The Pennsylvania State University

The Graduate School

The Mary Jean and Frank P. Smeal College of Business

LEVERAGING DIVERSITY AND TECHNOLOGY FOR TEAM PERFORMANCE:

THE ROLE OF VARIETY, DISPARITY, VIRTUALITY AND KNOWLEDGE SHARING

A Dissertation in

Business Administration

by

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Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy

August 2009

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ABSTRACT

My dissertation examined how diversity and virtuality impact team performance. I hypothesized that knowledge sharing was a key team process linking these two domains to performance. Consequently, I developed a theoretical framework that explains the combined effects of a) team member knowledge differences (variety) and status differences (disparity), and b) team communication configuration (face-to-face and virtual communication) on knowledge sharing and performance. I tested this theoretical framework using a sample of 168 teams via a four-wave, longitudinal (panel) study. Results show that perceived variety accentuates knowledge sharing and that disparity (leadership status disparity and self-status disparity) attenuates it. Additionally, face-to-face and virtual interactions among team members have independent and unique effects on knowledge sharing. Knowledge sharing enhances team performance. Finally, knowledge sharing transmits the effects of diversity (perceived variety, leadership status disparity and self-status disparity) and team communication configuration (face-to-face and virtual communication) on performance. Findings from this study indicate two key insights. First, capitalizing on diversity requires managing the dilemmatic effects of variety and disparity on knowledge sharing. Second, virtual communication has unique effects on knowledge sharing after accounting for the effects of face-to-face communication even in teams whose work is accomplished in primarily collocated settings.

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ACKNOWLEDGEMENTS

This dissertation and the many steps leading up to it were made possible due to the advice, support and mentorship of the Penn State M&O faculty and staff, and the larger Penn State community. I am truly grateful to my advisor Dave Harrison for five years of fantastic mentorship, insights, patience and encouragement. I'd like to thank Kelly, Stephen and Shyam for not just being very helpful and insightful committee members but also for being totally approachable and fun.

I've also benefited greatly from the wise counsel on all things under the sun that I've been privileged to receive from Denny, Raghu and Vilmos. I've benefited enormously from and thrived in the courses offered by M&O faculty. I am grateful to Don, Dave, Denny, Linda, Martin and Wenpin for facilitating wonderful and insightful seminars.

To the truly exceptional dream team in the M&O office, thank you for being so welcoming, helpful, cheerful and wonderful each and every time that I have approached you for help. Thanks Holly, Nicole, Shirley, Michelle and Jamie.

I've also been fortunate to have found wonderful friends in the PhD cohort at Penn State. I cherish the times that I've spent with each of you. Kristin! You were the best office-mate one could ever hope for. I am sure that you are making others happy in your new office in the Brighter World. I will always treasure our friendship. Thanks to Arijit, Kwangho, Meena, Dan, Jen and Aimee for being around for commiserations, confabulations and congratulations. I also greatly appreciate Craig Crossland for lots of prompt and helpful advice on many matters. Thanks to John, Ralph, Abhi and Guoli for being wonderful office-mates at different stages of the PhD program.

The journey culminating in this document reflects the love, encouragement, prayers and blessings of family and friends. Thanks to Amma and Appa for your lifelong encouragement, prayers, blessings and other countless ways in which you have made all this possible. I was also greatly inspired by my uncle Dr. Subramaniam and aunt Kamala perima to pursue academics as a vocation. I am truly grateful to Sai, Nisha, Viji Mummy, Ramya, Bhavana, Vijay, Bhuvan, and Preethi for keeping me sane and grounded on this long academic trip. Most importantly, half this PhD degree should actually be awarded to my wife Jaya for her efforts, enthusiasm, patience, and the unstinting and unwavering support she has shown on this great big adventure. To my children Advaith and Anika…love you guys.

Akhil, Sonali, Tom, Karthik, Anjali, Mug, Jairam, Arpita, Mahesh, Ranjani, Dama Ravi, and Uday B -- thank you for being such wonderful friends and champions all the way. Thanks to PVM Raj, Dr. Debashsish Bhattacherjee, Dr. Unnikrishnan and Dr. Chandru Rajam for your advice and recommendations that made my journey to Penn State possible. Finally, I'd like to express my heartfelt thanks to my spiritual mentor Chariji for showing me the way ahead.

Chapter 1

INTRODUCTION

Organizations are increasingly employing teams to meet the challenges of knowledge work (Kozlowski & Bell, 2003). Teams represent important vehicles for bringing together individuals with diverse backgrounds and complementary expertise, skills and resources to perform work that may be too big, and too complex for a single individual to undertake (Cohen & Bailey, 1997; Marks, Mathieu & Zaccaro, 2001). For teams to be effective, members have to share their diverse knowledge, ideas, and experience relevant for the conduct of collective tasks. That is, knowledge sharing among team members is critical for team performance (e.g., Faraj & Sproull, 2000, Lewis, 2004; Cummings, 2004).

However, this seemingly simple mechanism for team performance turns out to be fraught with difficulty (Cohen & Bailey, 1997; Cronin & Weingart, 2007; Ilgen, Hollenbeck, Johnson, Jundt, 2005). Knowledge exchange in teams can be stymied by inequalities in power and status among members. Members who are low in influence and status may not always be willing to share valuable information that they possess (Bales, 1950; Tucker & Edmondson, 2003; Jetten, Hornsey & Adarves-Yorno, 2006). In addition, more powerful members may ignore the information provided by other less influential members, or inadvertently limit opportunities for articulating such information (Cohen & Zhou, 1991; Jackson, 1996). Moreover, individuals may only share only “safe” information that is already common across team members (Wittenbaum, 1998; 2000). Consequently, it is important to examine how teams can effectively manage the contrasting effects of the two forms of diversity -- differences in team member knowledge bases and differences in team member power and status.

A recent theoretical development crystallizes these two types of diversity by introducing the concepts of *variety* – "differences in kind or category, primarily of information, knowledge or experience among unit members", and *disparity* – differences in the concentration of valued social assets such as power, status, and influence among team members (Harrison & Klein, 2007; Klein & Harrison, 2007). Teams are likely to differ -- and even covary -- in their levels of variety and disparity. Teams differing in variety would differ in the distribution of *distinct* caches of task-relevant knowledge across team members. Teams that are low on variety have a great deal of knowledge that is *common* among team members. This may be a result of members having similar kinds of functional or educational backgrounds, expertise, experience, training, and ties to similar others. In contrast, teams high on variety have very little knowledge that is shared among team members. Each member possesses unique quanta.

When disparity is high, valuable social resources are concentrated within a single member or small subset of the team (Harrison & Klein, 2007). When disparity is low, social resources are equally distributed amongst team members. Disparity in teams can be a result of structural factors such as hierarchical position or functional background (Hambrick, 1994). It can also emerge from individual characteristics of team members such as physical attractiveness, gender, or race (see Berger, Cohen & Zelditch, 1972; Ridgeway, 2001; Bunderson, 2003). Structural factors and individual characteristics together result in a distribution of members along power and status hierarchies within the team.

Team variety and disparity are likely to have important, but likely opposing, implications for knowledge sharing in teams. Scholars propose that the benefits of knowledge sharing are likely to result in high quality decisions and more innovative products when teams have high levels of variety (Van Knippenberg & Schippers, 2007; Harrison & Klein, 2007; Mannix &

Neale, 2005; Bunderson & Sutliffe, 2002). Yet, the lack of parity among members could curb the free exchange of task relevant information in the team, and detract from performance (Eisenhardt & Bourgeois, 1988; Haleblian & Finkelstein, 1993, Hambrick & D'Aveni, 1992). Thus, the consideration of the simultaneous operation of variety and disparity appears to highlight a tension that motivates the first substantive research question driving this dissertation:

RQ1: How can and do teams capitalize on variety in the presence of disparity? That is, how do teams deal with the joint operation of status differences and knowledge differences, especially when within-team alignment of those characteristics fluctuates widely among teams?

In addition to team composition, team communication is a crucial process that has an impact on knowledge sharing (Kozlowski & Bell, 2003; Ilgen et al., 2005). Interactions among members represent opportunities for sharing information, ideas, experiences and feedback. Face-to-face interactions (F-t-F), both formal and informal, provide opportunities for a rich, broad band of information exchange (Short, Williams & Christie, 1976; Daft & Lengel, 1986). More and more, however, virtual technologies such as email and instant messenger (IM) also support knowledge sharing. Virtual technologies enable access to those who may not be readily available for face-to-face conversations. In addition, they also enable knowledge to be codified for future use by team members and others in the organization (Griffith, Sawyer & Neale, 2003). That is, virtual modes of communication augment the range of potential options for team members to share knowledge. In addition, some virtual technologies may be more appropriate than face-to-face interaction for knowledge sharing on particular types of tasks (Maruping & Agarwal, 2004; Gallupe, Batianutti, & Copper, 1991; Dennis & Valacich, 1993). For example, sharing a market forecast estimate for a new product may be accomplished by emailing it in an hyperlinked excel sheet and soliciting comments that appear in a common document on the internet. This provides team members with an opportunity to asynchronously examine and reflect on the numbers and assumptions underlying the forecast at their own convenience. Relative to a face-to-face meeting, sharing the document virtually may enable more comprehensive feedback from all members, which reduces the risk that members' feedback is lost because of production blocking (Diehl & Stroebe, 1987). Finally, the feedback can be documented for future reference and re-use by team members.

Nonetheless, the use of virtual technologies in teams has mainly received attention in the context of distributed teams or virtual teams, whose members are dispersed across multiple locations, rather than as a central or substantive variable that potentially impinges on all teams. That is, for some scholars, face-to-face teams do not use virtual technologies, and virtual teams do not meet face-to-face (e.g., Walther & Bunz, 2005; Alge, Wiethoff & Klein, 2003). In contrast, other scholars have proposed that such teams represent ideal types and do not represent organizational reality (Griffith et al., 2003). Most work teams in organizations are likely to be characterized by a hybrid of face-to-face and virtual interaction, somewhat irrespective of the level of geographic dispersion (Griffith et al., 2003; Kirkman & Mathieu, 2005). Hence, I expect that organizational teams are likely to use face-to-face interactions *and* virtual technologies to support knowledge sharing. Research, thus far, has not addressed how the effects of interacting virtually might be complementary or supplementary to those of meeting face-to-face, as members perform tasks that require sharing knowledge. This leads to my second substantive research question:

RQ2: How do differences in teams' configuration of face-to-face and virtual communication modes influence knowledge sharing in teams?

My final research question seeks to integrate the earlier two research questions by examining how the interrelationship between variety and members' configuration of virtual and face-to-face communication influences knowledge sharing. That is, in addition to having an independent impact on knowledge sharing, could teams' communication configuration also influence how teams' capitalize on variety? Face-to-face and virtual interactions represent avenues for sharing information, expertise and feedback. Such interactions are especially crucial for teams that would like to enhance the prospects of benefiting from team variety because such interactions potentially function as the medium for translating the plurality of knowledge bases distributed among team members into actionable insights for performing the team's task. Therefore, for a given level of team variety, increasing face-to-face and virtual interactions is likely to increase the likelihood of knowledge sharing among members. In addition, the way teams configure face-to-face and virtual interaction is likely to influence how teams profit from having members with diverse knowledge bases. That is, team communication configuration could accentuate the impact of variety on team knowledge sharing. Therefore my third research question is concerned with the impact that teams' configuration of virtual communication technologies and face-to-face interaction has on their ability to profit from variety.

RQ3: How do differences in teams' configuration of face-to-face and virtual interactions impact teams' capacity to capitalize on variety?

I attempt to answer these questions by developing a theoretical framework that folds together team variety, disparity, and team communication configuration to examine their independent and interlinked effects on team performance, through the mechanism of knowledge sharing. I propose formal hypotheses concerning the links between the constructs in my theoretical framework, and then outline my proposed method for testing these hypotheses.

Chapter 2

THEORY AND HYPOTHESES

In this section, I present the theoretical model that links team diversity and team communication configuration to knowledge sharing and team performance. Figure 1 summarizes this theoretical model. First, I briefly outline what is meant by the term team in the context of this dissertation. Next, I examine team variety in more detail, and develop arguments linking variety to knowledge sharing. I then examine how team disparity influences knowledge sharing, as well its effects on variety -- knowledge sharing relationship. Subsequently, I introduce the concept of team communication configuration, and theorize how variance in teams' configuration of face-to-face and virtual communication influences knowledge sharing. In addition, I also posit that teams' communication configuration accentuates the effects of team variety on knowledge sharing. Finally, I present arguments that link knowledge sharing to team performance.

Insert Figure 1 about here

2.1 What is a Team?

In this dissertation I draw on Kozlowski and Ilgen (2007)'s comprehensive definition of a team "as (a) two or more individuals who (b) socially interact (face-to-face or, increasingly, virtually); (c) possess one or more common goals; (d) are brought together to perform organizationally relevant tasks; (e) exhibit interdependencies with respect to workflow, goals, and outcomes; (f) have different roles and responsibilities; and (g) are together embedded in an encompassing organizational system, with boundaries and linkages to the broader system context and task environment" (p.79). I would like to qualify this definition for the purposes of this dissertation by treating as a team only those units that comprise at least three individuals. This definition highlights the nature of real work teams (Hackman, 1990) that are characterized by one or more tasks that they are collectively responsible for, co-operation and interaction among team members, differentiated member roles and responsibilities, and that operate within an organizational context.

2.2 Team Variety

In response to an abundance of research, narrative reviews and meta-analytic evidence suggesting that the consequences of diversity are weak and inconsistent, Harrison and Klein (2007) proposed that the construct of diversity itself warranted further examination and refinement. Defining diversity as "the distribution of differences among the members of a unit with respect to a common attribute, X, such as tenure, ethnicity, conscientiousness, task attitude, or pay" (p.1199), they forwarded a new typology of diversity types that proposes that diversity is not one thing, but three things –separation, disparity and variety.

Separation refers to differences in position or opinion among team members, and indicates the extent of disagreement or opposition among team members on attributes whose values can be represented along a continuum. The majority of research on diversity has examined separation as the primary type of diversity (Jackson, Joshi & Erhardt, 2003). Disparity as a type of diversity in team has received the least attention of the three types of diversity. Disparity refers to within-team differences among members in the concentration of valuable social resources such as status, power, and pay.

Team variety refers to the extent of differences among team members in kind or category, principally of information, knowledge or experience. Team variety has primarily been studied in the form of functional diversity, although less than a third of published studies have examined this form of team member differences (Jackson, Joshi & Erhardt, 2003). However, members can also differ in the kind or category of knowledge as a result of differences on other attributes such as educational specialization, social networks, training, and industry background. Research investigating these attributes as forms of variety is somewhat scarce (Harrison & Klein, 2007; Jackson, Joshi & Erhardt, 2003).

Why is variety consequential for teams? A primary reason for the existence of teams in organizations is to integrate the distributed expertise and experience of individual members into relevant and actionable collective knowledge (Cohen & Bailey, 1997). That is, teams exist because they potentially provide an efficient mechanism for harnessing the *variety* represented by team members' distinct information caches (Hinsz, Tindale, & Vollrath, 1997). The fundamental intuition behind assembling variety in teams is that it enables organizations to tackle organizational tasks that may be impossible for a single individual to handle, and more importantly, the presence of diverse knowledge bases will result in a higher quality product (Hackman & Morris, 1975; Cohen & Bailey, 1997). Greater variety potentially translates into greater breadth and depth of information potentially available to the team that can be leveraged to improve planning and decision-making, and to stimulate innovation (Harrison & Klein, 2007). In addition, differences among members in the distribution of task relevant knowledge may also reflect members' access to external non-overlapping social networks (Austin, 2003).

Variety in a team can most appropriately be thought of as a latent resource that needs to be drawn out of the individuals in whom it resides, transformed, and synthesized into a usable commodity. Assembling variety in a team alone does not assure team performance. Empirical evidence for the direct effects of variety (operationalized as functional, or knowledge diversity) on team performance is inconsistent (see Bettenhausen, 1991; Williams & O'Reilly, 1998; Van

Knippenberg & Schippers, 2007). Variety is likely to enhance task performance only if team members are willing to share their unique knowledge and insights and have opportunities to do so; and, only if the shared knowledge is integrated by team members in their efforts to meet the requirements of the task. Therefore, I expect that knowledge sharing is a crucial process that makes it possible for the team to capitalize on team variety.

2.3 Team Variety and Knowledge Sharing

Knowledge sharing is defined as a team process consisting of the conferral or receipt of task related information, ideas, expertise, feedback, and experience among team members concerning team product, procedures, practices or actions (Cummings, 2004; Srivastava, Bartol & Locke, 2006). Knowledge sharing by team members with specialized information is a primary mechanism for ensuring that member knowledge, skills and experience are brought to bear on the team task. Knowledge *sharing*, therefore, is a behavioral process related to but distinct from the knowledge distribution or *composition* within a team (variety).

Knowledge sharing among team members is a critical proximal "summary variable" that has been theorized to explain a significant amount of variance in team effectiveness (Hackman & Morris, 1975: p.62). Hackman and Morris (1975) argue that team member composition in terms of their knowledge, skills, and abilities provides the greatest leverage for influencing knowledge sharing in teams. In a related vein, a recent theoretical development in diversity research also proposes that diversity's influence on team performance is mainly through its effects on information exchange among team members (Van Knippenberg, De Dreu and Homan, 2004). Knippenberg et al. (2004) forward information elaboration among team members as the primary mechanism for transmitting diversity's beneficial effects. Information elaboration is an iterative process of sharing of ideas, knowledge and perspectives between group members (in the entire group or in subgroups) followed by the processing of and reflection on this information by individual members, and sharing the feedback of such reflection and processing to other members of the group (Van Knippenberg et al., 2004). By proposing that diversity in members' possession of task-relevant information, expertise and social networks provides teams potentially with an advantage over more homogenous teams, their framework suggests that diversity's beneficial effects mainly flow from variety (p.1011). They further argue that for teams engaged in non-routine, complex intellective tasks, greater informational diversity leads to greater information elaboration.

Why should team variety be positively related to knowledge sharing? According to Van Knippenberg et al. (2004), team members' awareness of and exposure to differences in team members knowledge bases stimulates discussion and debate that leads to "more thorough creative information processing, problem solving, and decision making" (p.1012). Similarly, Tiwana and MacLean (2005) argue that expertise heterogeneity in software teams increases the range of software design alternatives generated, increases the depth of decision making concerning such designs, and results in greater debate about the assumptions underlying the designs. In addition, research suggests that team member homogeneity is an antecedent to groupthink (Janis, 1972). In contrast, team variety is likely to minimize the likelihood of groupthink because it results in greater team information search and processing (Aldag & Fuller, 1993). The Upper Echelons perspective also offers a similar rationale for the benefits of top management team (TMT) heterogeneity (Hambrick & Mason, 1984). According to Hambrick and Mason (1984), group heterogeneity, conceptualized as heterogeneity in members' knowledge and background, "allows a thorough airing of alternatives" (p.202). Similarly, Wiersema and Bantel (1992) proposed that TMT demographic heterogeneity represents diversity in cognitive bases of team members i.e., variety, which they argued would lead novelty and comprehensiveness in problem-solving and decision-making. Because members have different perspectives and knowledge bases, the need to reconcile these diverging perspectives stimulates group discussion. As a consequence, team members question each other's assumptions and viewpoints, and this in turn leads to higher quality solutions.

