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UNDERSTANDING THE ADAPTIVE USE OF IT CAPABILITIES AND DEVELOPMENT OF SHARED MENTAL MODELS IN VIRTUAL TEAMS

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ABSTRACT

Virtual teams (VT) consist of people who rely on information technology (IT) capabilities to interact and work from different geographic locations to accomplish explicit team goals. The virtual team has become an important building block in organizations to fulfill such purposes as generating new knowledge, managing a project, and delivering customer services. However, virtual teams continue to present many challenges to organizations. Developing shared mental models (SMM), which are team members' shared understanding about key elements of the team's environment, is one of the most significant challenges facing virtual teams. Despite the critical importance of IT in virtual teams, no study has empirically examined how virtual teams' adaptive use of IT capabilities will influence the development of SMM in virtual teams. Drawing on theories from shared mental models and technology use research, this dissertation examines the interplay between the adaptive use of IT capabilities (AUITC) and the development of shared mental models in virtual teams. Using multiple longitudinal case studies within an educational setting, this dissertation examines this interplay relationship in detail through within-case analysis and cross-case analysis. Overall, study results showed that the degree to which virtual teams' shared mental models converge is affected by the three dimensions of IT capabilities adaptive use: inclusiveness, usage experience, and fit. The findings suggest that managers of virtual teams should 1) encourage teams' inclusive use of IT capabilities, 2) build an open and innovative culture, 3) choose knowledgeable, proactive, and responsible team leaders, 4) introduce

technologies to support VTs that are compatible across heterogeneous platforms, and 5) set up clear team expectations about IT capabilities. Based on the results of this study, further research is provided.

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CHAPTER 1: INTRODUCTION

"Far-flung teams can be remarkably productive, even outperforming groups whose members work side by side. But to make these teams succeed, you have to follow new rules about how to manage them."----Majchrzak, Malhotra, Stamps, & Lipnack (2004, p.131).

1.1. Research Question

For many organizations, global competition has transformed the nature of work, expanded the scope of the firms, and increased the diversity within a firm. The changes pose unprecedented challenges for firms in management. Increasingly, firms in business find interaction is an important type of value-adding activity. Collaboration and teamwork are, therefore, critical to attaining a firm's competitive advantages.

Advances in technology have made virtual teams now commonplace in organizations for nearly two decades. As a distinct type of organization, a virtual team consists of team members who work from different geographic locations toward an explicit goal. Team members in virtual teams rely on information technology[1] (IT) to communicate and share information. Virtual teams can benefit organizations in several ways, such as bringing together people with diverse skills and knowledge, reducing the payroll costs, and working around-the-clock (Nemiro, Bradley, Beyerlein,

[1]The phrase information technology (IT) in this dissertation encompasses all technologies that are used for collaboration between individuals and teams, including a variety of electronic tools, such as email, project management applications, web-based conferencing tools, wikis, blogs, and asynchronous shared spaces.

& Beyerlein, 2008; Powell, Piccoli, & Ives, 2004). The virtual team has become an important building block in organizations to fulfill such purposes as generating new knowledge, managing a project, and delivering customer services (Powell et al., 2004). However, virtual teams continue to present many challenges to organizations. Developing shared mental models[2], which should facilitate the shared understanding or build the shared language among team members, is one of the most significant challenges facing virtual teams (Nemiro et al., 2008; Powell et al., 2004).

Shared mental models (SMM) are "team members' shared, organized understanding and mental representation of knowledge about key elements of the team's relevant environment" (Mohammed, Ferzandi, & Hamilton, 2010, p.4). Team members develop their shared mental models through interactions during teamwork. Developing shared mental models is particularly important to virtual teams because possessing a shared mental model can help in resolving conflicts and building trust between team members and, thus, increase the virtual teams' overall effectiveness (Wakefield, Leidner, & Garrison, 2008). However, time pressure, work stress, team complexity and communication breakdown are among the most important factors hindering the development of SMM in virtual teams (Mohammed et al., 2010; Rooji, Verburg, Andriesen, & Hartog, 2007; Waller, Gupta, & Giambatista, 2004).

Many managerial practices, such as team training and team interventions, have been developed to foster the development of shared mental models in teams

[2]Shared mental models are synonymous with team mental models and shared understanding. Studies on examining shared mental models in teamwork proposed two types of mental models, namely taskwork mental models and teamwork mental models. The two mental models are compared in Table 1.

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(Marks, Zaccaro, & Mathieu, 2000; Volpe, Cannon-Bowers, Salas, & Spector, 1996). In spite of recognizing the importance of IT, few empirical studies have specifically examined IT's impact on the development of SMM in virtual teams. Two exceptional studies (McComb, Kennedy, Perryman, Warner & Letsky, 2010; Warner, Letsky, & Cowen, 2005) examined how the use of a single IT tool affected SMM development in lab settings. These two studies found that distributed teams[3] followed a more linear style and took a significantly longer time to develop SMM compared to the face-to-face teams. However, no study has examined how virtual teams' adaptive use of IT capabilities[4], which may be provided by one or more IT tools, influences the virtual teams' SMM development.

Advancements in IT have made possible various capabilities, such as communication, team process, and interaction[5]. As suggested by prior literature (Majchrzak, Rice, Malhotra, & King, 2000; Sun, 2012; Thomas & Bostrom, 2010; Burton-Jones & Straub, 2006), the virtual team will adaptively use those capabilities and ideally such adaptive use of IT capabilities can help organizations reach the full potential of IT. Virtual teams' adaptive use of those capabilities may constrain or foster the development of SMM in virtual teams by changing the degree to which the

[3]Since the studies were conducted in a lab setting, subjects assigned in the distributed team's condition were co-located and only interacted through an online collaboration space..

[4]The term adaptive use of IT capabilities fits into the post-adoptive IT use research stream. Adaptive Structuration Theory (AST) posits that users develop their own ways of using technology capabilities in interactions to resolve the inadequacies of formed structures, such as the team norms, the management style, and likely failures associated with IT (DeSanctis & Poole, 1994). IT capabilities provide potential features, both current and yet to be discovered, that can be developed for specific functionality (Davis et al., 2009). The term adaptive use of IT capabilities fits into the post-adoptive IT use research stream.

[5]A detailed discussion of IT capabilities is provided in Chapter 3.

teams communicate and interact effectively. Conversely, in developing the shared mental models, the teams establish clearer and shared understandings about the task needs, the team members' preferences and skills, the team's communication styles, and the technology capabilities and limitations. This shared understanding will then guide virtual teams to revise their way of using IT capabilities or stop a virtual team from further technology adaptation. This dissertation is focused on the interplay between IT use and development of SMM in virtual teams by studying how the adaptive use of IT capabilities interact with SMM development in virtual teams.

Thus, the overall objective of this dissertation is to gain a better understanding of the interaction between IT capabilities adaptation and the shared mental models development in virtual teams. In particular, this dissertation aims to a) investigate if, when, and how virtual team IT capabilities adaptation can influence the shared mental model development and b) examine if, when, and how the established shared mental models affect the virtual team technology adaptation.

The general research question of this dissertation is:

What is the interplay between the adaptive use of IT capabilities and development of shared mental models in virtual teams?

Prior literature of shared mental models proposed two interrelated types of mental models: a) taskwork mental models that embrace teams' shared knowledge and beliefs about the task and the equipment and b) teamwork mental models that refer to mental models about the team interaction and the nature of the team. Thus, the specific research questions of the dissertation are:

What is the interplay between the adaptive use of IT capabilities and development of taskwork mental models in virtual teams?

What is the interplay between the adaptive use of IT capabilities and development of teamwork mental models in virtual teams?

1.2. Importance of Research

The topic of this dissertation is important for three reasons. First, the virtual team has become a critical component in organizations. As competition from globalization becomes more intense and technologies become more accessible, the widespread use of virtual teams will increase in the future (Petter, DeLone & McLean, 2012). Thus, studying challenges associated with virtual teams is necessary for understanding and managing virtual teams.

Second, maintaining shared mental models is important to virtual teams' effectiveness (Cannon-Bowers & Salas, 1993). Having shared mental models among the team members can help establish the team's mutual awareness of one another and resolve the task, team, and team interaction conflicts (Fiore, Salas, Cuevas, & Bowers, 2003). Possessing shared mental models may also increase the team's capability to adapt to the changing environments (Cannon-Bowers & Salas, 1993).

