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Examining Shared Understanding and Team Performance in Global Virtual Teams

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by

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We hereby certify that this dissertation, submitted by Alva Bullard, conforms to acceptable standards and is fully adequate in scope and quality to fulfill the dissertation requirements for the degree of Doctor of Philosophy.

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An Abstract of a Dissertation Submitted to Nova Southeastern University in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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Modern organizations face many significant challenges because of turbulent environments and a competitive global economy. These competitive demands have forced many organizations to increase levels of flexibility and adaptability through the use of virtual environments, and global teams are prevalent in business organizations. Although significant research has been conducted on virtual teams, the development of shared understanding among the members of these teams has not been studied adequately. Time/space barriers, communication complexities, and team diversity hinder the development of shared understanding in these teams.

Based on the Media Synchronicity Theory (MST), a new theoretical model was created that used the constructs use of communication media, mode of interaction and team diversity to ascertain the influence shared understanding in global virtual teams. Additionally, the research model examined the relationship between shared understanding and team performance.

The developed, web-based survey measured the participants' use of communication media, mode of interaction, diversity, shared understanding, and team performance in virtual environments. The survey was administered through SurveyMonkey and distributed to a pool of opt-in respondents from firms with virtual teams. A total of 118 respondents participated in the study.

The findings of this study indicate that use of communication and familiarity with systems are strong determinants of shared understanding, and subsequently shared understanding is a strong predictor of team performance. The study also indicates that mode of interaction is less of a predictor of shared understanding, and that cultural diversity, modified diversity construct, did not influence shared understanding.

As virtual teams continue to proliferate, executive leaders and managers must ensure that teams and environments are designed for collaboration through use of communication technologies that promote synchronicity, and that its members are familiar with systems which subsequently promotes shared understanding.

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The journey to the completion of this dissertation has been long and difficult. When I started the program, my children were in elementary school. After many twists and turns, by completion, my children had entered college. Life happened. However, with the guidance and support of Dr. Amon Seagull, Dr. Ling Wang and my chair, Dr. Souren Paul, I was able to get back on a course to completion.

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Chapter 1

Introduction

Background

The changes in the nature of work and the advances in information and communication technology have created more flexible and adaptive organizational structures and processes, resulting in increased team-based work among geographically dispersed teams (Hinds & Mortensen, 2005; Peters & Karren, 2009). These virtual teams consist of members in different locations working together interdependently and using advanced telecommunication and information technologies to engage in a geographically distributed work (Hinds & Mortensen, 2005; Lipnack & Stamps, 1997). There are a number of advantages to virtual teams. Virtual teams enable organizations to pool the talents and expertise of employees by eliminating time and space barriers, which can then reduce development time (Ebrahim, Ahmed, & Taha, 2009; Shachaf, 2008). While there are a number of benefits to distributed teams, previous research has shown that distributed teams also have some disadvantages with respect to communication, coordination, trust, power struggles, and conflicts (Hinds & Mortensen, 2005; Jarvenpaa & Leidner, 1998; Rosen, Furst, & Blackburn, 2007). These disadvantages create challenges to building trust among team members and mitigating feelings of isolation (Shachaf, 2008), which subsequently may impact shared understanding and team performance.

Communication and coordination in large software development projects have always been intense and challenging. Global software development (GSD) adds to that intensity and complexity with the inclusion of team members from varying cultural

backgrounds, language barriers, and the coordination of significant virtual work, (Herbsleb, Mockus, Finholt, & Grinter, 2001). As companies continue to expand their virtual teams globally, managers and team leaders will need to understand how to mitigate these challenges to meet core company objectives that include reduced development time and increased organizational performance. This paper will focus on understanding the predictors and consequences of shared understanding within these virtual teams.

Problem Statement

For a number of business reasons, geographically distributed software development teams have become prevalent in the workplace (Ebrahim et al., 2009; Fiol & O'Connor, 2005; Hinds & Mortensen, 2005; Peters & Karren, 2009; Shachaf, 2008). While remote development of software offers several advantages, it is also fraught with challenges. (Fiol & O'Connor, 2005; Sengupta, Chandra, & Sinha, 2006). These virtual teams coordinate work toward a common goal (Hinds & Weisband, 2003; Rosen et al., 2007), but while members of virtual teams rely heavily on the use of communication technologies for their day-to-day communications, they do not share the same work context, and they are not geographically proximate (DeLuca & Valacich, 2006; Jarvenpaa & Leidner, 1998; Peters & Karren, 2009). Additionally, infrequent and limited face-to-face (mode of interaction) contact between remote counterparts may result in difficulties in sharing norms, attitudes, and behaviors (Oshri, Kotlarsky, & Willcocks, 2007). Further, coordination of software development in different time zones can reduce synchronous communications due to lean communication media, and difficulties in resolving unclear messages, reduced opportunities for spontaneous interaction, and lack

of contextual reference (Espinosa & Carmel, 2003). A review of the literature also highlights the challenges that arise from having members from diverse nationalities working together in teams. For example, rich and meaningful interpersonal relationships can be impacted by different approaches towards teamwork, or by different perceptions of power relations and deadlines among diverse groups (Ranganathan & Alfaro, 2011).

First formulated by Dennis and Valacich (1999), Media Synchronicity Theory (MST) has a foundational role in this study. MST focuses on the ability of media to support synchronicity, a shared pattern of coordinated behavior among individuals and teams as they work together. Based on MST, proposed by Dennis and Valachich (2008), this study develops a theoretical model that examines the constructs influencing shared understanding. The model is helpful in the investigation and the understanding of constructs such as the use of communications to support synchronicity, mode of interaction, and diversity, and their influences on shared understanding, and, ultimately, team performance. The moderating effect of appropriation factors such as familiarity with systems, training in distributed team work, past experience with distributed team work, and experience with technologies on these constructs were examined as no other research exists that examined all of these factors among global virtual teams.

Dissertation Goal

Bass et al. (2007) indicated in their research that kicking off a software project using geographically distributed teams can be problematic, specifically in the transfer of domain or technical knowledge, knowledge about the infrastructure and processes to be used on the project, and knowledge about the people working on the project across sites are key knowledge areas of concern. While virtual software development teams provide

advantages, teams with weak team interactions that lack a common organizational culture, team coordination and shared understanding may impact the performance of virtual software development teams (Sengupta et al., 2006).

Being employed at a global credit service bureau, and responsible for co-managing global software development across the United States, Costa Rica, Australia, and Malaysia, I have observed the challenges that occur when merging teams that have different work styles, practices, and cultures, and I have experienced the difficulty presented in the coordination of work and shared understanding among heterogeneous teams, as well as the impact upon team performance when there is struggle in achieving shared understanding.

The goal of this dissertation is to examine the influence of use of communication technology, mode of interaction, and diversity on shared understanding, and, subsequently, team performance. The research design made use of a survey instrument to measure the constructs. The participants were a group of adults from companies of the researcher's employment. The results and analysis of the survey data will equip business practitioners with directional guidance on the predictors of shared understanding and team performance, as well as contribute to the body of knowledge on this subject matter.

Research Questions

1. How does team diversity affect the development of shared understanding in virtual teams?
2. How does mode of interaction affect the development of shared understanding in virtual teams?

3. How does the use of communication technology affect the development of shared understanding in virtual teams?
4. How does the development of shared understanding influence team performance?
5. How does the influence of appropriation factors impact the development of shared understanding?

Relevance and Significance

In today's global economy, increasing numbers of software engineers are expected to operate in a globally distributed environment (Herbsleb, 2007). While global software development is becoming the norm, it takes much longer than co-located work, and it suffers from a wide range of problems, including the development of shared understanding (Ågerfalk, Fitzgerald, Holmstrom, & Conchúir, 2009; Herbsleb, 2007). Researchers and practitioners in the field are constantly seeking factors that may help organizations understand and mitigate the negative effects that cultural diversity, language barriers, and team interaction can have on team performance and the development of shared understanding (Ranganathan & Alfaro, 2011). Further, if the technical and socio-technical challenges of GSD projects are not fully understood and sufficiently addressed, there is a high likelihood of project disruption, confusion and misunderstandings among team members (Herbsleb, 2007). As such, understanding the predictors and consequences of the development of shared understanding will help organizations devise the appropriate strategies to exploit the benefits of global software development, mitigate the negative effects of barriers found in GSD, and achieve optimal performance.

In an ideal traditional co-located project, team members have a history of working together, a shared view of how the work should proceed, have frequent formal and informal interactions, all of which provide a sense of the expertise available among team members, and a general awareness of what everyone is working on (Herbsleb, 2007). The perceived benefits of GSD include reducing development costs, leveraging time-zones, cross-site modularization of development work, access to large skilled labor pool, innovation and shared best practices, and closer proximity to market and customer (Ågerfalk, Fitzgerald, Holmstrom, & Conchúir, 2009). However, the fundamental problem with GSD is that many of the mechanisms that function to coordinate the work in a co-located setting are absent or disrupted in a distributed setting (Herbsleb, 2007). Herbsleb and Moitra (2001a) state that without effective information and knowledge sharing mechanisms, the benefits of GSD cannot be exploited.

The results of this study will be beneficial to IT management when setting up global software development programs. The study was designed to advance knowledge and increase insight into the predictors and consequences of shared understanding in global virtual teams.

Limitations

This study made use of a web-based survey. Web-based surveys are subject to self-selection bias (Rea & Parker, 2005). Only those comfortable with taking web-based surveys and interested in the topic will complete the survey (Edwards, 2015). This survey requires that the participants are members of a virtual team, which also restricted the pool of eligible participants.

Barriers and Issues

While software development has become increasingly distributed, and its advantages recognized, research continues to confirm the challenges in knowledge sharing and the development of shared understanding and coordination in those environments (Sengupta, Chandra & Sinha, 2006; Garrison, Wakefield, Xu, Kim, 2010). These challenges have been shown in the research to be routinely rooted in team diversity including cultural and functional heterogeneity, collaboration capability and interaction, and team identification (Fiol & O'Connor, 2005; Joshi, Sarker, & Sarker, 2007; Sengupta et al., 2006; Stapel & Schneider, 2012). Chinbat (2010) also claims in his research that global software development teams face the following barriers and difficulties.

- Difficulty in knowledge transfer, especially tacit knowledge.
- Problems in remote communication (ambiguity in communication, less communication richness).
- Difficulties in coordination of team member efforts. Cultural issues, including language barriers.
- Reduced opportunity for building personal relationships.

Acquiring a sufficient enough qualified participants can be problematic. To acquire a sufficient number of participants, the researcher opened the survey to two places of employment where virtual teams exists.

The study examined use of communication media to promote synchronicity, mode of interaction, and team diversity to determine whether these factors, together, could have a positive effect on the development of shared understanding in global virtual teams.

Additionally, this study examined the correlation of shared understanding and team performance.

Summary

Shared understanding in teams can lead to improved performance by helping teams to anticipate behavior and to better coordinate their work and increase team members' motivation. However, it can be more difficult to achieve shared understanding in virtual teams (Hinds & Weisband, 2003). Hinds and Weisband (2003) also claim that, taken together, being virtual can lead to reduced similarity, fewer shared experiences, less team spirit or identity, less open communication, and less information sharing—all factors that reduce shared understanding on teams either directly or because differences become too difficult to identify and resolve. Hinds and Weisband (2003) suggest that members and managers of virtual teams can combat these problems to some extent. This study sought to identify the determinants of shared understanding and how they influence team performance, thereby adding to the body of knowledge on this topic.

Chapter 2

Literature Review

Introduction

Changes in the nature of work and the advances in information and communication technology have created more flexible and adaptive organizational structures and processes, resulting in increased team-based work among geographically dispersed teams (Hinds & Mortensen, 2005, Peters & Karren, 2009). These virtual teams consist of members in different locations working together interdependently and using advanced telecommunication and information technologies to engage in a geographically distributed work (Hinds & Mortensen, 2005, Lipnack & Stamps, 1997). There are some advantages to virtual teams. Virtual teams enable organizations to pool the talents and expertise of employees and non-employees by eliminating time and space barriers which can reduce development time (Ebrahim, Ahmed, & Taha, 2009, Shachaf, 2008). While there are some benefits to distributed teams, previous research has shown that distributed teams also have some disadvantages in communication, coordination, trust, power struggles, and conflicts (Hinds & Mortensen, 2005, Jarvenpaa & Leidner, 1998; Rosen, Furst, & Blackburn, 2007). This study examines the determinants of shared understanding in virtual teams and its development, and how that shared understanding influences team performance. The members of the virtual teams are from different countries, use mediating technology, do not share context, come from different cultural backgrounds, and, therefore, have less homogeneity. As such, it is difficult to have a shared understanding among the members of the team, which can affect team performance.

Improving shared understanding is important among virtual teams so they can be effective. Having a shared understanding enables people to anticipate and predict the behaviors of their team members and the behavior of the group. Hinds and Weisband (2003) posit that shared understanding of work processes among team members increases the propensity of team members to take actions that are consistent with those of others on the team, leading to more rapid and successful implementations. A shared understanding of goals and work processes serves to focus team members on behaviors that will contribute to their success. In order to study the predictors, some of the antecedents have been identified, as have appropriation factors, which moderate the relationships between antecedents and shared understanding. The Media Synchronicity Theory is the underlying theoretical foundation upon which this research rests to develop a new model of shared understanding in virtual teams.

This chapter, in addition to addressing the Media Synchronicity Theory as the underlying foundation of the study, provides a review of the current literature and also presents the hypotheses for this study.

Theoretical Foundation

Media Synchronicity Theory (MST) is the underlying theoretical foundation to develop this new model on shared understanding in virtual teams. MST was advanced by Dennis and Valacich (1999), and expanded and refined by Dennis, Fuller and Valacich (2008). MST looks beyond Daft and Lengel's media richness theory. MST is the extent to which a communication environment encourages individuals to work together on the same activity, with the same information, at the same time to agree on a shared meaning and focus, and then act together to reach a common goal (Dennis & Valacich, 1999). The

theory takes an outcome-centered approach; that is, to reach a group outcome, both conveyance and convergence must occur. During the conveyance phase, information is exchanged, followed by deliberation on its meaning (Dennis & Valacich, 1999). The researchers further posit that conveyance can be divergent; that is, not all participants need to focus on the same information at the same time, nor must they agree on its meaning (Dennis & Valacich, 1999). Further, the researchers state that, in general, high synchronicity is preferred for conveyance.

The second process, convergence, is the development of shared meaning for information. Dennis and Valacich (1999) state that by definition "it is convergent, in that participants strive to agree that they have agreed." The researchers further state that this means that participants must understand each other's views, and that, in general, high synchronicity is preferred for convergence.

Dennis and Valacich (2008), expand the original MST theory by providing a stronger theoretical basis for the constructs and relationships that make up the theory (See Figure 1).