The foregoing discussion presumes member awareness of differences in knowledge, expertise, experience, and network ties within the team. Such an assumption is not unreasonable in real work teams whose composition is purposefully designed to maximize effectiveness at the team task (Ilgen et al., 2005). Although members may not always be able to accurately estimate the specific differences in member information caches, the mere awareness that such differences exist could lead to attempts at mapping out these differences through discussion and debate (Earley & Mosakowski, 2000). Further, team interactions are likely to surface differences among members in task related knowledge, which could also lead to recognition of unique information components possessed by different members. Interaction, self-disclosure, and shared experiences result in team members learning about each other’s domains of expertise (Hollingshead, 1998, Bunderson, 2003). There is indirect evidence to suggest that when members are aware that team members possess specialized knowledge relevant to the collective task, it has a positive impact on knowledge sharing in teams (Hollingshead, 1998). Stewart and Stasser (1995) found that when team members possessed expertise in a specific domain, and members were aware of each other’s expertise, they were more likely to remember and discuss unique (unshared) information, which improved team performance. Stringfellow (1998) found that perceived knowledge diversity was positively related to generation and sharing of ideas, which in turn was positively related to knowledge integration.

There is also some direct empirical support for variety being positively related to knowledge sharing in teams. Homan, Van Knippenberg, Van Kleef, and De Dreu (2007) found that groups high on informational diversity shared more information than groups that had more homogenous information. Drach-Zahavy and Somech (2001) found that team variety -- functional heterogeneity -- was positively associated with information exchange among team members. Curseu, Schruijer and Boros (2007) found that team variety predicted team cognitive complexity, which is a measure of the richness of the collective knowledge structures that arise from the sharing and integration of members' specialized knowledge. All these arguments lead to my first hypothesis:

Hypothesis 1*: Team variety is positively related to knowledge sharing*

2.4 Disparity and Knowledge Sharing

Disparity among team members impacts patterns of interaction and communication, influence attempts, and resource allocation (Cohen & Zhou, 1991; Jackson, 1996; Harrison & Klein, 2007). Disparity in power or status among team members impacts the *willingness* to share information by low status members. High levels of disparity in power are likely to arise when the team is dominated by a single individual or a small group of individuals (e.g., a dominant team leader or CEO in the case of a TMT, a ruling coalition). Disparity is commonly viewed as fostering conformity and silence among low status team members (Sherif & Sherif, 1964; Guinote, Judd, and Brauer, 2002; Jetten, Hornsey & Adarves-Yorno, 2006). When disparity is high, low status members are unwilling to share information because they fear that dominant member(s) may ignore or devalue their contributions of lower status. For example, Tucker and Edmondson (2003) found that nurses would not share information with higher status unit members because they perceived that it would be ignored. Additionally, low status team members could be afraid of sharing knowledge or ideas that they perceive runs counter to those of the dominant member(s) (Eisenhardt & Bourgeois, 1988; Haleblian & Finkelstein, 1993, Hambrick & D'Aveni, 1992).

Disparity also dampens the motivation to share information by diminishing responsibility to contribute to the team's output. Centralization of power in teams means that only a few members have influence over the outcomes of the group. This reduces the stake of low power members in the decisions made in the team, and, in turn, their motivation to share knowledge and ideas with the team is reduced (Bunderson, 2003). Disparity may also encourage conformity with the powerful or dominant leader's views and ideas. It may result in team members trying to fathom the preferences of the powerful leader, and in attempting to tailor shared knowledge and ideas to match the leader's preferences, rather than sharing unique knowledge that might run counter to those preferences but that could improve task performance (Haleblian & Finkelstein, 1993; Maier & Hoffman, 1961). In the context of teams involved in knowledge work, such conformity and self-censoring by low status members translates into the reduced motivation to share unique knowledge.

The presence of disparity may also reduce *opportunities* for low-status team members to share information and ideas relative to high status members. High status team members are more likely to be seen as influential, and, therefore, to be given more opportunities to participate in team discussions (Bales, 1950; Driskell, 1982; Ridgeway, 2001). They are also more likely to have other members address them more often relative to low status members, and have their ideas evaluated more favorably (Berger et al., 1972; Cohen & Zhou, 1991). In contrast, low status individuals are less likely to offer suggestions or interrupt high status team members. High status individuals are likely to dominate meetings and conversations, and low status individuals may be unable to voice their knowledge and ideas. To the extent that the status differentials are steep, these discrepancies in the opportunity for inputs should be large.

The presence of disparity may also result in inequalities in *valuing* of contributions by team members. The knowledge and ideas of high status members is likely to be attended to, positively viewed, and integrated to a greater degree by team members relative to those shared by low status members (Ridgeway, 1991). Their higher expectations of competence could lead high status members to express their unique knowledge and insights because they believe that their perspectives are especially worthwhile or instrumental (Nembhard & Edmondson, 2006). Even if low power members share their knowledge and ideas, verbal hesitation and nonverbal gestures in expression is likely to lead other members to discount their information and perspectives (Keltner, Gruenfeld, & Anderson, 2003).

Disparity within teams is also likely to have differential effects on knowledge sharing behaviors of high status vs. low status members. For high status members the need for social validation or evaluation apprehension -- two likely explanations for the unwillingness of members to share their unique knowledge (Brodbeck, Kerschreiter, Mojzisch, & Schulz, 2007) -- is likely to be lower than for low power or low status members, because their cost of presenting risky or unique information is lower (Phillips & Zuckerman, 2001). In contrast, low power members are more likely to be sensitive to threat and punishment from high power members and feel greater accountability for the knowledge and ideas shared (Keltner et al., 2003). This could lead to behavioral inhibition in the form self-censoring, in being passive or silent and uninvolved in team meetings. Therefore, I expect:

Hypothesis 2*: Team disparity has a negative effect on knowledge sharing*

Team disparity is likely to be especially detrimental to capitalizing on team variety. The benefits of variety for enhancing team effectiveness are realized primarily when members are willing, able and have the opportunity to share their knowledge and ideas, and to provide constructive feedback to other members. Earlier, I argued that discussion and debate among team members, and challenging each others' assumptions are some of the mechanisms through which teams can integrate the diverse informational inputs of their members. However, the presence of disparity distorts this process. The differential distribution of power and status within a team is likely to influence the extent to which knowledge and ideas from different team members are likely to be shared, attended to, equitably valued, and integrated into performing the team's task.

Corresponding to the expectation that disparity diminishes the impact of variety on knowledge sharing, Pitcher and Smith (2001)'s case studies of three top management teams indicated that in the presence of disparity (powerful CEO and COO, and other members with low power), the potential knowledge sharing benefits from the presence of variety (cognitive heterogeneity) were overridden by dictates from those with power. Similarly, Brooks (1994) examined knowledge sharing and integration among 4 R&D teams consisting of engineers, technicians and machine operators, and found that power differentials within the team inhibited knowledge contribution by low power members. For example, operators (low power members) were unwilling to contribute to the problem identification stage because they believed that it may direct managerial attention to problems in their work zone. Stringfellow (1998) found that perceptions of status-diversity in cross-functional new product development teams led to decrease in the sharing of ideas within the team.

Research also suggests disparity leads to centralization of information processing, which means that variety in the team remains underutilized (Burns & Stalker, 1961; Eisenhardt & Bourgeois, 1998; Sheremata, 2000). Disparity may also result in the strategic use of information. Rather than the free sharing and integration of knowledge within the team, knowledge may be hidden from "high power" members, or used by low power members to gain leverage over high power members, which in turn could reduce the potential benefits that flow from team variety (Eisenhardt & Bourgeois, 1998).

Earlier, I argued that the benefits of variety come from an initial awareness that team members have differential expertise, and subsequent interaction among and self-disclosure by members is expected to further stimulate knowledge sharing. Disparity can attenuate member efforts to identify and explore the distribution of distinct knowledge quanta within the team. In a study of how team members identify and use expertise, Bunderson (2003) found that when disparity is high, members have little motivation to understand the different types of expertise, experience, or network ties present in the team. Team members believe that because influence is unequally distributed, variety is unlikely to have an impact on team ideation, decision-making, or problem-solving. Consequently, disparity induces members to pay less attention to, and be less effortful and comprehensive in their evaluations of others' expertise (Bunderson, 2003). Moreover, while team variety can increase knowledge sharing by decreasing team member perceptions of dispensability, disparity could attenuate the beneficial effects of team variety by increasing member perceptions of dispensability because their contributions are less likely to impact team tasks, which in turn may result in withholding effort expended in sharing knowledge, ideas and feedback (Price, Harrison & Gavin, 2006).

While it is plausible that disparity in a team reflects underlying differences in expertise, experience or competence, previous research suggests that such an outcome is likely a result of political actions aimed at hoarding power and influence (Eisenhardt & Bourgeois, 1998; Ibarra, 1992; Edmondson, 2002; Bunderson, 2003). In sum, as long as disparity covaries less than perfectly with the amount of task-relevant information, disparity in distribution of power and status will attenuate the potential benefits to be gained from variety. Especially, when low status members have unique knowledge or ideas, high levels of disparity may result in less than optimal knowledge sharing.

Hypothesis 3*: Team disparity attenuates the positive effect of variety on knowledge sharing*

2.5 Team Communication Configuration

The proliferation of computer network-based information and communication technologies (ICTs) in the workplace has altered the way in which team members exchange knowledge (Wellman et al, 1996). Such technologies, commonly referred to as virtual technologies (Merriam-Webster Online, 2007; Kirkman & Mathieu, 2005), are used in tandem with face-to-face interactions to support communication among team members. This addition of virtual modes of communications among team members likely expands the number of conduits for sharing information, ideas, and feedback among team members, by providing supplements to face-to-face interaction. Teams are likely to differ in the level of virtual interactions among their members, which refers to the frequency or amount of team members' use of information and communication technologies to allow or support team member interactions. Information and communication technologies (ICTs) include telephones, cell phones, voicemail, email, instant messenger, and NetMeeting.

Traditionally, however, the role of virtual technologies has either been studied in the context of ad-hoc virtual groups, which typically compare groups using only computer mediated communication (CMC) to those interacting face-to-face (F-t-F), or by studying virtual or distributed teams, whose members are dispersed across multiple locations. Research on ad-hoc virtual groups has focused on how virtual teams differ from collocated teams (e.g., Walther & Bunz, 2005). Scholars in this tradition typically treat virtual teams as composed of members who interact using only virtual technologies, but who do not interact face-to-face. They also treat co-located teams as consisting of members that seldom use virtual technologies (e.g., Alge, Wiethoff and Klein, 2003; Hambley, O'Neill & Kline, 2007; Walther & Bunz, 2005).

Other scholars, however, have argued that treating teams as either interacting only virtually or only through face-to-face interactions represent ideal and unlikely types (e.g., Griffith et al., 2003; Gibson and Gibbs, 2006). In contrast, they argue that virtual interaction is a characteristic of most work teams, and that teams differ in the extent to which their members interact virtually. However, implicit in their theorizing is an emphasis on virtual interaction primarily in the context of geographical dispersion, and an underlying assumption that virtual technologies are of consequence primarily in such spatially distributed settings. (see also Maruping & Agarwal, 2004; Martins, Gilson, Maynard, 2004; Chudoba,Wynn, Lu, & Watson-Mannheim , 2005). The confounding of geographic dispersion and virtual interaction shifts attention away from ubiquity of virtual communication technologies even in more "traditional" collocated teams (Quan-Hasse, Cothrel & Wellman, 2005; Haythornwaite, 2002). Emphasizing that team members interacting with virtual technologies is a characteristic of all work teams, Kirkman and Mathieu (2005) argue that it is not dispersion that characterizes virtuality, but ICT use. Their use of the term *virtual* focuses exclusively on ICT use by team members, which is in contrast to use of this term to refer to non-ICT related concepts such as dispersion and diversity (see for example Gibson & Gibbs, 2006; Griffith et al., 2003). They use the term team virtuality to refer to the a) extent of use of virtual technologies, b) the utility of these tools in completing team tasks, and c) the synchronicity of interaction afforded by these tools.

However, Kirkman and Mathieu (2005) treat face-to-face communication as part of the virtuality continuum. Teams that have a high degree of face-to-face communication are, according to their formulation, necessarily low on virtuality (a zero sum, and a mandated inverse relationship). In contrast, I argue that face-to-face and virtual interactions could be treated as separable, perhaps additive dimensions of team communication. Such a distinction is crucial because differences in teams' configuration of virtual and face-to-face communications could have a differential impacts on team outcomes, especially knowledge sharing. The effects of face-to-face interaction on team process and performance have often been overlooked in the context of dispersed teams on the assumption that such interaction is unlikely or irrelevant. However, as Maznevski and Chudoba (2000)'s in-depth case studies reveal, regular face-to-face interaction is a crucial factor determining team effectiveness even in geographically dispersed settings that might otherwise have been referred to as virtual. Conversely, the effects of virtual modes of communication on team process and performance have primarily been examined in the context of geographically dispersed teams. However, dispersion is not a pre-requisite for their adoption and use. In physically collocated teams, virtual interactions could result from use of ICTs both as substitutes for or as complements to face-to-face interaction. Teams with regular face-to-face meetings also interact through virtual means.

2.6 Communication Configuration and Knowledge Sharing

Team members are likely to be the most important sources of knowledge for team related tasks relative to external impersonal sources such as written documents or electronic databases (Mintzberg, 1973; Tushman, 1978; Allen, 1979; Brown and Duguid, 1991; Cross, Parker, Prusak & Boragtti, 2001; Quan-Haase & Cothrel, 2003). Although team member external ties could also be conduits of knowledge crucial for team task performance (Ancona & Caldwell, 1992), such knowledge has to be shared within the team for it to have a substantial impact on team tasks. Because team members can and do interact with each other using an array of face-to-face and virtual communication modes, both types of interactions represent opportunities for the exchange of information, experience, expertise and ideas, and feedback relevant to the teams' task (Haythornwaite, 2002; Woerner, Orlikowski & Yates, 2004; Stephens, 2007).

Nonetheless, not all such exchanges may involve knowledge sharing. Some interactions between team members may only involve social exchange such as banter, gossip, or humor. To the extent that such social exchange could foster and strengthen interpersonal ties between team members, they could be viewed as occasions facilitating knowledge sharing in future interactions (Nardi, 2005). Other face-to-face and virtual communications among members may serve as conduits for task coordination, which likely includes the coordination of opportunities for exchange of information, ideas and feedback (Woerner et al., 2004). In sum, both face-to-face and virtual exchanges among team members either directly or indirectly enhance the likelihood of knowledge sharing within the team.

Although both face-to-face and virtual interactions increase the chances of knowledge sharing, insights on how teams orchestrate their face-to-face and virtual interactions -- the *team communication configuration* -- to enable optimal levels of knowledge sharing are lacking in the organizational literature. In this dissertation I examine three plausible communication configuration models that could explain how teams structure face-to-face and virtual communications. The first model -- the *compensatory* model -- treats face-to-face interaction and virtual interaction as having independent effects on knowledge sharing. The second model -- *virtuality* model -- treats virtuality as a necessary evil that needs to be minimized. Teams have to endure virtuality due to a variety of circumstances, all of which lead to a process loss relative to face-to-face interaction. The third model -- the *interactive* model -- views face-to-face and virtual interaction as having independent and complementary effects on each other. Higher levels of virtual interaction augment the effect of face-to-face interaction on knowledge sharing, and vice versa. Although each of these three models is expected to explain substantial variance in team knowledge sharing, I expect that the interactive model will have the greatest explanatory power. Therefore, even though I examine each of these potential alternative configurations in more detail in the following paragraphs, I will not propose formal hypotheses for the compensatory and virtuality models.

Compensatory Model. The theoretical basis of the *compensatory* model (mathematically represented as: F-t-F Interaction + Virtual Interaction → (+) Knowledge Sharing) is Walther's (1992) Social Information Processing Theory (different from Salancik and Pfeffer's (1978) Social Information Processing theory), which would predict that face-to-face communication and virtual communication support knowledge sharing equally well. The effect of each form of communication on knowledge sharing is independent of the level or value of the other. According to SIP Theory, virtual team members can adapt even relatively lean media such as email to transmit task related and socio-emotional communication just as effectively as face-to-face teams. Because the two forms of communication are expected to have compensatory effects such that increased virtuality can make up for low levels of face-to-face interaction and vice versa, the core prediction derived from the SIP model would be that virtual communication would be just as effective as face-to-face communication for knowledge sharing, only that it could take more time (see also Iacono & Weisband, 1997; Walther & Parks, 2002; Wilson, Strauss & McEvily, 2006).

Evidence from the JEMCO series of studies conducted by McGrath and his colleagues (see McGrath & Berdahl, 1998 for a review) also provides support for the compensatory model. Evidence from these studies suggests that as virtual groups gain experience with their communication technologies, their performance improves and even exceeds that of face-to-face groups. The principal implication of the compensatory model is that geographically dispersed teams do not have to ever meet, they only have to increase their virtual communication to substitute for any decrease in face-to-face interaction. Teams could save on travel costs. Similarly, teams that are collocated need not invest in expensive ICTs because they can co-ordinate and perform their tasks primarily through face-to-face interaction (see Teasley, Covi, Krishnan & Olson, 2000 for an example).

Further, the compensatory model suggests that face-to-face and virtual interaction have additive effects on knowledge sharing. Because the model treats the two types of interaction as substitutable, what matters then is the aggregate level of collaboration (Harrison, Price, Gavin & Florey, 2002) among team members via face-to-face and virtual interactions, and not the relative levels of face-to-face and virtual interaction.

Virtuality Model. In contrast to the compensatory model, the *virtuality* model (mathematically represented as: Virtual Interaction/ F-t-F Interaction → (-) knowledge sharing) emphasizes the relative levels of virtual and face-to-face interaction. It privileges face-to-face communication over virtual communication. Here, virtuality refers to the dominance of virtual interaction over face-to-face interaction. Such a definition is consistent with Kirkman and Mathieu's (2005) treatment of virtuality, which argues that the higher the proportion of virtual interaction there is in a team, the higher the team's virtuality. The greatest leverage for increasing knowledge sharing comes from increasing face-to-face interaction, while increasing virtual interaction is seen as compromising knowledge sharing (e.g., Staples & Webster, 2008). Support for this model comes from the work of Brown and Duguid (1991) and Lave and Wenger (1991) that suggest that knowledge is situated and tacit, and can be shared only through ongoing face-to-face interaction in communities of practice. Therefore, virtual communication is seen as a less effective mode for sharing knowledge. Related arguments that privilege face-to-face communication over virtual communication can also be found in the studies by Nardi and Whittaker (2002), Nardi (2005), and Teasley et al. (2000). According to these scholars, face-to-face interactions are imperative to create conditions (interpersonal connections) that enable virtual interaction, co-ordination and knowledge sharing. Therefore, increases in virtual communications have to be sustained by greater increases in face-to-face interactions to sustain interpersonal connections necessary for sharing knowledge.