Third, examining the interaction between IT capabilities adaptation and shared mental models development in virtual teams is necessary to understand managing virtual teams. An understanding of how a virtual team's "technology use" interacts with the development of a virtual team's shared mental model will put virtual team practitioners in a better position in terms of selecting and evaluating IT tools and

purposefully using team interventions to optimize the benefits of technology adaptation.

1.3. Research Approach

Given the research question of this present study, I adopted the case study as the research method. The purpose of the study is to understand the complex interaction between the adaptive use of IT capabilities and the development of shared mental models in virtual teams. By enabling a holistic view of the study context, case study is suggested to be an appropriate research method for studies that investigate interaction processes (Dubé & Paré, 2003).

1.4. Dissertation Overview

The dissertation is organized into seven chapters.

Chapter 2 lays the theoretical foundation of the study by summarizing the literature review on virtual teams, shared mental models, and adaptation of IT capabilities, respectively. Chapter 3 develops the research framework of the study and proposes three theory-based dimensions of adaptive use of IT capabilities to account for the interplay relationship between the adaptive use of IT capabilities and shared mental models development. Chapter 4 explains the details of the research method for this study. Lessons learned from pilot studies are also included in Chapter 4. Chapter 5 presents results of analysis for both qualitative data and quantitative data. Chapter 6 discusses findings from the results of analysis and answers the research questions explicitly. Lastly, Chapter 7 provides the limitations, implications, contributions of the study and concludes the dissertation.

CHAPTER 2: THEORETICAL BACKGROUND

"A central concern of studies of adaptive processes is the relation between exploration of new possibilities and the exploitation of old certainties." ----March (1991)

2.1. Virtual Teams

Consistent with previous literature, I define virtual teams as "*geographically, organizationally and/or time dispersed workers brought together by information and telecommunication technologies to accomplish one or more organizational tasks"* (Powell et al., 2004, p. 7). Like traditional teams, virtual teams consist of groups of people who work interdependently toward specific goals. But instead of physically working in the same location, virtual team members rely on IT to collaborate (Johnson, Bettenhausen & Gibbons, 2009).

Research on virtual teams began in the early 1990s. A literature review on virtual teams by Powell and et al. (2004) summarized early studies on virtual teams and identified three dimensions (namely, managerial, technical, and social) of challenges to build and manage virtual teams.

Managerial challenges of virtual teams relate to the difficulty of maintaining efficient information exchange within the team and developing plans for the team. Studies found virtual teams were less likely to engage in more satisfied communication than the face-to-face teams (Warkentin, Sayeed, & Hightower, 1997). In addition, predictable communication (i.e., team members have a shared understanding on how long on average a message will get a reply) was found to

positively correlate with effective virtual team communication. Virtual team interventions were developed and tested to address the managerial challenges. Common virtual team inventions are conducting team building exercises, developing shared norms, clarifying the team structure, and arranging necessary face-to-face meetings (Edwards & Day, 2006; S. Mohammed, Ferzandi, & Hamilton, 2010; Smith-Jentsch, Cannon-Bowers, Tannenbaum, & Salas, 2008). Research found out that both proactive and reactive virtual team interventions were effective in helping virtual teams in technology choices (Mitchell, 2012). Leadership is also an important approach to help virtual teams overcome the managerial challenges. With successful leadership (i.e. the leadership can be attained by both person and the assistance of IT capabilities), a virtual team can be structured and everyone on the team freely engages in team communication and builds up good social-emotional relationships with each other (Beranek, Broder, Reinig, Romano Jr, & Sump, 2005; Kayworth & Leidner, 2002; Yoo & Alavi, 2004; Zigurs, 2003).

The social challenges of managing virtual teams are evidenced by the lack of social-focused activities, mistrust, and low respect in virtual teams. Studies showed that compared with traditional face-to-face teams, virtual teams are less likely to achieve cohesion because they rely on electronic means to communicate (Carlson, Carlson, Hunter, Vaughn, & George, 2013; Montoya-Weiss, Massey, & Song, 2001). With no to few face-to-face meetings, members of virtual teams usually feel weakly bonded to the team and need to balance between interdependent preparation activities and virtual team interactions (Majchrzak, More, & Faraj, 2012; Maynard, Mathieu,

Rapp, & Gilson, 2012). Building trust among the team is challenging when the time is short and limited. In many cases, virtual teams have to build trust within the team quickly without adequate interactions because of the task requirements. Scheduling regular face-to-face meetings are a way to overcome the social challenges associated with virtual teams. For global virtual teams, additional social challenges occur when members speak different languages and experience significant culture differences (Montoya-Weiss et al., 2001; Pinjani & Palvia, 2013).

A third aspect is the challenges with the technology. Many IT tools, such as electronic meeting systems, have been developed to assist important collaboration activities in a group or virtual team (Chen, Nunamaker Jr, Orwig, & Titkova, 1998). Technical challenges occur when a virtual team experiences an unexpected technology breakdown or the virtual team members are not capable of using new technologies for team communication or to support the team process. Studies show that the IT literacy of virtual team members had a positive correlation with the members' satisfaction with the virtual team experience. The higher the IT literacy a virtual team member possess, the more satisfied the member is with working in a virtual team (Beranek et al., 2005; Carte & Chidambaram, 2004).

To enable smooth and effective team communication, the team members have to adaptively use all types of IT capabilities to overcome the limits of the virtual teams while taking advantage of the benefits of virtual teams. For example, virtual teams should combine the use of both synchronous and asynchronous communication tools. Prior studies suggest that synchronous tools, such as instant messaging, allow

virtual team members to share expertise informally and spontaneously. and synchronous tools, such as electronic whiteboards, make it easy for virtual team members to collaboratively work on a common place and show tacit assumptions clearly (Malhotra & Majchrzak, 2012). Therefore, synchronous tools are suggested for ambiguous tasks[6] or resolving conflicts (Shih, Lai, & Cheng, 2013). On the other hand, asynchronous tools, such as emails or a common repository that allows files uploading enable virtual teams to collaboratively work on a document or a task and allow the teams to track the changes made on the document or the task. Asynchronous tools are suggested to be suitable for more structured work (Shih et al., 2013). Working in a virtual team also requires the team members know how to compromise when not all members possess the same technical skills (Powell, Piccoli, & Ives, 2004). Team training and mentoring programs are suggested to be a viable approach to resolve the problems of the diverse technical skills of the virtual team members (Powell et al., 2004). Technology experience and prior habits are important contingent factors influencing the process by which a virtual team establishes its own ways of interaction (Louis & Sutton, 1991).

The literature review shows virtual teams' collaboration consists of two prominent processes. One of the processes is to build the shared mental models in virtual teams. According to the literature, the development of shared mental models is a socio-emotional process of a virtual team. Building shared mental models among a virtual team was suggested to be the primary goal or objective for the design of a

[6]Ambiguity tasks refer to the unstructured tasks that do not have explicit procedure to follow for accomplishing the tasks.

virtual team interaction strategy (Powell et al., 2004). Another process is the adaptive use of IT capabilities process engaged by virtual teams. The two processes are linked together through the virtual teams' interaction activities. However, it is unknown about how these two processes (they refer to the development of shared mental models and adaptively use of IT capabilities) interplay with each other.

Prior studies suggest virtual teams may develop different shared mental models for different types of virtual teams. Therefore, clarifying the type of virtual team that is relevant to this dissertation is important. Specifically, this dissertation uses two dimensions (virtuality and previous work-together experience) to set up the specific type of virtual team for this study.

Virtuality refers to the function of the degree of reliance on IT-mediated communication and the degree of geographical dispersion (Gibson & Cohen, 2003). Previous research has suggested that frequent communication is essential to shared mental models development in teams (Athens, 1982). Several studies (e.g., Hinds & Weisband, 2003; Nemiro, 2004; Rooji et al., 2007) posit that IT-mediated communication cannot be as effective as a face-to-face meeting; thus, the virtual team would be more likely to experience misunderstanding because of its reliance on IT-mediated communication. This dissertation examines *virtuality* by studying virtual teams that rely on IT-mediated communication and rarely meet face-to-face.

