared context with nominated leaders, were both positively associated with participation role intentions. The group-level variables, group mean psychological safety and perceived number of leaders, were also both positively associated with participation role intentions. Finally, the individual-level variables tenure and direct interaction with nominated leaders were, surprisingly, negatively associated with participation role intentions.

Chapter 6: Discussion and Summary

This study combined data from individual survey data and online archival messages to perform cross-level analyses using hierarchical linear modeling (HLM), a multi-level regression technique. We tested our hypotheses with data from 535 survey responses from members of thirty-three different online groups along with online group communication history spanning 135,477 messages.

Combining a solid theoretical framework with novel, yet rigorous, methods of online data collection and analysis, this dissertation makes three major contributions to the study of online groups.

- First, it breaks new ground in the under-studied area of leadership in online groups both by providing empirical evidence for the impact of group leadership and by demonstrating how leaders influence individual participation intentions.

- Second, it establishes group psychological safety both as a contextual factor influenced by group leadership and as a contextual factor that impacts individual participation intentions. This demonstrates the importance of a multi-level approach to studying online group participation.

- Finally, it identifies a clear differentiation between participation role intentions and turnover intentions. This bolsters the utility of a nuanced view of participation in building theories of online groups.

All together, the improved understanding of continued participation in online groups provided by this study extends theories of online groups and expands practitioner knowledge of this important phenomenon.

Discussion

This study expands our understanding of the relationships between past participation in online groups, the impact of interaction with online group leadership and the impact of online group characteristics on individual continued participation intentions in online groups. Specifically, there were four major areas of findings.

1. This study explored two conceptually related constructs that both reflected continued participation intentions: participation role intentions (what roles a participant plans on performing) and turnover intentions (are they likely to remain in the group). Importantly, we found that despite the close conceptual relationship, these two constructs did not share the same antecedents.

2. The study refined and extended previous research into past participation as a predictor of continued participation. Whereas our results ran counter to other studies that found reply percentage and group tenure predict continued participation, we did confirm the utility of past participation as a predictor of future intentions.

3. A major contribution of the study is identifying not only that interaction with group leadership predicted future participation role intentions but also that the nature of the interaction with nominated leaders--direct interaction or shared context--resulted in different outcomes.

4. Finally, we identified group psychological safety as a key construct linking past participation, interaction with leadership, and participation role intentions. This is the first study we know of to measure psychological safety in online groups. We found that psychological safety was both positively related to individual

participation and positively related to shared context with nominated leadership. Furthermore, members of groups with higher levels of psychological safety reported higher levels of participation role intentions.

In Figure 5, we present a model that combines the statistically significant paths found in the analyses presented above. The solid lines represent statistically significant relationships with a positive parameter estimate. The dashed lines, a negative parameter estimate. This is a summary *conceptual model*, not a unified *measurement model*. Future research with advanced (though still relatively new) methods such as multi-level structured equation modeling would be required to test all of these paths in a single measurement model.
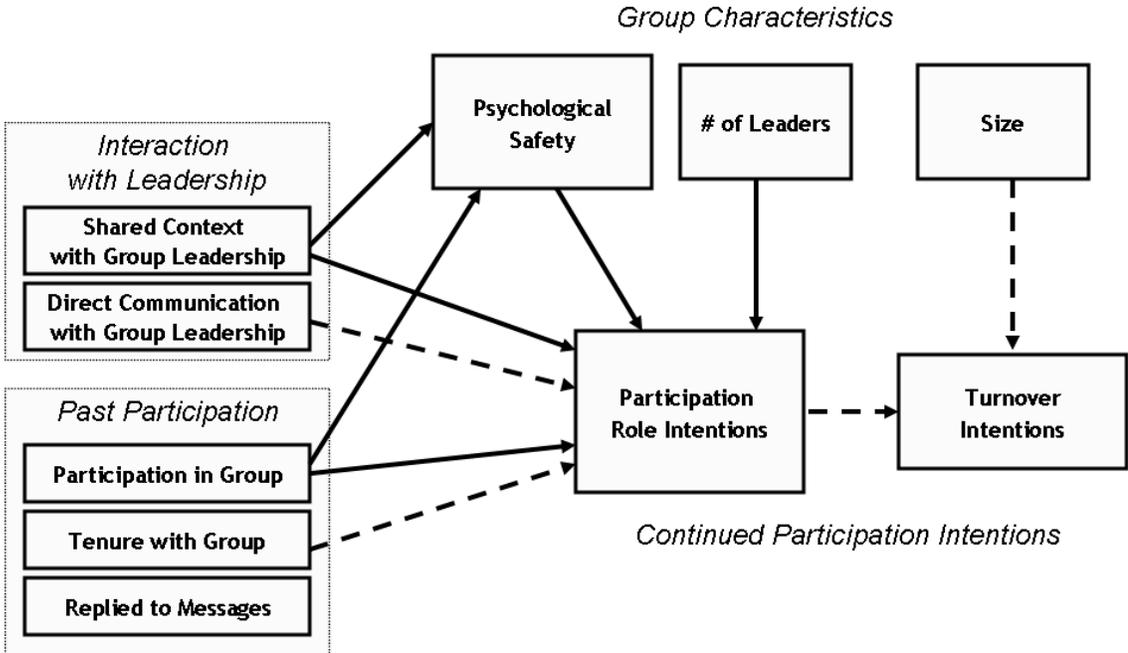
Note. Solid lines represent positive parameter estimates; dashed lines, negative estimates.