Interactive Model. The interactive model (mathematically represented as: F-t-F Interaction* Virtual Interaction → (+) knowledge sharing) proposes that face-to-face and virtual interaction have catalytic effects on each other. Higher levels of virtual interaction strengthen the effect of face-to-face interaction on knowledge sharing, and vice versa. This is likely because in teams, face-to-face interaction and virtual communication are expected to be inter-related and complementary (Belanger & Watson-Mannheim, 2006; Quan-Hasse et al., 2005; Stephens, 2007; Woerner et al., 2004). Face-to-face interaction often drives virtual communication, and vice-versa, as these quotes from managers interviewed by Belanger and Watson-Mannheim, 2006 illustrate (p. 315-316).

> *"if it's an important thing that's got a short time frame on it like – you know when you send an e-mail this needs to be taken – action needs to be taken upon it within the next hour or something today. I would rather that someone track me down [by phone or face-to-face] and say look, I'm sending you this e-mail, however we really need to move on this right now or within the next hour."*

> *"I suppose if I had already started a conversation in E-mail and it wasn't getting the required result or a desirable result. Then I would want a face-to-face meeting. If I really want to impress something upon someone then a face-to-face meeting"*

Virtual communications such as emails are often used as "pre-work" for a face-to-face meeting, and some tasks are partly completed in face-to-face meetings, with the remainder of the tasks completed over email (for more such examples see Belanger & Watson-Mannheim, 2006; Woerner et al., 2004, and Stephens, 2007). Equally, face-to-face interaction may generate virtual communication. For example, members may use email to circulate minutes of face-to-face meetings, and document decisions and next steps from the meeting. In addition, virtual communication may also be used to distribute materials such as Powerpoint presentations, handouts, or drawings that were used in a meeting, so that it can be referred to or re-used by members at a later date.

Another reason to expect face-to-face and virtual interaction to have interactive effects on knowledge sharing is that they could play somewhat unique roles in facilitating information exchange among team members. As a consequence, the dearth of virtual interaction cannot easily be made up by increasing face-to-face interaction, and vice versa. Ceteris paribus, face-to-face interaction is more suited to the transmission of ambiguous information because it has greater information richness relative to virtual technologies (Daft & Lengel, 1986; Daft, Trevino & Lengel, 1987; Trevino, Webster & Stein, 2000). That is, when team members' share knowledge that is relatively tacit, or when team tasks require sensemaking of equivocal information, face-to-face interaction may be more effective than virtual communications. However, even for equivocal tasks, information relevant to the sensemaking process can be shared virtually, and may increase the effectiveness of face-to-face interaction. For example, face-to-face interaction may be ideally suited for knowledge sharing during the planning phase of a project, which involves the relatively ambiguous task of defining the team's goals and tasks. At this point, getting team members physically into a room to get their inputs and feedback would be much faster and more efficient than attempting to plan virtually (Teasley et al., 2000). This would also ensure that team members have a common understanding of the overall goals of the project. However, this face-to-face planning process can be supported and supplemented by virtual communications that may include distribution of forecasts, budgets, copies of past plans, and pre-meeting knowledge sharing by individual members that may form the basis for further face-to-face discussion.

However, under other situations, knowledge sharing via virtual communications may be more appropriate than face-to-face communication for accomplishing team tasks. For idea generation tasks, sharing ideas electronically may be more effective than face-to-face meetings because it minimizes production blocking (Diehl & Stroebe, 1987), and increases the likelihood synergistic idea production (Gallupe et al., 1991; Dennis & Valacich, 1993; Derosa, Smith & Hantula, 2007). In addition, for some tasks virtual communications carry greater informational value (Kirkman & Mathieu, 2005) about the specific task. For example, it may be easier to exchange information or provide feedback on a research paper, a software program module, or a machine part design virtually, because such virtual objects are integral to the knowledge being shared. Face-to-face interactions for the same purposes would likely be inefficient and complex because it would involve too many meetings, and require members to process and remember too much information.

Virtual communications may also allow members to share knowledge without the high co-ordination costs associated with scheduling face-to-face meetings. Scheduling face-to-face meetings each time that members have to share information, ideas or feedback may take time away from task execution. Instead, virtual groupware technologies such as such as Microsoft Project and Lotus Notes Calendar allow team members to share knowledge relevant to task co-ordination that update team members about each other's activities without having to be in constant face-to-face communication (Kellogg, Orlikowski & Yates, 2006).

Virtual communication technologies also afford capabilities for knowledge sharing that are not as effectively implemented in pure face-to-face contexts. For example, numerous capabilities embedded in office productivity software (e.g., Microsoft Office) increase the team members' knowledge sharing repertoire by providing them with an array of formats for appropriate representation of their information and ideas such as spreadsheets, databases and Powerpoint presentations. Such virtual tools provide members the opportunity to process and deliberate on information prior to providing explicit feedback (e.g., inserting comments on a document), which could increase the quality of information exchange in the team by allowing, and document team knowledge for future re-use (Yates & Orlikowski, in press).

Virtual interaction also augments team knowledge sharing capabilities by allowing partial substitution of face-to-face interaction in sharing of information, ideas and feedback. That is, it extends access to team members who may not always be present at the same location and at the same time: travel, telecommuting, having members distributed across different locations are some common reasons. Unavailability of members impedes knowledge sharing (Straub & Karahanna, 1998). However, virtual technologies increase accessibility of physically unavailable members and the information they possess. Therefore, teams that use virtual modes of communication in addition to face-to-face interaction are less likely to face impediments to knowledge sharing on account of team member physical unavailability.

Hypothesis 4*: There will be a positive interactive effect of teams' face-to-face interaction and virtual interaction on knowledge sharing.*

2.7 Communication Configuration and the Variety – Knowledge Sharing Relationship

Although variety is a crucial reason for the existence of teams, the presence of specialized knowledge bases means that team members are often largely unaware about the activities of members in other domains (Kogut & Zander, 1996; Postrel, 2002). Team members from different functions and expertise areas may inhabit different "thought worlds" (Dougherty, 1992), which means that team members in one domain may not be able to readily understand the language, methods and issues of those in other domains. Another consequence of team variety is the possibility of a process loss in the form of representation gaps (Cronin & Weingart, 2007), which are inconsistencies between individual members' definitions of the team's problem. Cronin and Weingart (2007) argue that differences in member knowledge lead to different representations of the same problem faced by the team. Each team member attempts to represent the problem in terms of the knowledge of their own domain causing a representation gap.

Knowledge sharing among members represents one solution for coordinating team variety. Increased variety spurs members to step up the exchange of information, ideas, and experiences to bridge “thoughtworlds” and minimize representation gaps. Furthermore, any team process that enhances the capacity for team information exchange can accentuate the impact of variety on team effectiveness. Therefore, for a given level of team variety, increasing team interactions, both face-to-face and virtual, increases opportunities for knowledge sharing among members. Interactions provide a forum for the discovery of different knowledge bases within the team that heighten the awareness that team members possess differentiated expertise, which in turn facilitates the sharing of unique information. Consistent with my reasoning for Hypothesis 4, I expect that face-to-face and virtual interaction communication work in tandem to increase knowledge sharing within the team because members can configure both types of interaction to gain greater access to each other, and improve member capabilities for representing and documenting their knowledge and ideas to minimize representation gaps.

Hypothesis 5*: The interactive effect of teams’ face-to-face interaction and virtual interaction will accentuate the positive effect of variety on knowledge sharing*

2.8 Knowledge Sharing and Team Performance

Team effectiveness is a multifaceted concept comprised of external and internal criteria for evaluating team outcomes (Kozlowski & Bell, 2003). External criteria refer to degree to which a team meets or exceeds the standards of stakeholders other than its members (e.g., quality, efficiency) while internal criteria refer to member attitudes (e.g., satisfaction) and interpersonal outcomes (e.g., team cohesion). Hackman (1987), drawing on McGrath’s (1964) conceptualization of group effectiveness, proposed three criteria for evaluating team effectiveness: a) assessment of team performance by relevant individuals external to the team, b) meeting team member's needs, and c) viability, or the willingness to continue to be a member of the team. Although subsequent researchers have assessed team effectiveness using slightly different terminology (e.g., Cohen & Bailey's, 1997 use of behavioral outcomes instead of team viability), typical operationalizations of team effectiveness are consistent with the spirit one or more of three criteria proposed by McGrath (1984) and Hackman (1987) (e.g., Ancona & Caldwell, 1992; Campion, Medsker & Higgs, 1993; Stewart & Barrick, 2000).

In this dissertation, I focus on team performance -- the degree to which a team meets or exceeds the standards of stakeholders other than its members -- as a measure of team effectiveness. In comparison to more affective processes such as exchange of social support and expression of friendship that have an impact on team viability, knowledge sharing is an instrumental process that primarily impacts the completion of the team's task (Balkundi & Harrison, 2006). According to McGrath and Hollingshead (1994), team information processing in team principally impacts the production function, which suggests that team performance rather than team viability or member satisfaction is the most relevant outcome of knowledge sharing (p.101). In a similar vein, Hackman and Morris (1975) argue that knowledge sharing among members is a critical summary variable that primarily impacts task performance.

The central role of knowledge sharing in influencing task performance is a consequence of teams' embeddeness within a larger organizational context. Knowledge sharing among team members represents an attempt at meeting the demands originating from that larger context. To cope with these demands, teams must "do things…make decisions…and create, invent, and adapt solutions to resolve task driven problems." (Kozlowski & Bell, 2003: p. 80). That is, teams must continuously cope with uncertainty that arises from its task environment through knowledge sharing among members to ensure effective performance (Tushman, 1978; Ancona &

Caldwell, 1992; Argote, 1999). Information exchange between team members enables the team to make decisions, solve problems, and identify alternative courses of action to deal with increased uncertainty (Okhuysen & Eisenhardt, 2002). Knowledge sharing among team members also leads to improved team performance because discussion and deliberation among members can result in the “emergence” of new ideas and insights concerning task performance (Argote, 1999: p. 114). That is, information exchange can stimulate the generation of knowledge that did not exist within the team prior to the collaboration (Reus & Liu, 2004).

Srivastava (2001) proposed that another reason to expect improved performance from knowledge sharing is a result of conceptualizing knowledge sharing among team members as a form of participation in decision-making (PDM), which is associated with higher quality of decision making, and performance (Locke, Alavi, & Wagner, 1997; Wegge, 2000). Consistent with this argument, Latham, Winters, and Locke (1994) found that the principal benefit of PDM for group performance was to improve the group’s task knowledge.

Knowledge sharing could also contribute to improved performance because it can result in the development of cognitive structures or knowledge representations such as team mental models and transactive memory (Klimoski & Mohammed, 1994; Wegner, 1986). Both these types of cognitive structures are expected to improve team members’ effectiveness at performing team tasks (Cannon-Bowers, Salas & Converse, 1993; Austin, 2003; Lewis, 2004). Knowledge sharing is likely the medium for the emergence of shared understandings concerning the team’s task, tools, team member skills, resources, habits and preferences, and process (Klimoski & Mohammed, 1994). Similarly, knowledge sharing could also potentially result in the development of teams’ transactive memory (TM) systems because it influences three processes that are relevant to the development of TM – directory updating, communicating to allocate information, and communication to retrieve information (Wegner, Giuliano, & Hertel, 1985; Wegner, 1986). The sharing of task relevant information allows members to recognize, and update their directories of member expertise. In turn, this facilitates members directing knowledge they come upon outside there area of expertise to the appropriate members. Finally, some forms of knowledge sharing represent information retrieval because it is often stimulated by queries directed towards a particular member with specialized expertise. However, because it is knowledge sharing that is the focus of this dissertation, I do not include these cognitive structures as part of my theoretical framework.

A number of studies have provided support for the benefits of knowledge sharing between team members for team performance. Allen (1979) found that higher levels of technical communications among members distinguished high performance R&D teams from those that had lower levels of performance. Faraj and Sproull (2000)'s study of expertise co-ordination in software teams found that sharing of expertise was positively associated with team performance. Similarly, Tiwana and McLean (2003) found that expertise sharing in software teams was positively associated with team creativity, and Tiwana (2004) found that knowledge integration in software teams reduced the incidence of software defects, resulted in lower project cost overruns, and improved customer satisfaction with the software design. Hoegl and Gemunden (2001)'s study of 145 software laboratory teams involved in innovative projects finds that project success was significantly predicted by team members' open, informal, and spontaneous exchange of project knowledge, and by each member having sufficient opportunities to contribute all their task relevant knowledge. Cummings (2004) found evidence that knowledge sharing among team members predicted team performance. The findings from a recent meta-analysis suggest that extensive information sharing and collaboration between team members, represented by a dense network of advice ties, enhances team effectiveness (Balkundi & Harrison, 2006). Therefore, I expect:

Hypothesis 6: Team knowledge sharing will be positively related to team performance

Chapter 3

METHOD

I tested my hypotheses via a four-wave panel investigation of the effects of variety, disparity and team communication configuration on knowledge sharing and performance. Methodological details are provided below.

3.1 Research Setting and Sample

To determine the sample size necessary for this study, I used G*Power 3 software (Faul, Erfelder, Lang & Buchner, 2007), which allows the *a priori* estimation of power for multiple regression based on the assumed α-level of the test, magnitude of effect size, desired power level, and number of predictors. I assumed an α-level of .05, medium effect size of $r = .30$, which is typical in social science research for main effects (Cohen, 1992), desired power level of .80, and number of predictors as equal to 10. I assumed 10 predictors to account for a) the three-way interaction test proposed in the framework, and b) control variables. Based on these assumptions, G*Power 3 suggested a target sample size of 118 teams.

A key criterion governing the choice of research setting was the challenge of measuring variety (see Appendix D for Guidelines for Measuring Variety). To effectively assess the effects of variety, I had to ensure that my sample consisted of teams that are a) engaged in similar tasks, and b) are embedded within similar contexts. Additionally, I needed to choose a research setting that would allow a great deal of between-team variance on a) variety, b) disparity and c) communication configuration, so that covariance between these antecedents and my proposed consequences would be more readily detected.

Therefore, I tested my hypotheses on a sample of senior undergraduate students enrolled in twenty-eight sections of a mandatory course on business and industry analysis at a business school in a large Northeastern research university. Across the 28 sections, there were 919 students enrolled in this course who were randomly distributed by the course coordinator into 168 teams. Each section had six teams. Students were randomly assigned to teams by instructors prior to the beginning of the semester. They were also not permitted to change their assigned teams during the course of the semester.

Team - based project work formed a core component of coursework, and accounted for 46% of the grade. All coursework assigned to teams consisted primarily of knowledge based work: that is, teams were primarily engaged in intellective, judgment, creativity, or planning tasks (McGrath, 1984). All team projects and assignments were designed to foster cross-functional interdependence among members and assess the impact of changing business trends on organizations. Key student team deliverables for the course include a) managing a $100 million company in a competitive, capstone simulation (CAPSIM) by analyzing the enterprise-wide effects of key business decisions (see Appendix E for a detailed description); b) writing an analytical report on the key external trends affecting a Fortune 500 company; and c) presenting two reports to peers and executives about their strategies for the CAPSIM business simulation and their analysis of business trends.

The business and industry course was a semester-long, approximately 16-week course. The course consisted of a weekly lecture by the instructor that provided the conceptual foundations of the course. This was followed by a weekly “laboratory” session facilitated by instructors (MBA students from the business school) where students would have the opportunity to apply the concepts from the theory class to team projects.

This is a suitable research setting to test my hypotheses because it satisfies the criteria proposed earlier. First, the number of teams in this setting exceeded the suggested target number of teams required for having sufficient power to detect the proposed main effects. Second, all teams were assigned the same tasks that were performed in very similar contexts in the same semester. Further, all sections had the same course coordinator. However, this research setting also raised potential concerns about the degree of between-team variability on the variables of interest. To ensure that there would be sufficient variance on variety attributes, I first identified the relevant variety attributes by interviewing the course instructor and teaching assistants, inspecting the syllabus, and reading descriptions of team tasks. The course coordinator had access to information in spreadsheets about the distribution of these attributes among members of teams in past years, and after examining these spreadsheets verified that it was reasonable to expect between-team differences on the chosen variety attributes.

Unlike organizational teams, student teams do not have structural or other *a priori* bases for generating disparity. Nevertheless, past research on status, power and influence suggests that interaction between members, even when they are peers, is an important source of disparity within teams (Bales, 1950; Cohen & Zhou, 1991). Further, drawing on status characteristics theory (Berger et al., 1972, Ridgeway, 2001), I anticipated between-team variance in disparity levels because of the expected variance between teams in the distribution of specific characteristics (task relevant attributes such as major area, experience with team work) and non-specific characteristics (task irrelevant attributes such as gender or ethnicity) among their members.

Status characteristics determine performance expectations associated with team members, and therefore influence the emergent status and influence orders in the team. In addition to task relevant status characteristics such as expertise and experience, research suggests that status is attributed to individuals on the basis of gender, age and ethnicity (Jackson, 1996). For example, Cohen & Zhou (1991) found that even after controlling for performance, members of R&D teams accorded males higher status than females. Therefore member status in a team is likely to be a result of a complex combination of specific or task relevant characteristics as well as non-specific characteristics such as gender and ethnicity. Because the distribution of configurations of status characteristics among members likely varies across teams, levels of disparity are also likely to vary.

Another potential concern about this research setting is the use of student teams, which could limit the external validity of findings from this study. However, although the participants in this research were undergraduate students, almost all students were in their senior year and had meaningful organizational work experiences in the form of internships and full-time or part-time work. Because the majority of students were a few months away from entering the job-market as full-time employees, a key objective of the business and industry analysis course was to prepare them for this by providing them opportunities to work in multi-functional team based projects.

The wide range of tasks that teams were expected to complete were specifically designed to simulate those encountered by organizational teams. The realism associated with team tasks was enhanced by including decision-making and strategy formulation tasks while competing for market-share in a computer based industry simulation, and communication of strategy and decisions via written reports and presentations to executives. Additionally, the temporal pacing of team tasks in the course simulates that of project teams or task forces in organizations. Finally, the use of student teams for research is widespread because it allows researchers to test for hypothesized relationships without the interference of extraneous variables (Kozlowski & Bell, 2002).

3.2 Data Collection Procedure

I collected data in four waves, which included surveys, archival data, and data collected as part of class assignments (see figure 2 for a graphical summary of the data collection timeline). Wave 1 data were collected in the first week of the course and provided two measures of variety: Variety $_{\text{(major)}}$ and Variety $_{\text{(functional experience)}}$ (these and other measures are described in detail below in *Measures*). Archival data on Variety $_{\text{(major),}}$ which summarizes the distribution of major areas within a focal team, was obtained from a spreadsheet provided by the course instructor. Information on student majors was available for all students enrolled in the course. Data on Variety $_{\text{(functional experience)}}$ were collected as part of an in-class assignment administered in the first week of course. As part of that assignment, students were asked to provide information about their full-time and part-time work experiences, including details about specific functions and roles they held. The individual-level response rate for this in-class assignment was 92%.