Second, research has found that new virtual teams are especially exposed to a high risk of communication breakdowns (Hinds & Mortensen, 2005), which are believed to be associated with the building of shared mental models in virtual teams.

Therefore, this case study examines the newly formed virtual teams in which virtual team members have little to no shared work-together experience.

2.2. Shared Mental Models

2.2.1. The Nature of Shared Mental Models

Shared mental models are an extension of mental models, a construct with origins in cognitive science. Mental models theory states that the human mind forms working models to comprehend the world and to predict future events (Craik, 1947). Mental models act as a center controller that guides human behaviors by developing a purposive description of the world and triggers a response function (Newell, 1990). Individuals vary in terms of the process through which a person forms a mental model, and the value and outcome of mental model varies dramatically across individuals. For example, in contrast to a novice programmer, an experienced programmer has mental models that can more quickly identify reasons why a piece of software may have errors and can use this mental model to describe the issue in a manner that allows him or her to solve the problem.

Shared mental models (SMM) represent the "knowledge structures held by members of a team that enable them to form accurate explanations and expectations for the task, and in turn, to coordinate their actions and adapt their behavior to demands of the task and other team members" (Cannon-Bowers & Salas, 1993, p. 228). The SMM construct is proposed as a viable means to understand highly effective team decision-making (Cannon-Bowers & Salas, 1993). Consistent with previous literature, in this dissertation research, SMM are assessed through shared mental model convergence, which is evaluated by *examining a team's communication*

on information relating to a team's taskwork mental model and a teams' teamwork mental model (Cannon-Bowers & Salas, 1993; S. A. McComb, 2007; Rentsch & Woehr, 2004). A team's taskwork mental models are knowledge structure and beliefs held by the team about the task goals, steps to accomplish the tasks, and the technologies used to accomplish the tasks. The teamwork mental models refer to the knowledge structure and beliefs held by the team about the team interaction and team members' roles, skills, and knowledge. Specifically, according to Cannon-Bower and Salas (1993), taskwork mental models consist of an equipment mental model and a task mental model. The teamwork mental models include mental models on team interaction and the nature of the team.

Table 1 provides definitions and knowledge contents for each of the two types of shared mental models.

Table 1

Taskwork Mental Models and Teamwork Mental Models

SMM	Sub Type	Definitions	Knowledge Contents
Taskwork Mental Models	EM	A type of mental model that contains knowledge structure and beliefs regarding the dynamics and control of the equipment with which they are interacting to extract information.	Equipment functioning Operating procedures Equipment limitations Likely failures
	TKM	A type of mental model that contains knowledge structure and beliefs regarding what is the task, how to accomplish it, and how various facets of the environment affect the task and task demands.	Task procedures Likely contingencies Likely scenarios Task strategies Environmental constraints
Teamwork Mental Models	TIM	A type of mental model that contains knowledge structure and beliefs regarding team members' roles in the task; for example, how they contribute to the team, how they must interact with other team members, and who requires particular types of information. They must also know when to monitor their teammates' behavior, when to step in and help a fellow member who is overloaded, and when to change his or her behavior in response to the needs of the team.	Roles/responsibilities Information sources Interaction patterns Communication channels Role interdependencies
	TM	A type of mental model that contains knowledge structure and beliefs regarding their teammates' knowledge, skills, abilities, preferences, and other task-relevant attributes of their teammates.	Teammates' knowledge Teammates' skills Teammates' abilities Teammates' preferences Teammates' tendencies

*Note.*Cannon-Bowers, J. A., & Salas, E. (Eds.). (1993). *Shared mental models in expert decision making*. Hillsdale, NJ: Lawrence Erlbaum Associates.

SMM = Shared Mental Models, EM = Equipment Model, TKM = Task Model, TIM = Team Interaction Model, TM = Team Model.

2.2.2. Development of Shared Mental Models in Teams

According to a number of research studies, a team's possession of a shared mental model is helpful in enabling team members better anticipate other members'

information needs and in reducing the explicit communication and coordination overhead (e.g., Cooke et al., 2001; Lim et al., 2006; Mathieu et al., 2005). Specifically, developing SMM is important in teams that involve intense stress and teams that are unable to engage in constant communication, such as virtual teams.

Given the importance of possessing shared mental models in teams, many studies have examined the development of the shared mental model in face-to-face teams. Researchers have suggested several areas for identifying important antecedents to SMM development. These areas include individual characteristics (that is, tenure and experience), team-level efficacy (that is, the team's effectiveness in planning, team interaction, and leadership), and contextual factors, such as stress, workload, and novel situations in the environment (Mohammed et al., 2010). More converged shared mental models were found among senior employees and especially people with shared working experience in the past (Rentsch, Heffner, & Duffy, 1994; Smith-Jentsch, Campbell, Milanovich, & Reynolds, 2001). Effective team planning, regular team interaction and strong leadership were found to positively correlate with the convergence of shared mental models (Marks, Zaccaro, & Mathieu, 2000; Smith-Jentsch et al., 2008). Further, teams were found to experience difficulty in developing shared mental models under stressful work environments and under novel situations (Ellis, 2006; Waller, Gupta, & Giambatista, 2004). Additionally, teams' learning behaviors, such as construction of important concepts, and constructive conflicts (i.e., dealing with differences between team members with clarifications and arguments) among the team, were found to positively influence the development of

shared mental models (Van den Bossche, Gijselaers, Segers, Woltjer, & Kirschner, 2011).

The development of the shared mental models process has also been viewed as a dialectic process during which teams develop collective minds through resolving conflicts with the appropriate use of IT capabilities (Carlo, Lyytinen, & Boland Jr, 2012).

Building on the research of shared mental models in traditional teams, in the last decade, an increasing body of research began to examine the issue of developing shared mental models in virtual teams. Developing shared mental models in virtual teams is especially challenging compared to face-to-face teams because of the lack of nonverbal cues, of context knowledge, and of common ground about how to communicate with each other (Cramton, 2001). In an inductive case study, Rooij et al. (2007) identified three barriers of building SMM in virtual teams; namely, complex team and management structures, team member culture diversity, and ICT[7]-mediated communication. Responses from virtual team leaders revealed two types of challenges (i.e., lack of visual cue and lack of awareness) that result from ICT-mediated communication. Lack of visual cue refers to situations when important body languages are lost because of mediated communication. Lost non-verbal communication can include important information, such as one understands a message or one agrees and one holds more power. Not being able to see colleagues in a virtual team meeting can also easily distract a member and, thus, make the team

[7]ICT refers to information and communication technology.

communication less effectiveness. The loss information because of mediated communication is suggested to cause lack of shared understandings in virtual teams.

Another type of challenge associated with mediated communication is lack of awareness. Lack of awareness is concerned with knowing what is happening in the team at other geographic locations, such as circumstances that will have impacts on work progress in general or circumstances about colleagues' personal lives. For example, team members discussing technical issues of test equipment over telephone rely on other team members clearly explaining what they were seeing. If they cannot describe it well, the team will have difficulties in building SMMs.

A later study[8] conducted by McComb et al. (2010) assessed team mental models convergence in action teams[9]. After analyzing the transcripts of the team's communication, the authors identified six types of mental model contents. The findings revealed the temporal interdependencies among the six types of mental models. In other words, the convergence of a specific type of mental model will prompt the convergence of another type of mental model. For example, a mental model about the advantages and disadvantages of given collaboration tools can be expected to influence a mental model about how the team interacts. Further, the study compared the mental model convergence pattern between distributed teams and face-to-face teams through examining the communication patterns of the teams.

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[8]McComb et al. (2010) examined EWall, which is an electronic collaboration space, where information can be stored in text cards and communication is allowed through a chat tool.

[9]In McComb et al. (2010)'s study, action teams were formed to develop a rescue plan for three trapped Red Cross workers on a fictitious South Pacific island. Prior to the task, teams were given related background information.

McComb et al. (2010) found that for all six types of mental model, the convergence of SMM was more likely to occur later in distributed teams than face-to-face teams. Further, distributed teams followed a linear approach to converge their shared mental models and tended to streamline cognitive processes; that is, "the internalized and externalized high-level mental processes employed by teams to create new knowledge" (Letsky & Warner, 2008, p.7). In contrast, face-to-face teams converged on multiple mental models simultaneously and took less time to converge. Again, these differences were explained by the different interaction modes enabled by technology compared to face-to-face communication.