Figure 5: Summary of Results - Conceptual Model

In summary, our study found that participation role intentions and turnover intentions are distinct constructs, with participation role intentions (and group size) predicting turnover intentions. We found that newer participants, participants who

participate more, participants who communicate directly less frequently with nominated

group leadership, and participants with a higher shared context with leadership have

higher participation role intentions. Also, participants of groups with higher levels of

psychological safety and higher numbers of perceived group leaders have higher

participation role intentions. Finally, our analysis showed higher levels of participation

and higher levels of shared context with leadership are associated with higher group

psychological safety.

Contribution

It is useful to review the study findings in light of previous research in online

groups. We do so next, organized by the four major findings summarized above. For each

finding we relate our results to the most relevant prior work.

We extend the work of multiple studies in finding different antecedents for

participation role intentions and turnover intentions. Studies of online groups have

typically measured continued participation in terms of actively posting additional

messages (e.g., Joyce & Kraut, 2006) or in terms of remaining a member of a group (e.g.,

Butler, 2001). The study of online groups generally assumes these behaviors are closely

related and likely to share similar antecedents. Our findings confirm the merit of treating

participation as a continuum of participation roles (Butler et al., 2007) and the importance

of differentiating between *what* roles a participant intends to fulfill in an online group and

how long a participant is likely to remain an online group member.

In addition to finding that participants with higher participation role intentions

had lower turnover intentions, we also found that larger groups were associated with

lower turnover intentions. This finding extends our understanding of the applicability of

resource-based and information-overload theories of online groups. Previous work (Butler, 2001; Jones et al., 2004) supports the hypothesis that as groups get larger, existing members are less likely to participate--as though they are crowded out by new participants. In our sample, we found a different result. First, we found no relationship between online group size and participation role intentions. Second, we found that the number of active members was associated with lower turnover intentions.

One possible reason for a difference in findings between their studies and ours is the different technology platform we studied. The vBulletin technology platform provides more participation structures (ways of organizing content) as compared to online groups supported by USENET and news groups. Their studies concluded that participation structures might mitigate negative impacts of group size. Therefore, it is possible that the negative effects of size found by Butler (2001) and Jones et al. (2004) were not present in the online groups in this sample.

Our results provide an expanded understanding of the antecedents of continued participation role intentions. After controlling for group effects, we found no relationship in our sample between message reply percentage and participation role intentions. This outcome extends what is known about the relationship between reply percentage and actual continued participation found by Joyce and Kraut (2006). In their study of 2,777 newcomers in six news groups, Joyce and Kraut (2006) focused on replies to the very first message posted by a newcomer to a news group. We measured the percentage of replies to messages posted over longer period of membership. Together, these findings suggest that receiving a response to the initial message posted to an online group has a

stronger influence on continued participation than cumulative response rates does on continued participation intentions.

Our findings regarding the importance of interaction with leadership open up new areas of study for online groups. Previous work on leadership in online groups has delineated different types of leadership roles common to online groups (Butler et al., 2007). Our work reinforces the importance of considering participation roles, first by demonstrating that different types of interaction with leadership had different impacts, and also by showing that the number of perceived leaders predicted participation role intentions. The finding that shared context with group leadership had a positive effect while direct communication with leadership had a negative effect on participation role intentions may indicate that both the presence of communication as well as what was being communicated are important.