Insert Figure 2 about here

Data collection for Wave 2 and Wave 3 consisted of Internet-based student surveys that were administered via Surveymonkey.com. The Wave 2 survey included questions measuring disparity, face-to-face and virtual communication, and perceived variety. The Wave 3 survey included questions measuring knowledge sharing and member assessments of their team's performance. For each of the two waves of the student surveys, respondents who had provided informed consent were sent emails with a link to the web-hosted survey. The Wave 2 survey was sent to students in the 7th week of the course. The Wave 3 survey was sent to students in the

13th week of the course. A week after each survey was sent to students, reminders were sent to those who had not responded. Both surveys were closed to respondents two weeks after they had been sent. Students that responded to Wave 2 and Wave 3 surveys were given extra-credit equivalent to 3% of their course grade. In addition, students also received a gift certificate for $25 that could be redeemed for meals at local restaurants. This resulted in 862 students completing both waves of the survey for an individual level response rate of 94%.

Finally, I collected Wave 4 data on two external measures of team performance in the 16th week of the course. The first was an archival measure reflecting the teams' grades on the projects shared by all team members. The second measure was a rating of team performance by the instructors for the teams that they supervised in the laboratory sessions. Such performance data were available for all teams in the course.

Sample. For a team to be included in the sample, a) a majority of members must have participated in the survey and b) teams must have at least three members (Allen, Stanley, Williams & Ross, 2007). All 168 teams met these criteria and were included in the final sample. Team size ranged between 4 and 7 members. The average team size was 5.5 members and the median team size was 5. The average team-level response rate was 94% for the Wave 2 student survey and 92% for the Wave 3 survey. Team members that responded to the survey were from 39 different countries, and the majority (93%) was from the United States. The largest ethnic group was Caucasian (82%), followed by Asian (10%), African-American (3.5%), and Latino or Hispanic (3%). The remaining 1.5 % described themselves as multi-racial or other. The average age of team members was 21.3 years and 39% of them were female.

3.3 Measures

(The specific items for each of the measures are listed in Appendix C)

Variety. Because teams can have variety on multiple attributes that are specific to the research setting, I conducted the equivalent of a job analysis at the team – level to identify relevant variety attributes that differentiate members' unique caches of knowledge (see Appendix D - Guidelines for Measuring Variety – for a detailed discussion concerning the challenges associated with measuring team variety). To gather the necessary information required for the team task analysis, I first interviewed the course instructor about the tasks that teams performed as part of the course assignments. During the interview, I focused on knowledge, skills and experience that would be relevant for the performance of these tasks as well as the best indicators of their presence. I also conducted similar interviews with laboratory instructors that had facilitated the past years' course. In addition, I analyzed the course syllabus, the descriptions and instructions related to the team task, and the materials associated with the CAPSIM simulation. All these suggested two objective measures of team variety -- Variety $_{\text{(major)}}$ and Variety $_{\text{(functional experience)}}$.

Variety $_{\text{(major)}}$ summarized the distribution of undergraduate business major areas in the team. Each team member specialized in one of nine possible major areas offered in the business school – accounting, finance, marketing, supply chain, management information systems, management, business economics and actuarial science. Variety $_{\text{(functional experience)}}$ refers to the distribution of functional work related experiences among team members. These could be either part-time or full-time work experiences. Team members' functional experiences were distributed across 11 distinct functional areas -- accounting, finance, marketing / sales, supply chain, management information systems, management, actuarial science / insurance, real estate, research & development, engineering and business law.

Because team variety is a configural construct (Klein & Kozlowski, 2000), both variety measures were calculated using the Blau's index of heterogeneity (Blau, 1977; Harrison & Klein, 2007). The formula for Blau's index is $(1 - \sum p_k^2)$ where p represents the proportion of team members in the *k*th category, and k is the total number of possible categories across teams on that specific attribute.

In addition to these objective variety measures, I also included a 3-item subjective measure of variety -- *perceived team variety* -- to gauge member assessments of knowledge, expertise and experience differences among members of their unit. Team members provided their responses on a five point Likert-type scale that ranged from 'All members have the same knowledge / experience' to 'Each member possesses unique knowledge / experience'. The estimated reliability of this 3-item scale was acceptable ($\alpha = .73$). Table 2 contains reliability estimates for this and other team-level indexes created in this dissertation.

Because perceived variety is operationalized as a shared construct with the team as the referent (Klein & Kozlowski, 2000; Chan, 1998), demonstrating within-team agreement on and between-team variance in their assessments of the distribution of unique knowledge is crucial for justifying the aggregation of individual member responses to the team level. I used three measures to demonstrate the appropriateness of aggregation: ICC (1,k), ICC (2,k) and r_{wg}. The first index, ICC(1,k) (Shrout & Fleiss, 1979; James, Demaree & Wolf, 1993) assesses the degree to which variability in perceived variety can be predicted from team membership, and it can be thought of as a proportion of variance explained. The second index, ICC (2,k) measures the reliability of between-team differences in the mean level of perceived variety, and r_{wg} reflects the portion of team member agreement relative to a random (uniform) baseline on the level of perceived variety (Klein & Kozlowski, 2000). Table 1 provides the results of the ICC analysis and r_{wg} values for all team – level scales. The ICC analysis and within-unit agreement scores for this measure provided adequate justification for aggregation to the team-level -- ICC (1,k) = .33, ICC (2,k) = .73 and median r_{wg} = .87 (Bliese, 2000).

Disparity. Similar to variety, disparity can exist on multiple attributes within a team. Past research on team disparity suggests that hierarchical position in the organizational chart, highest level of educational credentials, team and organizational tenure, and formal assignment of leadership role are all bases for status differences (Cohen & Zhou, 1991; Bunderson, 2003). However, all of these structural or *a priori* forms of disparity are less meaningful in undergraduate student teams, which typically have members joining the team at the same time, and for which the assignment of members to formal hierarchical positions is uncommon. Instead, interactions among team members form the basis for status, influence and power within teams (Bales, 1950; Berger et al., 1972; Cohen & Zhou, 1991). I used three measures of disparity resulting from teams' emergent social context. The first measure -- team status disparity -- adapted from Cohen and Zhou (1991) asked team members to nominate those members who they believe were valuable for completing the team's task. The second measure -- informal leadership status adapted from Neubert (1999), asked team members to nominate those members who they thought emerged as leaders in the team (see also Oh, Labianca & Chung, 2006).

The third measure was disparity in perceptions of one's own team status referred to in this document as *self-status disparity*. This was operationalized using a 4-item instrument adapted from Chiaburu, Harrison and Ren (2008) that asked members to rate the amount of status, influence, power and credibility that each member believed they had in the team, in comparison to other members. Members provided their responses on a 7-point Likert-type scale that ranged from 'less than anyone else' (1) to 'more than anyone else' (7).

Similar to team variety, team disparity is a configural construct (Klein & Kozlowski, 2000). The amount of disparity in the team is calculated using the coefficient of variation (Harrison & Klein, 2007): $SD(D)/D_{mean,}$ for a disparity attribute D. For the first two measures of disparity -- team status and informal leadership -- the disparity attribute D was the number of nominations or votes each member received from other members for that measure, which could range from zero to a maximum of n-1, where n refers to team size (self-nominations were excluded). For the third measure of disparity, the disparity attribute D was the mean score for each member's assessment of their relative standing in the team on each of the 4 items. Disparity for this measure also was calculated using the coefficient of variation.

Face-to-face Communication. The extent of face-to-face communication in the team was initially measured using a 4-item index created specifically for this study. Two items assessed the use of face-to-face mode of interaction in team meetings involving a) the entire team, and b) subsets of members. The third item assessed the extent of spontaneous work-related face-to-face interaction among team members, while the fourth item measured the prevalence of informal (nonwork) face-to-face interaction among members. Scales composed of somewhat comparable items can be found in Smith et al., (1994) and Timmerman & Scott (2006). The one noteworthy difference between these two scales and the one used in this study is that they measure absolute frequency (e.g., number of times per day or week), whereas my scale was a Likert-type scale.

I chose to drop the second item -- face-to-face team meetings involving subsets of members -- from the final scale because it was negatively correlated with the first item -- face-to-face team meetings involving the entire team, which suggested that the two items were not parallel indicators. The final 3-item scale demonstrated good internal consistency (α = .85) and the relevant aggregation indices were at levels that justified aggregation to the team-level -- ICC (1,k) = .26, ICC (2,k) = .66 and median r_{wg} = .72.

Virtual Communication. Scholars have operationalized virtual communication in two related but distinct ways -- as the frequency of use of different information and communication technologies by team members (e.g., Gibson & Gibbs, 2006) and as the frequency of virtual work behaviors or practices (e.g., Staples & Webster, 2008). Accordingly, virtual communication was initially measured using two different measures. The first measure assessed the frequency of use of communication technologies by team members via an index created by the extent of use of eight types of communication technologies by team members (see Appendix C for a complete list). Team members were asked to estimate how often members of their team used each of the eight communication technologies for communicating or interacting electronically. Responses ranged from 'Never' (0) to Always (6).

The second measure was a seven-item measure that assessed virtual communication behaviors was partly based on the technology subscale of Maznevski and Chudoba's (2000) virtuality index (see Appendix C for a complete list). Some sample items are -- 'use email or Angel to follow-up face-to-face team task related discussions' and 'communicate with other members using mobile devices (e.g., cell phone, Blackberry)'. Team members provided the frequency of use of the virtual communication behaviors in their team. Responses ranged from 'Never' (0) to Always (6).

Of the eight communication technologies whose usage frequency was tracked in the first measure, three technologies -- social networking software, group collaboration software and teleconferencing -- had a very low base rate: the median response for frequency of use was "Never". Therefore, I excluded these items from the measure. Subsequently, exploratory factor analysis (more details provided in the results sections) of the remaining items along with those from the virtual communication behavior scale resulted in the exclusion of two more items -- instant messenger and Angel -- because they did not cleanly load on a single factor. Further, based on the EFA, I decided to aggregate the remaining three items from the first measure with the second measure assessing virtual communication behaviors to form a larger ten-item measure. Items from this combined measure loaded on two factors (see Table 3). Six items that referred to computer-mediated communications loaded on one distinct factor. Four items that referred to communications enabled by phones (e.g., text messaging, mobile communications) loaded on another factor. The final ten items that were included in the measure are listed in Appendix C under Virtual Communication. The estimated reliability of this scale was $\alpha = .82$. Aggregation to the team-level for the combined measure was substantiated by ICC (1,k) = .16, ICC (2,k) = .50 and median $r_{wg} = .88$.

It is also important to note that virtual interaction is measured independent of the level of face-to-face interaction: this differentiates my operationalization of virtual interaction from measures of virtuality that could be created based on Kirkman and Mathieu (2005). Their instrument mandates an inverse relationship between face-to-face interaction and the level of team virtuality (Mathieu, 2008: personal correspondence).

Knowledge Sharing. Knowledge sharing was assessed using a seven-item instrument that captures members' observations of the extent to which team members exchange information, expertise, and ideas in completing team tasks. The seven items for this scale were adapted from Srivastava, Bartol and Locke (2006). Their scale, in turn, was created by adapting four items from Faraj and Sproull's (2000) items that measured the sharing of expertise in teams along with three items from Durham's (1997) information sharing scale. Team members provided responses on a seven point Likert-type scale that ranged from 'Strongly Disagree' to 'Strongly Agree'. The estimated reliability of the seven-item scale was high ($\alpha = .94$).

Because variety is a key construct of the theoretical model, I felt it was important to track the contribution of unique knowledge, or experience by team members. However, the items of the Srivastava et al. (2006) scale do not specifically capture such uniqueness. This unique knowledge sharing is also crucial for many types of team tasks such as this one (Mesmer-Magnus & DeChurch, 2009). Because contributions of unique or novel knowledge involve uncertainty or risk in bringing it forward, I deployed an additional measure to track sharing of such knowledge by creating five items specifically for this study. A sample item is 'Provide solutions to resolve team problems that are original'. This second measure of knowledge sharing is called risky knowledge sharing to distinguish it from the Srivastava et al. (2006) measure, which is simply referred to as knowledge sharing. Team members rated the frequency of unique knowledge sharing behaviors by their team on a seven point Likert-type scale that ranged from 'Never' to 'Always'. The estimated reliability of the scale was $\alpha = .94$.

Exploratory factor analysis (details provided in the Results section) indicated that the two measures loaded on distinct factors (see Table 3). However, because of the somewhat high correlations between the two measures ($r = .53$), I decided to combine them into a single twelve-item knowledge sharing measure. To do this I standardized each measure and summed them to create a composite knowledge sharing measure. All analyses that included the variable *Knowledge Sharing* were conducted on this twelve item measure. The estimated reliability of this composite scale was $\alpha = .95$.

Similar to team self-rated performance, knowledge sharing was operationalized as a shared construct with the team as the referent (Klein & Kozlowski, 2000; Chan, 1998). Therefore, to justify the aggregation of individual member responses to the team level, I calculated ICC (1,k), ICC (2,k) and r_{wg} scores for the twelve item knowledge sharing measure. The ICC analysis and r_{wg} score were at sufficient levels to justify aggregation to the team-level -- ICC (1,k) = .25, ICC (2,k) = .65 & median r_{wg} = .97 (Bliese, 2000).

Team Performance. Team performance was assessed using three different measures derived from three independent sources. The first measure of team performance -- team project scores -- is an index of scores on the three team projects including the competitive simulation (CAPSIM), analysis of global trends, and team presentations. These scores along with scores on the individual quizzes and assignments were consequential to members in that they are used in calculating student grades. Scores in the index are weighted to reflect their contribution to the student grade. The scores on the CAPSIM simulation are generated by a computer algorithm that assesses performance based on a series of team decisions on various aspects of running a firm competing in a multi-million dollar electronics sensor industry. Scores on the "global trends" report were given by the course instructor and scores on team presentations were determined by a panel of laboratory instructors that had not previously interacted with the team. That is, the evaluation panel excluded the instructor supervising a focal team in its laboratory sessions.

Overall, the first measure of team performance represents evaluations based primarily on concrete team outputs by sources that are either impersonal (CAPSIM algorithm) or relatively remote from the team (course instructor, panel of judges) which means that they do not have the opportunity to observe team processes or behavior. However, especially for knowledge worker teams, in addition to evaluation based on output, subjective ratings are also consequential because they are often used in performance evaluations and promotion of team members, and for making decisions on resources and support for the team (Ancona & Caldwell, 1992). Not surprisingly, subjective or supervisor ratings of team performance are a commonly used measure of team performance in field studies (e.g., Ancona and Caldwell, 1992; Stewart and Barrick, 2000; Sparrowe, Liden, Wayne and Kramer, 2001; Oh, Chung and Labianca, 2004; and Van Der Vegt, Gerben and Bunderson, 2005).

Therefore, to complement the first measure of performance based on team outputs, the second measure of team performance -- instructor rating -- consisted of using a subset of 5 items from a nine-item scale adapted from Campion, Papper and Medsker (1996). The remaining items were dropped because they were either not relevant to the student teams' tasks and context or instructors could not make distinctions between teams on those criteria. For example, one such item assesses cooperation with others external to the team. Teams were assessed on their quality of work, adherence to schedules, innovativeness, initiative displayed by the team, and overall performance by instructors that supervised their laboratory sessions. They rated teams on a seven point response format that ranged from 'Very Poor' to 'Outstanding'. The 5-item scale also demonstrated robust internal consistency ($\alpha = .85$).

Laboratory instructors were chosen as raters because they have the opportunity to observe team processes and performance, especially for the CAPSIM simulation. They provided instruction and advice on technical matters relating to the CAPSIM simulation. Teams often discussed their strategies for competing in the CAPSIM simulation with them. Further, the laboratory instructors also acted as mediators for those teams that experienced team process issues such as conflict among or shirking by team members. Laboratory instructors for this course were drawn from the business school's MBA program and had an average of 4 years of work experience prior to beginning their MBA. There were 11 such laboratory instructors assigned to the 28 sections of the course; each was responsible for 2 or 3 sections.

The third measure of team performance consisted of team members evaluating their unit on an eight-item scale adapted from Campion, Papper and Medsker (1996). Member responses were collected in Wave 3 of the data collection process. Team members assessed their group on productivity, adherence to schedules, speed of response to problems or opportunities, initiative displayed, innovativeness, creativity, and overall performance of the team. They rated their teams on these criteria on a seven point Likert-type scale that ranged from 'Very Poor' to 'Outstanding'. The estimated reliability of the scale was $\alpha = .95$. The ICC (1,k) = .16, ICC (2,k) = .51 and median $r_{wg} = .96$ values for self-rated team performance provide adequate justification for aggregating individual responses into a team-level construct.

Control Variables. I included team size as a control variable because past research has found that it can impact team outcomes (Kozlowski & Bell, 2003). Other control variables that I considered included team longevity and task interdependence. However, because all teams had the same tenure and performed the exact same tasks, I did not include them.

Chapter 4

RESULTS

4.1 Exploratory Factor Analysis

To examine the construct validity of key variables, I used exploratory factor analysis (EFA) with squared multiple correlations as initial communality estimates. I applied principal axis factoring for factor extraction followed by oblique rotation, which allows factors to be correlated. I first employed EFA on team-level data for the following constructs -- perceived variety (3 items), face-to-face communication (3 items), virtual communication – use of communication technology (5 items after eliminating communication technologies with low frequency of use -- see Measures section for further details), virtual communication behaviors (7 items), knowledge sharing (7 items from Srivastava et al., 2007), risky knowledge sharing (5 items) and member ratings of team performance (8 items). I started the EFA with an expectation of a seven-factor solution. The scree plot of eigenvalues from the EFA suggested a seven-factor model. I also conducted a parallel analysis employing the same communality estimates (SMC) and extraction techniques (principal axis) (Fabrigar et al., 1999). The first seven eigenvalues for the random data fell below the observed eigenvalues in the real data, which corroborated the seven-factor solution suggested by the scree plot. Deliberate under-factoring and over-factoring moved the factor solution farther away from simple structure and increased ambiguity concerning factor loadings compared to the seven-factor solution. The rotated factor pattern generated the theoretically expected factor structure except for the items related to the two measures of virtual communication.

Two items from the first virtual communication measure (see Appendix C for the complete list) -- 'using Angel for communication and coordination' and 'Instant Messaging / chatting with team members' -- had very low factor loadings across all factors (< |.20|) and did not load cleanly on any factor. Therefore, I dropped these items from further analyses.

The pool of ten remaining items for the virtual communication - use of communication technology (3 items) and virtual communication behaviors (7 items) measures were distributed across two factors without cross-loadings. Five items from the virtual communication behaviors measure and one item from the virtual communication – use of communication technology measure loaded composed the first factor (see items under Virtual Communication - Computer Mediated in Table 3). The remaining four items (2 items from each of the two measures) loaded on the second factor (see items under Virtual Communication – Phone Mediated in Table 3). These items loading on the two factors could be meaningfully distinguished from each other -- the first factor could be broadly described as composed of items referring to computer mediated communications and the second factor was composed of items referring to phone mediated communications. I chose to pool items from both factors in a single virtual communications measure, which was composed of two dimensions -- computer based communication and phone based communication.