Methods and practices were developed to foster the development of shared mental models. Team-level interventions (i.e., planning, reflexivity, leadership, and training) have received the most attention as facilitators of SMM development. Since team training is perceived as a primary mechanism that motivates team members to develop a shared mental model efficiently, various team training methods (including self-correction, team interaction training, computer based, and cross-training) have been proposed and examined (Blickensderfer, Cannon-Bowers, & Salas, 1998; Marks, Sabella, Burke & Zaccaro, 2002; Marks et al., 2000). Studies have also examined the role of the leader in facilitating the development of shared mental models in teams (Orasanu, 1990). Effective leader briefing and debriefing were found to be positively associated with the team interaction model's similarity and accuracy.

The above-reviewed studies revealed that the methods and reasons a virtual

team's adaptive use of IT capabilities interplays with the development of a shared mental model in virtual teams are unknown.

2.2.3. Assessment of Shared Mental Models

Various methods can be used for measuring shared mental models. Paired comparison ratings, concept mapping, card sorting and qualitative methods are the four major methods used to assess shared mental models. The method of paired comparison ratings is the most used one in the SMM literature. One advantage of using the paired comparison ratings is its capability of measuring the similarity between team members not only in terms of the contents but also in terms of the perceptions on the knowledge structure (that refers to the relationships among the knowledge contents). However, a method of this type has limitations when applied to different problem domains. To conduct such a paired comparison rating on teams, a list of paired statements related to tasks first must be developed. Previous researchers mostly consult with domain experts on constructing such a list (Lim & Klein, 2006; Mathieu, Heffner, Goodwin, Salas & Cannon-Bowers, 2000; Smith-Jentsch et al., 2001). For complex tasks, creating such a list of paired statements can be time consuming and such a list can be biased when the most important and relevant knowledge contents are not captured.

In contrast to the paired comparison method, there has been limited use of qualitative methods for studying virtual teams. One qualitative method is to ask specific questions to the team and collect responses from all team members. Then researchers compare the team's answers to the questions and give a similarity score

for the team based on a pre-defined rule (McComb, 2007). Another approach is to use a questionnaire to measure the degree to which the team develops shared mental models. The questionnaire method is criticized for not being capable of measuring the knowledge structure for the team (Carley, 1997; Susan Mohammed, Klimoski & Rentsch, 2000; Waller et al., 2004). A third approach of the qualitative method is to examine the communication protocol of the teams. Drawing on information-processing theory, Kennedy and McComb (2010) suggested that although the process of shared mental models convergence is an internal process of teams, the team's communication represents an observable component of that process. Further, they proposed that the team's shared mental models convergence is an iterative process. During that process members of a team actively exchange information about different contents of mental models, reach shared understandings, and apply the shared understandings in problem solving subconsciously until new problems occur.

Among various approaches[10] of assessing shared mental models, assessing shared mental model convergence through examining a team's communication not only permits knowing what particular types of mental models have been converged but also allows knowing when a specific mental model convergence occurs. Using this approach of assessing shared mental models allows the examination of interrelationships between the adaptive use of IT capabilities and the occurrences of different mental models convergences in virtual teams' teamwork. In addition, prior literature suggests studies combine methods to evaluate the shared mental models

[10]A review of current approaches used to assess shared mental models can be found in the paper written by Mohammed, Ferzandi & Hamilton (2010).

convergence. Considering the purpose of this research, this research uses two methods (a) the questionnaire and (b) examination of the teams' communication protocol to assess the shared mental models convergence.

2.3. Adaptation of Technology Capabilities

2.3.1. The Nature of IT and IT Capabilities

IT can be broadly understood as "a composite made up of some combination of software, hardware, database and network components with an information processing capability aimed at enabling individual, group and organizational tasks" (Nevo et al., 2009, p. 224). Though IT takes many forms and serves business in various areas, such as in transaction processes, in analytical reporting, in knowledge management, in automation processes, and in big data management (Danvenport & Short, 1990), this present study is particularly interested in collaboration technology, a type of IT that has drawn many researchers' attention. Some examples of collaboration technology are instant messaging, email, voice mail, group support systems, groupware, commercial collaborative software, and instant online communication tools (Marakas, Sun, Liu, Lee & Mao, 2010). Consistent with prior literature, collaboration technology is defined in this study as "*comprising one or more computer-based tools that support the communication, coordination, and/or information processing needs of two or more people working together on a common task*" (Zigurs & Munkvold, 2006).

Studies on typologies of collaboration technologies have taken different perspectives on categorizing collaboration technology. A popular approach is the 2 X 2 (time/place) configuration of technology (e.g., Munkvold, 2003). This approach

characterized collaboration technology into four modes of group interaction with particular instantiations of technology, namely same time same place, same time different place, different time same place, and different time different place.

A second perspective characterized technology in terms of its capability of supporting group decision making. Level 1-2-3 framework (G. DeSanctis & Gallupe, 1987) is one of the most widely cited approaches. The higher the level, the higher the capability of technology is in supporting effective group decision making.

Another alternative to categorize technology is based on examining the functional tasks that technology supports (Zigurs & Buckland, 1998a). This approach divides technologies into five specific categories, namely communication technologies, information sharing technologies, process support technologies, coordination technologies, and integrated technologies across functional categories.

2.3.2. The Adaptive Use of IT Capabilities

Technology use is one of the most important factors influencing successful technology implementation (Delone & McLean, 2003). Studies in technology use have been concerned with the nature of the process of technology use, the patterns associated with technology use and antecedents to technology use (Jurison, 2000; Kim, 2009; D. W. Straub & Ang, 2008). Findings from the technology use research have suggested that users engage in a cycle of adaptive technology use once they adopt the technology (Limayem, Hirt, & Cheung, 2007; Sun, 2012; Thomas & Bostrom, 2010). In each cycle of adaptive IT use, users start with learning about the technology to developing their own ways of using the technology or eventually abandoning the

technology (Jasperson et al., 2005).

According to the adaptive view of IT capabilities usage, IT is understood as a collection of capabilities. These IT capabilities provide potential features, both current and yet to be discovered, that can be developed for specific functionality. IT capabilities can be bundled together by people to accomplish a specific task or goal. Capabilities are dynamic; they can change with time through the process of users' adaptation and appropriation (Davis et al., 2009). The adaptive use of IT capabilities can bring either positive or negative impacts to the overall outcomes (Jasperson et al., 2005). In one case, the adaptive use of IT capabilities helped achieve a better fit between the task needs, the technology capabilities, and the team situations (Majchrzak et al., 2000; Sun, 2012). Consistent with prior literature (Thomas & Bostrom, 2010), in this study, adaptive use of IT capabilities by the virtual team is defined as *the process during which* a *virtual team modifies the way it uses one or more communication and collaboration technologies.* Collaboration technologies are defined as *"comprising one or more computer-based tools that support the communication, coordination, and/or information processing needs of two or more people working together on a common task"* (Zigurs & Munkvold, 2006, p. 145).

Many studies have been conducted to examine the important antecedents with the goal of predicting users' IT use. Political issues, such as organization norms and mandatory use from top managers, are suggested to influence the initial technology adoption (Karahanna et al., 1999). Users' perceptions of technology, specifically the attitudes and beliefs with the technology, are found to significantly

influence how users adapt the technology in its context of use (Karahanna et al., 1999; Venkatesh & Davis, 2000). Task-technology fit is another important factor explaining why users make changes in the process of technology use (Goodhue & Thompson, 1995; Zigurs & Buckland, 1998). For example, Sun (2012) found that novel situations, discrepancies, and deliberative initiatives were three important factors influencing users' adaptive use of technology features.

Compared to the above reviewed studies on individual technology adaptation, few studies have examined this dissertation's focus: IT capabilities adaptation at a team level. Those that have been done contributed to the understanding of a team's technology adaptation behaviors. Sarker and Valacich (2010) stressed the importance of team consensus and experts' opinions on technology adoption in teams. Majchrzak et al. (2000) studied how an inter-organizational virtual team adapted to collaborative technologies (CT). The CT used in the virtual team included a virtual workplace: the "Internet Notebook"[11], which was complemented by using telephone conferencing along with synchronous system entries for synchronous, multi-media collaboration. Following a case study approach, the authors found that the virtual team adapted to the CT when discrepant events occurred. These discrepant events were mostly unforeseen and unwelcomed problems as viewed by team members. These discrepant events[12] could range from one interface of the Notebook taking too long to launch to a team member being unaware of an uploaded team members'

[11]The Internet Notebook allowed users to remotely access the Internet Notebook from anywhere through a custom-designed HTML browser.