We conjecture that direct communication could have had a negative impact on participation role intentions when member's needs (informational or social) were satisfied through direct communication with the most influential members of an online group. Alternatively, direct communication could dampen participation role intentions if the communicate was of a negative tone. Either way, this unresolved question speaks to the usefulness of also studying message content (e.g., Joyce & Kraut, 2006; Kudaravalli, 2007) and communication network structures (e.g., Faraj et al., 2008) to gain additional insights into communication incentives, patterns, and motivations.

We found that psychological safety was a key construct linking past participation, interaction with leadership, and participation role intentions. Psychological safety was positively related both to individual participation and to shared context with nominated

leadership; members of groups with higher levels of psychological safety reported higher levels of participation role intentions. These findings were consistent with previous work on the importance of self-expression as a predictor of long-term relationship formation in online groups (McKenna et al., 2002). The two-step linkage from shared context with nominated leaders to psychological safety and then from psychological safety to participation role intentions also speaks to the key role the most influential members play in developing group-specific norms for participation behavior. This further demonstrates the importance of studying online groups as groups; that is, treating each group as a unique context with group-specific norms and conditions that impact individual behaviors.

Limitations and Future Work

As with any research project, this one had a number of design and implementation trade-offs that suggest opportunities for future study. An essential design element of the study was the choice to limit the sample to online groups supported by the same technology platform and with similar topics. A primary advantage of a consistent technology platform--a consistent operationalization of measures of observed behaviors-- also suggests caution in comparing findings to studies of other online groups for variables that may be sensitive to measurement issues. For example, as noted above, different studies have operationalized participation in different ways (e.g., joining a group versus posting a message). The significance of these activities should be considered within the context of the overall study as well as the technology platform(s) studied.

Whereas it was relatively simple to ensure the large number of groups in the study sample shared the same technology platform, it was more challenging to limit the

variance in online group topic. Despite the popularity of the vBulletin board technology platform, the supply of groups meeting the study criteria was not without limit. Care was taken to ensure that all of the study groups involved discussions related to information technology (hardware, software) or technology-intensive consumer products. Nonetheless, there are differences in the focus of the study groups. Group-level differences in factors such as bond-basis (Ren et al., 2007), the nature of identification members have with a group, could serve as exogenous factors contributing to unexplained variance in, for example, turnover intentions. Two groups covering similar topics, such as Web site development and computer programming, may vary in emphasis on meeting participants' transactional information needs versus promoting relationship building between members with similar interests. Investigating the impact of these differences represents a compelling area of future study.

Finally, we note that our results may be sensitive to decisions made in the calculation of study measures based on archival and observation period data. We presented results based on a twenty-one-day observation period. Further analysis is warranted to identify how sensitive these results are to longer or shorter time periods. (A related theoretical question is what time period leadership influence acts most strongly within.) Also, the measures of direct interaction with leadership and shared context with leadership are newly derived measures for this study. While we believe the presented results represent the most theoretically sound method of measuring these variables, other alternatives exist to measure similar--and potentially equally insightful--forms of interaction.

Summary

In closing, this study improves our understanding of both the nature of continued participation intentions in online groups and the importance of online group leadership. As a practical implication, it suggests that bulletin board owners should indeed view participation as the most effective antidote to turnover. Members who intend to actively participate are less likely to leave that those who are not. Newer members may be more inclined to participate that those with longer tenure--recent participation history is the best indication of future intentions. Encouraging the emergence of influential members also appears to provide positive benefits for overall participation--assuming the influential members are promoting a positive climate where others feel comfortable participating. Thus, it is important not only to monitor the overall level of participation and encourage active members, but also to monitor the overall tone of participation.

This study combined data from 535 survey responses from thirty-three vBulletin-based online groups with archival communication history data. We analyzed 135,477 messages to measure the levels of interaction between study respondents and nominated group leaders. We identified that participation role intentions and turnover intentions are distinct constructs that reflect continued participation intentions in different ways. We found that past participation provides some insight into future behavior, though not necessarily in the ways predicted by past studies.

Importantly, we identify that direct interaction with leadership and shared context with leadership provide different types of influence. This demonstrates both the importance of leadership in voluntary groups as well as the need to further study the pathways by which leaders exert influence. We identify psychological safety as an

outcome of shared context with leadership and a predictor of continue participation. Our results suggest that leaders in online groups are influential because of their ability to develop group-specific norms. Our study itself demonstrates the value and need for online group research to both theorize about and pay special attention to measurement issues of online groups as unique context. We demonstrate the use of HLM as one technique for expanding multi-level research into the field of online group study.