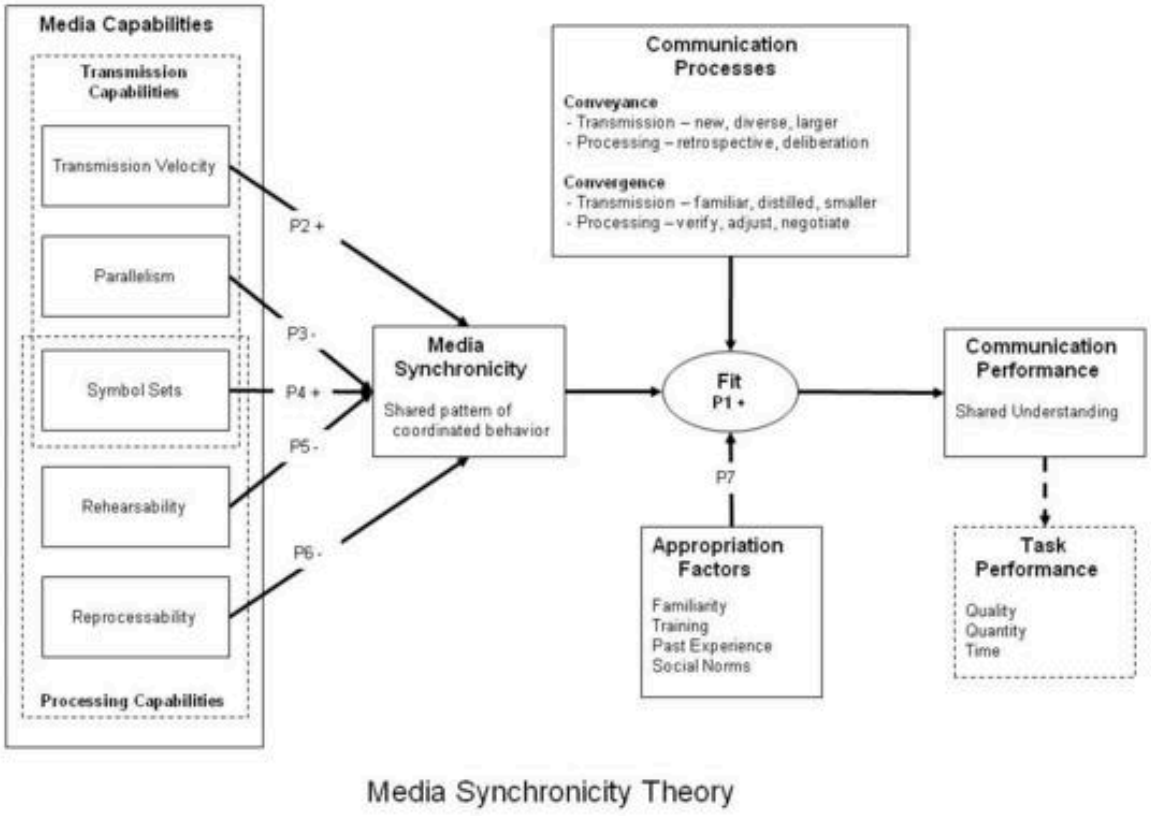

Figure 1. Media Synchronicity Model (Dennis & Valacich, 2008)

As shown in Figure 1, it is not solely the media or their capabilities that directly influence communication performance, but also the way in which they are appropriated and used (Dennis et al., 2008). Dennis and Valacich's (2008) expanded version of MST supports their theory with five fundamental assumptions, which represent boundary conditions to their theory.

1. The purpose of communication is to develop shared understanding.

2. Shared understanding can be constructed by the communication participants.

3. The spirit by which shared understanding is developed is what Habermas terms ideal speech:

"To ensure that (a) all voices in any way relevant can get a hearing, and that (b) the best arguments we have in our present state of knowledge are brought to bear, and that (c) disagreement or agreement on the part of the participants follows only from the force of the better argument and no other force (Nielsen & Habermas, 1990, p. 104)."

4. A medium has objective physical characteristics (e.g., it can or cannot transmit voice, it can or cannot store a copy of a message) that are also referred to as media capabilities.

5. The focus of the theory is one of communication performance, not of media choice on which prior media theories have focused.

The research model for this study is adapted from the MST model (See Figure 2). The constructs of the model include use of communication, mode of interaction, team diversity, shared understanding, and team performance.

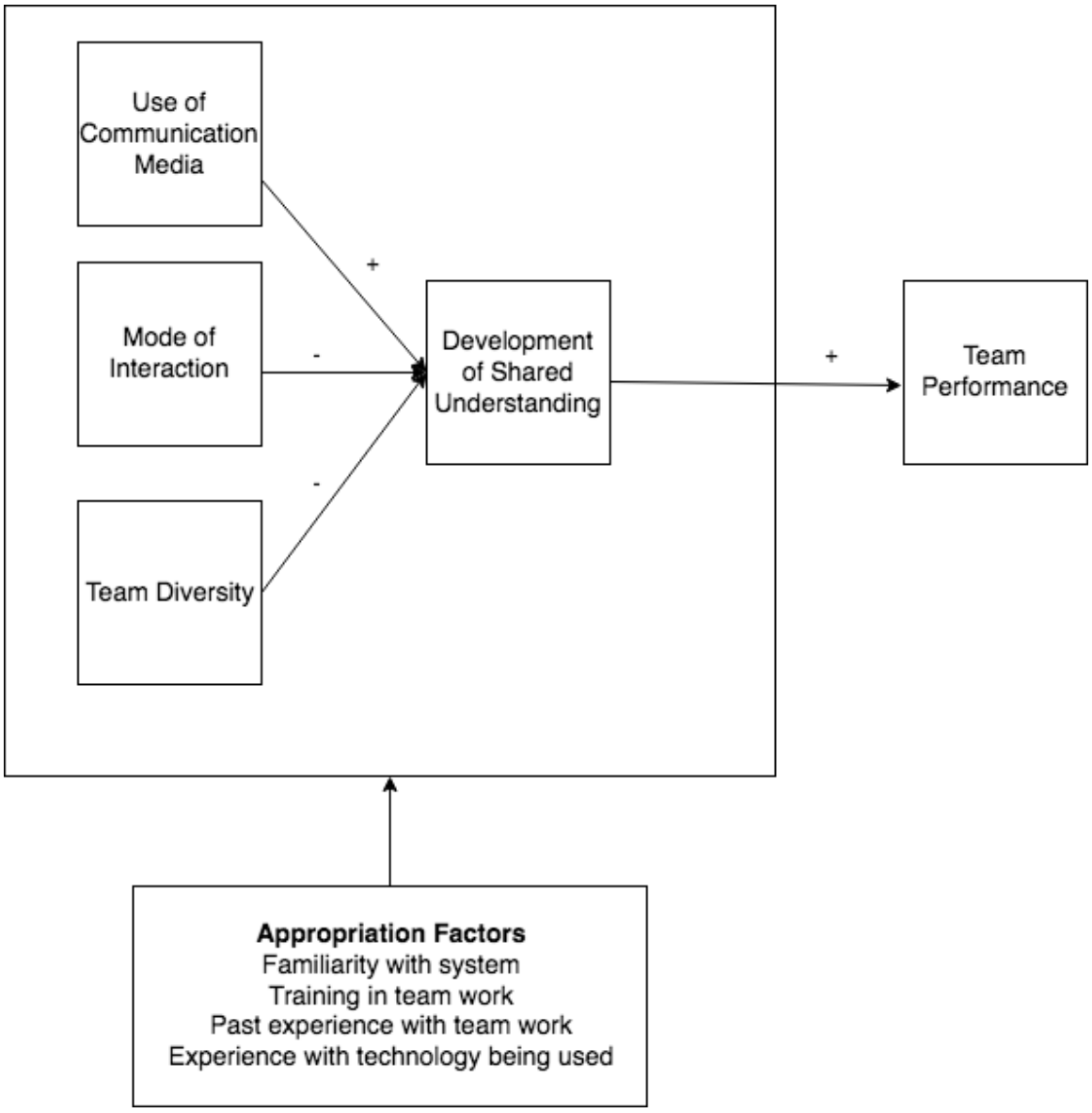

Figure 2. Research Model

Use of Communication Media - Definition & Prior Research

Hinds and Weisband (2003) state that communication and information sharing among team members contributes to shared understanding. Hinds and Weisband (2003, p. 25) also posit that:

> "Communication provides the opportunity to talk through problems, share perspectives, get feedback, and answer questions that arise among team members. The virtual environment presents considerable challenges to effective communication including time delays in sending feedback, lack of a common frame of reference for all members, differences in salience and interpretation of written text, and assurance of participation and trust from remote team members."

For virtual teams to be successful, information must be adequately shared (Powell, Piccoli, & Ives, 2004). Donnellon et al. (1986), as cited by Hinds and Weisband (2003), suggests that for shared meaning and understanding to develop, communication and collaboration among team members are required. The researchers state that without communication, misunderstandings are more frequent and difficult to solve.

The use of virtual teams as a channel for organizational knowledge sharing has increased due to globalization (Beranek and Martz, 2005 and Horowitz et al., 2006). Klitmoller and Lauring (2013), in their study on virtual teams, stated that the impact of media on knowledge sharing in global virtual teams has been understudied. Walther et al., (2005) reports that a host of problems associated with distance and restricted communication media impacts the ability of distributed groups to function as effectively as non-mediated groups. Managing communication processes is more challenging in virtual teams than in co-located teams, existing research suggests (Fiol & O'Conner, 2005; Jarvenpaa & Lender, 1999; Montoya-Weiss et al., 2001). Klitmoller and Lauring (2013) state that the reason for this is due primarily to challenges inherent in communicating through lean media such as e-mails. Communication challenges can be

misinterpretations of the message due to the absence of body language and tone of voice, according to research found in Daft et al. (1987), Hayward (2002), Kezborn (2000), and Lengel and Daft (1988). The researchers also posit that rich media communications, for example, video conferences, are more suitable when sharing knowledge that is complex in nature.

The rise of global virtual teams is a phenomenon of globalization (Hinds & Weisband, 2003; Klitmoller & Lauring; 2013). The researchers state that new information and communication technologies play an ever-increasing role in all aspects of global business relations, but are vital in the emergence of new global organizational work structures and virtual work environments. Information and communication technologies have been viewed as an indispensable tool for multi-national corporations that choose to move beyond the geographic constraints of face-to-face employee interactions and that endeavor to build a virtual workplace and use virtual teams as new components of a traditional work structure. For geographically dispersed employees, information and communication technologies are essential. However, computer-facilitated communication technologies are only as effective as those using them. Even though information and communication technologies impact knowledge sharing, team coherence, and team performance, it is the human component in the virtual environment and the interactive relational bonds that facilitate or hinder the development of a shared knowledge culture and organizational learning (Zakaria, Amelinckx, & Wilemon, 2004).

In a virtual computer-mediated communication environment, global virtual teams rely on information and communication technology usage to facilitate knowledge exchange, transfer, and sharing. Nonetheless, creating a knowledge-based environment

requires more than information and communication technology. It requires other crucial elements such as intra-team trust and intra-team relational bonds, leadership, intercultural communication competence, and cross-cultural training that foster a collaborative, interactive, permissive space where global virtual team members are actively encouraged to engage in regular, frequent, and reciprocal cross-cultural exchange of ideas. Team members are also encouraged to engage in the creation of new team-created solutions.

Qureshi and Zigurs (2001) suggest that the greater the degree of virtualization, the more people need to manage the relationships, share knowledge and expertise, and coordinate joint activities in new ways. Also, those working in virtual team settings need to enrich their computer-facilitated communication processes through the use of multiple communication channels, media, and feedback mechanisms.

Table 1. Communication - Prior Research

Prior Research	Resources
Virtual team members have to rely heavily on information and communication technologies. The lack of mutual knowledge at the onset of the project and the lack of a shared language among team members tend to hamper communication.	Klitmoller & Lauring (2013); Powell, Piccoli, & Ives, (2004); Crampton (2001)
Virtual team research to date has focused on mitigating communication difficulties and fostering an information-sharing culture. The frequency and predictability of communication and the extent to which feedback is provided	Powell, Piccoli, & Ives (2004); Jarvenpaa et al. (1998); Jarvenpaa & Lender (1999)

on a regular basis, improves communication effectiveness, leading to higher trust and to improving team performance.	
Geographically dispersed teams often have no choice except to communicate electronically, even though some individual team members may strongly prefer face-to-face interaction.	Gibson & Cohen (2003)
Computer facilitated communication technologies are one way of sharing information, and are essential in the communication and knowledge sharing processes.	Ebrahim (2009)
The ability to learn is often facilitated by transmitting information via multiple dimensions (visual cues, voice modulations, oral and written means using examples, metaphors, and in certain contexts, allegorical storytelling). In cross-cultural settings, however, the use of the above communication techniques may not resonate with those who do not share the same culture context.	Qureshi & Zigurs (2001)

Mode of Interaction

In the discussion of global teams, Wiredu (2006) states that the greatest organizing challenge is coordination of interactions between dispersed people, processes, information and technology. Robillard (2011) states that face-to-face and virtual interactions have many purposes. These purposes could serve to build trust or be used to share or acquire knowledge or know-how.

Hinds and Weisband (2003, p. 24) provides insight on the benefit of shared understanding of team interaction:

> "Team members benefit from a shared understanding of the interaction anticipated among team members, including roles and responsibilities, interdependencies, communication patterns, and executions for the flow of information. Having a common understanding of how the team will interact contributes to the more effective team process, including coordination, communication, and cooperation among team members. Team members who are confident about whom to go to, what information to provide to other team members, the media expected for various communications, and so forth are more likely to have a mutually shared perspective for anticipating and predicting the actions of others. Furthermore, such predictability in team member behaviors is likely to engineer trust among members."

For global virtual teams, being both heterogeneous cultural entities and geographically disperse virtual entities, the risk of potential misunderstandings and mistrust is heightened. Certain researchers contend that trust is facilitated, even for virtual teams, by initial face-to-face interactions (Maznevski & Chudoba, 2000). While face-to-face interactions have the propensity to facilitate trust when people relate well to each other, the trust may not be furthered among team members if they do not have shared understanding with each other or the whole team. As Roberts (2000) observed (as cited by Zakaria et al., 2004), the development of trust, whether on a local or international basis, requires more than face-to-face contact or its technological and spatially indifferent substitute video-conferencing. Trust depends on the sharing of a set of socially embedded

values, cultural institutions and expectations (Roberts, 2000, p. 6 as cited by Zakaria et al., 2004).