I conducted a second EFA on the same team-level data as the earlier EFA but without the two virtual communication items that did not load cleanly on any factor. Similar to the first EFA, I started the second one with an expectation of a seven-factor solution. Examination of the scree plot of eigen values again suggested a seven factor solution. This was consistent with the seven-factor solution indicated by parallel analysis wherein I compared eigenvalues from the second EFA to those generated from random data (Fabrigar et al, 1999). Deliberate under-factoring and over-factoring worsened simple structure compared to the seven-factor solution. The final rotated factor pattern resulted in a theoretically meaningful seven-factor model with no cross-loadings that exceeded |.30|. The factor loadings are presented in Table 3. Examination of the inter-factor correlations highlighted the somewhat high correlation between knowledge sharing and risky knowledge sharing (r = .47), which suggested that although the two types of knowledge sharing are at least partially independent, they might be combined (see also discussion on Knowledge Sharing in the Measures section).

Insert Table 3 about here

4.2 Hypothesis Tests

Table 4 presents the means, standard deviations and intercorrelations of the variables in this dissertation. Several trends are discernible from Table 4. Of the three variety measures, only perceived variety is moderately and positively correlated with knowledge sharing (r = .20). Leadership status disparity and self-status disparity had moderate negative connections with knowledge sharing (r = -.16 & r = -.21, respectively). Of all the antecedents of knowledge sharing, face-to-face communication had the strongest connection to it (r = .47). Virtual communication was also moderately strongly connected to knowledge sharing (r = .27). Knowledge sharing was strongly correlated with team ratings of performance (r = .63), moderately strongly connected to instructor ratings of performance (r = .30), and only moderately connected to performance assessed from course grades (r = .23).

I tested all hypotheses using multiple regression. I chose multiple regressions over structural equation modeling (SEM) for two reasons (Bobko, 1995). First, two of my hypotheses involved tests of moderating effects. Although it is possible to use SEM for testing moderating relationships, it is not commonly used in the management literature (Cortina, Chen & Dunlap, 2001). Instead, multiple regression is preferred for testing interaction effects (Jaccard, Turrisi & Wan, 1990; Cohen, Cohen, West & Aiken, 2002). Second, most SEM software packages assume multivariate normality for all observed and latent variables. However, the distributions of some of the diversity variables in this study violate this assumption. Multiple regression is relatively robust procedure that only assumes multivariate normality for the error terms (Bobko, 1995).

The results of the tests of specific hypotheses formulated *a priori* are presented in Tables 5 to 8. Although not formally hypothesized, indirect effects of the antecedent variables on team performance via the intervening variable -- knowledge sharing -- were assessed using bootstrap tests for indirect effects (MacKinnon, Lockwood, and Williams, 2004). Results of this analysis are presented in Table 9.

Insert Table 4 and 5 about here

Hypothesis 1 proposes that variety is positively related to knowledge sharing. Model I in Table 5 summarizes the results of the test of Hypothesis 1. The three measures of variety -- variety $_{major}$, variety $_{function}$ and perceived variety together, account for a statistically significant portion of variance in knowledge sharing (Model I: $\Delta R^2 = .05$); however, the model was significant only at $p < .10$ level of significance. Therefore, Hypothesis 1 was tentatively supported. Only perceived variety had a significant unique contribution in the model ($\beta = .21$, $p < .01$).

According to Hypothesis 2, disparity should be negatively related to knowledge sharing. Hypothesis 2 was supported. Details of the test of Hypothesis 2 are presented in Table 5. The three measures of disparity -- team status disparity, leadership status disparity and self-status disparity -- together accounted for a statistically significant portion of variance in knowledge sharing (Model II: $\Delta R^2 = .06$; $p < .05$). Of the three disparity measures, self-status disparity exhibited the strongest unique effect on knowledge sharing ($\beta = -.20$, $p < .05$) followed by leadership status disparity ($\beta = -.15$, $p < .10$), which was marginally significant. The effect of the third disparity measure -- team status disparity -- on knowledge sharing was not significant. Further, disparity accounted for unique variance in knowledge sharing after accounting for variety (Model III: $R^2_{III} - R^2_{I} = .06$; $p < .05$), and, self-status disparity ($\beta = -.17$, $p < .05$) and leadership status disparity ($\beta = -.16$, $p < .05$) had significant, unique contributions to this larger model.

Insert Table 6 about here

Hypothesis 3 predicted that the positive effect of variety on knowledge sharing would be attenuated by disparity. Table 6 provides the results for Hypothesis 3. For each measure of disparity, I first created a separate model that included the three variety measures and the control variable as main effects in the regression equations (see Model I: Team Status Disparity; Model III: Leadership Status Disparity & Model V: Self-status Disparity). Then I added the interaction terms to these models by multiplying the focal disparity measure with the three measures of variety (Models II, IV & VI). As is evident from Models II, IV and VI, none of the moderating effects were significant. Therefore, Hypothesis 3 was not supported.

Hypothesis 4 predicted a positive interactive effect of face-to-face and virtual communication on knowledge sharing. Table 5 summarizes the results of the test of Hypothesis 4. I first created a model that included face-to-face and virtual communication and control variable as main effects in the regression equation (Model VIII). I added the interaction term by multiplying face-to-face and virtual communication (Model IX). The interaction term was non-significant ($\beta = -.16$, *n.s.*). Therefore, Hypothesis 4 was not supported.

Recall, however, that I had also identified (but not formally hypothesized) alternative models for predicting the effects of face-to-face and virtual communication on knowledge sharing that were derived from past literature. The first model was the Compensatory model (mathematically represented as: Face-to-face Communication + Virtual Communication → (+) Knowledge Sharing) that hypothesized that the two forms of communication would independently explain unique variance in knowledge sharing. Model VIII ($\Delta R^2 = .06$; $p < .05$) in Table 5 provides a test of the Compensatory model: face-to-face ($\beta = .44$, $p < .01$) and virtual communication ($\beta = .18$, $p < .05$) uniquely explained statistically significant variance in knowledge sharing. Further, as Model VII in Table 5 demonstrates, even after accounting for variance explained by variety and disparity, face-to-face ($\beta = .39$, $p < .01$) and virtual communication ($\beta = .15$, $p < .05$) uniquely explained statistically significant variance in knowledge sharing. Importantly, virtual communication explains significant unique variance in knowledge sharing after accounting for variance explained by variety, disparity and face-to-face communication (Model VII: $R^2_{VII} - R^2_{V} = .02$, $p < .05$). Therefore, overall the Compensatory model was supported.

The second model -- Virtuality model (mathematically represented as: Face-to-face Communication / Virtual Communication → (+) Knowledge Sharing) -- predicted that the ratio of face-to-face to virtual communication would explain significant unique variance in knowledge sharing. This prediction offered by the Virtuality model (Model X in Table 5) was not supported: the ratio term was not significant ($\beta = -.15$, *n.s.*).

Insert Table 7 about here

Hypothesis 5 predicted that the interactive effect of face-to-face and virtual communication would enhance the positive effect of variety on knowledge sharing. Table 7 presents the results of the test for each of the three measures of variety -- variety $_{major}$ (Models I & II), variety $_{function}$ Models (III & IV) and perceived variety (Models V & VI). For each of the three variety measures, I first entered the focal variety variable, face-to-face communication, and virtual communication and control variables as main effects. Then, I added the 3 possible second order interaction terms and the three way interaction term. Hypothesis 5 was not supported. The three way interactions were not significant for all three variety measures.

Insert Table 8 about here

The last hypothesis -- Hypothesis 6 -- proposed that knowledge sharing would be positively related to team performance. Table 8 provides the details of the tests of this final hypothesis. Hypothesis 6 was supported for all three measures of team performance. Knowledge sharing had a significant positive effect on a) instructor rating of team performance ($\beta = .29$, $p < .01$); b) member rating of team performance ($\beta = .63$, $p < .01$); and c) performance based on course grade ($\beta = .23$, $p < .01$). It explained the most unique variance in member ratings of performance ($\Delta R^2 = .40$; $p < .01$) followed by instructor ratings ($\Delta R^2 = .09$; $p < .01$) and course grade ($\Delta R^2 = .05$; $p < .05$).

I also examined the indirect effects of variety, disparity and face-to-face and virtual communication on performance. Although I did not propose any hypotheses about these effects, I expected knowledge sharing to play the role of an intervening variable. I tested for the presence of indirect effects using a bootstrap approach (MacKinnon, Lockwood, and Williams, 2004; Preacher and Hayes, 2008; Shrout and Bolger, 2002). Specifically, I obtained the 95% percentile bootstrap confidence intervals (CI) for the hypothesized indirect effects using 1001 bootstrap samples. Table 9 presents the bootstrap CIs for each indirect effect between each antecedent -- variety, disparity, face-to-face communication and virtual communication -- and team performance. The intervening variable for all tests of indirect effects in Table 9 was knowledge sharing. Knowledge sharing transmitted the effects of perceived variety, leadership status disparity, self-status disparity, face-to-face communication and virtual communication on all three measures of team performance: the CI for each of these indirect effects did not include zero. The signs of the unstandardized regression coefficient estimates for the lower and upper limits of the confidence intervals that did not include zero were consistent with theoretical predictions. Leadership status disparity and self-status disparity had negative indirect effects on team performance while perceived variety, face-to-face communication and virtual communication had positive indirect effects.

Insert Table 9 about here

Finally, although the majority of tests of my hypotheses used data from multiple sources and a longitudinal (panel) approach, some of my tests involved data from the same source separated by lag of about a month. Specifically, the significant relationships between three predictors -- perceived variety, face-to-face communication and virtual communication -- and dependent variable knowledge sharing involved data from the same source. Despite the time lag of over four weeks between collecting data on the independent variables and knowledge sharing, the relationships may still be affected by common method bias (Harrison, McLaughlin &

Coalter, 1996). I took the approach suggested by Ostroff, Kinicki & Clark (2002) to address this potential bias.

First, I randomly split members of each of the 168 teams in my sample into two sub-groups -- sub-sample A and sub-sample B. Next, in sub-sample A, I aggregated the responses of members on the three independent variables -- perceived variety, face-to-face communication and virtual communication -- to the team-level. Then, I aggregated the responses of members on knowledge sharing in sub-sample B. Finally, I regressed knowledge sharing from sub-sample B separately on each of the three predictors. The effect of perceived variety on knowledge sharing was not significant ($\beta = .06$, *n.s.*). The effect of face-to-face communication on knowledge sharing was significant ($\beta = .21$, $p < .01$). Similarly, virtual communication ($\beta = .14$, $p < .10$) also significantly predicted knowledge sharing, albeit at a $p < .10$ level of significance. Therefore, when the predictors and dependent variable were reported by different sets of team members, two of three relationships were significant. Although not conclusive, the pattern of evidence is indicative that the significant effects seen in the complete dataset cannot solely be accounted for by common method bias.

Chapter 5

DISCUSSION

Diversity and virtuality are integral parts of organizational life that present challenges for both theory and practice in organizational behavior (Harrison & Klein, 2007; Mannix & Neale, 2005; Schneider & Northcraft, 1999; Kirkman & Mathieu, 2005; Cramton, 2001). Yet, research has not completely examined the possibility that these two domains may have interrelated influences on workplace outcomes (see Bhappu, Griffith & Northcraft, 1997 for an exception). Consequently, I developed and tested a conceptual model that integrates how teams can leverage diversity, face-to-face communication, and virtual communication to influence knowledge sharing and consequently, performance. A central intuition guiding this model is that knowledge sharing is a key team process underlying the effects of diversity and virtuality. Using data from a sample of 168 teams, I empirically tested the proposed model.

5.1 Overview of Findings

Supporting Hypothesis 1, perceived variety enhanced knowledge sharing. In contrast, sustaining Hypothesis 2 leadership status disparity and self-status disparity reduced knowledge sharing. Both face-to-face and virtual communication had strong independent, unique effects on knowledge sharing, which supported the Compensatory model but refuted the predictions of Hypothesis 4. Corroborating Hypothesis 6, knowledge sharing had significant connections to three different measures of performance -- instructor rating of performance, team rating of performance and performance assessed through the course grades on team projects. The moderating effects of disparity (Hypothesis 3) and team communication configuration (Hypothesis 5) on the variety-knowledge sharing relationship were not supported. Knowledge sharing was the mainstay variable linking diversity (perceived variety, leadership status disparity and self-status disparity) and team communication configuration (face-to-face and virtual communication) to performance. Below, I discuss these findings (and non-findings) in more detail.

5.2 Discussion of Findings

This study's conceptual model was motivated by three related, but distinct research questions. First, how do teams deal with the joint operation of status differences (disparity) and knowledge differences (variety), especially when within-team alignment of those characteristics fluctuates widely among teams? To capitalize on diversity, I proposed that teams must work through the potentially dilemmatic operation of variety and disparity, which were expected to have contrasting effects on knowledge sharing and performance. Findings from this study provide some support for the operation of the conflicting effects of variety and disparity on knowledge sharing. Perceived variety is positively related to knowledge sharing while leadership status disparity and self-status disparity are negatively related to knowledge sharing. This contrasting effect on knowledge sharing was also transmitted to team performance: the positive indirect effects of perceived variety on performance were the opposite of the effects of leadership status disparity and self-status disparity on performance.

The lack of significant effects on knowledge sharing for the two objective measures of variety ($\text{Variety}_{\text{major}}$ and $\text{Variety}_{\text{function}}$) examined in conjunction with perceived variety's significant effect raises the possibility that they may be distal predictors of knowledge sharing -- that is, perceived variety likely mediates their effects on knowledge sharing (Harrison et al., 2002). Objective measures of variety are context specific and depend on the nature of team tasks. The objective variety measures for this study were developed based on information obtained from interviews with experts (faculty members) and examination of the syllabus and course materials. Therefore, it is reasonable to expect that these objective measures of variety represent task-relevant knowledge domains that are important for performance on team projects. However, what this also suggests is that the presence of Variety $_{major}$ and Variety $_{function}$ may be necessary for but not sufficient for knowledge sharing. In addition, team members may need to recognize the existence and distribution of unique caches of knowledge for it to be shared within the team. Support for this line of reasoning comes from a series of studies by Stasser and colleagues (Stewart and Stasser, 1995; Stasser, Stewart & Wittenbaum, 1995; Stasser, Vaughan & Stewart, 2000) that demonstrate that unique information is more likely to be shared if members are aware of the presence of such knowledge distributed among team members. In contrast, teams where members were unaware of the distribution of unique knowledge among members, even when all or some of its members possessed such knowledge, had a lower likelihood of sharing such knowledge.

To test the possibility that perceived variety mediates the effect of objective forms of variety on knowledge sharing, I conducted a post hoc-analysis to test for the indirect effects of Variety $_{major}$ and Variety $_{function}$ on knowledge sharing. Variety $_{major}$ significantly predicted perceived variety ($\beta = .16$, $p < .05$). Further, a test of indirect effects using the bootstrap approach (MacKinnon et al., 2004; Preacher and Hayes, 2008; Shrout and Bolger, 2002) provided tentative support for the indirect effect of Variety $_{major}$ on knowledge sharing (90% CI: .03 to .67). However, Variety $_{function}$ did not have any significant direct effects on perceived variety. These findings provide support for the argument that team members must be aware of the existence of variety for it to impact knowledge sharing.

In addition to predicting opposing effects of variety and disparity on knowledge sharing, I also expected an interactive effect of these two forms of diversity, such that disparity was expected to weaken the strength of variety's positive effect on knowledge sharing. This expectation was not borne out in my sample: the effects of disparity on team knowledge sharing were independent of the level of variety. This disappointing result merits future research attention. While the expectation that disparity would take a heavier toll on teams that are higher on variety is theoretically plausible (Bunderson, 2003; Harrison & Klein, 2007), lack of power for detecting moderator effects offers one possible explanation for my results (McClelland & Judd, 1993; Aguinis, Beaty, Boik & Pearce, 2005).

In my second research question, I asked how differences in teams' configuration of face-to-face and virtual communication modes influence knowledge sharing in teams. A key argument underlying my conceptual model was that the use of these two modes of communication was important for all teams irrespective of whether their members are collocated or distributed across more than one location. I developed two team communication configuration models -- the Compensatory and Virtuality models -- that reflect theorizing from prior literature. Each model reflects distinct possibilities concerning the effects of face-to-face and virtual communication on team knowledge sharing. Then, I proposed a third model -- the Interactive model -- that was expected to explain more variance in knowledge sharing relative to the earlier two models. The predictions of the Interactive model were not supported by the data. Instead, my findings indicated that the Compensatory model best predicted the effects of face-to-face communication and virtual communication on knowledge sharing -- the two modes of communication had independent and unique effects on knowledge sharing. Face-to-face communication had a stronger unique effect, and notably, virtual communication influenced knowledge sharing even after accounting for the effects face-to-face communication. Face-to-face and virtual modes of communication also indirectly influenced performance via knowledge sharing.

The finding that virtual communication influences knowledge sharing even after accounting for the effects on face-to-face communication is especially striking because of the nature of this study's research setting. The sample was taken from a business and industry analysis course that was structured so that teams had ample opportunities for scheduled face-to-face meetings with all of its team members present. For example, the laboratory sessions were intended to provide teams a forum to discuss strategies for each of the eight competitive rounds of the CAPSIM simulation and to facilitate discussion around their global trends report. In this way, no deliberate effort was made to ensure that team members communicated virtually. In addition, most students likely stayed on campus or close to it, further lowering the potential costs of having to coordinate face-to-face interaction. Therefore, the bias for team face-to-face communication meant that this study's research setting provided a relatively conservative test of the Compensatory Model's argument that virtual communication had a unique role to play in knowledge sharing. This relative bias may also explain why the Interactive model was not supported -- perhaps there was insufficient scope for virtual communication to further enhance the effect of face-to-face communication on knowledge sharing.

My final research question inquired whether differences in teams' configuration of face-to-face and virtual interactions could impact teams' capacity to capitalize on variety. Accordingly, I theorized an interactive effect between variety and team communication configuration on knowledge sharing. Specifically, I hypothesized that the positive effect of variety on knowledge sharing would be enhanced by the interaction of face-to-face and virtual communication. This argument was not supported by the data in my study for any of the three variety measures. As pointed out earlier, the bias towards face-to-face interaction in the course design may have restricted the enhancing effect of virtual communication, which in turn may have weakened their joint interactive effect on the variety–knowledge sharing relationship. Inadequate power to detect the hypothesized three-way interaction is another possibility for lack of support for Hypothesis 5.

Time may offer another possible explanation for lack of support for the predictions of the Interactive Model (see Hypotheses 4 and 5). Recall that face-to-face communication and virtual communication were measured in Week 7 of the course. Referring to the Marks et al. (2001) taxonomy of team process behaviors, teams at this stage can be described as being close to the end of their transition phase. At this point, team members had been working as a collective for six weeks; they were involved in training for the CAPSIM simulation, completing other team-based assignments intended to build teamwork skills, and planning for their two major course assignments (i.e., the competitive CAPSIM industry simulation and global trends report). It is possible that the teams may not have had sufficient time to create norms and develop experiences about the role of virtual technologies for knowledge sharing and task completion (DeSanctis & Poole, 1994).