[12]A summary of discrepant events can be found at Table 3 on page 583-586 in Majchrzak et al. (2000).

conversations to the Notebook. The authors did not categorize these discrepant events.

Another study conducted by Thomas and Bostrom (2007) examined triggers to technology adaptation in virtual teams by interviewing13 virtual team leaders about the success of IT projects. They drew on the mental model theory, taskwork mental model in particular, to understand the technology adaptation. They expanded the definition of the equipment model to the ICT context by defining three components: (a) understanding how to operate ICT, (b) understanding what the ICT is doing and what to do if something goes wrong, and (c) understanding how the ICT can be useful. The authors suggested that the team leader has an important role in facilitating the on-going development of such equipment model. Their findings suggested that teams with a stronger equipment model would experience a more successful ICT adoption.

As teams become major sources of value-adding activities in organizations, studying and understanding the adaptive use of IT capabilities at the team level is necessary. This dissertation draws on the theory of shared mental models, which is constructed at the team level, to understand the adaptive use of IT capabilities by virtual teams.

2.4. Summary of Chapter 2

Virtual team outcomes can be enhanced to the extent that virtual teams develop a shared mental model. Virtual teams that have a high degree of *virtuality* and are composed of members with little *previous work-together experience* are suggested to experience more challenges in developing shared mental models.

Information technology (IT) can be viewed as a collection of capabilities. IT

capabilities provide potential features, both current and yet to be discovered, that can be developed for specific functionality. Capabilities are dynamic; they can change with time through the process of users' adaptation and appropriation.

What we do not know is the relationship between adaptation of IT capabilities and the shared mental model development in virtual teams. Studies have not investigated the interplay between virtual teams' adaptive use of IT capabilities and the development of shared mental models in virtual teams.

CHAPTER 3: CONCEPTUAL FRAMEWORK

This chapter builds a conceptual framework of this dissertation to guide the process of examination of the research question: *What is the interplay between adaptive use of IT capabilities and development of shared mental model in virtual teams?* The pictorial conceptual framework presented in Figure 1 describes the IT-mediated virtual team collaboration in terms of context, the interplay between the adaptive use of IT capabilities and shared mental models development, and virtual team outcomes. Consistent with previous literature (DeSanctis & Poole, 1994; Thomas & Bostrom, 2010), the context in which virtual teams adaptively use IT capabilities is defined by the three structures: *virtual team*, *task*, and *technology*. The interplay between adaptive use of IT capabilities and shared mental models development includes two interdependent processes; namely, IT capabilities adaptation and shared mental model convergence. This interaction process leads to a variety of virtual team outcomes; for example, the decision quality, the team

performance, user satisfaction, and the team effectiveness.

A framework to study the interplay between adaptive use of IT capabilities and shared mental models convergence is proposed in Figure 1. This framework provides an integrated view of previous work that can be used to understand IT capabilities adaptation (Davis et al., 2009; DeSanctis & Poole, 1994; Majchrzak et al., 2000; Thomas & Bostrom, 2010) and shared mental models convergence (Cannon-Bowers & Salas, 1993; Mohammed et al., 2010). The following sections discuss each component of the interplay between AUITC and SMM.

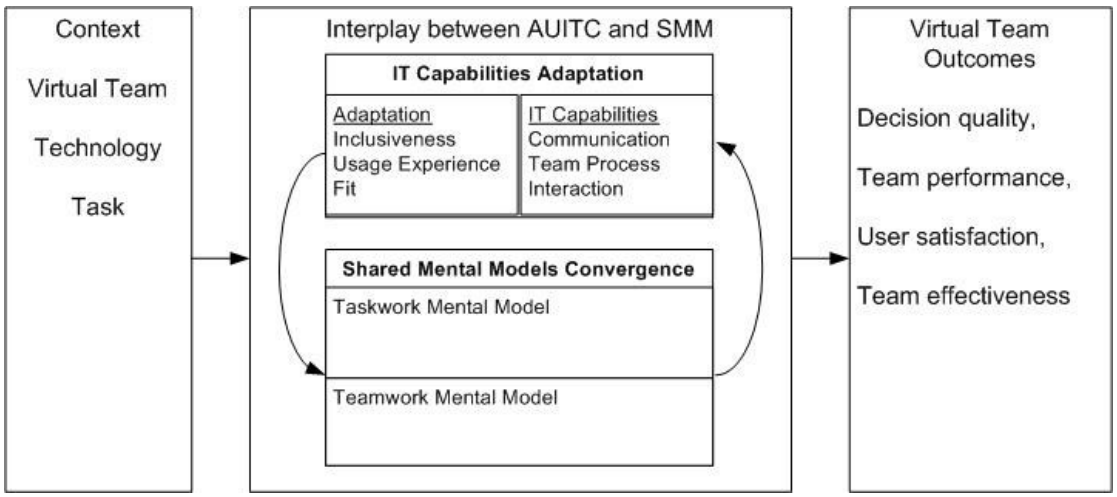

*Figure 1.*Conceptual framework of the dissertation.

3.1. Adaptive Use of IT Capabilities

Information technology is an integral part of virtual team collaboration and interaction. Consistent with prior research (DeSanctis & Poole, 1994; Orlikowski, 1992), IT can be understood as a set of capabilities. IT capabilities refer to "*distinctive features of a specific technology that include various technological functionalities and offer an undeveloped potential that is dynamic, representing a starting point that can change through interaction in the environment*" (Davis et al., 2009, p. 95). IT capabilities with collaboration technologies used in virtual teams can be broadly

classified into three areas: *communication*, *team process*, and *interaction* (Davis et al., 2009).Table 2 presents the definitions of the three areas of IT capabilities.

Table 2
Definitions of IT Capabilities

IT Capabilities	Definitions
Communication	Any capabilities that support a virtual team's communication and collaboration.
Interaction	Any capabilities that support the process of people working with others and engaging with the virtual collaborative environment.
Team Process	Any capabilities that support team processes, such as process structure, information processing, appropriation support, and socialization/community building.

Note. Adapted from Davis et al. (2009). Avatars, people, and metaverses: Foundations for research in metaverses. Journal of the Association for Information Systems, 10(2), 99-117.

Prior research suggests that when virtual teams are introduced to one or more new technologies, virtual teams will adapt the technology to the existing context of virtual teams (Thomas & Bostrom, 2010). In the context of virtual teams, adaptive use of IT capabilities refers to the process by which virtual team members collectively use or modify one or more capabilities to perform a task (Burton-Jones & Straub, 2006). Virtual teams vary in using IT capabilities. Given the same IT, different virtual teams may use different features with different specific capabilities to communicate, interact, or team process. Further, in the interaction with IT tools, virtual team members may modify what features they use and how they use those features (Sun 2012). In some cases, virtual teams may use features in a way that exceeds the developer's expectations.

3.2. Shared Mental Models Development

Virtual teams develop their shared mental models through communication and collaboration. The development of shared mental models is a convergence

process. Specifically, as suggested by prior literature (McComb et al., 2010), members of teams actively exchange information, and thus, diverse individual mental models converge to a shared mental models, which allow the teams to execute with few conflicts in the teamwork.

The theory of shared mental model (Cannon-Bowers & Salas, 1993) has suggested the interdependencies among the two types of mental models (that are taskwork mental models and teamwork mental models). For example, the change of task requirements may require a different team interaction pattern or a new role assignment in teams. Since the focus of this dissertation is to examine the interplay between technology adaptation and shared mental model development, the interdependencies between taskwork mental models and teamwork mental models were not examined.

3.3. Interplay of AUITC and SMM Development

Drawing on theories on technology usage and shared mental models development, I proposed the interplays of AUITC and SMM development can be studied by examining the three dimensions of AUITC: usage experience, inclusiveness, and fit.