For global virtual teams to be effective, intra-group trust must exist (Javenpaa & Leidner, 1998). However, initial relationship building between global or cross-cultural members face more challenges, as does the establishment of intra-team trust. Jarvenpaa, Knoll, and Leidner (1998) posit that virtual teams require a high degree of 'swift trust' through demonstration of enthusiastic and proactive team members' behaviors. Lipnack and Stamps (1997) contend that, "In the networks and virtual teams of the information age, trust is a 'need to have' quality in productive relationships" (Lipnack & Stamps, 1997). Trust between group members and trust between the team and the organization are equally important. Trust and reciprocity of it are at the center of a team's ability to collaborate (Scott, 2000). Sharing of information and knowledge will not occur freely without trust and collaboration (Scott, 2000).

Virtual team members are often brought together to work on a common task with specialized skills and competencies. Members of virtual teams work with little or no face-to-face contact and focus on a finite lifespan or a temporal basis (Zakaria et al., 2004). Zakaria et al. (2004) suggest that this implies a limited history of working and less potential of future collaboration. As such, swift trust needs to be imported, rather than developed. According to Meyerson, Weick and Kramer (1996), swift trust is a form of trust that is created in a temporary system, a system that assumes behavior that presupposes trust. Hence, sources of trust like familiarity, shared experience, reciprocal disclosure, fulfilled promises, and demonstrations of non-exploitation of vulnerability are not obvious in such systems (Meyerson, Weick & Kramer, 1996).

If there are extreme deadline constraints, researchers have found that trust is formed without any relationship building (Zakaria et al., 2004). If that is true, how do cross-cultural members form swift trust? Jarvenpaa and Leidner (1998) suggested that the virtual members would import the expectations of trust from other settings with which they are familiar. In such a case, stereotypical impressions of others are formed based on the initial use of category driven information processing. This technique may be problematic for a culturally-diverse virtual team if individual team members' cultural stereotypes are flawed, biased or incomplete. Once communication is developed among culturally diverse members, trust could be maintained by actions that are highly dynamic, proactive, and enthusiastic. To be effective, this active communication must be predicated on accurate cultural knowledge. Therefore, swift trust is made possible when teams working in a temporal and virtual environment bring their competence and expertise to meet the specified goals.

> "A team that does most of its work through use of the telephone, e-mail, electronic bulletin boards, chat groups, electronic databases, or teleconferences, and rarely if ever meets face-to-face, is more virtual than a team that meets regularly face-to-face, even if both teams use the same technologies to some extent in doing their work" (Berry, 2011, p. 188).

The degree to which a team is virtual is a complex and multidimensional construct (Gibson & Cohen, 2003), with a major determinant of virtualness being simply the amount of time that members spend working through computer-mediated communication instead of face-to-face communication. Characteristics of teams with the highest degree of virtuality include all members working apart from each other in distant

locations, members only communicating and interacting through computer-mediated communication and distance communication technologies (Kirkman, Rosen, Gibson, Tesluk, & McPherson, 2002).

Virtual teams are not temporally constrained or bound by geographic location as are most face-to-face teams, giving an advantage to virtual teams since the team members can communicate, collaborate, and create outputs irrespective of time and space (Berry, 2011).

Table 2. Mode of Interaction

Prior Research	Resource
In the discussion of global teams, Wiredu (2006) states that the greatest organizing challenge is coordination of the interactions between distributed people, processes, information and technology. Robillard (2011) states that face-to-face and virtual interactions have many purposes. These purposes could serve to build trust or be used to share or acquire knowledge or knowhow.	Wiredu (2006); Robillard (2011)
The risk of misunderstandings and mistrust is heightened in global teams that are culturally diverse and geographically dispersed. The researchers state that trust is facilitated, particularly for virtual teams, by initial face-to-face interactions.	Zakaria (2004)
Virtual team members are often brought together to work on a common task with specialized skills and competencies. Members	(Maznevski & Chudoba, 2000).

essentially work virtually with little or no face-to-face contact and focus on a finite lifespan or a temporal basis.	
A team that does most of its work through computer-mediated technologies, video and telephone conferences, e-mail, and rarely meets face-to-face is more virtual than a team using the same technologies, but meet face-to-face on a more regular basis.	Berry (2011)

Team Diversity

Virtual teams' creative and problem-solving capabilities emerge from their culturally mediated knowledge structure and shared knowledge base. Although research has focused on how the lack of physical presence, along with the cross-cultural nature of such a team, provides many challenges, as mentioned above. What has not been explored is that the knowledge that is generated is itself culturally constructed, defined, and constrained by the global virtual team members. Zakaria, Amelinckx, and Wilemon (2004) propose in their research that new patterns of communication and social exchange can emerge in a computer-mediated team environment that influences this cultural learning process. Likewise, the quality and depth of intra-team member relationships impact the creation and maintenance of a shared knowledge base.

A prominent feature of virtuality is that it brings together highly diverse groups, including people from different nations, different regions, organizations, and professions (Gibson & Cohen, 2003). This feature sets them apart from co-located teams (Gibson & Cohen, 2003). Diversity of any kind is likely to detract from shared understanding because it emanates from and leads to different perspectives even when the objective

information remains the same (Hinds & Weisband, 2003). Advances in technology, globalization, and labor mobility have significantly increased the likelihood of employees working with others of different cultural backgrounds (Randall, 2003, as cited by Barrett & Oborn, 2010). Cultural differences can manifest themselves in multiple forms, including tacit assumptions and expectations, diverse working practices, and varying preferences in communication and collaboration (Jaanu, Paasivaara, & Lassenius, 2012; Barna 1994, and Shachaf (2008) suggests that several cultural factors inhibit mutual understanding among culturally diverse teams, among them false assumptions of similarity, language unfamiliarity, nonverbal misunderstandings, misconceptions and stereotypes and the tendency to evaluate other team members, and high anxiety that may exist among culturally different teams.

Studies by Dougherty and Souder (Peters & Karren, 2009) found that functional diversity, the "distribution of team members across a range of relevant functional categories," affects both team processes and team psychosocial traits. There is an underlying assumption that a larger knowledge base is created when different functional backgrounds result in non-overlapping knowledge and expertise. This expanded knowledge base can be drawn upon in making decisions and taking actions (Pinjani & Palvia, 2013). Because functional diversity is associated with differing opinions and perspectives, it may result in less effective performance (Peters & Karren, 2009).

Management practitioners have often undervalued the profound influence of culture on knowledge conceptualization and transfer. Knowledge sharing is often facilitated by communication that involves the exchange of meaning. The process of communicating is dynamic, multifaceted and complex. Cultural conditioning affects the

evaluation of experience as well as the means by which information and knowledge is conveyed and learned. Another salient concern is that the transmission of information does not necessarily ensure learning. Typically, we view the transmission of information from sender to receiver as a one-way process where the active participant is the sender and the receiver is an inactive recipient. When miscommunication occurs, particularly in a cross-cultural setting, the argument goes, it is due to the sender's inability and/or refusal to shape the information in a culturally appropriate and understandable form for the receiver. However, in reality, the sender and receiver should be seen as both active participants engaged in knowledge transfer and culturally mediated discourse. Communicating effectively in a cross-cultural setting resides in the ability to be understood within each other's cultural contexts, which requires a continuum of decoding and encoding messages for clarity.

An understanding of how national and organizational cultures influence team dynamics is crucial to developing a successful knowledge sharing base and culture for global virtual teams (Zakaria et al., 2004). Individuals from different cultures vary in their group behaviors and communications styles (Gudykunst, 1997). Edward Hall's contextual theory (1976),as cited by Zakaria et al., (2004) posits that in order to understand the communication and behavior preferences of those from varying cultures, one must understand the context in which they occur. Cultures can be classified into two categories: 'High context' and 'low context.' High context cultures rely heavily upon the external environment for behavioral cues that are associated with subtle and indirect communication styles. Low context cultures are generally associated with communication

styles that put less emphasis on non-verbal or behavioral cues, resulting in an avoidance of ambiguity owing to a more direct communication style (Zakaria et al., 2004).

Apart from national culture, organizational culture has a strong effect on management systems. Organizational culture is embedded in the national culture in which an organization operates. Although both cultures play different roles, each influences the way things operate in multinational corporations. Both factors need to be considered, especially in the context of global virtual teams using information and communication technologies. By definition, organizational or corporate culture includes the values and beliefs expressed in prefects, symbols, and practices, as well as organizational language, traditions, myths, rituals and stories. As Schein (1999) views it, "…it is the way we do things around here. In essence, corporate culture is the learned, shared, and tacit assumptions such as values, beliefs, and assumptions." Hence, the organizational impact varies greatly on information and communication technology usage by global (virtual) teams; indeed, it may act as a barrier or restraint to information and communication technology usage, or it may provide the necessary support regarding technology, infrastructure, and organizational culture, or even actively foster it.

If cultural differences are not clearly understood, information and communication technology usage could have unintended outcomes by promoting conflict rather than promoting a shared knowledge culture and learning environment (Zakaria et al., 2004).

The degree of technological sophistication among virtual team members may not be an accurate predictor of its effectiveness (Zakaria et al., 2004). Duarte and Snyder (1999) emphasize that technology is only one of the critical factors determining the success of virtual teams. Moreover, virtual teams and their leaders seldom claim that

technology is a primary reason for their success or failure (Nunamaker Jr, Briggs, Romano Jr, & Mittleman, 1997). As Potter and Balthazar (2002) observed, "the effect of communication technology and its usage may be quite secondary to those that result from how the virtual group or team interacts."

While information technology-facilitated communication processes rely on technologically advanced systems to succeed, the ability to create a knowledge sharing culture within a virtual team rests on the existence and maintenance of positive individual and group relationships that build on trust and mutual respect (Zakaria et al., 2004). The use of electronic communication technology can reduce or overcome certain cultural challenges within virtual teams as information and communication technologies facilitate interaction among team members by introducing a shared framework and virtual work setting. In that light, the role of information and communication technologies is regarded as a functional tool that facilitates cross-cultural collaboration and communication. Information and communication technologies can provide a common medium for work and shared meaning.

Information and communication technologies-mediated environments, in addressing conflict situations and/or detecting the existence of conflict, are not always straightforward. For example, avoidance behavior may indicate conflict in certain cultures, but in other cultures confrontational behavior may indicate conflict. Virtual teams need to anticipate potential areas of conflict in the formation stage and develop norms/ rules around conflict resolution. While all cultures have strategies to prevent or minimize conflict situations, the ways that societies perceive, and address conflict reflect profound cultural differences.

Team members from low-context cultures are more apt to separate issues from people, while members from high-context cultures are less likely to separate people from issues and may see disagreement (perceived as conflict) as a personal affront.

Since conflict is understood differently among cultures, its resolution will vary as well. Cultural differences may also impact the resolution process. Team members from low-context cultures may respond in a direct, confrontational way, and expect a quick resolution. On the contrary, high-context members may respond to conflict in an evasive and non-confrontational manner, employing an indirect, inactive approach to resolution. Diverse virtual teams need to be aware of such differences and create protocols that effectively respond to conflict or pre-conflict situations. Unacknowledged conflict has the capacity to diminish intra-team trust and negatively impact team cohesion, particularly in information and communication technology-mediated work environments where non-response is not necessarily seen as an indication of conflict.

Gibson and Gibbs, (2006), Maznevski et al., (2006) & Stahl et al. (2010) posit that cultural difference is perceived to represent challenges to communication effectiveness and knowledge sharing, including the exchange of complex ideas and notions. However, studies of co-located teams have shown that cultural differences may positively affect knowledge sharing since the intercultural engagement makes the contextual and tacit knowledge more explicit (Doughtery, 1992, and Earley & Mosakowski, 2000). The combination of rich media and complex, ambivalent knowledge to be shared and debated is likely to be beneficial (Trevino, Webster & Stein, 2000).

Table 3. Team Diversity

Prior Research	**Resource**

A prominent feature of highly virtual teams that set them apart from co-located teams is that virtuality brings together highly diverse groups, including people from different nations, different regions, organizations, and professions.	Gibson & Cohen (2003)
Diversity on any dimension is likely to detract from shared understanding because diversity leads to different perspectives even when the objective information remains the same.	(Hinds & Weisband, 2003).
Researchers have argued that functional diversity, the "distribution of team members across a range of relevant functional categories," affects both a team's processes and psychosocial traits, as found in studies by Dougherty and Souder.	Dougherty & Souder (Peters & Karren, 2009).
The use of electronic communication technology has the capacity to reduce or overcome certain cultural challenges within virtual teams as information and communication technologies facilitate intra-team interaction by introducing a shared framework and virtual work setting.	Klitmoller & Lauring (2013)
Cultural difference is generally perceived to represent a challenge to communication effectiveness and knowledge sharing, in general, and, in particular, to the exchange of complex ideas and notions.	(Gibson and Gibbs, 2006, Maznevski et al., 2006, and Stahl et al., 2010)

Shared Understanding & Team Performance

Shared understanding is the knowledge that members in a virtual team share and know that they share (Cramton, 2001). Based on their findings from Krauss and Bricker (1990) and Krauss & Fussell (1990), Alavi and Tiwana (2002) suggest that shared understanding among team members enhances comprehension and interpretation of the information that is communicated to them. Alavi and Tiwana (2002) state that the circumstances of virtual teamwork (team dispersion, team diversity, and lack of work history among team members) raise barriers in communication and constrain the development of shared understanding among the team members. The researchers argue that to establish the mutual understanding among dispersed teams, they must seek alternative means to facilitate this understanding through the use of technology-mediated interactions. However, issues may still arise with communication delays and errors, and the absence of nonverbal cues may result in misunderstandings and conflict among team members. These problems are exacerbated in virtual environments that span functional, cultural, national, and organizational boundaries (Alavi & Tiwana, 2002).

Contextual knowledge sharing is facilitated in co-located environments because of the proximity of team members and their ability to visit with each other and attend the same meetings in the same locale. Contextual knowledge is shared in these environments through direct observation and shared experience, which, in turn, contributes to a shared understanding of the team's context. Conversely, contextual knowledge is unevenly distributed among team members in virtual team settings (Alavi & Tiwana, 2002).

Alavi and Tiwana (2002) state that failure to share and remember contextual knowledge in virtual team environments may lead to misunderstanding or

misinterpretation of a remote team member's behavior. For example, delays in responding to team members due to technical failures or cultural events, such as local holidays, may be attributed to disinterest, which may lead to conflict and coordination efforts within teams, thereby impacting team performance (Alavi & Tiwana, 2002).

Berry (2011) has similar findings as Alavi and Tiwana (2002), stating that shared goals and shared understandings are required on any team. Similarly, Berry (2011) argues that social information occurs more slowly in virtual environments, as opposed to face-to-face environments, and that a shared understanding of task and process has a significant impact on the ability of teams to coordinate and perform well and with consistency.

In their study, Hinds and Weisband (2003) found that shared understanding enables people to anticipate easily and predict the behaviors of individual team members and the group as a whole. The researchers also found in their study that virtual team members tend to share less information than members of face-to-face teams, with the result that team members have a weaker shared understanding of needed outcomes, which may negatively impact performance outcomes.