In summary, this cross-level analysis furthers our understanding of the relationship between interaction with group leadership, psychological safety, participation role intentions, and turnover intentions. We found that leadership in online groups is a determinant of online group outcomes. Online group leaders shape the group context, including psychological safety, which encourages or discourages participation. This study shows that leadership processes, group context, and differentiation among dimensions of participation intentions are all important considerations for further understanding of online groups.

Appendix A: Survey Instrument – Adapted Items

Participation Roles Intentions (PR)

Item Label (not shown) and Item		Response Options
Thinking about your on-going participation related to this online group, choose the response that most closely matches your level of agreement with the following statements:		1 = strongly disagree; 2 = somewhat disagree; 3 = neither agree nor disagree; 4 = somewhat agree; 5 = strongly agree
PR.1	I expect to regularly read others' content in this online group.	1 2 3 4 5
PR.2	I intend to regularly post messages at this online group.	1 2 3 4 5
PR.3	I plan to tell others about this online group.	1 2 3 4 5
PR.4	I intend to praise members of this group when they are supportive towards others.	1 2 3 4 5
PR.5	I plan to reprimand other members' inappropriate behaviors. *(Item dropped from measure.)*	1 2 3 4 5

Turnover Intentions (TI) – Adapted from Kelloway et al. (2007)

Item Label (not shown) and Item		Response Options
Choose the response that most closely matches your level of agreement with the following statements:		1 = strongly disagree; 2 = somewhat disagree; 3 = neither agree nor disagree; 4 = somewhat agree; 5 = strongly agree
TI.1	I am thinking about leaving this online group.	1 2 3 4 5
TI.2	I am planning to look for other online groups	1 2 3 4 5
TI.3	I intend to ask people about new online groups.	1 2 3 4 5
TI.4	I don't plan to be in this online group much longer.	1 2 3 4 5

Online Group Leadership (GL)

Item Label (not shown) and Item		Responses
GL.N	How many different members do you feel regularly provide leadership to this online group (GROUP NAME)?	1. (GL.N)
GL.C	Please enter a member name (userid) of a group member you feel has the most influence on what the group does and how it does it. (This is one of up to three group members you can name.)	1. (GL.C1)
	(repeated)	2. (GL.C2)
	(repeated)	3. (GL.C3)

Group Psychological Safety (PS) - Adapted from Tucker et al. (1999)

Item Label (not shown) and Item		Response Options
Choose the response that most closely matches your level of agreement with the following statements:		1 = strongly disagree; 2 = somewhat disagree; 3 = neither agree nor disagree; 4 = somewhat agree; 5 = strongly agree
PS.1	Members of this online group are comfortable checking with each if they have questions about the right way to do something	1 2 3 4 5
PS.2	The members of this online group value others' unique skills and talents	1 2 3 4 5
PS.3	Members of this online group are able to bring up problems and tough issues	1 2 3 4 5

Appendix B: Study Groups

There were thirty-three vBulletin-based message boards with valid and complete survey responses from five or more active members. Each group was assigned a 3-6 letter study tracking code. The website domain and website-provided description are also noted below.

Code	Domain	Tagline
ACRE	community.acresso.com	Acresso Community - Powered by vBulletin
ACTS	actionscript.org	ActionScript.org Forums - Powered by vBulletin
AGW	agw.bombs-away.net	alt.games.warbirds - Powered by vBulletin
BLEND	blenderartists.org	Blender Artists Forums - Powered by vBulletin
BREWQ	brewforums.qualcomm.com	BREW Forums - powered by vBulletin
CMFAM	thecomputermechanics.com	Welcome to The Computer Mechanics!
CODEF	codingforums.com	CodingForums.com- Web coding and development forums. Get help on JavaScript, PHP, CSS, XML, mySQL, ASP, and more!
DANGER	poweredbydanger.com	Powered By Danger - Powered by vBulletin
DEVX	devx.com	DevX.com Forums - Powered by vBulletin
DOOM	forum.doom9.org	Doom9's Forum - Powered by vBulletin
FRUGAL	frugalsworld.com	Frugal's World of Simulations - Powered by vBulletin