First, usage experience is an initial condition in the process of adaptation. Usage experience refers to the user's experience with using and interacting with technologies (Yu et al., 2011). More specifically, usage experience refers to the amount of time and frequency of using a particular IT capability by virtual teams in this dissertation study. Prior studies found that a high level of technology usage

experience was associated with greater satisfaction with technology (Bhattacherjee et al., 2012; Limayem et al., 2007). In addition, as a virtual team collectively uses the technology, the team develops shared understanding about how the technology functions and what limitations the technology has. Through the use of IT capabilities, virtual teams may engage in team interactions that are critical to develop shared mental models among the team. Moreover, early studies of shared mental models mostly focused on studying the influence of communication capabilities of IT on shared mental model development; literature on technology usage suggests the team should use communication, team process, and interaction these three types of capabilities in teamwork. Therefore, I propose:

Proposition 1a: the interplay of adaptive use of IT capabilities and development of shared mental models is affected by the usage experience dimension of AUITC.

Proposition 1b: the interplay of adaptive use of IT capabilities and development of taskwork mental models is affected by the usage experience dimension of AUITC.

Proposition 1c: the interplay of adaptive use of IT capabilities and development of teamwork mental models is affected by the usage experience dimension of AUITC.

Next, inclusiveness is a necessary condition for adaptation. Inclusiveness is the extent to which users explore diverse IT capabilities (Yu, Owens, Arora & Khazanchi, 2011). For example, virtual teams that explore only one particular IT

feature at a time are considered to have a low degree of inclusiveness. Previous studies found that personal innovativeness is an important factor influencing the intention of users concerning trying out different IT features (Bhattacherjee, Limayem, & Cheung, 2012). The capabilities view of technology suggests that IT is a bundle of capabilities (Carte & Chidambaram, 2004; Davis, Murphy, Owens, Khazanchi & Zigurs, 2009; G DeSanctis & Poole, 1994). The negative effects of diversity of virtual teams can be mitigated by purposefully using IT capabilities(Carte & Chidambaram, 2004). A relevant study found that when IT's bundle of reductive and additive capabilities is used in an appropriate phase of teamwork, IT will help teams reduce team conflicts, increase the task-related conflicts and increase group cohesion (Carte & Chidambaram, 2004). To develop a more converged shared mental model, a virtual team should use diverse IT capabilities for enhancing the building of a shared language in the team. Conversely, evidence has shown that once teams establish shared mental models about the ICT tools the teams interact with, the teams experience more successful ICT adoption under the team leader's facilitation (Thomas & Bostrom, 2007). Thus, I propose that:

Proposition 2a: the interplay of adaptive use of IT capabilities and development of shared mental models is affected by the inclusiveness dimension of AUITC.

Proposition 2b: the interplay of adaptive use of IT capabilities and development of taskwork mental models is affected by the inclusiveness dimension of AUITC.

Proposition 2c: the interplay of adaptive use of IT capabilities and development of teamwork mental models is affected by the inclusiveness dimension of AUITC.

Finally, fit refers to the ideal use of a capability or set of capabilities that affect group performance (Yu et al., 2011). This understanding of fit is consistent with task-technology fit theory that defines fit as "*ideal profiles composed of an internally consistent set of task contingencies and GSS*[13] *elements that affect group performance*" (Zigurs & Buckland, 1998, p. 323). Establishing an ideal profile of technology capabilities usage for virtual teams can help virtual teams develop shared mental models more effectively.

Virtual teams rely on IT to collaborate and interact. Previous studies on building SMM in virtual teams have been mostly focused on examining the IT communication capabilities' influence on SMM development (McComb et al., 2010; Rooji et al., 2007). Some capabilities of IT (e.g., visual anonymity[14], asynchronous communication) will lead to misunderstandings among members in virtual teams (Rooji et al., 2007). Another study found that with the synchronous chat capability, virtual teams' shared mental models converged in a linear fashion, which is different than the face-to-face team (McComb et al., 2010). To attain success, virtual teams need to adapt IT capabilities to the task and to the team. For example, phone calls provide better support for the unstructured problem than the asynchronous

[13]GSS refers to group support systems that contain integrated technologies to provide solutions to group meeting.

[14]A detailed discussion of visual anonymity can be found in the paper written by Carte and Chidambaram (2004)

communication tools do.

Oliver (1980) suggested that users' satisfaction with product, in general, increases when the perceived performance exceeds the pre-consumption expectation held by users. Consistent with prior literature (Bhattacherjee, 2001), this dissertation applies this expectation confirmation theory to understand the adaptive use of IT capabilities. Thus, virtual teams will adaptively use IT capabilities based on the common expectations formed through team interaction, coupled with the virtual team's shared understandings of the performance of the IT capabilities the team has used. The following propositions capture the previous discussion.

Proposition 3a: the interplay of adaptive use of IT capabilities and development of shared mental models is affected by the fit dimension of AUITC.

Proposition 3b: the interplay of adaptive use of IT capabilities and development of taskwork mental models is affected by the fit dimension of AUITC.

Proposition 3c: the interplay of adaptive use of IT capabilities and development of teamwork mental models is affected by the fit dimension of AUITC.

3.4. Summary of Chapter 3

The conceptual framework presented in this chapter identified IT capabilities adaptation and shared mental models convergence as two key constructs that will be investigated in the dissertation study. Building on previous theoretical work and prominent evidence, the dissertation proposes a cross-relationship between AUITC and SMM convergence in virtual teams. Three dimensions of AUITC, namely inclusiveness, usage experience, and fit, are proposed to be used to account for the

interplays between AUITC and SMM convergence.

CHAPTER 4: RESEARCH METHOD

4.1. Research Design

4.1.1. Description of Case Study Method

According to Yin's (2002, p.5) suggestion, the research method should be carefully chosen based on the assessment of three conditions of one's study. The three conditions are (a) the type of research question, (b) the extent of control an investigator has over actual behavioral events, and (c) the degree of focus on contemporary, as opposed to historical, events. This dissertation uses a multiple case study research method to balance rigor and relevance.

In contrast to the survey and lab experiment research methods, case studies allow investigators to get holistic and meaningful characteristics of the study context (Yin, 2002). The in-depth understanding of the study context, in turn, gives the researchers an opportunity to identify new findings. Let us consider the research question of this dissertation study:

What is the interplay of the adaptive use of IT capabilities and development of shared mental models in virtual teams?

Although some relevant theories of adaptive use of IT capabilities and theories of shared mental models exist, an analysis of *a priori* literature suggests that no specific theory explains the interplay between the adaptive use of IT capabilities and shared mental models development, and few empirical studies examine this specific

relationship. Considering the exploratory nature of the research question, a multiple case study method is a perfect fit. Both qualitative and quantitative data are collected in a case study. Using these multiple types of data, the researcher can develop greater understanding of the interplay between the adaptive use of IT capabilities and the shared mental models development.

One of the concerns associated with using a single case study method is how achieving a balance between rigor and relevance. Results and findings from the case study are often criticized for lacking generalizability. A compromise made in this study is to adopt the multiple-case-study design approach following the theoretical replication logic (Yin, 2002).According to a rule of thumb on the number of cases, four to ten cases are suggested to increase the generalizability of case study findings(Eisenhardt, 1989). In this dissertation research, three cases were examined in the pilot study and five cases were examined in the full study.

To ensure the reliability and validity of the study, pilot case studies were conducted. Despite the importance of pilot studies, Dubé & Paré (2003) found that in only 7% of 183 case articles from seven major IS journals[15], researchers explicitly said they had conducted pilot cases. Successful pilot cases should help researchers gain first-hand information of the research problem, refine the research questions properly, and refine the data collection methods. Most importantly, researchers gain some initial insights about the research questions through pilot cases.

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[15]The seven IS journals are *European Journal of IS*, *Information and Management*, *Information and Organization*, *Information Systems Research*, *Information Technology & People*, *Journal of MIS*, and *MIS Quarterly*. Dubé & Paré examined case articles published during the period 1990 through 1999.

For the purpose of this dissertation research, the goals of the pilot studies are to (a) improve the study design, (b) establish the methods for data collection, and (c) develop a general data analysis strategy. The following four tactics address reliability and validity of the study (Street & Ward, 2011; Wynn & Williams, 2012; Yin, 1984):

- Collect both qualitative and quantitative data from multiple sources.
- Build a chain of evidence.
- Maintain a case study database and use a case study protocol to help achieve reliability of the research design.
- Test the psychometric properties of the survey instruments that are used in the case study.