McComb et al. (1999) state that, at the onset of team activities, the members must develop a common understanding of the direction in which they must go to complete the assignment. This common understanding requires establishing goals and developing a shared understanding of those goals among all team members, the team leader, and the organization.

The results of the Mathieu et al. (2000) study revealed that team mental model sharedness related significantly to team performance. The researchers stated that this

result, along with others in their study, offered empirical confirmation for the inferred impact of shared mental models on team effectiveness (Mathieu et al., 2000). This study showed that the similarity in knowledge structures among team members could predict the quality of team process and performance.

In a study conducted by Klimoski and Mohammed (1994) as cited by Mathieu et al. (2000), the researchers argue a number of variables, including communication processes, strategy and coordinated use of resources, and interpersonal relations or cooperation are important for linking shared mental models with team performance.

Appropriation

Panjani and Palvia (2013) posit that challenges in virtual teams are caused by "distance and time zone changes, by language and cultural differences, by adoption and implementation of technology, by member interaction, and by a lack of trust and shared understanding among the team members." Teams need common language and artifacts to share knowledge virtually. This shared background can only be created, it is believed, through face-to-face communication (Huysman, Steinfield, Jang, David, Veld, Poot, Mulder, 2003). Using technology both influences and is influenced by numerous context dependent conditions. According to Huysman, Steinfield, Jang, David, Veld, Poot, and Mulder (2003), this implies that research on how teams use communication technology to communicate with each other should take into account such aspects as past experiences, task division, time orientation, and institutional and organizational forms. Global virtual teams have no history of working together and may lack the skills needed to work productively with people of different cultures and time zones, and may also have incompatible systems. The researchers further posit that members who are not competent

in using new technologies effect team performance and member satisfaction (Arnison & Miller, 2002). Based on this research, appropriation factors which include familiarity with systems, training in team work, past experience with team work and experience in the system used will be used as control variables to determine its influence on other constructs in this study.

Hypotheses

Use of Communication

Virtual teams require robust, well-integrated technology to sustain communication (Suchan & Hayzak, 2001). Virtual teams face significant immediate challenges in organizing and communicating. Chudoba et al. (2005) argues that communication technologies are commonly recognized as enablers of virtuality, and that communication technologies mitigate barriers to collaboration and enhance flexibility required to meet the rigors of a rapidly changing work environment. When group members are unfamiliar with one another, and the team is vulnerable to dysfunction and conflict, they must use communication to define team purpose, lay a foundation for trust, and establish communication interactions and media choice patterns (Shachaf, 2008). The concept of shared understanding is defined as ”a collective way of organizing relevant knowledge, which can influence the ability of teams to coordinate work and perform well” (Hinds & Weisband, 2003, p. 21).

Hypothesis 1. The higher the use of communication technology in virtual teams, the greater the development of shared understanding in the virtual team.

Mode of Interaction

Mulder, Swaak, and Kessels (2002) state that in both in face-to-face situations and in technology-mediated situations, it is difficult for team members to understand each other, and that understanding is even more difficult if group members are globally distributed and their interaction is completely mediated by technology. In their study, Hinds and Mortensen (2005) state that an increasing number of organizations rely on technology-enabled, geographically distributed teams, that these teams are often difficult to manage, and they fall short of performance expectations as they frequently suffer from coordination problems and unhealthy group dynamics. In her study of distributed teams, Cramton (2001) observed that when information was missing or miscommunications occurred, team members made harsh attributions about their distant colleagues that led to conflict and impaired coordination.

Hypothesis 2. Virtual teams with higher levels of mode of interaction will have lower levels of shared understanding.

Team Diversity

Dahlin, Weingart and Hinds (2005) posit that organizations are increasingly dependent on diverse teams for developing innovative products, making important decisions, and improving efficiency. However, working in diverse teams can be challenging. Moreover, the very nature of these teams' diversity makes it difficult for their members to communicate, coordinate their work, and perform. Due to the ad hoc, cross-functional nature of these teams, group members who are unfamiliar with each other may have different language norms based on functional area expertise, and may lack shared patterns or routines for dividing tasks, coordinating work, handling conflict, and formulating rules. Shachaf (2008) cites in her research that previous studies have

found that culturally diverse groups exhibit lower levels of integration and cohesion; the lack of shared mental models inhibits understanding among team members. Dahlia, Weingart, and Hinds (2005) state that to better understand how diversity influences teams, it is necessary to understand the different types of diversity and how they relate to information use.

Hypothesis 3. Virtual teams with higher levels of team diversity will have lower levels of shared understanding.

Shared Understanding & Team Performance

McComb et al. (1999, p. 8), Smircich (1983), and Weick (1993) state that "by acquiring shared mental models, teams allow themselves to develop a framework for conducting the required work without a continuous process of interpretation and re-interpretation of meetings." The researchers suggest that the framework formalizes roles, rules, and procedures that exist among team members (McComb et al., 1999). The higher the level of shared meanings held by the team members, the more elaborate the frameworks that are developed; conversely, fewer shared meanings result in less elaborate frameworks (McComb et al., 1999). McComb et al. (1999, p.8) and Mitchell (1986) state in their research that "by aligning their views and developing frameworks, teams have been found to achieve higher performance."

Hypothesis 4. Virtual teams with higher levels of shared understanding will have higher levels of team performance.

Appropriation Factors

Dennis et al. (2008) in their study on media synchronicity state that users are free to choose how they adopt and use different media, that media can often create dominant

appropriation paths. Therefore, the fit between the capabilities of the media and the needs of the task influence how users choose to adopt and use them. The researchers further state that media that fit user needs are more likely to be faithfully appropriated and used; media that do not fit the needs of the user very well are less likely to be faithfully appropriated and used (Dennis et al, 2008). The researchers found that familiarity with and training on the use of media can increase the likelihood that the media will be appropriated faithfully. They also found that positive past experience and social norms can influence the likelihood that the media will be appropriated faithfully (Dennis et al, 2008).

Hypothesis 5. The greater the influence of appropriation factors on the use of communication, mode of interaction, and team diversity, the higher the level of shared understanding.

Summary

Shared understanding in teams can lead to improved performance by helping them to anticipate behavior, better coordinate their work, and increase team members' motivation. However, it can be more difficult to achieve shared understanding in virtual teams (Hinds & Weisband, 2003). Hinds and Weisband (2003) also claim that taken together, being virtual can lead to reduced similarity, fewer shared experiences, less team spirit or identity, less open communication, and less information sharing—all factors that reduce shared understanding on teams either directly or because differences become too difficult to identify and resolve. Hinds and Weisband (2003) suggest that members and managers of virtual teams can combat these problems to some extent.

The purpose of this research is to add to the body of knowledge in the identification of the determinants of shared understanding, and how those determinants influence team performance.

Chapter 3

Methodology

Research Setting

The research setting refers to the place where the data are collected. Specifically, this research used a quantitative method for the collection of numerical data to describe and explain the predictors of shared understanding in virtual teams. The study made use of a survey that measured constructs use of communication, mode of interaction, team diversity, location, shared understanding, and team performance.

The survey instrument was a web-based instrument since a primary advantage of using web-based surveys is that they make survey data collection available a multitude of people. Researchers can get access to significantly high numbers of respondents at dramatically lower costs than traditional methods, and web-based surveys can put the survey instrument in the hands of almost every person with access to the internet (Couper, 2000). Web-based survey research takes advantage of the ability of the internet to provide access to groups and individuals who would be difficult, if not impossible, to reach through other channels (Wright, 2005). Other advantages of web-based surveys are that participants can complete the survey in their own locations and at their own pace (Rea & Parker, 2005). Additionally, web-based surveys save time by allowing researchers to collect data while they work on other tasks (Llieva, Baron, & Healy, 2002, as cited by Wright, 2005).

There are some disadvantages to using web-based surveys. Low response rates, self-selectivity of internet users, technological issues with the deployment of the research tool, and concerns over internet security have troubled some recent studies (Sills & Song,

2002). Another disadvantage is that investigators can encounter problems with sampling as relatively little may be known about the characteristics of people in online communities, aside from some basic demographic variables, and even this information may be questionable (Wright, 2005). There may be access issues as some researchers contact potential participants by posting to discussions groups and chat rooms. However, some online communities may view this behavior as rude or offensive, and the community moderator may delete the unwanted post (Wright, 2005). Other challenges to web-based survey research may include incomplete responses, unacceptable responses, and multiple submissions (Schmidt, 1997).

Sample Characteristics

Bradley (1999) stated that any survey is only as representative as the subjects chosen to be interviewed. According to Sekaran (2003), a sample is a subgroup or subset of the population. By studying the sample, the researcher should be able to draw conclusions that would be generalizable to the population of interest (Sekaran, 2003).

In this study, the researcher examined the behavior of persons that work on virtual teams. After approval from the Institutional Review Board (IRB) at Nova Southeastern University and the executive managers of the departments of the firm where the study was conducted. The firm in this study was the researcher's place of employment. An email was sent to every employee explaining the study and encouraging participation. The email included an access link to the web-based survey where the participants had an opportunity to provide consent and answer questions covering the use of communication, mode of interaction, team diversity, location, shared understanding, and team performance in virtual teams. The survey was hosted on SurveyMonkey.

Sample Size

According to Cohen (1992, p. 99), "In planning research, deciding the sample sizes is crucial. Because research costs are approximately linear in the number of subjects, cost-effectiveness demand(s) that this decision is appropriate." Cohen (1992) states that to determine the necessary sample size, one needs to posit the alpha, effect size, and desired power. Cohen stated:

> "Statistical power analysis exploits the relationships among the four variables involved in statistical inference: sample size (N), significance criterion (a), population effect size (ES), and statistical power. For any statistical model, these relationships are such that each is a function of the other three. For example, in power reviews, for any given statistical test, we can determine power of a given (a), N, and ES. For research planning, however, it is most useful to determine the N necessary to have a specified power for given (a) and ES." (p. 98)

To determine the sample size for the study, the researcher calculated the sample size using G*Power v3.1.9.2. G*Power was designed as a general stand-alone power analysis program for statistical tests commonly used in social and behavioral research (Faul, Erdfelder, Buchner, & Lang, 2009). Using G*Power, the following inputs were made: alpha = .05, power = .95, and a medium effect size of .3. The results of the power analysis showed that the minimum desired sample size for this study is 111 participants (See Figure 3). A total of 118 participants participated in the survey.

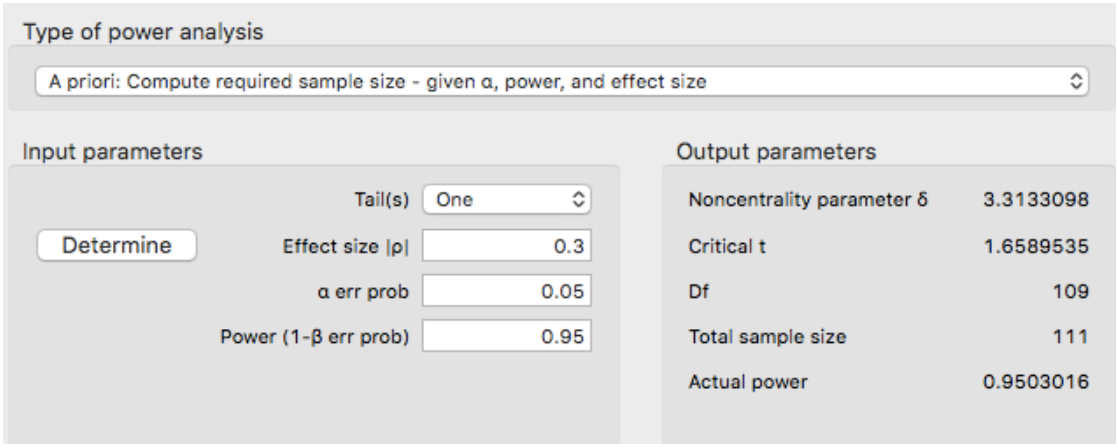

Figure 3. G*Power Analysis Results

Instrumentation

Surveys are a flexible technique for measuring shared understanding (Braunschweig & Seaman, 2014). Braunschweigh and Seaman (2014) also state that as a technique, surveys ask members of a team about their shared work, such as project goals and tasks, or about each other, such as expertise in different areas. Answers can be compared for consistency. Responses are given as ratings on a Likert scale and can be analyzed using various statistical techniques.

According to Kitchenham and Pfleeger (2002), researchers rely on using existing instruments because of two advantages: 1) The existing instruments have already been assessed for validity and reliability, and 2) By using common instruments, it is easy to compare new results with the results of other studies. The researcher used already validated questions to assess use of communication, mode of interaction, location, and team diversity on shared understanding and subsequent team performance. The researcher will used features of the SurveyMonkey tool to distribute survey links to the study participants. A web-based survey was used to mitigate data entry errors and to facilitate ease of distribution.

According to Wright (2005), an advantage of virtual communities as sites of research is that they offer a mechanism through which a researcher can gain access to people who share specific interests, attitudes, believes, and values regarding an issue, problem, or activity. The internet enables communication among people who may be hesitant to meet face-to-face and express themselves openly (Wright, 2005). These groups and others can be reached in larger numbers than would be possible using face-to-face research methods (Wright, 2005).

Operationalization of Variables

Measure of Use of Communication

In their study, Chudoba et al (2005) stated that access to information communication technology (ICTs) affect interactions among members in a distributed team where lack of access may make it difficult for some team members to contribute to team efforts. Among other measures of virtuality in their study, Chudoba et al. (2005) developed four questions that measured the use ICTs:

1. "Work with people via internet-based conferencing applications."
2. "Participate in real-time online discussions, such as chat or instant messaging."
3. "Meet with people via video-conferencing tools."
4. "Work with mobile devices."

The researcher added a fifth item: Work with email.

Similar to the Fulk (1993) study, perceptions of ICT richness was measured by asking respondents to rate the ICTs on a five-point scale (1 = not at all rich, 5 = extremely rich). To assist with this judgment, the respondents will be provided with the Daft and Lengel (1984) definition of media richness, in which four criteria are applied:

1) Ability to give and receive timely feedback.
2) Ability to transmit a variety of nonverbal cues.
3) Ability to tailor messages to personal circumstances.
4) Communication using rich and varied language.

As in the Fulk (1993) study, the respondents were assessed by the same questions, but will evaluate the usefulness on a five-point scale (1 = not at all useful to 5 = extremely useful).