| Code	Domain	Tagline
GEAR	gbxforums.gearboxsoftware.com	Gearbox Software Forums - Powered by vBulletin
GREY	greydogsoftware.com	Grey Dog Software - Powered by vBulletin
IROSE	indigorose.com	Indigo Rose Software Forums - Powered by vBulletin
JONNY	jonnyguru.com	jonnyGURU Forums - Powered by vBulletin
KIRU	kirupa.com	Shocked Resource for Making Designers better Developers!
LAKE	lakeridgesoftware.com	Lakeridge Software Forums - Powered by vBulletin
MACRUM	macrumors.com	Mac Forums - Mac News and Rumor Discussion
NORTH	northernsounds.com	northernsounds.com - Powered by vBulletin
NOTEB	notebookforums.com	Where technology and people unite.
NSIDE	n-sider.com	N-Forums - Powered by vBulletin
OSNN	forum.osnn.net	OSNN Forum
PCPER	pcper.com	PC Perspective Forums - Powered by vBulletin
PSOFT	forum.psoft.net	H-Sphere Forum - Powered by vBulletin
RCGR	rcgroups.com	RCGroups.com: The ABCs of Radio Control - Aircraft, Boats, and Cars!
SRVR	servercommand.org	ServerCommand - Powered by vBulletin
SWEET	sweetwater.com	Sweetwater Forums - Powered by vBulletin
TALKF	talkfrontpage.com	Free Front Page Help and Webmaster Support - powered by vBulletin

Code	Domain	Tagline
UGOPL	ugoplayer.com	UGOPlayer Forums - Powered by vBulletin
VDEP	vizdepot.com	the Vizdepot - Viz, Max, Autocad and ADT/Viz Render. Architect, 3D, 3D news, 3D forum, 3D studio max, 3D Images, 3D studio viz, Vray Render, Lightscape, 3D Discussion, Architect, Architecture, 3D Visualization, 3D Interior visualization, Rendering, 3D rendering
VJFORM	vjforums.com	VJForums - Powered by vBulletin
VWNAVI	vwnavi.com	vwNavi - Powered by vBulletin
WINX	winxpcentral.com	Windows Central Forums - Powered by vBulletin

Appendix C: HLM Data Summary - Descriptive Statistics

| Variable	N	Mean	SD	Minimum	Maximum
Individual Level					
Participation Role Intentions	535	3.61	0.78	1.00	5.00
Turnover Intentions	535	2.25	0.81	1.00	5.00
Tenure (years)	535	2.01	1.76	0.10	8.77
Experience (LN) (# of Msgs)	535	3.98	2.04	-4.61	9.06
Reply Percentage	535	0.86	0.18	0.00	1.00
Shared Context w/ Nominated Leaders	535	0.31	0.40	0.00	1.00
Direct Interaction w/ Nominated Leaders	535	0.07	0.18	0.00	1.00
Psychological Safety (ind. response)	535	4.17	0.62	2.00	5.00
Group Level					
Psychological Safety (group mean)	33	4.15	0.26	3.62	4.60
Perceived # of Leaders (LN) (group mean)	33	2.08	0.41	1.33	2.93
Number of Active Members (LN)	33	4.82	1.30	1.39	8.19

Note. Shared context with nominated leaders, direct interaction with nominated leaders and number of active members were all measured during a 21 day period.