In fact, a better description for the overall research design of the dissertation is a *longitudinal multiple-case study* in an educational setting. Specifically, the study was conducted in an asynchronous, internet-mediated course taught by the instructor at the University of Nebraska Omaha (UNO).The information technologies used in the study are three collaboration technologies: Gmav (interchangeable with email in this dissertation), Blackboard, and Google Sites[16]. Participants of the study were students enrolled in the class. Participants were assigned into teams of three to four to accomplish the group task of developing a business plan.

[16]Gmav and Google Sites are two tools offered by Google Apps for Education. Gmav is an email program, and Google Sites allows users to easily build and customize their own web pages based on web site templates. Google Sites also allows users to write their own scripts in an html view of the web page (www.google.com). Blackboard is an online collaborative learning system that allows students to interact with the course instructors and their classmates (www.blackboard.com).

4.1.2. Assumptions

Important assumptions were made in the dissertation research. The first important assumption relates to the determination of valid research. The author follows a positivist approach in conducting the case study. Ontologically, this assumes an objective physical and social world where the researcher cannot intervene. The researcher has a neutral role in the process of acquiring new knowledge about a phenomenon of interest. Epistemologically, this assumes that the relationships among the constructs of interest in this study exist independently and can be measured objectively. The conceptual framework proposed in chapter 3 guides the dissertation research. In that conceptual framework, definitions of the key constructs along with the relationships among the constructs were developed based on prior relevant theories. Methodologically, the researcher chose the triangulation[17] approach that derives findings from independent measures of the construct. In triangulation, independent measures of the construct should agree or at least not contradict with each other (Benbasat, Goldstein & Mead, 1987; Campbell & Fiske, 1959; Gable, 1994; Jick, 1979; Miles & Huberman, 1994; Yin, 2002). Data were compiled on each of the constructs. The findings of the study are derived from the compiled data and are intended to enrich our understanding of the relationships among the constructs and also help further refine the constructs.

The second assumption that was made has to do with measuring the study construct(s). As the study investigates the shared mental models development in

[17]Triangulation in this dissertation study refers to both of the triangulation between three data sources (i.e., self-reports, team communication data, and technology usage logs) and the triangulation between two data types (i.e., qualitative data and quantitative data).

virtual teams, it is assumed that virtual teams' shared mental models are established through team communication, and therefore, the teams' shared mental models can be examined through carefully studying the team communication data. Specifically, text chat is the primary source of team communication examined. Voice chat is also an important and necessary form of team communication; however, because of the limited control on the subjects, it was not possible to capture voice chat. As a substitute for the voice chat data, subjects' self-reported reflections on the use of a voice chat tool are used.

An important assumption regarding technology usage is also made. It is assumed that no external forces face virtual teams as they choose which technology to use and when to use the technologies. All virtual teams use technology capabilities according to their own free will. Further, the set of technologies provided to the study subjects are assumed to provide sufficient and adequate capabilities needed for accomplishing the task(s).

Last but not least, the study of the interplay of the adaptive use of IT capabilities and shared mental models development is based on the premise that this interplay can be captured through observing the(a)on-going team communication, (b)the usage of technologies (c) and the self-reported perceptions on the technology usage experience. Following this combined approach to examine the interplay of two complex constructs avoids a single, biased view of the phenomenon of interest. Specifically, this approach allows the capture of when and how the interplay occurs.

4.2. Pilot Cases and Lessons Learned

Two pilot studies were conducted prior to the full dissertation study. Both of the pilots were in an undergraduate-level class of information systems, CIST2100 Organizations, Applications, and Technology, at UNO.

The first pilot was conducted during the fall 2010 in the CIST2100 class. The first pilot met partial requirements of the full study, because students met face-to-face two times per week in the class, and therefore, the students did not form completely virtual teams. But this pilot is an important step at which I developed the guidelines of the virtual team project, determined the timeline of the project, assessed the technologies, especially the Google Sites, to be used in the full study, and pilot test the relationships between the adaptive use of IT capabilities and the development of shared mental models convergence in virtual teams.

The second pilot was conducted during the fall 2011 in an online session of the CIST 2100 class. Students of the class did not meet face-to-face, and they communicated through emails, Blackboard, and Google Sites. So they naturally formed virtual teams in the class when assigned to teams of three or four for the class team project. In the second pilot study, I gained important knowledge regarding the overall research design, data collection and data analysis strategy.

The following subsections present the major achievements of the pilot studies, important lessons learned from the pilot and the preliminary results from pilot studies.

4.2.1. Pilot Study Design

This subsection describes the overall study design employed in the pilot

study[18] and important lessons learned regarding study design.

Case Study Setup, Technologies

Three cases were studied in the pilot study.

The pilot study was conducted in an online class, CIST2100, Organizations, Applications, and Technology, taught by the researcher at UNO. Gmav, Blackboard (BB), and Google Sites were the collaborative technologies used in this study; the three technologies were chosen for their stability and adaptability as collaborative technologies. Specifically, in Blackboard, students watched the pre-recorded lecture videos, downloaded course materials and assignments, participated in discussions around specific topics, and turned in homework each week. For the purpose of this study, Blackboard also served as an important collaboration tool through which virtual team members communicated and interacted toward their assigned tasks. Google Sites, for the purpose of this study, was used for one or multiple purposes, such as team collaboration, project management and web page design. Email is a common communication tool used by all virtual teams.

Virtual Team Project

The group project was a seven-week-long project; the goal was to develop an e-commerce business plan. The teams had three interim deliverables. The first deliverable was a general description of the company and a market analysis using key concepts introduced in the class lectures. The second deliverable required each team to turn in a description of their IT platform design along with detailed IT budget

[18]Since the full dissertation study was most developed based on the study design used in the second pilot study, the pilot study here referred to the second pilot study specifically.

analysis. The final deliverable of the project asked each team to design a mock-up web site for their business. Table 3 summarizes the deliverables along with their respective time frame.

Table 3
Three Deliverables of Virtual Team Projects

Deliverable	Description	Time Frame
Deliverable 1	Define an e-commerce business, state the business's mission, explain the business products and examine the business market.	Week 1- Week 3
Deliverable 2	Design the IT platform for the business and complete a budget analysis of the IT platform	Week 4, Week 5
Deliverable 3	Design a mock-up web site for the business through several mock-up web pages	Week 6, Week 7

This virtual team project is consistent with the purpose of the course, which aims to introduce students to various important concepts related to technology, management, and organizations.

This virtual team project is also a good fit for the purpose of this study for the following reasons. First, the task is complex enough given the four criteria for assessing task's complexity by Campbell (1988). The task of creating a business plan has clearly more than one desired outcome. Virtual teams will have to find a variety of resources to identify their business idea and to support how the business idea can be executed. No one certain solution will ensure the success of the task. Second, the task requires long time spans of technology use, so that the process of technology adaptation and shared mental models convergence can be studied. Third, the task is a type of cognitive conflict task, which requires team members to engage in proper communication and coordination to resolve conflicting viewpoints. The intensive communication allows for more chances of explicitly observing the shared mental

models convergence in virtual teams.

Study Procedures

First, the course instructor formed student virtual teams. Each virtual team worked on a project given by the instructor of the class. Guidelines to the virtual team projects were delivered through Blackboard. Prior to the beginning of the project, a warm-up exercise was used to familiarize the students with the technologies, especially the Google Sites. In the beginning of the team project, each team was asked to choose a team leader. The IRB[19] approval letter regarding the study design and study purpose was made available to students in Blackboard.

A weekly plan of the study is shown in Table 4.