Measure of Mode of Interaction

Questions for this construct are adapted from the Chudoba, Wynn, Lu and Watson (2005) study where the mode of interaction is measured in areas that include working with people from different business groups, time zones, or cultural backgrounds; using different media and technologies; working at different sites including mobile; and working with people outside of their main company. In the Chudoba et al. (2005) study, team distribution — the degree to which people work on teams that have people distributed over different geographies and time zones— had a reliability of alpha = 0.85 on the four items measuring this dimension, working environments other than regular offices, including home, travel routes, and places outside of company sites had a dimension of reliability of alpha = 0.70 for this dimension, variety of practices - the degree to which employees experience cultural handiwork process diversity on their teams - three items measured in the Chudoba et al. (2005) study have a reliability of alpha = 0.73. All questions are measured on a six-point frequency scale with options of Daily, Weekly, Monthly, Quarterly, Yearly, and Never.

Measure of Team Diversity

Two important types of team diversity are functional (arising from differences in educational background, experience, and expertise among team members) and social category (arising from differences in race, culture, genre, and age among team members (Kankanhalli, Tan, & Wei, 2006). When people with different functional backgrounds work together, they may have dissimilar belief structures (e.g., priorities, assumptions, and understanding) based on their previous training experience (Kankanhalli et al., 2006). Functional diversity will be measured by the number of different functional areas in a group (Peters & Karren, 2009). Cultural diversity includes national and linguistic differences among members, as well as differences in broader cultural dimensions (Kankanhalli et al., 2006). National diversity is based on team members' dominant national affiliations. Their study contained two pieces of information (citizenship and nation of birth), were always consistent and therefore provided a reliable measure of nationality (Dahlin, Weingart, & Hinds, 2005). In this study, the researchers used the Blau (1977) index to measure diversity.

Team diversity, due to the data collection strategy, was modified to represent a cultural mosaic. In Chao and Moon's (2005) work, the researchers state that workforce population trends have increased the numbers and kinds of culturally diverse people who work together. While traditionally in organizational behavior, culture has been examined through values, cultural values can be based on collections of people other than traditional nation states. For this study, the cultural mosaic is a codification of the participant's cultural background and job function.The codification included creating a value for each respondent from the combination of the citizenship variable and the job

function variable. The job function variable was grouped into four broader categories of job function.

Measure of Shared Understanding

Mulder (1999) and Mulder, Swaak, and Kessels (2002) (cited by Van den Bossche et al.,2006), developed and used a self-scoring instrument measuring shared understanding. They measured the perception of shared understanding both at a certain moment (product), and with respect to the development of shared understanding (process) (Van den Bossche et al., 2006). Van den Bossche et al. (2006) only used items from the questionnaire referring to the perceived shared understanding at a certain moment. Van den Bossche et al. (2006) split the questions in the Mulder (1999) study and the Mulder, Swaak and Kessels [2002} study, which resulted in a scale existing of the following items: "At this moment, this team has a common understanding of the task we have to handle" and "At this moment, this team has a common understanding of how to deal with the task."

Van den Bossche et al. (2006) factor analysis revealed that both questions loaded very highly on one factor (minimum = .938). Concomitant with this factor analysis is the high internal consistency of this scale (alpha =.86) (Van den Bossche et al., 2006).

Measure of Team Performance

Measures of performance were adapted from the work of Potter and Balthazard (2002) who adapted their work from Cooke and Lafferty (1988). In the Potter and Balthazard (2002) study, the researchers measure performance across four key items which they named: Solution Acceptance, Satisfaction, Group Commitment, and Perceived Efficiency. Member acceptance of the group's decision (solution acceptance)

was measured by three supplementary questions in this work (Potter & Balthazard, 2002). The questions are: 1) To what extent are you personally committed to the solution proposed by the team? 2) To what extent do you think the solution generated by the team was better than the one you developed? 3) To what extent do you feel that the solution had been reached on a consensus basis? Responses to each of these items ranged from 1= not at all to 5=to a very great extent, and were averaged for each team member (alpha=0.74) in the Potter and Balthazard (2002) study.

Satisfaction with the process are assessed by two questions which include: 1) To what extent did the members of the group work together effectively? 2) To what extent to did the group come up with the best possible solution, given time and geography constraints? These questions are also adapted from the Potter and Balthazard (2002) study, which adapted the questions from Cooke and Lafferty (1988). Responses to each of these items, which range from 1=not at all to 5=to very great extent, were averaged for each team member (alpha = 0.73) in the Potter and Balthazard (2002) study.

Perceived efficiency with the process was ascertained using one question and it is also from the work of Cooke and Lafferty (1988), cited by Potter and Balthazard (2002). The item “to what extent did the group seem to waste time and energy?” was used to assess members’ perceptions of the efficiency of the process.

Appropriation Factors

Data are collected on appropriation factors to get an understanding of the team members experience and familiarity with systems, training and teamwork. For each of the appropriation factors familiarity with systems, training in team work, past experience with team work and experience in system being used, responses are collected using a 5-

point Likert scale. The responses range from 1=not at all familiar to 5=extremely familiar.

Demographic Variables

The final section of the survey consists of five items that gather general information regarding the participant's gender, age, highest level of education, ethnicity, number of years at company and years working on virtual team.

The full questionnaire can be found in Appendix A.

Validity and Reliability Assessment

Validity

Among the many forms of validity, having valid content (content validity) is desirable in instruments for assuring that constructs are drawn from the theoretical essence of what they propose to measure (Straub, Boudreau, & Gefen, 2004). The essential question posed by this validity is: "Does the instrumentation (e.g. questionnaire items) pull in a representative manner from all of the ways that could be used to measure the content of a given construct" (Berlinger, 1964; Cronbach, 1971). To increase content validity, the researcher adapted questions from previous studies.

Straub, et al. (2004) state that construct validity is an issue of operationalization or measurement between constructs. Construct validity raises the basic question of whether the measures chosen by the researcher fit together in such a way as to capture the essence of the construct, as compared to other latent constructs—a reasonable operationalization of the construct (Cronbach & Meehl, 1955). Construct validity differs from internal validity in that it focuses on the measurement of individual constructs,

while internal validity focuses on alternative explanations of the strength of the links between constructs (Straub et al.)

Convergent validity is important for reflective variables. “Convergent validity is evidenced with items thought to reflect a construct converge, or show significant, high correlations with one another, particularly when compared to the convergence of items relevant to other constructs, irrespective of method” (Straub et al., 2004). Discriminant validity is “the degree to which scores on one test do not correlate with scores on other tests that are not designed to assess the same construct” (Rovai, Baker, & Ponton, 2014). Performing an assessment of convergent and discriminant validity should provide support for the construct validity of constructs (Straub et al).

The major survey questions are adapted from existing surveys, which may reduce the concern about validity. This research study anticipated that the results would not be limited to a region or a particular industry. Further instrument validation includes factor analysis to validate the instrument items and constructs.

Reliability

Internal consistency is important for reflective constructs and, for this reason, Cronbach’s alpha or other reliability measures are used to ensure the measures are reliable (Petter, Straub, & Rai, 2007). Sekaran (2003) states: “Cronbach’s alpha is a reliability coefficient that indicates how well the items in a set are positively correlated to one another. Cronbach’s alpha is computed in terms of the average intercorrelations among the items measuring the concept” (Sekaran, 2003, p. 307). It is expressed as a number between 0 and 1 (Cronbach, 1951). There are guidelines for evaluating Cronbach’s alpha coefficients: Coefficients of .49 or less are unacceptable, coefficients

of .5 to .59 are poor, coefficients of .6 to .69 are questionable, coefficients of .7 to .79 are acceptable, coefficients of .8 to .89 are good, and coefficients greater than .9 are excellent (George & Mallery, 2003). The internal reliability of the tools is demonstrated in the Operationalization of Variable section of this chapter where Cronbach's alpha values are highlighted for various constructs for the study.

To ensure that individual level measures can be aggregated to find the measure of a construct at the team level, Cohen's Kappa will be used. Berry and Mielke (1988) state that one of the most popular indices of agreement was introduced by Cohen (1960) as a reliability index for measuring chance-corrected agreement between two observers employing nominal scales. Kappa is the proportion of agreement corrected for by chance, and scaled to vary from -1 to +1 so that a negative value indicates poorer than chance agreement, and zero value indicates exactly chance agreement, and a positive value indicates better than chance agreement (Fleiss & Cohen, 1973).

To increase the reliability of the data in the survey, the SurveyMonkey tool was used to administer the survey where controls are in place to mitigate gaps and non-answers to key questions. The results, as collected, will be stored on the SurveyMonkey survey which should mitigate any transcription errors increasing the reliability of the data collected. The data can be transferred to popular statistics packages and programs, including SPSS, Excel and more.

Data Collection

The survey will be made available to each participating adult who works on a virtual team at investigator's place of employment. While the investigator has familiarity with the firm, there are limitations on the objective data that can be obtained due to

privacy concerns. The survey will use both a 5-point Likert scale with 1 = strong disagree, 2 = disagree, 3 = neither disagree nor agree, 4 =agree, and 5 = strongly agree, and a true/false question.

When participants access the survey link, they were directed to an informed consent page. The informed consent page contains the following information: The purpose of the study, what participants will be asked to do, the risks and benefits of the study, and what the participants' rights are. Specifically, the informed consent states that the study is voluntary and that participants have the right to stop taking the survey without consequence at any time. The informed consent stated that participants' responses are anonymous and will be kept confidential. After reading the informed consent information, participants were directed to answer an item at the bottom of the page indicating whether or not they agree to participate.

Individuals who agreed to participate were directed to the next part of the survey containing the study instruments and demographic questions. The researcher anticipated that it would take approximately 15 minutes or less for each participant to complete the survey, however, it took approximately five minutes. After answering all of the survey questions, participants were directed to a page informing them that their participation is complete. At the completion of data collection, the survey responses were downloaded as an electronic spreadsheet file and imported into SPSS for statistical analysis.

Data Analysis

The unit of analysis in this study was at the level of the individual business professional. To ensure the accuracy of the data, this study followed a pre-analysis data screening procedure. Levy (2006a) indicated that data analysis involves conducting pre-

analysis data screening to ensure the accuracy of the data collected. Levy (2006b) stated that a pre-analysis data screening "deals with the process of detecting irregularities or problems with the collected data" (p.150). This study will follow Levy's (2006a, 2006b) recommended pre-analysis data screening procedure for several reasons. First, the pre-analysis data screening will check the accuracy of the data collected via the survey instrument. The second step will be to eliminate cases with response-set, which is where all responses are marked with the same score on all items in the survey. The third task is to check for missing data. While the intent was to construct the web-based survey instrument in a manner that required a response to all items, further research indicated that participants may drop out when forced to answer questions specifically related to demographics. Therefore, the requirement to answer all questions was eliminated.

Descriptive statistics were computed and reported for each of the study variables and demographic variables. Means and standard deviations were reported for continuous variables, and frequencies and percentages will be reported for categorical variables. Additionally, an inter-item reliability analysis using Cronbach's alpha was conducted for each of the subscales used in the study (i.e., use of communication media, mode of interaction, development of shared understanding, and team performance). Reliability coefficients will be evaluated based on the recommendations of George and Mallery (2016) who suggest that coefficients of .7 or greater indicate acceptable reliability.

Multiple Regression

The research hypotheses were tested by conducting multiple linear regression. Multiple regression is a flexible method of data analysis that may be appropriate whenever a quantitative variable is to be examined in relationship to any other factors

expressed as independent or predictor variables. This analysis is appropriate when the research involves assessing the relationships between a single dependent variable and multiple independent variables (Tabachnick & Fidell, 2007). Development of shared understanding will be the dependent variable in this analysis. Use of communication media, mode of interaction, and cultural mosaic will be the independent variables in this analysis. The control variables that will be included in the analysis are familiarity with system, training in teamwork, past experience with teamwork, and experience with technology being used. In line with the standard method of multiple regression, all independent and control variables will be entered into the regression model at the same step. An additional regression was conducted to determine the relationship between development of shared understanding and team performance. In this analysis, the dependent variable will be team performance and the independent variable will be development of shared understanding.

Regression Assumptions

The following key assumptions are prerequisites for running the multiple regression analysis, and have been adapted from Rovai et al., (2014,) as cited by Edwards (2015).

- Selection of participants is random to allow for generalization of results to a target population.
- Variables are interval scale variables. Variable have unrestricted variance.
- No measurement errors. Measurement errors in the DV may cause weakness in the test of statistical significance. IV measurement errors may lead to bias in the regression coefficients.

- No extreme multicollinearity or singularity should exist. Multicollinearity occurs when variables are highly correlated and singularity occurs when the variables are perfectly correlated. Multicollinearity and singularity indicate that redundant variables exist, and so will require the removal of variables from the analysis.
- Normality should exist. Normality is the normal distribution of the disturbance term for all cases in a sample. The disturbance term is unexplained difference between the observed values and the predicted values.
- No extreme outliers exist. Extreme outliers can have excessive influence on the regression solution, which may create misleading results.
- The variance of errors is the same across all levels of the IV (homoscedasticity). Lack of homoscedasticity decreases the reliability of test statistics, confidence intervals, and the stand error of the estimate.
- The relationship between IVs and the criterion variable is linear. Otherwise, the true relationship will be underestimated.
- There is an adequate sample size.

As stated earlier, in order to determine the relationships between the independent variables and the dependent variables, multiple linear regression will be used. Multiple linear regression analysis examines the relationship between multiple independent variables and a dependent variable.

Summary

This study was to understand the predictors and consequences of shared understanding. In order to study the influence of use of communication, mode of

interaction, diversity on shared understanding and team performance in virtual teams, the researcher developed a web-based survey.

The design of the study takes into account validity and reliability threats, and such known threats were addressed. Multiple regression analysis was used to analyze the data.

Chapter 4

Results

Introduction

This chapter contains the results of the study conducted to answer the research questions:

RQ1: How does team diversity affect the development of shared understanding in virtual teams?

RQ2: How does mode of interaction affect the development of shared understanding in virtual teams?

RQ3: How does the use of communication technology affect the development of shared understanding in virtual teams?

RQ4: How does the development of shared understanding influence team performance?

This chapter also includes analysis of the demographic data and results of normality, common method bias, reliability and validity tests for the measures of the constructs. Additionally, this chapter presents the results of the hypotheses tests, tables to complement the analysis and summary.

Sample Profile

A total of 118 participants responded to the survey. Table 4 displays descriptive statistics for the categorical variables of the study and Table 5 displays descriptive statistics for the continuous variables of the study. The majority of participants were men (n = 66, 55.9%), and the largest proportion of participants were 45 to 54 years old (n = 56, 47.5%). White/Caucasian was the most commonly reported ethnicity (n = 64, 54.2%). Most participants were born in (n = 93, 78.8%) and were citizens of (n = 107, 90.7%) the

United States. The most commonly reported job functions of the participants were information technology (n = 21, 17.8%), management (n = 20, 16.9%), and engineering (n = 14, 11.9%). Finally, the largest proportion of participants had been in their current position for 10 years or more (n = 40, 33.9%).