# Appendix D: Boxplot of Participant Role Intentions by Group
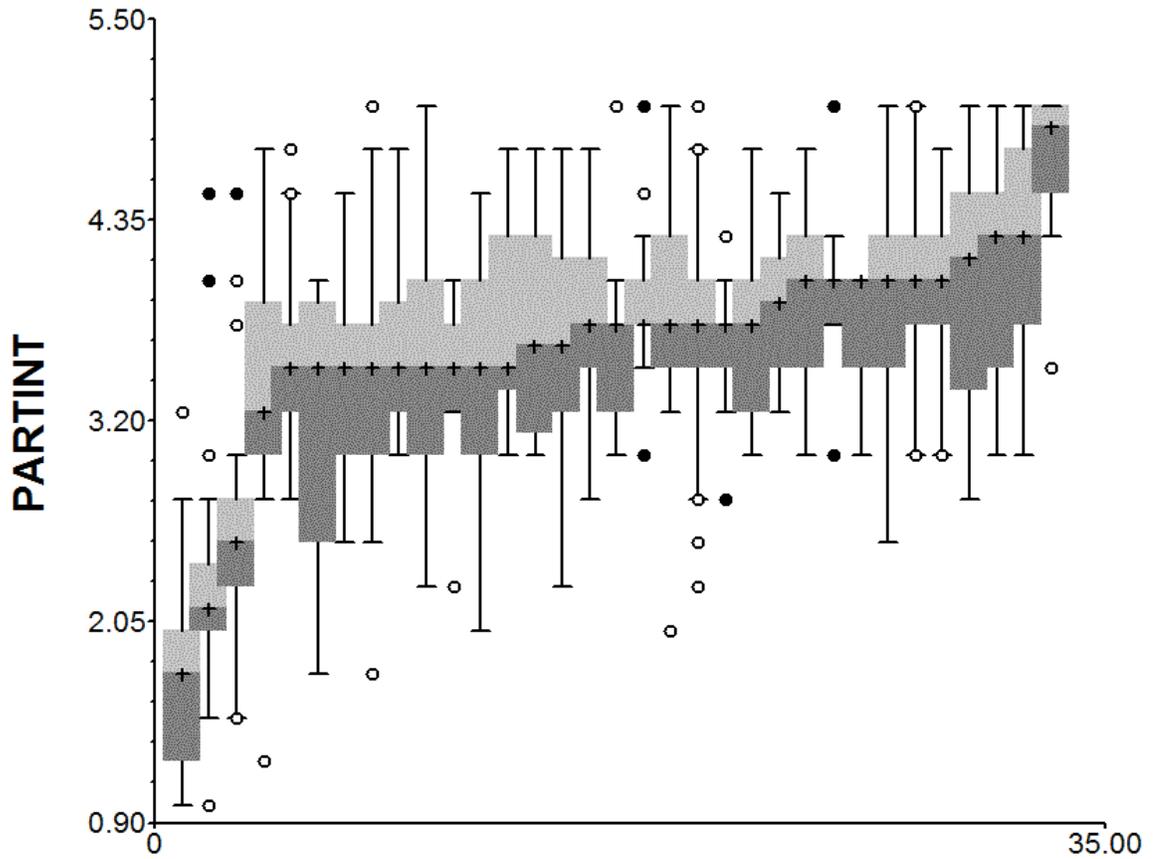
Note. Groups are sorted by group mean participation role intentions.