In the context of this study's research setting, perhaps, measuring the two forms of communication at a later point in time (e.g., Week 12) could have allowed for the emergence of the hypothesized interactive effect between face-to-face and virtual modes of communication. At this point, teams would have moved to the initial stage of the action phase of the Marks et al. (2001) taxonomy and would have been engaged in activities that contribute to task completion. Possible explanations for how time could act as a medium for strengthening the interactive effects of the two communication modes come from research on computer-mediated communication (CMC) and from insights offered by work on Channel Expansion Theory (Carlson & Zmud, 1999). Research from the CMC tradition has found that over time, teams are able to better adapt technologies for task performance. (e.g., McGrath et al., 1993; Walther, 1996; see also DeSanctis & Poole, 1994). In a similar vein, insights from channel expansion theory suggest that the richness associated with communication technology is not fixed, but expands with time as communication partners (team members) gain experience with each other as well as with the communication technologies that they use to interact with each other (Carlson & Zmud, 1999). Therefore, over time, their ability to use those technologies for sharing complex information insights and experience is expected to improve.

Consider also research that suggests that face-to-face interaction likely accelerates the process of team members getting to know one another (e.g., Hill, Bartol, Tesluk & Langa, 2009; Keisler & Cummings, 2002; Nardi & Whittaker, 2002; Handy, 1995). Therefore, as face-to-face interaction increases, and members build trust and gain familiarity with each other, this should in turn, enhance team members' capability for using virtual technologies for knowledge sharing. That is, over time, face-to-face interaction among team members likely enhances their perception of the richness of virtual communication technologies. In sum, the interactive effects of face-to-face communication and virtual communication are likely to strengthen as team tenure increases.

The final link of my conceptual model predicted that knowledge sharing is positively related to performance. I found strong support for the significant effect of knowledge sharing on three distinct measures of performance including instructor rating of performance, team rating of performance and performance assessed through the course grades on team projects. I also found robust support for the principal intuition guiding this study -- that is, that knowledge sharing would be the central variable that links diversity and virtuality to team performance. Indeed, knowledge sharing conveyed the effects of the three diversity variables (i.e., perceived variety, leadership status disparity, and self-status disparity) and the two communication variables (i.e., face-to-face communication and virtual communication) on all three measures of team performance.

5.3 Key Contributions

By providing an empirical test of the effects of the simultaneous operation of variety and disparity on knowledge sharing and performance, this dissertation answers recent calls (a) to examine more complex conceptualizations of diversity; (b) to pay attention to the process through which diversity has its effects; and (c) to investigate the joint operation of multiple diversity dimensions in the same study (Van Knippenberg & Schippers, 2006; Jackson, Joshi & Erhardt, 2003; Mannix & Neale, 2005; Harrison & Klein, 2007). Harrison and Klein's (2007) diversity typology forms the theoretical foundation for my model and subsequent tests of the relationships between variety and disparity. More specifically, my conceptual model helps provide concrete shape to the authors' speculations about the mechanisms and outcomes associated with the joint operation of different types of diversity. In addition, my findings contribute to research on diversity by articulating the processes and outcomes associated with the simultaneous operation of variety and disparity.

The findings of this study also contribute to advancing researchers' understanding of the process and outcomes of team virtuality (Griffith, Sawyer & Neale, 2003; Kirkman & Mathieu, 2005). By simultaneously examining the effects of face-to-face and virtual communication modes on knowledge sharing, findings from this study highlight the importance of accounting for the effects of virtual communication in even in collocated teams. Prior research, especially those studying the impacts of proximity, has demonstrated the importance of face-to-face communication for knowledge sharing (Allen, 1979; Keisler & Cummings, 2002; Nardi & Whittaker, 2002). However, the role of virtual communication has mainly been emphasized in research on distributed or virtual teams. Furthermore, research on virtual teams or computer mediated communication (CMC) has either studied face-to-face communication or virtual communication, but to the best of my knowledge has not examined outcomes from teams using both modes of communication either sequentially or in parallel to complete team tasks (although see Hill et al., 2009 for an example of the impact of sequential but not simultaneous use of the face-to-face and virtual communication modes). Therefore, a key contribution of this study is demonstrating that each of the two modes of communication has unique, and arguably complementary, effects on knowledge sharing.

Another noteworthy feature of this study is the high team-level response rates (92%-100%) for diversity variables. According to Allen et al. (2007), inconsistent findings about the effects of diversity can partly be attributed to poor team-level response rates when measuring diversity variables. Their analysis demonstrates that poor response rates can weaken observed correlations between diversity variables and the relevant outcome variables. Their review also suggests that few studies report team-level response rates. For those that did report them, the response rate ranged from 50 % to 75%. Therefore, this study's high response rate reduces concerns about possible distortions in observed relationships due to missing responses (Allen et al., 2007) and increases confidence in the findings from this study.

Finally, another contribution of this study is the development of a set of guidelines for identifying and measuring variety (see Appendix D). Relative to separation or disparity attributes that are arguably more generalizable across research settings, measuring variety is challenging because these characteristics are more closely tied to the research setting. In addition, to ensure comparability across different teams, all teams included in the study must be engaged in similar tasks so that variety attributes are the same across units. Therefore, to identify variety attributes, and, to develop valid measures of variety that are relevant and comparable across all teams in the sample, I proposed that researchers conduct the equivalent of a job analysis at the team-level. Given the challenges associated with measuring variety, a key feature of this study's research setting is that all teams performed the same set of tasks under similar contexts. This made possible meaningful comparisons among teams on variety. It also helped control for various task related factors such as task interdependence and task complexity.

5.4 Implications for Theory and Future Research

Implications for Diversity Research. The findings of this study contribute to improving our understanding about the role played by knowledge sharing in conveying the effects of two types of diversity on team performance. Past research has proposed task conflict as a key mechanism through which informational diversity (variety) influences team performance (e.g., Jehn, Northcraft & Neale, 1999; Pelled, Eisenhardt & Xin, 1999). However, recently scholars have questioned the viability of this mechanism after meta-analytic evidence suggested that task conflict is negatively related to team performance (De Dreu & Weingart, 2003; Van Knippeberg et al., 2004; Van Knippenberg & Schippers, 2006). Instead, Van Knippeberg et al. (2004) proposed that information elaboration, which is conceptually similar to knowledge sharing, was the key mechanism responsible for transmitting the effects of diversity on team performance. Consistent with this perspective, my dissertation revealed that knowledge sharing is the lynchpin variable that transmits the effects of perceived variety, leadership status disparity, and self-status disparity on team performance. These findings provide empirical support for Van Knippeberg et al.'s, (2004) argument that knowledge sharing is a key mechanism that transmits the effect of diversity on team performance (see also Homan et al., 2007; Homan et al., 2008).

More importantly, however, my theorizing expands on the Van Knippenberg et al. (2004) model by linking disparity to knowledge sharing. Their model makes a valuable contribution by examining how task related or informational diversity (variety) and social category diversity (separation) influence team knowledge sharing and performance. This study's conceptual model retains their model's central idea but expands its scope by examining how disparity influences knowledge sharing. Taken together with Van Knippenberg et al.'s (2004) theorizing about the effects of social category diversity (separation), the findings that variety and disparity influence knowledge sharing but in conflicting ways provide the basis for more complex conceptualizations of how different diversity types jointly influence team performance.

The importance of perceived variety for knowledge sharing has important implications for theorizing on informational or knowledge based diversity. My findings suggest that teams must teams must be aware of the presence of variety for it to lead to knowledge sharing. That is, assembling variety is insufficient for performance; teams must find ways to alert their members to the presence of diversity of informational resources distributed across its members. Therefore, an interesting theoretical question that this raises is -- How (or under what circumstances) can teams make members aware of the presence of variety? Alternately, what factors may inhibit the awareness of the existence of team variety?

Perceived variety can be conceptualized as emergent state that can influence the execution of teamwork processes such as knowledge sharing (Marks et al., 2002). Nevertheless, teams may need to consciously engage in actions that lead to awareness of the presence of variety. Further, awareness needs to be coupled with proper timing. Actions designed to encourage the emergence of perceived variety are likely to be of greatest value in the transition phase (Marks et al., 2001) preceding task accomplishment. That is, teams need planned interventions to facilitate emergence of perceived variety during the mission analysis, formulation and planning process rather than during the action phase (Marks et al., 2001). Interventions that teams could employ to increase awareness of variety in teams includes the creation and use of expertise / experience directories on company Intranet or electronic teamspaces (e.g., www.AskMe.com), which could increase awareness of variety present in the team. Similarly, the use of social networking software (e.g., Facebook) by teams may enhance awareness of variety distributed within the team. For example, using such social networking software may reveal more tacit forms of variety (Who knows who?) that may enable team members to take advantage of access to unique knowledge made possible by members' diverse social networks within the organization.

Although virtual tools such as teamspaces and social networking sites can enhance awareness of variety, there exists the possibility that virtuality could inhibit the awareness of variety distributed in a team. Future research could investigate this possibility, perhaps, using an experimental set-up where teams are randomly assigned to either face-to-face or virtual (CMC) condition. Teams would be similar on their levels of objective variety in both face-to-face and virtual conditions. However, I would expect that awareness of the presence of variety is likely lower in the virtual condition relative to the face-to-face one. Further, I would expect that this difference in awareness of variety explains differences between the two conditions in their levels of information sharing and performance.

Another interesting question for future research is -- does creating a perception that variety exists within the team sufficient to stimulate knowledge sharing irrespective of the level of team variety? That is, to what extent does objective variety matter for knowledge sharing? In a related vein, future research could also explore potential predictors of perceived variety in addition to objective forms of variety. For example, could surface-level markers of diversity (e.g., race, age, gender: Harrison et al., 2002) influence assessments of perceived variety? Other possibilities that could influence the level of perceived variety could include diversity in geographic location of team members (e.g., different office buildings or different cities: Cummings, 2004) and personal interests (e.g., sports, books).

Another fertile area for future research concerns approaches to mitigating disparity's damaging effects on knowledge sharing. Earlier, I argued that disparity may hamper knowledge sharing by reducing low status members' willingness and motivation to share knowledge. It may also reduce their opportunities for sharing expertise and insights and lead to unequal valuation of their contributions in favor of high status members. A comprehensive theoretical model is needed regarding how teams can address each of these mechanisms through which disparity's harmful effects on knowledge sharing unfold. A fruitful starting point towards building such a model could be to integrate insights from research on employee voice (e.g., Detert & Burris, 2007; Tangirala & Ramanujam, 2008), psychological safety in teams (Edmondson, 1999; Edmondson, 2003), and overcoming status generalization in groups (see Ridgeway, 2001). These streams of research are likely to offer insights on how organizations can improve the willingness and motivation of low status members to share their ideas and expertise. For example, Edmondson's (2003) work on inter-disciplinary surgical action teams, which tend to have high variety and disparity, suggests that leaders play a central role in coordinating member contributions. According to Edmondson (2003), leaders can create a psychologically safe climate for interpersonal risk-taking by "acknowledging their own fallibility and by emphasizing teamwork – both of which served to downplay the power imbalance in the team" (p.1446); they can also emphasize the benefits of member expertise contributions to the team.

Another avenue for future investigations concerns the role of leadership disparity. Research on leadership in teams suggests that leadership has beneficial effects on performance. Yet, my findings suggest that concentration of leadership in the hands of a minority or a single hurts team knowledge sharing. A possible explanation for this conundrum is that, perhaps, there is a non-monotonic relationship between leadership concentration and knowledge sharing such that too little or too much concentration of team leadership has deleterious effects on knowledge sharing. Research on shared leadership (e.g., Conger & Pearce, 2003) and dynamic delegation of leadership (e.g., Klein, Ziegert, Knight, & Xiao, 2006) in teams may also provide important insights on why high levels of leadership disparity may be harmful for knowledge sharing.

Implications for Research on Team Virtuality. An emerging view of scholars studying team virtuality is that the vast majority of organizational teams are hybrid teams; that is, they use face-to-face and virtual communication for completing their tasks (Griffith et al., 2003; Kirkman & Mathieu, 2005; Leenders, Van Engelen & Kratzer, 2003). However, even scholars that acknowledge that most organizational teams are hybrid teams have examined virtuality mainly in the context of distributed or dispersed teams (e.g., Leenders et al., 2003; Kirkman, Rosen, Tesluk & Gibson, 2004). For some, being dispersed is part of the definition of virtuality because of an implicit assumption that communication technologies are of interest only when team members are geographically separated (e.g., Gibson & Gibbs, 2006). Thus, this study's finding that virtual interaction is consequential for team process and performance even in collocated teams challenges the extant scholarly bias towards studying virtuality only in distributed or virtual teams.

The significant effect of virtual communication on knowledge sharing also brings into focus its role relative to face-to-face communication. Research in the CMC paradigm has treated virtual and face-to-face communication primarily as substitutes for each other. Face-to-face teams are compared to those interacting virtually by having both types of teams perform the *same* set of tasks (e.g., Wilson, Strauss & McEvily, 2006; Hill et al., 2009). This focus is appropriate for understanding processes and outcomes associated with distributed or virtual teams. As the level of dispersion of team members across multiple locations increases, virtual communication begins to gain importance as a substitute to face-to-face interaction. However, my findings suggest that, in addition to playing the role of substitute for face-to-face interaction, virtual communication could also complement or supplement face-to-face interaction in facilitating knowledge sharing. Especially in collocated teams, the complementary and supplementary roles may be of greater significance.

As a complement to face-to-face communication for knowledge sharing, virtual communication could extend the team information processing space (Nijstad, Rietzschel & Stroebe, 2006) beyond the physical confines of a face-to-face meeting. For example, email may be used by members to share documents and spreadsheets prior to a meeting, which allows that information to enter the team's processing space. Research based on findings from the "hidden profile" studies suggests sharing such information prior to the meeting increases the probability that it will be discussed during a face-to-face meeting (Wittenbaum, Hollingshead & Botero, 2004). The same research also indicates that such prior sharing, which makes information accessible on members' laptops (or in print-outs) during the face-to-face meeting, increases the probability that such information will be discussed (Wittenbaum et al., 2004). That is, virtual communication likely complements face-to-face knowledge sharing by increasing the probability that teams will focus on information, expertise, or insights shared virtually prior to the meeting. As a supplement, it may facilitate sharing of knowledge that was not shared in the face-to-face meeting because of lack of time, or allow continuation of a discussion that was ongoing in a meeting (Wittenbaum et al., 2004).

In addition to playing complementary or supplementary roles, are there situations where virtual communication technologies are preferred over face-to-face interaction, assuming such interactions were feasible without significant costs (see also Hollan & Stornetta, 1992)? For example, future research might find that virtual technologies reduce the damaging effects of disparity on participation opportunities for low-status members. There is some evidence that the use of virtual technologies can attenuate the effects of disparity by facilitating greater equality of participation among team members (e.g., Sproull & Kiesler, 1991; Dubrovsky, Keisler & Sethna, 1991; George, Easton, Nunamaker & Northcraft, 1990). This stream of research posits that the reduction in social cues during virtual interactions among team members reduces the salience of status and power differentials, and consequently, members experience fewer inhibitions about contributing their knowledge. This participation equalization was found to be stronger for judgment tasks, which are likely a common feature of work groups (e.g., Edmondson, 2003), than for intellective tasks (Tan, Wei, Watson, Walczuch, 1998). Finally, evidence from studies on group decision support systems (GDSS) and electronic brainstorming suggest that the anonymity associated with use of such virtual technologies for creative tasks may increase opportunities for providing their contributions and may enable surfacing of dissenting perspectives from low-status members (e.g., Gallupe, Bastianutti, & Cooper 1991; Valacich, Dennis & Nunamaker, 1992; Lam & Schaubroeck, 2000).

Virtual communication technologies may also be preferred over face-to-face communication for their ability to support hyperpersonal communication (Walther, 1996). The hyperpersonal model of computer mediated communication (Walther, 1996) was developed in response to research suggesting that mediated communication was impersonal and, therefore, was not ideal for development of interpersonal relationships. In contrast, Walther (1996) found evidence that virtual interactions can lead to development of more intense interpersonal relationships than face-to-face because it allows individuals more control over how they present themselves. Communication partners present idealized representations of themselves to each other, which accelerates relationship formation. At a more abstract level, this theory suggests virtual communication affords communicators capabilities that make it better than face-to-face at creating intense interpersonal relationships in a short span of time.

The hyperpersonal model suggests that features associated with virtual communication (e.g., the absence of certain nonverbal and environmental cues; the ability to plan and edit communication) may provide advantages relative to face-to-face communication for team knowledge sharing. Virtual communication may reduce the salience of status cues, which may increase contributions from low-status members (Dubrovsky et al., 1991). The ability to plan and edit communications may provide lower status members more time to optimally craft messages, which could reduce their apprehensions about how their messages would be received by the other members of their team. Further, the availability of "Web 2.0" technologies (O' Reilly, 2007) such as Facebook, Twitter and MySpace allows organizational members to communicate in intensely personal ways that would difficult to replicate in face-to-face settings (Walther, 2007). These social media are designed to accelerate the process of self-disclosure among communicators, which in turn, is expected to accelerate the process of relationship building. Strong interpersonal relationships among team members contribute to improving "open" forms of team knowledge sharing (Mesmer-Magnus & DeChurch, 2009).

Future research can also examine the possibility that different communication media may be used for communicating different forms of content. In the context of knowledge sharing, perhaps, face-to-face and synchronous phone based communication may be better suited sharing "unique" knowledge (Mesmer-Magnus & DeChurch, 2009). In contrast, asynchronous computer based (e.g., email) and phone based media (e.g., texting) may support "openness" in knowledge sharing (Mesmer-Magnus & DeChurch, 2009). Another promising direction for research on team virtuality is to move away from medium-centric (e.g., email vs. telephone) to more modality-centric or feature-based explanations (see MAIN model: Sundar, 2008 for an example of this approach) to explain the effects of the use of virtual communication technologies in teams.

Alternate Conceptualization of the Theoretical Model. A key purpose of this dissertation was to examine how diversity and virtuality jointly influenced team knowledge sharing and performance. However, findings from this research did not support the interactive effects of diversity and team communication configuration. Therefore, I proposed and tested an alternative conceptual model that examined the possibility that instead of playing a moderating role, team communication configuration may mediate diversity's effects on team performance. Some studies have found support for the role of communication as a mediator of diversity's effects (Reagans & Zuckerman, 2001; Smith et al., 1994). However, these studies did not parse out the effects of face-to-face and virtual communication modes in transmitting the effects of diversity. This study's findings that virtual communication influences performance even in collocated teams suggest that it may also have a unique role to play in mediating diversity's effects on team performance.

I conducted a post-hoc analysis with face-to-face and virtual modes of communication as mediators of the effects of perceived variety and disparity on knowledge sharing. Findings suggest that perceived variety had significant positive effects on both face-to-face ($\beta = .27$, $p < .05$) and virtual communication ($\beta = .17$, $p < .05$). Further, the test for indirect effects using the bootstrap approach supported the mediating role of face-to-face (95% CI: .04 to .24) and virtual communication (95% CI: .01 to .09) in transmitting the effects of perceived variety on knowledge sharing. Only one type of disparity -- self-status disparity -- had significant negative connections to face-to-face ($\beta = -.17$, $p < .05$) and virtual communication ($\beta = -.14$, $p < .10$). Team status disparity and leadership status disparity did not have significant effects on either form of communication. Further, while face-to-face (95% CI: -.02 to -.01) was a significant conduit for transmitting the indirect effects of self-status disparity on knowledge sharing, virtual communication (95% CI: -.01 to .00) did not play a mediating role.