Table 4. Descriptive Statistics for Categorical Variables

Variable	Frequency	Percent
Nation of birth		
Australia	1	0.8
Aruba	1	0.8
Bulgaria	1	0.8
China	2	1.7
Colombia	1	0.8
France	1	0.8
United Kingdom	4	3.4
India	2	1.7
Iran	1	0.8
Peru	1	0.8
Romania	1	0.8
Russia	1	0.8
Trinidad and Tobago	1	0.8
United States Minor Outlying Islands	1	0.8
United States	93	78.8
Vietnam	1	0.8
Missing/No response	5	4.2
Country of citizenship		
Australia	1	0.8
Aruba	1	0.8
Colombia	1	0.8
United Kingdom	1	0.8
India	2	1.7
United States	107	90.7
Missing/No response	5	4.2
Job function		
Accounting	1	0.8
Administrative	4	3.4
Advertising / Marketing	3	2.5
Analyst	6	5.1

Business Development	5	4.2
Consulting	2	1.7
Education	6	5.1
Engineering	14	11.9
Finance	2	1.7
General Business	1	0.8
Human Resources	1	0.8
Information Technology	21	17.8
Legal	1	0.8
Management	20	16.9
Production	1	0.8
Product Management	8	6.8
Project Management	3	2.5
Quality Assurance	1	0.8
Research	5	4.2
Sales	7	5.9
Science	1	0.8
Other (please specify)	3	2.5
Missing/No response	2	1.7
Gender		
Female	45	38.1
Male	66	55.9
Missing/No response	7	5.9
Age		
25 to 34	5	4.2
35 to 44	24	20.3
45 to 54	56	47.5
55 to 64	16	13.6
65 to 74	10	8.5
Missing/No response	7	5.9
Education		
Graduated from high school	1	0.8
1 year of college	5	4.2
2 years of college	5	4.2
3 years of college	5	4.2
Graduated from college	39	33.1
Some graduate school	10	8.5
Completed graduate school	46	39.0
Missing/No response	7	5.9
Ethnicity		

American Indian or Alaskan Native	1	0.8
Asian or Pacific Islander	6	5.1
Black or African American	34	28.8
Hispanic or Latino	4	3.4
White / Caucasian	64	54.2
Prefer not to answer	2	1.7
Other	2	1.7
Years in current position		
Less than 1 year	5	4.2
At least 1 year but less than 3 years	23	19.5
At least 3 years but less than 5 years	20	16.9
At least 5 years but less than 10 years	23	19.5
10 years or more	40	33.9
Missing/No response	7	5.9

Table 5. Descriptive Statistics for Continuous Variables

Variable	Mean	Std. Deviation
Use of communication	4.14	0.68
Mode of interaction	3.15	0.96
Shared understanding	3.50	0.84
Team performance	3.65	0.53
Familiarity with system	3.67	0.98
Training in team work	3.52	0.95
Past experience with team work	3.88	0.88
Experience with technology being used	3.60	1.00

Normality Tests

The assumptions of normality were tested for each regression. A normal distribution is assumed by many statistical procedures (Garson, 2012). According to Jarque and Bera (1987), violation of the normality assumption may lead to suboptimal estimators, invalid inferential statements, and inaccurate conclusions. Normality was tested using a quantile-by-quantile or Q-Q scatterplot. A Q-Q plot forms a 45-degree line when the observed values are in conformity with the hypothetical distribution (Garson, 2012). The solid line represents the theoretical quantiles of a normal distribution, and

normality can be assumed if the points form a relatively straight line. The residuals from each of the regression models were plotted. Normality can be visually assessed by looking at a histogram of frequencies or by looking at a normal probability plot (Garson, 2012). Visual examination of the scatterplots revealed that normality was met for each of the regressions tested (see figures 4-8). Details for each of the regressions can be found in the hypothesis/regression analysis section of this paper.

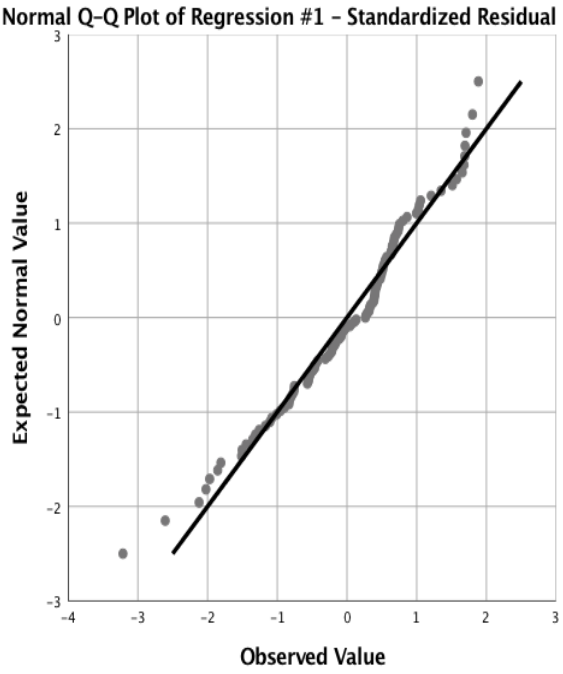

Figure 4. Q-Q scatterplot testing normality for multiple linear regression predicting shared understanding – Regression #1.

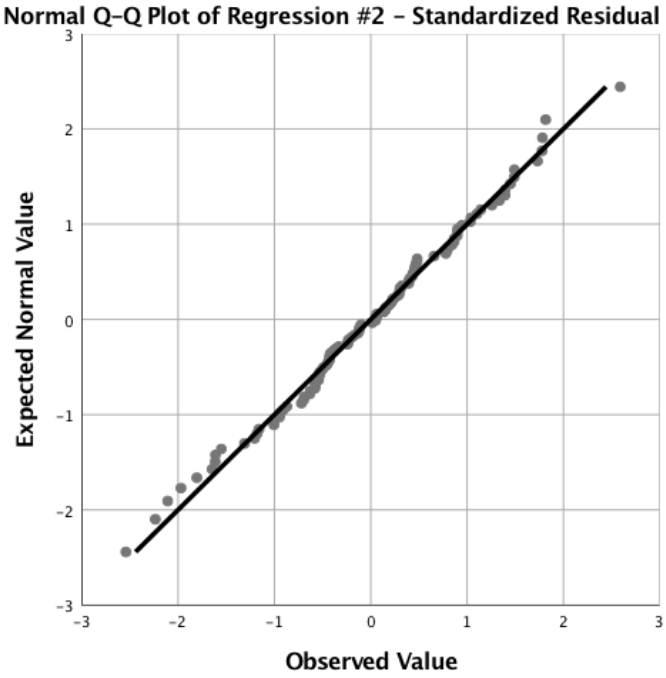

Figure 5. Q-Q scatterplot testing normality for multiple linear regression predicting shared understanding with control variables – Regression #2.

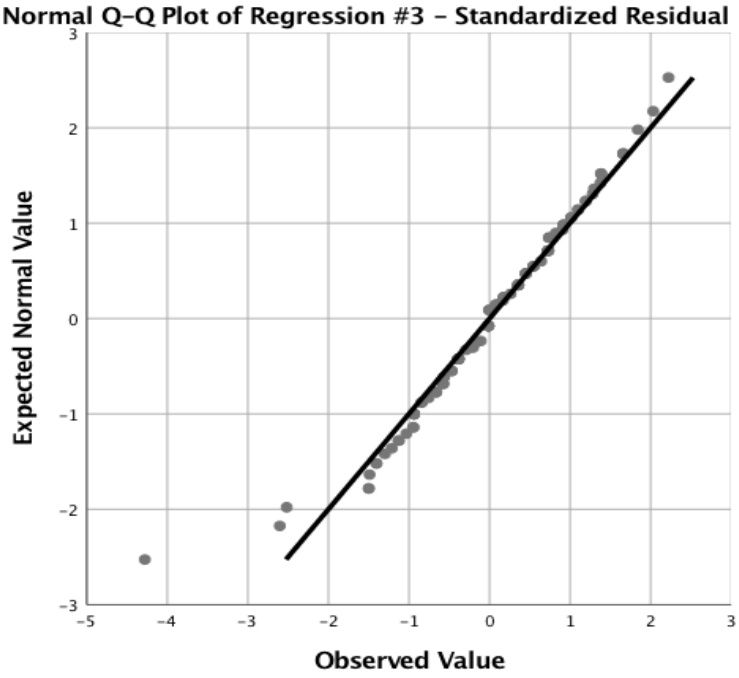

Figure 6. Q-Q scatterplot testing normality for multiple linear regression predicting team performance – Regression #3.

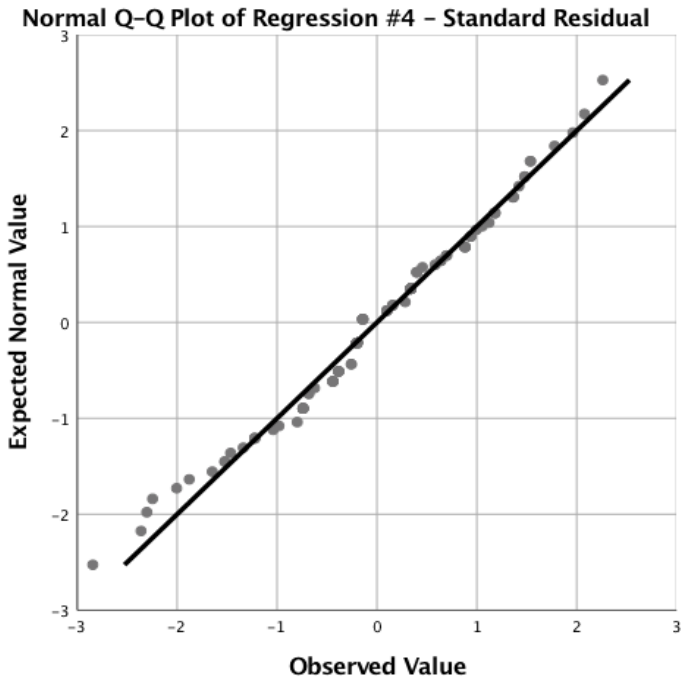

Figure 7. Q-Q scatterplot testing normality for multiple linear regression predicting team performance (modified) – Regression #4.

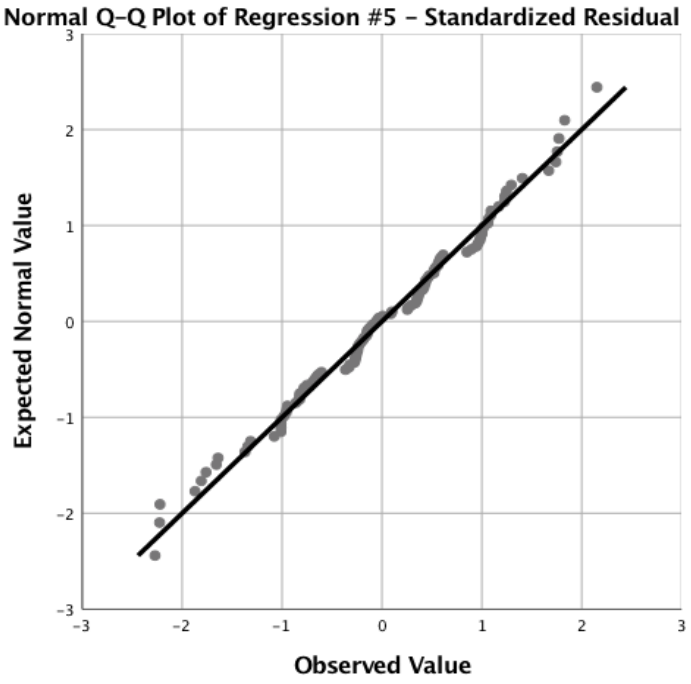

Figure 8. Q-Q scatterplot testing normality for multiple linear regression predicting shared understanding with interaction variable – Regression #5.

Test for Common Method Bias

Common method bias (CMB) occurs when there is a variance attributable to the measurement method instead of the constructs that the measures try to represent (Podsakoff et al., 2003). There are a few methods to test CMB which include the use of Harman's single-factor test, in which all items are loaded into one common factor (Podsakoff et al., 2003). If the total variance for a single factor is less than 50%, it suggests that CMB does not affect the data, hence the results. The results of the CMB test for this study resulted in a single factor of 20.9% which is less than 50% suggesting that CMB in this study does not affect the data.

Table 6. Harmon Factor Test – Common Method Bias

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.642	20.897	20.897	5.642	20.897	20.897
2	3.721	13.783	34.680			
3	1.856	6.872	41.552			
4	1.822	6.749	48.301			
5	1.579	5.850	54.151			
6	1.375	5.091	59.242			
7	1.096	4.058	63.301			
8	1.033	3.825	67.126			
9	.949	3.513	70.639			
10	.840	3.109	73.748			
11	.811	3.003	76.751			
12	.750	2.779	79.529			
13	.709	2.625	82.155			
14	.612	2.265	84.420			
15	.562	2.082	86.502			
16	.527	1.950	88.452			
17	.491	1.819	90.271			
18	.418	1.550	91.821			
19	.349	1.292	93.113			
20	.329	1.220	94.333			
21	.303	1.123	95.456			
22	.264	.979	96.435			
23	.248	.918	97.353			
24	.213	.788	98.141			
25	.192	.711	98.852			
26	.156	.578	99.430			
27	.154	.570	100.000			

Reliability and Validity Tests

Reliability

A Cronbach's alpha reliability analysis was conducted on each of the composite variables (i.e., use of communication, mode of interaction, shared understanding, and team performance). According to George and Mallery (2003), reliability coefficients of .7 or greater are acceptable. The results of the reliability analysis are displayed in Table 7. Reliability exceeded .7 for mode of interaction, shared understanding, and team performance. However, the reliability of use of communication was low (.60). Dropping three of the questions increased the reliability of the use of communication construct to .644. See Table 7.

Table 7. Reliability Coefficients for Composite Variables

Variable	Number of Items	Cronbach's Alpha
Use of communication	2	.64
Mode of interaction	10	.79
Shared understanding	2	.88
Team performance	6	.72

Validity

Convergent and discriminant validity are components of a larger scientific measurement concept known as construct validity (Straub et al., 2004). These two validation components capture some of the aspects of the goodness of fit of the measurement model, i.e., how well the measurement items relate to the constructs (Gefen & Straub, 2005). Convergent validity is shown when each measurement item correlates strongly with its assumed theoretical construct, while discriminant validity is shown when each measurement items correlates weakly with all other constructs except for the one to which it is theoretically associated (Gefen & Straub, 2005).

Convergent Analysis – Use of Communication

In Table 8, the solution could not be rotated due to only one component being extracted, however, the factor loading is shown.

Table 8. Component Matrix – Use of Communication

Component Matrix[a]	
Item	Component 1
Work with people via internet-based conferencing applications	0.861
Meet with people via video-conferencing tools	0.861

Notes. Extraction Method: Principal Component Analysis. [a] 1 component extracted.