Appendix E: Boxplot of Turnover Intentions by Group

Note. Groups are sorted by group mean turnover intentions.
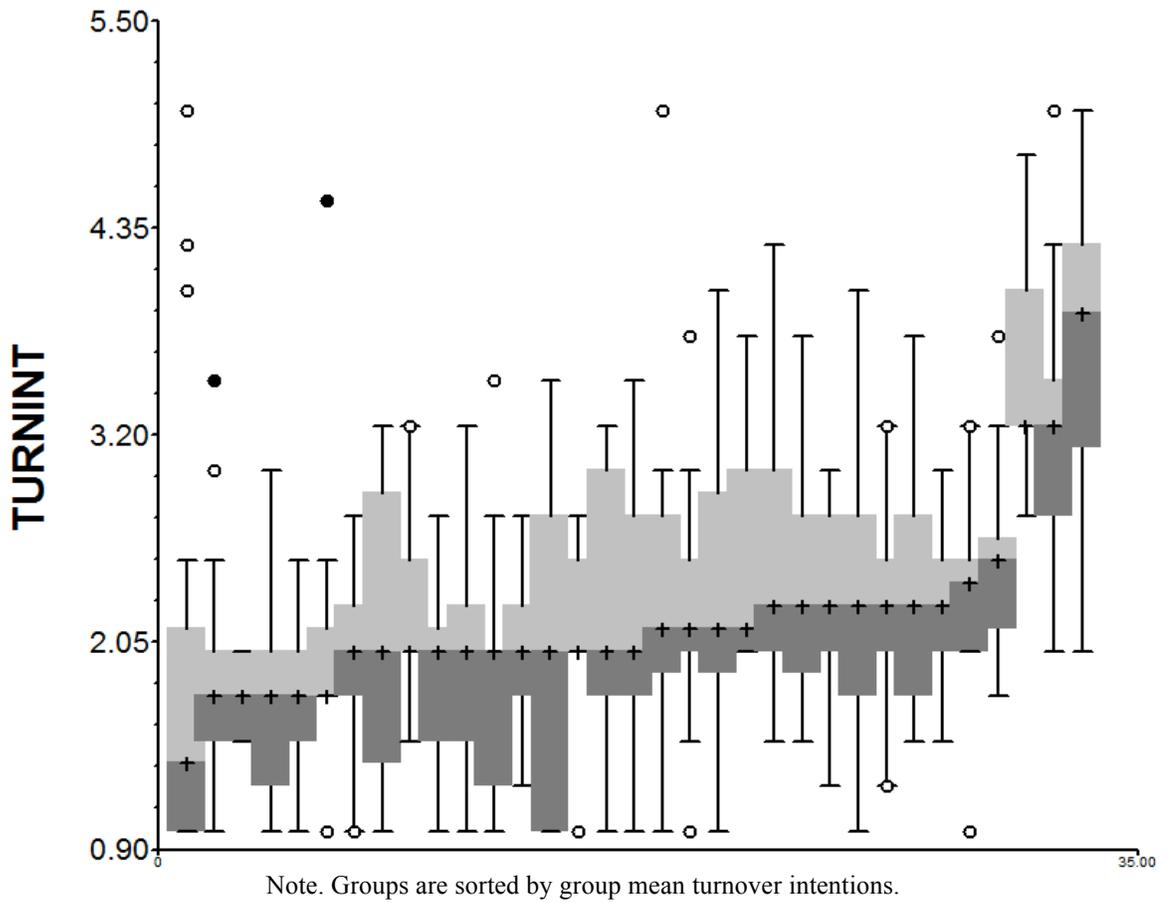
Appendix F: Turnover Intentions by Role Participant Intentions
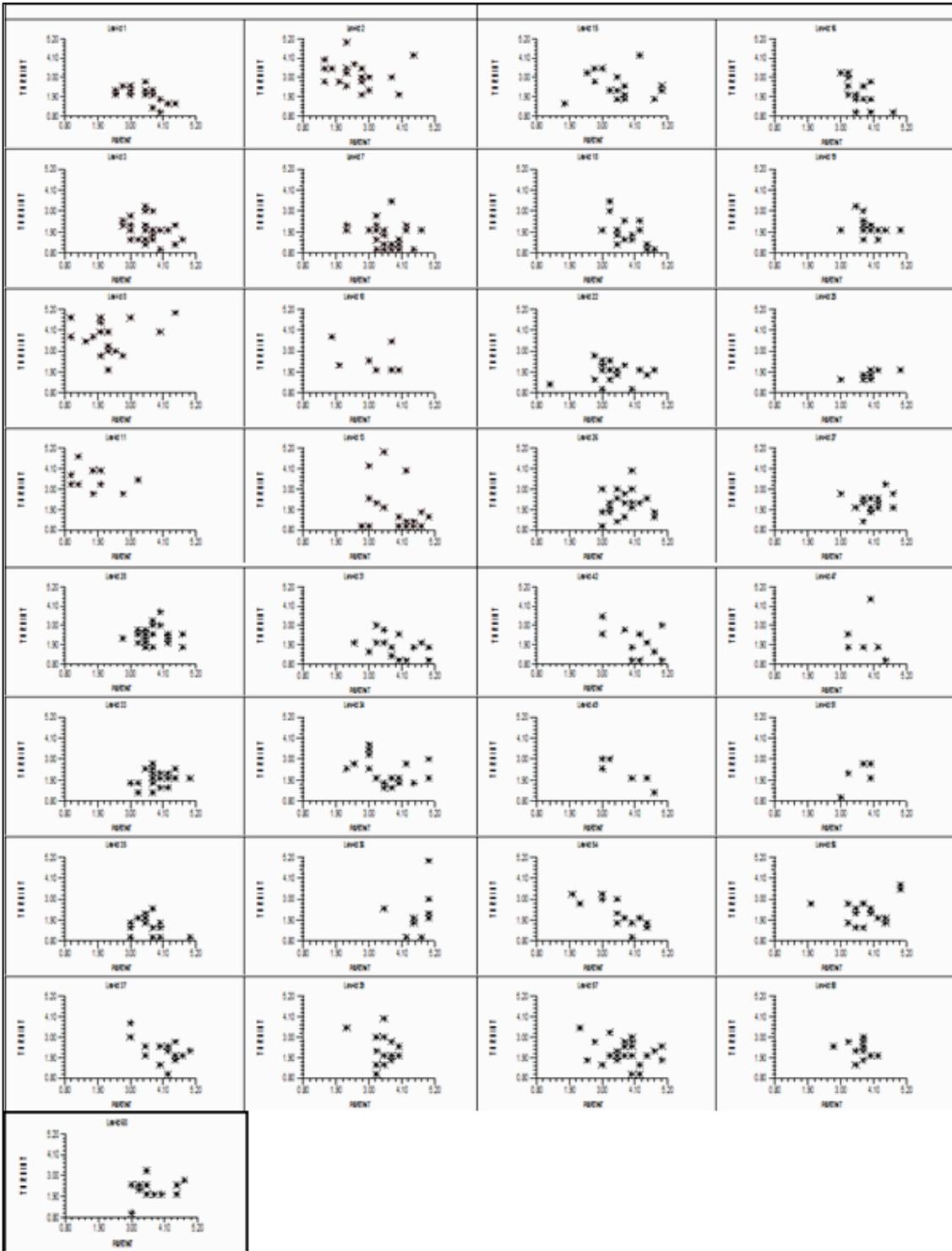
Note. All observations in all groups are plotted. The y-axis is turnover intentions and participation role intentions is the x-axis.