These results suggest that self-status disparity attenuates knowledge sharing through its effects on face-to-face communication only. That is, virtual communication appears to provide a status free path to knowledge sharing. The presence of disparity in teams that are composed of peers, perhaps, makes face-to-face interaction uncomfortable for lower status members. Further, lower status members may be less motivated to meet face-to-face because they likely have fewer opportunities for providing their inputs in the limited duration meeting format. However, virtual communication may be unaffected by disparity because it does not restrict opportunities for participation by lower status members. In addition, theorizing behind status equalization effects in computer mediated communication argues that the absence of nonverbal cues in mediated interaction attenuates status salience of communication partners (Dubrovsky et al.,1991). This, in turn, may reduce the potential discomfort or self-censoring by low-status experienced by members in face-to-face meetings due to evaluation apprehension.

5.5 Limitations

This study has several methodological strengths that increase confidence in the robustness of my findings. For example, data from multiple sources were used for measures of variety and performance. In addition, the four-wave panel design of the study strengthens claims about the direction of causality of my findings; and high individual and team-level response rates minimized non-response that could potentially have distorted relationships between diversity variables and outcomes. Despite these strong points, however, this study has several limitations.

First, although the sample size (n = 168) was large enough to provide adequate power to detect main effects, it was not large enough to prevent the restriction of power when testing interaction effects (McClelland & Judd, 1993; Aguinis et al., 2005). This implies that tests of Hypothesis 3 (two-way interaction) and Hypothesis 5 (three-way interaction) lacked adequate power to detect the presence of moderating effects.

Second, some measures that use same source data to test relationships may be susceptible to common method bias. I attempted to minimize this bias by using measures that are separated by time. However, research suggests that even time separation may not completely eliminate the effects of common method bias (Harrison et al., 1996). Therefore, for relationships whose tests involved the use of same-source measures, I attempted to address this potential bias using the approach suggested by Ostroff, Kinicki and Clark (2002). The results of this analysis, although generally supportive of the absence of common method bias, did not conclusively demonstrate that the significant effects were not solely a result of such a bias.

A third limitation of my study concerns the use of student teams. The use of student teams is common amongst scholars researching team composition, process and effectiveness (Kozlowski & Bell, 2002). However, the use of such teams raises questions about the external validity of findings in this study because of the patterns of interaction, communication, information exchange and performance may differ from those of work teams. A related issue is that student teams lack the structural bases for disparity that are common in work teams. Nonetheless, the findings from this study are likely to be valid even in work teams. Not only were the tasks designed to simulate those of multi-functional work teams in organizations, but almost all of the students in this sample had organizational work experience in the form of internships. Many of these students also had full-time and /or part-time functional work experience in their major areas of study. In addition, the course was offered to students who were close to graduation and were either actively interviewing for jobs or were planning to do so in the next few months. Therefore, the students' behaviors and interactions were likely to resemble those of work teams.

Finally, the provision of incentives for survey responses may have altered responses due to anticipation of reward. Students who participated were provided extra-credit and a restaurant gift certificate worth $25. However, several factors likely mitigated the potential for survey incentives altering student responses. For example, if they preferred not to answer the survey, students were offered an alternative assignment that was equal in time and effort costs. In addition, those who answered the survey were informed that their responses would be kept confidential and that the data would be analyzed only in the aggregate. They were also informed that there were no right responses to any question. The web-based questionnaire allowed them to skip any question that they did not want to answer.

5.6 Conclusion

A key purpose of this dissertation was to examine how teams can leverage diversity and virtual technologies to enhance performance. In this context, a principal intuition driving this study was that knowledge sharing is a key team process that conveys the effects of diversity and virtuality on performance. Accordingly, I developed and tested a conceptual model that examined the effects of diversity, face-to-face communication, and virtual communication on knowledge sharing, and, consequently, performance. Results of my study suggest three conclusions. First, variety and disparity have opposing effects on knowledge sharing -- perceived variety accentuates knowledge sharing but leadership status disparity and self-status disparity attenuate it. Second, virtual communication is consequential for all teams because it has a unique influence on knowledge sharing even after accounting for the effects of face-to-face communication and diversity. Third, knowledge sharing strongly predicts team performance. It also transmits the effects of diversity and communication (face-to-face and virtual) on team performance.

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APPENDIX A

FIGURES

FIGURE 1

Hypothesized Relationships

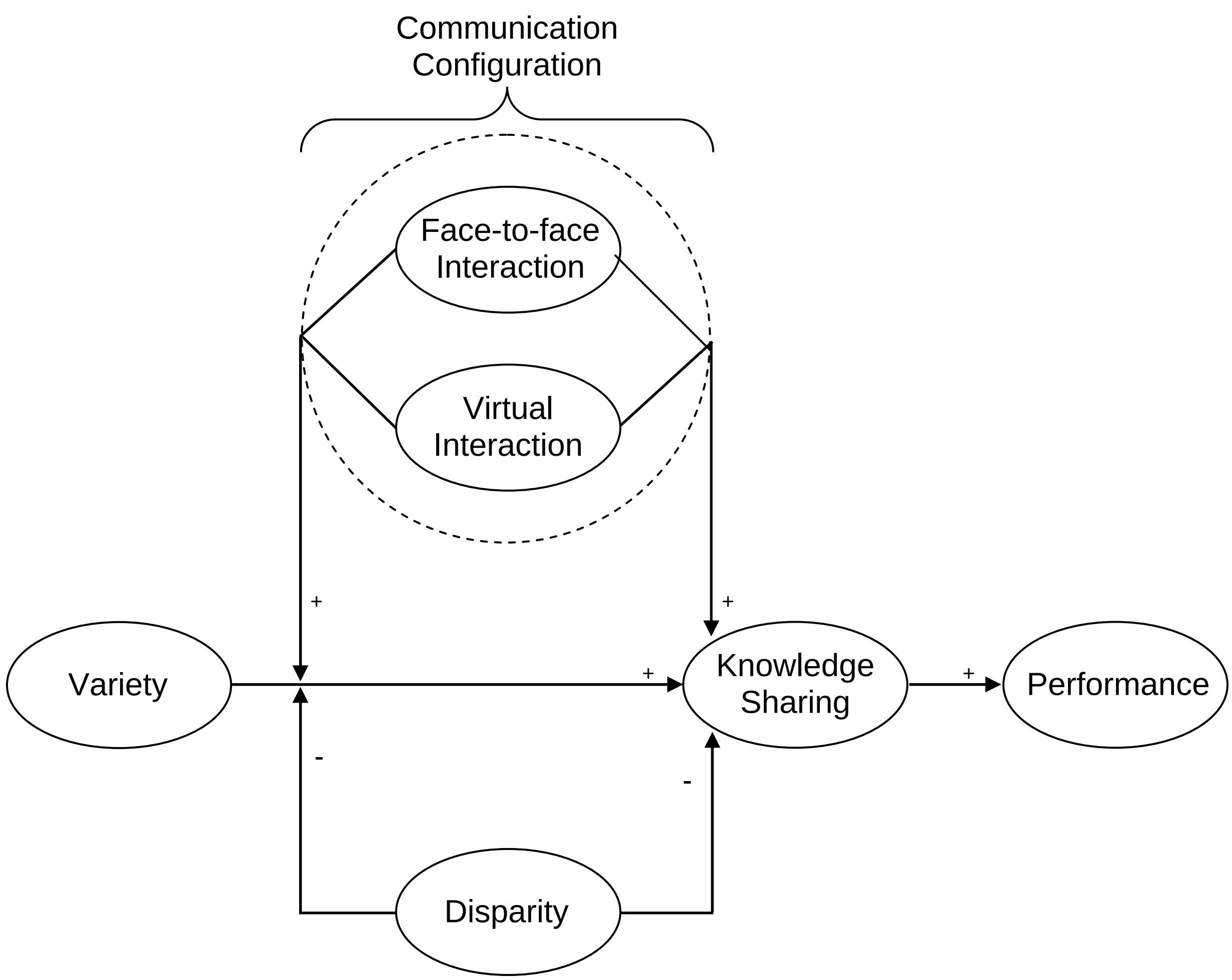
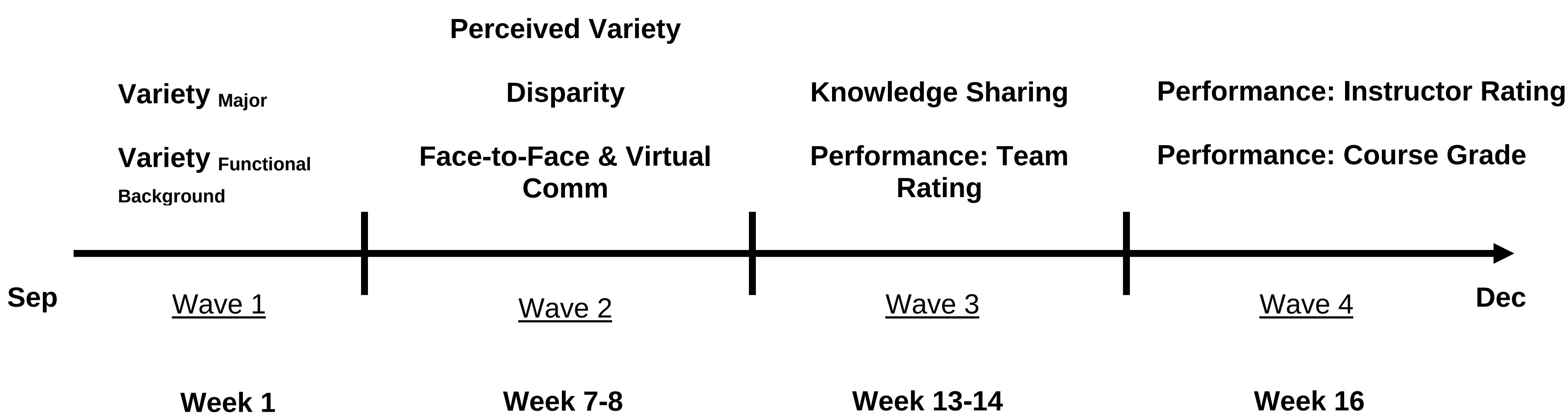


FIGURE 2

Data Collection Timeline



APPENDIX B

TABLES

Table 1
ICC Analysis and R_{wg} Scores

Variable	ICC (1,k)	ICC (2,k)	Median r_{wg}
Perceived Variety	0.33	0.73	0.87
Face-to-face Communication	0.26	0.66	0.72
Virtual Communication	0.16	0.50	0.88
Knowledge Sharing	0.25	0.65	0.97
Performance -- Team Rating	0.16	0.51	0.96

Table 2
Estimated Reliability

Variable	Alpha
Perceived Variety	.73
Face-to-face Communication	.85
Virtual Communication	.82
Knowledge Sharing	.95
Performance -- Team Rating	.95

Table 3
Exploratory Factor Analysis: Seven-Factor Solution on Perceived Variety, Knowledge Sharing, Communication Configuration and Member Ratings of Performance

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Perceived variety							
To what extent do members of this team possess distinct functional knowledge or expertise	-0.04	-0.02	0.06	-0.05	0.02	-0.04	**0.73**
To what extent are different members' work experiences distinct from one another	0.01	0.12	-0.16	0.01	0.00	0.08	**0.68**
To what extent do team members differ in the knowledge or expertise they draw on	0.01	-0.14	0.07	0.01	-0.01	0.02	**0.60**
Face-to-face Communication							
Face-to-face informal non-work related interaction (e.g., banter, gossip)	0.04	-0.05	-0.02	0.06	-0.04	**0.90**	0.04
Face-to-face spontaneous interaction among team members concerning the team's task	-0.01	0.03	-0.01	-0.02	0.02	**0.77**	0.06
Face-to-face team meetings with the entire team in attendance	0.00	0.05	0.05	-0.01	0.06	**0.75**	-0.07
Virtual Communication							
Computer Mediated							
Use email or Angel to follow-up face-to-face team task related discussions	0.04	0.04	0.00	**0.86**	-0.04	-0.05	0.02
Use email or Angel for pre-work before face-to-face meetings (e.g., circulate documents or pre-reading material)	0.07	-0.02	0.04	**0.86**	-0.02	-0.03	0.03
Use email or Angel to follow up on questions and clarifications from face-to-face interactions	0.03	0.09	-0.05	**0.80**	0.06	0.04	0.06
Seek feedback via email or Angel on documents, presentations, or ideas	-0.09	-0.01	-0.03	**0.74**	0.05	0.01	0.00
Co-ordinate work using electronic calendars, email, Angel, IM or other electronic means	-0.15	0.02	0.07	**0.66**	0.10	0.07	-0.03
Sending or responding to Email from team members	0.02	0.00	-0.01	**0.66**	-0.13	0.00	-0.11
Phone Mediated							
Communicate with other members using mobile devices (e.g., cell phone, Blackberry)	0.02	0.07	-0.05	-0.02	**0.91**	0.01	0.04
Text Messaging team members	-0.02	0.18	0.00	-0.14	**0.88**	0.02	-0.10
Spontaneous telephonic conversations among team members concerning the team's tasks	-0.03	-0.08	0.10	0.02	**0.75**	0.08	-0.02
Work with other members via phone	0.08	-0.25	0.03	0.19	**0.64**	-0.10	0.10
Knowledge Sharing							
Knowledge Sharing – initial measure adapted from Srivastava et al., 2006							
Members of this team help one another in developing relevant strategies	0.09	**0.89**	-0.02	0.05	-0.02	-0.04	-0.07
If a member in the team has some special knowledge about how to perform the task, he or she is likely to tell the other member about it	0.01	**0.89**	-0.07	-0.03	-0.02	0.00	0.06
There is a lot of exchange of information, knowledge, and sharing of skills among members	0.01	**0.88**	0.10	-0.02	0.00	-0.03	0.00
Members of this team share a lot of what they know with one another	0.07	**0.88**	-0.06	0.05	-0.01	0.06	0.04

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
More knowledgeable members freely provide other members with hard-to-find knowledge or specialized skills	-0.02	**0.83**	0.05	0.04	0.04	-0.02	-0.05
Members of this team offer lots of suggestions to each other	0.02	**0.83**	0.05	0.06	0.00	0.02	-0.12
Members of this team share their special knowledge and expertise with one another	0.07	**0.83**	0.05	-0.03	-0.03	0.02	0.05
Risky Knowledge Sharing							
Suggest fresh approaches to completing team tasks	-0.05	-0.04	**0.92**	0.01	0.00	0.07	-0.10
Come up with innovative ideas	0.09	-0.04	**0.91**	0.03	0.02	0.01	-0.10
Provide solutions to resolve team problems that are original	0.08	-0.05	**0.87**	0.03	0.05	0.00	0.00
Contribute their special knowledge, expertise or ideas	-0.04	0.20	**0.77**	0.01	0.02	-0.06	0.15
Make available their distinctive insights and experience	0.03	0.21	**0.70**	-0.07	-0.01	-0.06	0.15
Performance -- Team Rating							
Quality of work done	**1.01**	-0.04	-0.17	0.02	0.07	-0.07	-0.07
Overall Performance of the team	**0.94**	0.03	-0.06	-0.02	0.03	-0.04	-0.06
Productivity (i.e., quantity of work completed)	**0.89**	0.05	-0.02	-0.06	-0.02	-0.01	-0.03
Initiative displayed by the team	**0.87**	0.02	0.08	0.04	0.02	0.04	0.00
Innovativeness displayed by the team	**0.85**	0.03	0.02	0.00	0.05	0.04	0.08
Creativity displayed by the team	**0.81**	0.10	0.06	0.01	0.07	-0.03	0.07
Speed of response to problems or opportunities	**0.75**	-0.03	0.20	-0.02	-0.12	0.08	-0.01
Adherence to schedules	**0.62**	0.17	0.14	-0.07	-0.14	0.09	0.03

Table 4
Descriptive Statistics and Correlations [a]

Variables	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12
1. Teamsize	5.48	.83												
2. Variety $_{Major}$	.72	.08	.23**											
3. Variety $_{Function}$	.73	.14	.17**	.10										
4. Perceived Variety	3.42	.31	-.06	.08	-.14†									
5. Team Status Disparity	1.14	.28	.23**	.13†	.04	-.01								
6. Leadership Status Disparity	1.73	.48	.16*	-.05	.03	.00	.01							
7. Self-status Disparity	17.79	6.97	.01	.11	.12	-.09	-.05	.13						
8. Face-to-face Communication	2.90	.55	.00	-. 05	-.06	.21**	.03	-.05	-.17*					
9. Virtual Communication	2.66	.59	.07	-.01	.08	.16*	.08	-.06	-.14†	.21**				
10. Knowledge Sharing	.00	.79	.03	-.04	-.05	.20**	.03	-.16*	-.21**	.47**	.27**			
11. Performance -- Team-rating	5.16	.58	.03	.01	-.13	.09	.05	-.15†	-.02	.38**	.11*	.63**		
12. Performance -- Instructor rating	4.79	.89	-.03	-.11	-.02	-.02	.07	-.03	-.04	.13†	.07	.30**	.46**	
13. Performance -- Grade	.78	.06	.04	.03	-.12	-.09	.03	-.07	.10	.08	-.04	.23**	.57**	.40**

Note. † p<.10, * p<.05, ** p<.01
[a] N = 168

Table 5
Multiple Regression Results for the Effects of Variety, Disparity, and Communication Configuration on Knowledge Sharing (Hypotheses 1, 2 & 4, and Tests of Compensatory and Virtuality Models)

	Knowledge Sharing									
	Models									
Variables	I	II	III	IV	V	VI	VII	VIII	IX	X
Control Variable										
Team Size	0.06	0.04	0.08	0.02	0.06	0.01	0.05	0.01	0.05	0.06
Variety										
Variety $_{Major}$	-0.08		-0.09		-0.05		-0.04		-0.04	-0.04
Variety $_{Function}$	-0.03		-0.01		-0.01		-0.02		-0.02	-0.02
Perceived Variety	0.21^{**}		0.20^{**}		0.12		0.09		0.09	0.08
Disparity										
Team Status Disparity		0.04	0.06		0.04		0.02		0.02	0.02
Leadership Status Disparity		$-0.15^{\dagger}$	-0.17^{*}		$-0.14^{\dagger}$		$-0.13^{\dagger}$		$-0.13^{\dagger}$	$-0.12^{\dagger}$
Self-status Disparity		-0.20^{*}	-0.16^{*}		-0.11		-0.09		-0.09	-0.09
Communication Configuration										
Face-to-face Communication				0.47^{**}	0.42^{**}		0.39^{**}	0.44^{**}	0.49	0.30^{*}
Virtual Communication						0.27^{**}	0.15^{*}	0.18^{*}	0.26	0.28
Face-to-face * Virtual Communication									-0.16	
Face-to-face / Virtual Communication										-0.15
R^2	$0.05^{\dagger}$	0.06^{*}	0.11^{**}	0.23^{**}	0.27^{**}	0.07^{**}	0.29^{**}	0.26^{**}	0.29^{**}	0.29^{**}
Adj. R^2	0.03	0.05	0.07	0.22	0.24	0.06	0.25	0.24	0.25	0.25
Change in R^2	$0.05^{\dagger}$	0.06^{*}	0.06^{*}, 0.05^{*}	0.23^{**}	0.16^{**}, 0.04^{*}	0.07^{**}	0.02^{*}	0.26^{**}	0.00	0.00