Convergent Analysis – Mode of Interaction

In Table 9, the rotated component matrix shows that four of the variables load strongly on component 1, three variables load strongly on component 2 and another three items load on component 3.

Table 9. Rotated Component Matrix – Mode of Interaction

Rotated Component Matrix[a]			
	Component		
Item	1	2	3
Collaborate with people in different time zones	0.701	0.246	0.200
Collaborate with people you have never met face-to-face	0.738	0.272	0.084
Collaborate with people who speak different native languages and dialects from your own	0.717	0.179	-0.121
Work at home during normal business days	0.709	-0.144	0.235
Work at different sites	0.234	-0.076	0.755
Have professional interactions with people outside the organization	0.022	0.289	0.709
Work while traveling (e.g. at airports or hotels)	0.017	0.457	0.639
Work on projects that have changing team members	0.433	0.601	0.142
Work with teams that have different ways to track their work	0.142	0.826	0.247
Work with people that use different collaboration technologies	0.119	0.845	0.066

Notes. Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. [a] Rotation converged in 5 iterations.

Convergent Analysis – Shared Understanding

In Table 10, the solution could not be rotated due to only one component being extracted, however, the factor loading is shown.

Table 10. Rotated Component Matrix

Component Matrix[a]	
Item	Component 1
At this moment, this team has a common understanding of the task we have to handle.	0.946
At this moment, this team has a common understanding of how to deal with the task.	0.946

Notes. Extraction Method: Principal Component Analysis. [a] 1 component extracted.

Convergent Analysis – Team Performance

In Table 11, the rotated component matrix shows that three of the six variables have strong correlations and load on component 1. The remaining three variables load on component two.

Table 11. Team Performance - Rotated Component Matrix

Rotated Component Matrix[a]		
	Component	
Item	1	2
To what extent are you personally committed to the solution proposed by the team?	.777	.153
To what extent do you think the solution generated by the team was better than the one you developed?	.828	-.071
To what extent do you feel that the solution had been reached on a consensus basis?	.633	.322
To what extent did the members of the group work together effectively?	.313	.793
To what extent did the group come up with the best possible solution, given time and geography constraints?	.401	.713
To what extend did the group seem to waste time and energy?	-.196	.796

Notes. Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. [a] Rotation converged in 3 iterations.

Discriminant Validity

The Principal Component Analysis (PCA) method with varimax rotation (Straub et al., 2004) was used to assess convergent and discriminant validity across all constructs.

The correlation matrix produced by PCA shows that items for each construct are a mixed bag of moderately and highly correlated elements, supporting convergent validity. In addition, the correlation matrix shows that items for each construct are not highly correlated with items from other constructs, with the exception of three questions from team performance. The questions from shared understanding and three of the six questions from team performance load highly on component 1. A separate regression was executed that omitted the overlapping items from team performance. The factor loadings for discriminant validity are shown in Table 12.

Table 12. Discriminant Validity - Rotated Component Matrix[a]

Rotated Component Matrix[a]						
	Component					
Item	1	2	3	4	5	6
Work with people via internet-based conferencing applications	0.238	0.205	-0.101	0.041	0.232	0.763
Meet with people via video-conferencing tools	0.034	0.091	0.121	0.123	-0.027	0.857
Collaborate with people in different time zones	0.081	0.694	0.262	-0.023	0.144	0.172
Collaborate with people you have never met face-to-face	-0.021	0.674	0.345	-0.034	-0.001	0.227
Collaborate with people who speak different native languages and dialects from your own	0.007	0.715	0.184	0.053	-0.105	-0.023
Work at home during normal business days	-0.003	0.713	-0.137	0.010	0.271	0.026
Work at different sites	-0.031	0.297	-0.026	0.171	0.697	-0.005
Have professional interactions with people outside the organization	0.026	-0.038	0.380	-0.048	0.652	0.153
Work while traveling (e.g. at airports or hotels)	-0.068	0.012	0.406	0.003	0.692	0.055
Work on projects that have changing team members	-0.100	0.407	0.585	-0.099	0.195	0.051

Work with teams that have different ways to track their work	0.063	0.179	0.813	-0.020	0.253	-0.029
Work with people that use different collaboration technologies	0.002	0.143	0.795	0.116	0.096	0.030
To what extent are you personally committed to the solution proposed by the team?	0.364	0.000	0.139	0.657	-0.002	0.180
To what extent do you think the solution generated by the team was better than the one you developed?	0.093	0.067	-0.037	0.861	0.079	0.006
To what extent do you feel that the solution had been reached on a consensus basis?	0.447	-0.080	-0.080	0.513	0.075	0.046
To what extent did the members of the group work together effectively?	0.783	0.142	-0.071	0.116	0.042	0.071
To what extent did the group come up with the best possible solution, given time and geography constraints?	0.765	0.129	-0.057	0.211	-0.148	0.084
To what extend did the group seem to waste time and energy?	0.606	0.128	-0.234	-0.345	0.109	-0.199

At this moment, this team has a common understanding of the task we have to handle.	0.766	-0.141	0.158	0.245	-0.046	0.144
At this moment, this team has a common understanding of how to deal with the task.	0.826	-0.163	0.127	0.143	-0.022	0.095

Notes. Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. [a] Rotation converged in 8 iterations.

Hypotheses Test Results

Overview

Prior to analysis, the data were checked for accuracy, missing responses, and outliers. Accuracy was checked by ensuring that all responses fell within the possible range of values for each survey question. Outliers were examined by computing standardized scores for each composite variable (i.e. use of communication, mode of interaction, shared understanding, and team performance). Tabachnick and Fidell (2013) suggested that scores with standardized values with a magnitude greater than 3.29 should be considered outliers. One extreme low outlier was identified for team performance; this value was removed prior to analysis.

This research used multiple regression analysis which is used when the desire is to predict the value of a variable based on the value of two or more other variables. To determine the overall fit of the research model, five regression runs were executed. Each regression run consisted of one dependent variable and one or more independent variables.

Hypothesis/Regression Analysis

This study used 0.05 as the level of significance for testing hypotheses. The model summaries and coefficients for each regression run are presented. The first regression run contains independent variables use of communication, mode of interaction, and cultural mosaic. The dependent variable is shared understanding. The results of the regression are shown in Table 13 and Table 14.

Table 13. Regression #1 – Model Summary

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.219[a]	0.048	0.021	0.83295

Notes. [a] Predictors: (Constant), Cultural Mosaic, Use of Communication, Mode of Interaction. [b] Dependent Variable: Shared Understanding.

Table 14. Regression #1 – Coefficients

Coefficients[a]					
	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
1 (Constant)	2.937	0.404		7.278	<.001
Use of Communication	0.198	0.091	0.215	2.178	.032
Mode of Interaction	-0.069	0.086	-0.080	-0.806	.422
Cultural Mosaic	-0.007	0.006	-0.105	-1.093	.277
a. Dependent Variable: Shared Understanding					

Note. [a] Dependent Variable: Shared Understanding.

The second regression contains independent variables use of communication, mode of interaction, cultural mosaic, and appropriation factors. The dependent variable is shared understanding. The results are shown in Table 15 and Table 16.

Table 15. Regression #2 – Model Summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.576[a]	0.332	0.285	0.71942

Note. [a] Predictors: (Constant), Experience with technology being used, Cultural Mosaic, Mode of Interaction, Use of Communication, Training in team work, Familiarity with system, Past experience with team work.

Table 16. Regression #2 – Coefficients

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.463	0.464		3.153	.002
	Use of Communication	0.010	0.096	0.010	0.108	.914
	Mode of Interaction	-0.048	0.077	-0.054	-0.623	.534
	Cultural Mosaic	-0.006	0.005	-0.087	-1.032	.304
	Familiarity with system	0.344	0.101	0.394	3.412	.001
	Training in team work	0.177	0.113	0.198	1.565	.121
	Past experience with team work	0.115	0.125	0.119	0.916	.362
	Experience with technology being used	-0.042	0.108	-0.049	-0.388	.698

Note. [a] Dependent Variable: Shared Understanding.

The third regression run contains independent variable shared understanding and dependent variable team performance. The results of the regression are shown in Table 17 and Table 18.

Table 17. Regression #3 – Model Summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.618[a]	0.382	0.377	0.44899

Note. [a] Predictors: (Constant), Shared Understanding.

Table 18. Regression #3 – Coefficients

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.165	0.183		11.839	<.001
	Shared Understanding	0.419	0.051	0.618	8.250	<.001

Note. [a] Dependent Variable: Team Performance.

The fourth regression run contains independent variable shared understanding and dependent variable team performance modified. The discriminant validity test results showed items from the team performance construct overlapped with items from the shared understanding construct. The offending items from the team performance construct were omitted from this regression run. The results of the regression are shown in Table 19 and Table 20.

Table 19. Regression #4 – Model Summary

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.450[a]	0.203	0.196	0.61678

Notes. [a] Predictors: (Constant), Shared Understanding. [b] Dependent Variable: Team Performance (Modified).

Table 20. Regression #4 – Coefficients

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.314	0.251		9.213	<.001
	Shared Understanding	0.369	0.070	0.450	5.290	<.001
a. Dependent Variable: Team Performance						

Notes. [a] Dependent Variable: Team Performance (Modified).

Two separate models were developed to complete the fifth regression run. For this run, responses for the independent variables were grand-mean-centered prior to forming the multiplicative interaction terms (Jaccard et al. 1990). In the first model of the analysis, the independent variables use of communication, mode of interaction, cultural mosaic and appropriation factor familiarity with system were added. The familiarity with system appropriation factor was selected because it was shown in regression run #2 to be significant, while all other appropriation factors were not significant. In the second model, the interaction terms were entered. The results of the regression are shown in Table 21 and Table 22.

Table 21. Regression #5 – Summary

Model Summary[c]									
				Std. Error of the	R Square	Change Statistics			
Model	R	R Square	Adjusted R Square	Estimate	Change	F Change	df1	df2	Sig. F Change
1	.528[a]	0.279	0.251	0.73642	0.279	9.972	4	103	<.001
2	.540[b]	0.292	0.242	0.74088	0.012	0.588	3	100	.624

Notes. [a] Predictors: (Constant), Familiarity with system, Cultural Mosaic, Mode of Interaction, Use of Communication. [b] Predictors: (Constant), Familiarity with system, Cultural Mosaic, Mode of Interaction, Use of Communication, Mode of Interaction x Familiarity, Use of Communication x Familiarity, Cultural Mosaic x Familiarity. [c] Dependent Variable: Shared Understanding.

Table 22. Regression #5 – Coefficients

Coefficients[a]					
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.813	0.434		4.181	<.001
	Use of Communication	0.088	0.093	0.086	0.947	.346
	Mode of Interaction	-0.068	0.077	-0.076	-0.876	.383
	Cultural Mosaic	-0.007	0.006	-0.115	-1.347	.181

	Familiarity with system	0.429	0.077	0.493	5.545	<.001
2	(Constant)	2.771	1.107		2.504	.014
	Use of Communication	0.109	0.103	0.106	1.065	.289
	Mode of Interaction	-0.048	0.080	-0.054	-0.598	.551
	Cultural Mosaic	0.018	0.023	0.277	0.766	.446
	Familiarity with system	0.110	0.296	0.126	0.372	.710
	Use of Communication x Familiarity	0.002	0.092	0.002	0.020	.984
	Mode of Interaction x Familiarity	0.011	0.067	0.015	0.163	.871
	Cultural Mosaic x Familiarity	-0.076	0.068	-0.530	-1.113	.269

a. Dependent Variable: Shared Understanding

Notes. [a] Dependent Variable: Shared Understanding.

Use of Communication influences shared understanding (β = 0.215, *p* = .032), supporting Hypothesis 1 (Tables 13 and 14). Mode of interaction does not significantly influence shared understanding (β = -0.080, *p* = .422). Therefore, the results do not support Hypothesis 2, see Tables 13 and 14. Cultural mosaic does not significantly influence shared understanding (β = -0.105, *p* = .277), therefore, Hypothesis 3 is not supported (Tables 13 and 14). Shared understanding significantly influences team performance (β = .618, *p* <.001), supporting Hypothesis 4 (Tables 19 and 20). Shared Understanding's effect on team performance explained 38% of the variance (Adj. R^2 = .377).

In regression three, the regression analysis included constructs use of communication, mode of interaction, cultural mosaic and appropriation factors familiarity with system, training in teamwork, past experience with teamwork and experience with technology being used. In this run, the regression coefficient for familiarity with system was significant (β = 0.344, p < .001), indicating that participants with higher familiarity

with system tended to have higher shared understanding. In this run, no other coefficients were significant (Table 16).

Finally, in the fifth regression, the interaction terms use of communication and familiarity, mode of interaction and familiarity, and cultural mosaic and familiarity were not significant. Therefore, the appropriation factor familiarity with systems, had no impact.

Summary

Five multiple regression tests were conducted to address the study hypotheses. The results of the multiple linear regression showed that use of communication was positively related to shared understanding, supporting Hypothesis 1. Mode of Interaction was not positively related to shared understanding; therefore, Hypothesis 2 was not supported. Cultural mosaic was not positively related to shared understanding; therefore, Hypothesis 3 was not supported. The results of the regression showed that shared understanding was positively related to team performance, supporting Hypothesis 4. The next chapter will contain a discussion of these findings in relation to previous literature and directions for future research.

Chapter 5

Discussion, Implications, Future Direction, Conclusion

Introduction

In this chapter, conclusions are drawn and discussed based upon the analysis performed during the investigation of this study. Each of the research questions is discussed in the context of the results achieved along with any limitations of the study. The theoretical and practical implications for this study and their contribution to the body of knowledge within the study of Information Systems, Knowledge Management and virtual teams are discussed. Finally, the chapter concludes with recommendations on future direction and a final conclusion.

Discussion

In this research we investigated the constructs influencing shared understanding using a theoretical model based on MST. Through each of the research questions, we examine the effect of each construct on shared understanding and subsequently team performance.

The first research question asked how team diversity affects the development of shared understanding. Country of citizenship and job function were codified into a cultural mosaic variable to evaluate patterns of diversity. In regression run #1 (Table 14), cultural mosaic did not influence the development of shared understanding. The finding that cultural diversity did not influence shared understanding is a surprise in the findings as prior research suggests that it is difficult for culturally diverse teams to communicate, coordinate their work, and perform; and the lack of shared mental models along

culturally diverse groups inhibits understanding among team members (Darlin, Weingart & Hinds, 2005; Shachaf, 2008).