Appendix G: Shared Context by Participant Role Intentions
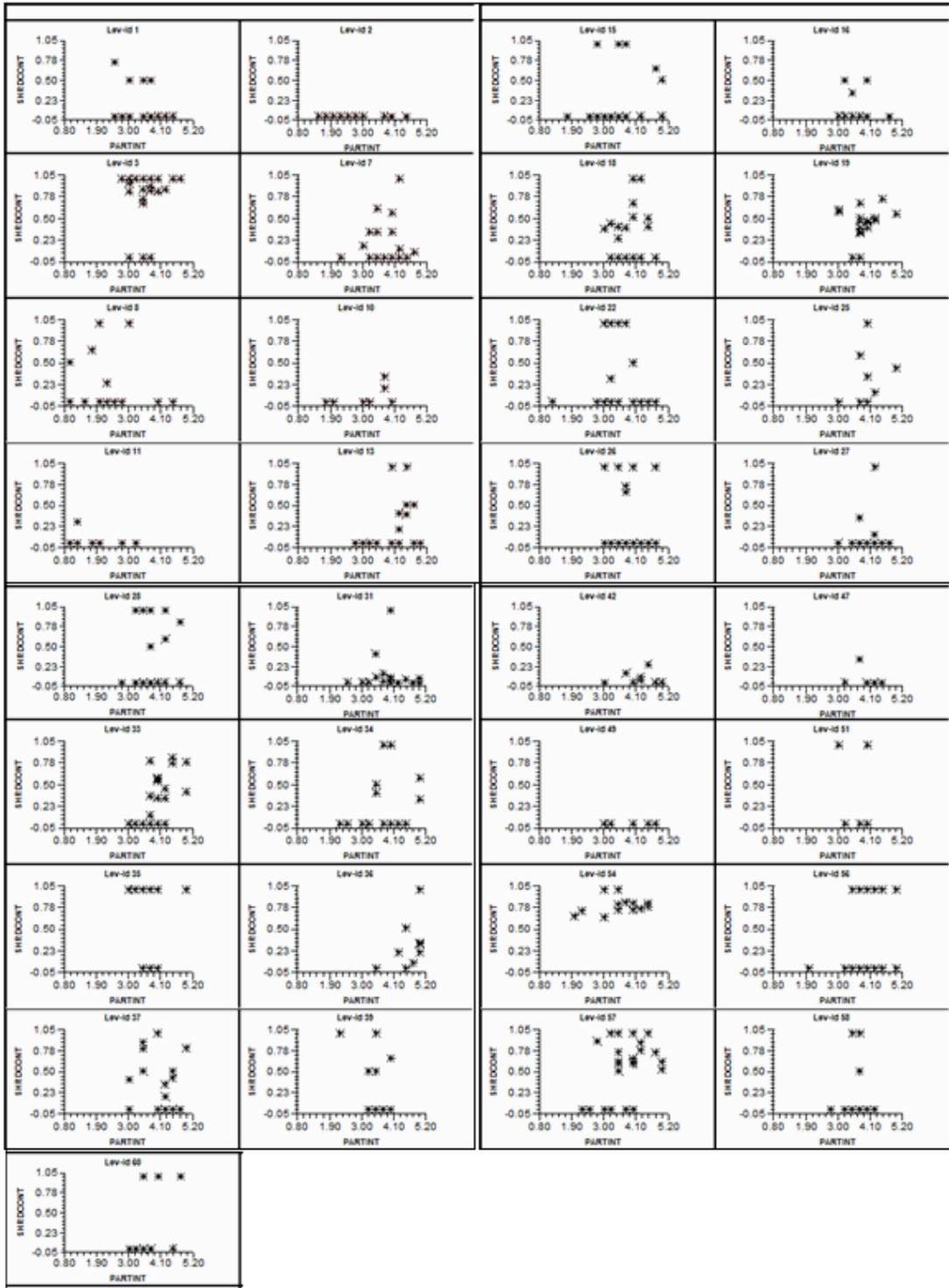
Note. All observations in all groups are plotted. The y-axis is shared context with nominated leaders and participation role intentions is the x-axis.

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