Note. † p<.10, * p<.05, ** p<.01; Standardized coefficients are reported
Changes in R^2 = [Model I: R^2_{I} - $R^2_{control}$; Model II: R^2_{II} - $R^2_{control}$; Model III: R^2_{III} - R^2_{I} , R^2_{III} - R^2_{II} ; Model IV: R^2_{IV} - $R^2_{control}$; Model V: R^2_{V} - R^2_{III} , R^2_{V} - R^2_{IV} ; Model VI: R^2_{VI} - $R^2_{control}$; Model VII: R^2_{VII} - R^2_{V} ; Model VIII: R^2_{VIII} - $R^2_{control}$; Model IX: R^2_{IX} - R^2_{VII} ; Model X: R^2_{X} - R^2_{VII}]

Table 6
Multiple Regression Results (Hypothesis 3)

	Knowledge Sharing					
	Models					
Variables	**I**	**II**	**III**	**IV**	**V**	**VI**
Control Variables						
Team Size	0.05	0.05	0.09	0.10	0.06	0.04
Variety						
Variety $_{Major}$	-0.08	0.26	-0.10	0.03	-0.06	-0.25
Variety $_{Function}$	-0.03	0.03	-0.02	-0.15	-0.01	0.21
Perceived Variety	0.21*	-0.05	0.22*	-0.52	0.19*	0.18
Disparity – Moderators						
Team Status Disparity	0.03	0.20				
Leadership Status Disparity			-0.18*	-2.15†		
Self-status Disparity					-0.19*	-0.56
Interactions						
Variety $_{Major}$ * Team Status Disparity		-0.95				
Variety $_{Function}$ * Team Status Disparity		-0.07				
Perceived Variety * Team Status Disparity		0.77				
Variety $_{Major}$ * Leadership Disparity				-0.47		
Variety $_{Function}$ * Leadership Disparity				0.23		
Perceived Variety * Leadership Disparity				2.37		
Variety $_{Major}$ * Self-asserted Disparity						0.72
Variety $_{Function}$ * Self-asserted Disparity						-0.52
Perceived Variety * Self-asserted Disparity						0.14
R^2	0.05	0.06	0.08*	0.11	0.09*	0.09*
Adj. R^2	0.02	0.01	0.05	0.07	0.06	0.05
Change in R^2	0.05	0.01	0.08*	0.03	0.09*	0.00

Note. † p<.10, * p<.05, ** p<.01; Standardized coefficients are reported
Changes in R^2 = [Model I: R^2_{I} - $R^2_{control}$; Model II: R^2_{II} - R^2_{I}; Model III: R^2_{III} - $R^2_{control}$; Model IV: R^2_{IV} - R^2_{III}; Model V: R^2_{V} - $R^2_{control}$; Model VI: R^2_{VI} - R^2_{V}]

Table 7
Multiple Regression Results (Hypothesis 5)

	Knowledge Sharing					
	Models					
Variables	**I**	**II**	**III**	**IV**	**V**	**VI**
Control Variables						
Team Size	0.01	0.01	0.02	0.01	0.02	-0.01
Variety						
Variety $_{Major}$	-0.02	-0.06				
Variety $_{Function}$			-0.05	-0.47		
Perceived Variety					0.09	
Communications Configuration – Moderators						
Face-to-face Communication (FtF)	0.44^{**}	0.80	0.43^{**}	0.47	0.42^{**}	0.05
Virtual Communication	0.17^{*}	-1.56	0.18^{**}	0.15	0.17^{*}	-4.44
Interactions						
Variety $_{Major}$ * FtF		-0.29				
Variety $_{Major}$ * Virtual Comm.		1.99				
Variety $_{Function}$ * FtF				0.30		0.21
Variety $_{Function}$ * Virtual Comm.				0.46		5.00
Perceived Variety * FtF						
Perceived Variety * Virtual Comm.						
FtF *Virtual		1.90		-0.27		4.75
Variety $_{Major}$ * FtF * Virtual Comm.		-2.13				
Variety $_{Function}$ * FtF * Virtual Comm.				-0.17		
Perceived Variety * FtF * Virtual Comm.						-4.90
R^2	0.26^{**}	0.27^{**}	0.26^{**}	0.26^{**}	0.26^{**}	0.31^{**}
Adj. R^2	0.24	0.24	0.24	0.23	0.25	0.28
Change in R^2	0.26^{**}	0.01	0.26^{**}	0.00	0.26^{**}	0.04^{*}

Note. † p<.10, * p<.05, ** p<.01; Standardized coefficients are reported
Changes in R^2 = [Model I: R^2_{I} - $R^2_{control}$; Model II: R^2_{II} - R^2_{I}; Model III: R^2_{III} - $R^2_{control}$; Model IV: R^2_{IV} - R^2_{III}; Model V: R^2_{V} - $R^2_{control}$; Model VI: R^2_{VI} - R^2_{V}]

Table 8
Multiple Regression Results (Hypothesis 6)

Variables	Performance		
	Instructor Rating	Team Rating	Grade
Teamsize	-.03	.01	.03
Knowledge Sharing	.29**	.63**	.23**
R^2	.09**	.40**	.05*
Adj. R^2	.07	.39	.04

Note. † p<.10, * p<.05, ** p<.01; Standardized coefficients are reported

Table 9
Bootstrap Confidence Intervals for Indirect Effects

Antecedent [Intervening variable for all indirect effects is Knowledge Sharing]	Performance					
	Instructor Rating 95% CI		Team Rating 95% CI		Course Grade 95% CI	
	LL	UL	LL	UL	LL	UL
Variety						
Variety $_{Major}$	-.75	.42	-.96	.53	-.04	.03
Variety $_{Function}$	-.37	.18	-.53	.24	-.02	.01
Perceived Variety	**.02**	**.34**	**.06**	**.42**	**.01**	**.02**
Disparity						
Team Status Disparity	-.14	.17	-.18	.23	-.01	.01
Leadership Status Disparity	**-.20**	**-.01**	**-.22**	**-.01**	**-.02**	**-.01**
Self-status Disparity	**-.02**	**-.01**	**-.02**	**-.01**	**-.02**	**-.01**
Communication Configuration						
Face-to-face Communication	**.10**	**.36**	**.21**	**.39**	**.01**	**.02**
Virtual Communication	**.05**	**.20**	**.08**	**.25**	**.01**	**.02**

Note. Unstandardized estimates are reported. CI= Confidence Interval LL= Lower Limit UP= Upper Limit
Indirect effects where CI does not include zero are indicated in boldface

APPENDIX C

MEASURES

Perceived Variety

Five point Likert-type scale: All members have same (knowledge / experience) to Each member possesses unique (knowledge / experience)

1. To what extent do members of this team possess distinct functional knowledge or expertise (e.g., marketing, finance, accounting, management)
2. To what extent are different members' work experiences (e.g., function, industry) distinct from one another. Work experience includes internships, part-time and full time employment.
3. To what extent do team members differ in the knowledge or expertise they draw on for team projects such as competing in the CAPSIM simulation

Disparity

***Team Status Disparity*:** In any team, the loss of one individual member might be more or less damaging to the team's chance of success, depending upon the individual's contribution of ideas, insights and/or possession of specialized knowledge or experience that would be difficult to replace.

Considering all your team members including yourself, please list up to 2 people that would be most difficult to replace. That is, who are the two people that you would consider most valuable for this teams' successful performance (INCLUDING YOURSELF)?

***Leadership Disparity*:** Has a leader emerged within the team (someone who is both a team member and a leader)? If yes, who is it? [You can nominate more than one leader]

Self-status Disparity*:* Compared to other members in my team.....(*Seven point Likert-type scale:* Less than anyone else to More than anyone else)

...the amount of influence I have in this team is:
...the amount of credibility I have in this team is:
...the amount of power I have in this team is:
...the amount of status I have in this team is:

Face-to-face Communication:

How often do members of this team use each of the following ways of communicating or interacting face-to-face?
Seven point Likert-type scale: not at all to a very great extent

1. Face-to-face team meetings with the entire team in attendance
2. *Face-to-face team meetings involving subsets of members***
3. Face-to-face spontaneous interaction among team members concerning work related matters
4. Face-to-face informal non-work related interaction (e.g., water cooler talk, banter, gossip)

** This item was dropped

Virtual Communication:

Items 1-8: *Use of Communication Technology* [How often do members of this team use each of the following ways of communicating or interacting electronically? *Seven point Likert-type scale: Never to Always]*

Items 9-15: *Virtual Communication Behaviors* [Based on your experiences as a member of this team, how often do team members….*Seven point Likert-type scale: Never to Always*]

1. Sending or responding to Email from team members
2. Spontaneous telephonic conversations among team members concerning the team's tasks
3. *Using Angel[1] for communication and coordination***
4. *Instant Messaging / chatting with team members (e.g., Yahoo Messenger, Google Talk)***
5. Text Messaging team members
6. *Interacting via social network programs (e.g., Facebook, MySpace)***
7. *Using group collaboration software (e.g., Netmeeting, Breeze, Wikis, blogs, Google Docs)***
8. *Teleconferencing with team members***
9. Use email, Angel, or phone to follow up on questions and clarifications from face-to-face interactions
10. Use email or Angel for pre-work before face-to-face meetings (e.g., circulate documents or pre-reading material)
11. Use email or Angel to follow-up face-to-face team task related discussions
12. Work with other members via phone
13. Communicate with other members using mobile devices (e.g., cell phone, Blackberry)
14. Seek feedback via email or Angel on documents, presentations, or ideas
15. Co-ordinate work using electronic calendars, email, Angel, IM or other electronic means

** These items were dropped

Knowledge Sharing

Items 1-7: *Knowledge Sharing – adapted from Srivastava et al. (2006)* [Based on your experience in this team, please rate to what extent you agree with the following statements… *Seven point Likert-type scale: Strongly Disagree to Strongly Agree*]

Items 8-12: *Risky Knowledge Sharing* [Based on your experiences as a member of this team, how frequently do team members...*Seven point Likert-type scale: Never to Always*]

[1] Angel was the course management system used by the University

1. Members of this team share their special knowledge and expertise with one another
2. If a member in the team has some special knowledge about how to perform the task, he or she is likely to tell the other member about it.
3. There is a lot of exchange of information, knowledge, and sharing of skills among members of this team
4. More knowledgeable members freely provide other members with hard-to-find knowledge or specialized skills
5. Members of this team help one another in developing relevant strategies
6. Members of this team share a lot of what they know with one another
7. Members of this team offer lots of suggestions to each other
8. Suggest fresh approaches to completing team tasks
9. Come up with innovative ideas
10. Provide solutions to resolve team problems that are original
11. Contribute their special knowledge, expertise or ideas
12. Make available their distinctive insights and experience

Team Performance – Instructor Rating

Please rate this team on the following criteria:
Seven point Likert-type scale: Very Poor to Outstanding

1. Quality of work done
2. Productivity
3. Innovativeness displayed by the team
4. Initiative displayed by the team
5. Overall Performance

Team Performance – Team Member Rating

Overall, how would you rate your team's performance on course related projects so far on the following criteria:
Seven point Likert-type scale: Very Poor to Outstanding

1. Quality of work done
2. Productivity (i.e., quality of work completed)
3. Adherence to schedules
4. Innovativeness displayed by the team
5. Speed of response to problems or opportunities
6. Initiative displayed by the team
7. Overall Performance

APPENDIX D

GUIDELINES FOR MEASURING VARIETY

Variety represents the distribution of unique *task relevant* information, knowledge and experience across members of the team (Harrison & Klein, 2007). Variety refers to the distribution of a specific attribute such as function, discipline, skill or expertise among members of the team.

Variety in a team can represent the distribution of non-overlapping cognitive content (information, knowledge and experience) or the distribution of potential access to such unique content, across members. Potential access to cognitive content can be assessed through the presence of network ties to others who are sources of unique information, knowledge and experience. I will not focus on access as a basis for variety in my dissertation because of challenges associated with collecting network data – a) high team-level response rates, b) overcoming potential hesitation on the part of respondents to name sources of unique knowledge, and c) establishing that unique ties to external members represent access to non-redundant content.

Variety for the purposes of this dissertation focuses on differences among team members in information, knowledge, and experience that could arise due to differences in members' education, training, function, role, disciplinary background, or work-related experience. Experience as a form of variety refers to what Tesluk and Jacobs (1998) describe as "type measures," which classify it into qualitatively distinct categories (e.g., industry, product category, geography). In addition, variety may also result from exposure to unique or proprietary document sources of information or knowledge such as trade publications, databases, or listservs (e.g., RMNet).

Assessing variety presents a number of challenges. The first challenge is to *a priori* specify what attributes of variety are meaningful in a focal research context. Researchers testing theoretical propositions that incorporate variety as a construct must specify the specific variety attributes that form the basis for their predictions to preclude the possibility that they are capitalizing on chance.

The first step to the *a priori* specification of variety attributes is selection of a research context. A crucial implication of Harrison and Klein's (2007) diversity typology is that the meaning of a diversity attribute has to be articulated by researchers based on the context under investigation. That is, universal interpretation of a specific attribute such as function or organizational tenure as variety, separation or disparity may result in confounding of one form of diversity for the other, or meaningless variance. In a similar vein, although researchers may theorize about the effects of variety in the abstract, the specific variety variables that could be expected to support the researchers' hypotheses are a subset of all possible attributes of variety that could exist. This is because what constitutes variety -- task relevant differences in information, knowledge and experience -- is likely to be a function of the research context. Note that this is not a special feature of variety as a construct. Most individual-level outcome variables in OB or HR, such as creativity, productivity, quality, and so on, depend on the tasks at hand, and are therefore context-specific.

Implication 1: Identify relevant attributes of variety for testing proposed theoretical framework after identifying the research context but before beginning data collection.

Implication 1 provides direction on the specific attributes to focus on for a focal research context. However, operationalizing variety also requires the specification of the categories that are associated with each attribute. The first challenge this creates concerns the level of abstraction of the set of categories that are associated with each variety attribute. This is best illustrated with an example.

Consider two teams each with four members. The first team consists of four members from the management department of a business school. Each is from a somewhat unique discipline -- Strategy, Organizational Theory, Organizational Behavior and Human Resources. The second team, from the Materials Research, department also has members from somewhat unique disciplines – Mechanical engineering, Materials engineering, Ceramics engineering and Polymer science. Can we compare the levels of variety across these two teams? Can we argue, for example, that both teams have maximal variety on disciplinary background? Before we can answer this question, we have to specify what the teams' tasks and contexts in which those teams are embedded.

Now suppose that the team from the management department was charged with deciding the Business School's strategy for the following year. Assume the Materials research team was working on an inter-disciplinary project to develop nano-scale motors, which requires the application of principles of mechanical engineering in designing the motor, the use of ceramics and polymers in creating the materials, and the use of computational methodologies developed in the material engineering. In the first case, the management team can be thought to have relatively low variety when assessed in relation to the team task and context, even though it had four distinct academic areas represented in the team. In comparison to variety of disciplines represented in the Business School, the four areas are actually sub-disciplines of one of many disciplines that are part of the Business School. However, in the second case, the Materials research team had maximal variety given the scope of their team task, and the context of the research project. Therefore, this suggests:

Implication 2: There should be a match between the level of abstraction of the categories for a focal variety attribute and the demands of the teams' task

Another challenge associated with specifying categories for attributes concerns the comparability of categories across different teams. Consider the team from the management department in the earlier example. Assume that it has been charged with recruiting doctoral students for the management department. In this scenario, the same team arguably has high variety, especially relative to the universe of such departments, wherein some split the "macro-" and "micro-" recruiting tasks between two teams. Can the level of variety in this team for this specific task then be compared to that of the Materials Research Team involved in the development of nano-scale motors? The challenge here is establishing that the categories that comprise variety in both teams are being assessed at the same level of abstraction. That is, the categories that members are distributed across in both teams are similar in their degree of distinctiveness. What clouds interpretation of the relative levels of variety across the two teams are the vastly different tasks and contexts that the two teams operate in. The absence of a common metric means that measuring relative variety across teams with different tasks and organizational contexts would largely be a function of (expert) judgment. Only those who are familiar with the specifics of the tasks across both the team contexts would be in a position to assess variety under such circumstances.

Locating experts who can pass judgments about relative level of variety across teams in different disciplines or industries is likely very difficult. Only exceptional individuals are likely to have the cognitive capabilities that enable them to become experts in two different areas. More pragmatic means to assess effects of differences in variety across units in a *field* paradigm would involve sampling teams that perform similar tasks in demonstrably similar contexts. This would ensure that the categories that are used to assess variety are similar in their levels of abstraction, and this would enable comparison of measures of variety across different units. An example of this would be product development teams within a single organization focused on the same industry.

Implication 3: To enable comparisons across teams on a focal variety attribute, choose teams that are engaged in similar tasks, and that are embedded within similar contexts.

Implications for the Dissertation:

Choose a research context where across different research sites teams are a) engaged in similar tasks, and b) are embedded within similar contexts. Assessing whether these teams are indeed engaged in similar tasks would involve seeking inputs from experts that are familiar with the research context.

Once I find a sample of teams that have similar tasks and are embedded within similar contexts, I would have to specify the theoretically relevant variety attributes. Then, for each of these relevant attributes, I have to identify the set of all categories that would meaningfully partition the focal variety attribute into qualitatively distinct types across the selected sample of teams. My plan for doing this involves the following:

Step 1: Consult literature to identify *a priori* variety attributes that are theoretically relevant in that focal context. Generate a list of attributes along with a rationale for their relevance. This would be similar to a job analysis, but conducted at the team level.

Step 2: Interview experts that have published research in that domain to a) verify the relevance and rationale of attributes generated in Step 1, and b) supplement (or replace) those listed with additional attributes suggested.

Step 3: In-situ organizational experts prioritize the list of attributes that have the greatest face-validity in the field context. This would ensure that only those familiar with the specific context (as opposed to the broad domain) have the final say on what is a relevant basis for variety in that organization.

APPENDIX E

DETAILED DESCRIPTION OF THE CAPSIM SIMULATION

The CAPSIM simulation consists of teams that are charged with running companies that are competing in the electronics sensor industry. The sensor industry was previously dominated by a monopoly that has been broken into several identical companies. Each team competing in the CAPSIM is responsible for running one such identical company. Teams take charge of their companies at a point where their financial results are respectable but their competitive position is threatened because they are saddled with an aging product line. Teams must compete to become the market leader by improving their products, increasing productivity and remaining profitable despite pricing pressure. To compete effectively, teams have to coordinate strategy and tactics across the different functional areas of their company including marketing, production, R&D, finance, human resources and labor negotiation. A key part of the simulation involves analyzing competitors and their products.

The industry is divided into five customer groups or market segments. Customers in each segment have different standards that they use to evaluate products offered by competing companies such as size and performance of the sensor, reliability, age and price. Teams compete over eight competitive rounds by making choices about the market that they will compete in and the characteristics of the products that they will market. Each round represents an annual competitive cycle in the electronics sensor industry. At the end of each round, teams are provided details about their company’s and competitors’ products, financial performance and market shares, and details about the growth rates of different market segments. Based on this annual industry-level analysis, teams must choose their strategy and tactics to maximize performance in subsequent competitive rounds.

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