The second research question asked about the effect of mode of interaction on the development of shared understanding. Mode of interaction did not positively influence shared understanding. Prior research states that in both face-to-face and technology-mediated situations, it is difficult for team members to understand each other, and that understanding is more difficult if group members are distributed and their interactions completely mediated by technology (Mulder, Swaak, & Kessels, 2002). Further when virtual teams first arose, Kurtzberg (2014) found that when virtual teams first arose, that it would be nearly impossible to develop shared meaning and trust team members without face-to-face interaction. However, in studies by Van der Kleij, Paashuis, and Schraagen's (2005) and Alge et al. (2003) comparing face-to-face teams to videoconferencing teams, the results suggest that after convergence (activity to build a shared mental model), significant differences on task performance between face-to-face and virtual teams had disappeared as virtual communication interaction approaches the levels of effectiveness found in face-to-face teams. Today, synchronous video-conferencing systems allow team members separated by geographical distances to interact in an approximation of face-to-face interaction through audio and video communication capabilities, thus, changing the way people interact and conduct business (Guo et al., 2009). Researchers have suggested as shared team mental models are built to engender shared understanding, the differences between mode of interaction becomes secondary and less of an influencer to shared understanding (Guo et al., 2009).

The third research question asked about the effect of the use of communication on the development of shared understanding. Adding use of communication to the regression analysis run #1 showed that there was a positive influence of use of communication on shared understanding (Table 14). This outcome was expected as prior research shows that use of communication technologies mitigates barriers to communication and enables virtuality and shared understanding (Chudoba, 2005; Hinds & Weisband, 2003; Shachaf, 2008). Guo et al. (2009) state that communication technologies have the ability to overcome constraints of time and place and enhance virtual team interaction effectiveness.

The fourth question asked how does the development of shared understanding influence team performance. As shown in Table 20, shared understanding significantly influenced team performance. This outcome was expected as prior research from McComb et al. (1999), Smircich (1983), and Weick (1993) argue that teams that acquire shared mental models and have higher level of shared meanings held by the team members have been found to achieve higher performance. Mathieu et al. (2000) state that shared mental models correlate positively to team process and team performance.

Theoretical Implications of Findings

The research model for this study was adapted from the MST model. The constructs of the model included use of communication, mode of interaction, team diversity, shared understanding, team performance and appropriation factors familiarity with system, training in team work, past experience with team work and experience with technology being used.

The investigation confirms that use of communication was significant and positively influences shared understanding, mode of interaction did not have an effect on shared understanding, and that shared understanding had a significant and positive effect on team performance.

The mode of interaction construct did not influence shared understanding directly or when moderated, however, this can be contributed to the differences between face-to-face and virtual team interaction being mitigated due to computer-mediated technologies attenuating to at least some degree the social context cues available in face-to-face interaction (Guo et al., 2009). Additionally, the appropriation factor familiarity with system was the only factor that proved to be significant and positively impact shared understanding. All other appropriation factors training in team work, past experience with team work, and experience with technology being used did not have a significant influence on shared understanding.

Practical Implications

This study contributes to the body of knowledge in the identification of the determinants of shared understanding and how these determinants influence team performance. It demonstrates that use of communication, familiarity with systems does influence the development of shared understanding, and that shared understanding positively influences team performance. There have been several studies on the development of shared understanding (Chudoba, 2005; Hinds & Weisband, 2003; Shachaf, 2008), however, this study extends these studies by examining all of these constructs in a single study.

Managers who are involved with virtual teams today need to consider these variables, use of communication and familiarity with systems in team composition and facilitation. Effectiveness of computer-mediated virtual teams can be enhanced upon formation where the team members had a shared history and the team has a shared understanding of effective communication among other traits (Guo et al., 2009). The findings show that these constructs matter directly or as a moderator for the development of shared understanding. Further, the findings show that shared understanding has a significant influence on team performance. As virtual teams continue to proliferate, executive leaders and managers must ensure that teams and environments are designed for collaboration through use of communication technologies that promote synchronicity, and that its members are familiar with systems which subsequently promotes shared understanding.

While the research highlights positive influences of shared understanding, managers could face other challenges as well. A team member's mode of interaction with others could impact the degree of shared understanding reached by the team without the establishment of shared mental models (Guo et al., 2009). Managers will need to explore ways to introduce facilitation techniques that address the deficiencies in collaboration and mode of interaction among virtual teams.

Limitations of Research

The pool of participants for this study were from researchers place of employment limiting the sample size of the study to just under 120 participants. Additionally, although the firm has offices in foreign countries, there were limitations in gathering participants from these offices. The average time spent on the survey was approximately five minutes as the survey did not require participants to answer all of the questions. The survey was also subject to self-reporting bias.

Future studies should attempt to survey a wider sample of firms and control for other potential problems. There were advantages to using SurveyMonkey as it provided the survey results in a format that allowed direct transfer of the results into SPSS, eliminating any possibility of transcription errors. The survey design also did not cover a critical question that would have helped in understanding a team project.

Future Directions

The study provided valuable information regarding key determinants of shared understanding among virtual team members and team performance. This study encourages researchers to consider investigation of additional antecedents for the development of shared understanding. Future research may collect primary data from a broader sample of companies and additional regions.

In future studies, researchers could operationalize the cultural mosaic construct to see if it could strengthen the cultural diversity representation in the study. Additionally, the results of mode of interaction on shared understanding indicates that this factor had a diminishing influence on shared understanding, and instead the development of shared

mental models prior to the commencement of interaction technology is trending in research today.

Finally, since global organizations continue to struggle with the right balance of virtual team composition and coordination to execute virtual team projects effectively, it is recommended that this study be expanded to evaluate other dimensions that would increase the explanatory strength of the model. In-depth research is necessary to further develop the body of knowledge and provide practical experiences on shared understanding in virtual teams. Information obtained in this manner can subsequently be used to develop a more comprehensive instrument to measure key determinants of shared understanding.

Conclusions

In summary, several aspects of the theoretical model were validated with opportunities for refinement. Using the theoretical model, it was shown that use of communication and familiarity with system positively influenced shared understanding. This highlights the importance of team members having experience and training, and organizations having strong communication technologies to support the complexities and diversity of its workforce that today, is not wholly present in a single location. It was also validated and concluded that mode of interaction remains a challenge to mitigate barriers to shared understanding. There are further research opportunities to refine the determinants of a mode of interaction construct that can be examined for its influence on shared understanding. This research also demonstrated the strong association and influence of shared understanding on team performance. While this strong association

exists, there still remains an opportunity to construct questions that lead to an in-depth examination of team centered projects and team performance.

While no strong generalizations can be made, it is clear that managers of virtual teams will continue to look for ways to build effective teams that collaborate and perform well together. This research provides guidance, and with its limitations, and motivation to pursue in-depth research with an enhanced theoretical model on global virtual teams and the development of shared understanding. Expanded sample size, refined constructs, increased diversity are just a few areas that can be explored in future research.

Appendix A – Survey Instrument

Virtual Teams and Team Performance

Introduction

Nova Southeastern University Consent to be in a Research Study Entitled
Examining shared understanding and team performance of virtual teams

Who is doing this research study?
The person doing this study is Alva Bullard with College of Engineering and Computing. They will be helped by Dr. Souren Paul.

Why are you asking me to be in this research study?
You are being asked to take part in this research study because you are working for a firm where all workers are not located in a single location.

Why is this research being done?
The purpose of this study is to expand the knowledge of researchers and business practitioners on behaviors and practices that influence shared understanding in virtual teams.

What will I be doing if I agree to be in this research study?
You will be taking a one-time, anonymous survey. The survey will take approximately 7-10 minutes to complete.

Are there possible risks and discomforts to me?
This research study involves minimal risk to you. To the best of our knowledge, the things you will be doing have no more risk of harm than you would have in everyday life.

What happens if I do not want to be in this research study?
You can decide not to participate in this research and it will not be held against you. You can exit the survey at any time.

Will it cost me anything? Will I get paid for being in the study?
There is no cost for participation in this study. Participation is voluntary and no payment will be provided.

How will you keep my information private?
Your responses are anonymous. Information we learn in this research study will be handled in a confidential manner, within the limits of the law. This data will be available to the researcher, the Institutional Review Board and other representatives of this institution, and any granting agencies (if applicable). All confidential data will be kept securely on SurveyMonkey encrypted servers and the researchers local computing devices. All data will be kept for 36 months and destroyed after that time by deleting from servers and related storage mechanisms.

Who can I talk to about the study?
If you have questions, you can contact Alva Bullard at 954-646-8208, that will be readily available

during and after normal work hours. Dr. Soren Paul may be reached at 954-262-2047 during normal business hours.

If you have questions about the study but want to talk to someone else who is not a part of the study, you can call the Nova Southeastern University Institutional Review Board (IRB) at (954) 262-5369 or toll free at 1-866-499-0790 or email at IRB@nova.edu.

Do you understand and do you want to be in the study?
If you have read the above information and voluntarily wish to participate in this research study, please provide your consent below.

1. Please indicate your consent to take the survey:

- ◯ Yes
- ◯ No

Virtual Teams and Team Performance

2. Please indicate the impact of the following technologies in terms of usefulness in communication:

	Not at all useful	Somewhat useful	Neutral	Very useful	Extremely useful	N/A
Work with people via internet-based conferencing applications	◯	◯	◯	◯	◯	◯
Participate in real-time online discussions, such as chat or instant messaging	◯	◯	◯	◯	◯	◯
Meet with people via video-conferencing tools	◯	◯	◯	◯	◯	◯
Work with mobile devices	◯	◯	◯	◯	◯	◯
Work with people via email	◯	◯	◯	◯	◯	◯

Virtual Teams and Team Performance

3. Indicate frequency for the following activity:

	yearly	quarterly	monthly	weekly	daily	N/A
Collaborate with people in different time zones	○	○	○	○	○	○
Collaborate with people you have never met face-to-face	○	○	○	○	○	○
Collaborate with people who speak different native languages and dialects from your own	○	○	○	○	○	○
Work at different sites	○	○	○	○	○	○
Have professional interactions with people outside the organization	○	○	○	○	○	○
Work at home during normal business days	○	○	○	○	○	○
Work while traveling (e.g. at airports or hotels)	○	○	○	○	○	○
Work on projects that have changing team members	○	○	○	○	○	○
Work with teams that have different ways to track their work	○	○	○	○	○	○
Work with people that use different collaboration technologies	○	○	○	○	○	○

Virtual Teams and Team Performance

4. Nation of Birth

5. Country of Citizenship

6. Which of the following best describe your job function?

- Accounting
- Administrative
- Advertising / Marketing
- Analyst
- Art/Creative/Design
- Business Development
- Consulting
- Customer Service
- Distribution
- Education
- Engineering
- Finance
- General Business
- Human Resources
- Information Technology
- Legal
- Management
- Manufacturing
- Production
- Product Management
- Project Management
- Public Relations
- Purchasing
- Quality Assurance
- Research
- Sales
- Science
- Strategy/Planning
- Supply Chain
- Training
- Other (please specify)

Virtual Teams and Team Performance

7. Please indicate the level of understanding among the team:

	Not at All	To some extent	Understand	Great extent	Very great extent
At this moment, this team has a common understanding of the task we have to handle.	◯	◯	◯	◯	◯
At this moment, this team has a common understanding of how to deal with the task.	◯	◯	◯	◯	◯

Virtual Teams and Team Performance

8. Please answer the following questions on team activity:

	Not at all	To some extent	Neutral	Great extent	Very great extent
To what extent are you personally committed to the solution proposed by the team?	○	○	○	○	○
To what extent do you think the solution generated by the team was better than the one you developed?	○	○	○	○	○
To what extent do you feel that the solution had been reached on a consensus basis?	○	○	○	○	○
To what extent did the members of the group work together effectively?	○	○	○	○	○
To what extent did the group come up with the best possible solution, given time and geography constraints?	○	○	○	○	○
To what extend did the group seem to waste time and energy?	○	○	○	○	○

Virtual Teams and Team Performance

9. Experience and comfort

	Not at all familiar	Somewhat familiar	Familiar	Very familiar	Extremely familiar
Familiarity with system	◯	◯	◯	◯	◯
Training in team work	◯	◯	◯	◯	◯
Past experience with team work	◯	◯	◯	◯	◯
Experience with technology being used	◯	◯	◯	◯	◯

Virtual Teams and Team Performance

Demographics

10. What is your gender?

- ◯ Female
- ◯ Male
- ◯ Other (specify)

11. What is your age?

- ◯ 18 to 24
- ◯ 25 to 34
- ◯ 35 to 44
- ◯ 45 to 54
- ◯ 55 to 64
- ◯ 65 to 74
- ◯ 75 or older

12. What is the highest level of education you have completed?

13. What is your ethnicity? (Please select all that apply.)

- ☐ American Indian or Alaskan Native
- ☐ Asian or Pacific Islander
- ☐ Black or African American
- ☐ Other (please specify)
- ☐ Hispanic or Latino
- ☐ White / Caucasian
- ☐ Prefer not to answer

14. About how many years have you been in your current position?

- ◯ Less than 1 year
- ◯ At least 1 year but less than 3 years
- ◯ At least 3 years but less than 5 years
- ◯ At least 5 years but less than 10 years
- ◯ 10 years or more

Appendix B – IRB Approval Letter

NOVA SOUTHEASTERN UNIVERSITY
Institutional Review Board

MEMORANDUM

To: **Alva Bullard**

From: **Ling Wang, Ph.D.,**
Center Representative, Institutional Review Board

Date: **May 2, 2018**

Re: **IRB #: 2018-229; Title, "Examining shared understanding and team performance of virtual teams"**

I have reviewed the above-referenced research protocol at the center level. Based on the information provided, I have determined that this study is exempt from further IRB review under **45 CFR 46.101(b) (Exempt Category 2)**. You may proceed with your study as described to the IRB. As principal investigator, you must adhere to the following requirements:

1) CONSENT: If recruitment procedures include consent forms, they must be obtained in such a manner that they are clearly understood by the subjects and the process affords subjects the opportunity to ask questions, obtain detailed answers from those directly involved in the research, and have sufficient time to consider their participation after they have been provided this information. The subjects must be given a copy of the signed consent document, and a copy must be placed in a secure file separate from de-identified participant information. Record of informed consent must be retained for a minimum of three years from the conclusion of the study.

2) ADVERSE EVENTS/UNANTICIPATED PROBLEMS: The principal investigator is required to notify the IRB chair and me (954-262-5369 and Ling Wang, Ph.D., respectively) of any adverse reactions or unanticipated events that may develop as a result of this study. Reactions or events may include, but are not limited to, injury, depression as a result of participation in the study, life-threatening situation, death, or loss of confidentiality/anonymity of subject. Approval may be withdrawn if the problem is serious.

3) AMENDMENTS: Any changes in the study (e.g., procedures, number or types of subjects, consent forms, investigators, etc.) must be approved by the IRB prior to implementation. Please be advised that changes in a study may require further review depending on the nature of the change. Please contact me with any questions regarding amendments or changes to your study.

The NSU IRB is in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations (45 CFR 46) revised June 18, 1991.

Cc: Souren Paul
Ling Wang, Ph.D.

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