[19]"In accordance with Health and Human Services Regulations for Protection of Human Subjects (45 CFR 46), an institutional review board committee, composed of members from a variety of scientific disciplines as well as community members, assists investigators in the protection of the rights and welfare of human subjects. The IRB also serves to facilitate valuable human subject research as well as protect the investigator and the institution through a comprehensive review process. All human research projects must be reviewed and approved by the IRB prior to initiation and then conducted in full compliance with the IRB guidelines." from http://www.unmc.edu/irb/

Table 4

A Week-by-Week Study Plan

Week	Activity	Deliverable
Week 1	Preliminary Setup 1. Set up Google Sites exemplar. 2. Set up survey 3. Create documents, such as project guidelines, the Google Sites instruction, and a technology usage report template. 4. Ask students to introduce themselves in Blackboard discussion forum. 5. Ask students to accomplish a quiz regarding course material. 6. Based on students' self-introduction and their performance on the first quiz, assign students in groups of three. Group students with a mixture of their backgrounds.	Self-introduction and Quiz
Week 2	Warm-up team exercise 1. Ask students to set up their Google Sites based on the Google Sites instruction provided. 2. Ask students to assign a team leader for their group project	An initial Google Sites for both managing group project and present future project deliverables.
Week 3	Group project kick-off 1. Provide project guidelines to students. Let the students be familiar with the purpose and requirements of the group project. 2. Enable student group functions in Blackboard.	Technology usage report
Week 4	Group project continue	Technology usage report
Week 5	Give survey 1 at the end of this week	Deliverable 1 and Technology usage report
Week 6	Group project continue	Technology usage report
Week 7	Give survey 2 at the end of this week	Deliverable 2 and Technology usage report
Week 8	Group project continues	Technology usage report
Week 9	Group project ends; give survey 3 at the end of this week	Deliverable 3 and Technology usage report

Lessons Learned from Pilots

Prior pilot studies revealed several issues related to the study design.

1) The technologies chosen in the study are a good choice for the purpose

of the study[20]. Pilot 1 revealed that students were content with Google Sites to develop their business plan. Students felt enthusiastic about the various capabilities Google Sites offers in terms of project management, as well as web site design. In the second pilot study, Gmav, Blackboard, and Google Sites provided necessary capabilities for virtual teams to collaboratively work on the team project. Again, the experience with Google Sites was reflected as user friendly in the students' self-report. Because of the limited control of the study on the subjects, recordings of these synchronous voice chat meetings were not requested of the students. But the reflections of the usage experience with these voice chat tools were included in the technology usage reports. Therefore, I can have a sense of the general topic that had been discussed in the team meetings.

2) The project was appropriate for the purpose of this study. During the project, students had to engage in team communication, collaboration, and interaction to finish the project. All virtual teams studied in the second pilot generated various amounts of team communication that was necessary for their virtual team project accomplishment.
3) Establishing a case study protocol is useful to ensure the reliability of the case study.
4) A brief introduction to all features available in the three technologies

[20]Occasionally, students used cell phone, Skype call, or Google Talk those synchronous chat tools for team meeting.

should be included. In the pilot study conducted the fall 2011, the team's activities on the BB site and Google Sites, as well as the examination of students' weekly technology usage reports, showed that not all teams were actively exploring the diverse features of the technologies. One team used the BB collaboration feature for team meetings and recorded sessions. The team members all liked this chat tool and recording function very much. However, the other teams either never tried the feature or tried one time without recording the session. One explanation could be that the other teams thought their teamwork was fine without the use of BB chat. But another explanation could be that they did not know that BB chat can record and is easy to use. In the full study, participants were provided a list of functionalities and assigned to use each of the three areas of IT capabilities. Table 5 provides such a list. This list was given to participants in the first week of the project.

Table 5

IT Capabilities of Technologies

IT Capabilities	Email, Blackboard, and Google Sites Functionalities
Communication	Email: 1. Emails exchanging 2. Attaching documents Blackboard: 3. Collaboration (online chatting) 4. File exchange 5. Group Discussion Board 6. Group Wiki 7. Send Emails Google Sites 8. Designing your own forum or using various apps available in Google Sites.
Team Process	Email: 1. Exchanging emails 2. Storing and searching emails 3. Storing and searching contacts information Blackboard: 4. Group Discussion Board 5. Group Wiki 6. Group Journal 7. Group Tasks Google Sites: 8. Group Calendar 9. Creating your own brainstorming forum 10. Deliverables management 11. Other apps that help you keep track of your project
Interaction	Email 1. Attaching files Blackboard: 2. File exchanging 3. Group Blog Google Sites: 4. Web page creating, editing, and deleting 5. File cabinet 6. Adding your own apps; e.g., weather report, Youtube video, Google Maps.

5) The technology usage report needed to be revised because students felt burdened with a weekly report. The pilot study data analysis suggested

that some information, such as amount of time/frequency of use, can be collected through direct observations. Therefore, in the full study, the technology usage report was reduced from six questions to four. Questions about the IT capability and total amount of time/number of times were removed, because answers to these two questions can be obtained through the archival records in each of technologies.

6) Students needed to specify the specific IT features they used in their technology usage report.

4.2.2. Data Collection

A special benefit that a case study offers is the collection of multiple types of data for a richer understanding of the study phenomenon and the study context. However, the complex nature of the case study data can also lead to biased study conclusions when the data are not properly collected, managed, and analyzed. Pilot case studies improved the data collection to be conducted in the full study.

In general, consistent with Yin's (1990) suggestion, the pilot study collected both qualitative and quantitative data from multiple sources to expect the evidence converge in the end. Specifically, in pilot study 2, data were collected in the following ways:

1) Surveys: three surveys were administered through emails during the project.
2) Communication data: Gmav, Blackboard posts, Google Sites posts.
3) Technology usage reports: turned in individually each week. Questions

asked in the report were: what technology capabilities did you use? What were your goals for using that technology capability? What were your reflections on the use of that technology capability?

4) Google Sites activities log: the log can be downloaded from the Google Sites through activities history.

Lessons Learned from Pilots

In terms of data collection, the following lessons were learned from the pilots.

First, surveys and/or in weekly technology usage reports may have missing data.

Second, the qualitative data must be organized by using separate file folders to store each of the different types of data, such as the communication data, the technology usage report, and the Google Sites activities logs. Then subfolders should be created to store the specific data for each virtual team. For example, I created a subfolder for virtual team 1 to include all of the technology usage reports by virtual team 1.

Third, participants varied in the degree of being reflective and elaborative when filling out the questionnaire. Some answers were found to exaggerate in either a negative or positive way in terms of IT capability usage. But most of the answers were non-biased and honest when I checked with other members' reports of the team and double checked the actual IT capability usage records. Occasionally, participants did not turn in their questionnaire during the process. So there were missing

questionnaires from the participants. In the full study, I double checked the technology usage by comparing technology usage digital traces with the technology usage report.

4.2.3. Data Analysis

Both quantitative data analysis on the survey and qualitative data analysis on all the qualitative data were conducted.

Common statistical analysis methods on survey data were used. Methods included the descriptive statistical analysis, non-parametric correlation analysis, and scatter plot display of the variables of interest.

For the analysis of qualitative data, a general data analytical strategy was developed based on Miles and Huberman's (1994) suggestion. First, the qualitative data were compiled based on each of the constructs of interest. Then data were reviewed carefully. Finally, findings were generated based on the examination of the compiled data.

Lessons Learned from Pilots

The following were the lessons learned from pilots in terms of data analysis.

First, coding scheme should be revised based on observation of the real data, especially on the Google Sites activities log.

Second, qualitative data needs to be compiled on each of the major constructs for each of the cases, so that a chain of evidence can be built when answering the research questions.

Third, specific tactics for qualitative data condense needs to be adopted to

help capture the interplay between adaptive use of IT capabilities and shared mental models convergence in virtual teams.

Fourth, the study should consider using both correlation analysis and visual display for analyzing survey data.

4.2.4. Pilot Study Results

Prior to the discussion of the preliminary findings of the pilot, reliability and validity of the measures must be acknowledged. The reliability and validity of the qualitative measurements on variables were achieved by building a database, using coding schemes, and yielding a chain of evidence. The instrument consisted of scales adapted from other studies; therefore, statistical validation of the instrument is out of the scope of this dissertation study.

During the pilot study 2, a total of 67 technology usage reports were collected, including a total of 165 pages. In addition, 20 pages of Google Sites activities log, 40 Blackboard posts, and a total of 24 valid surveys were collected.

Table 6 shows the means (responses were all measured on a scale of 1 to 7, with 7 highest) and standard deviations for each of the variables on time 1, time 2, and time 3 respectively.

Table 6

Summary of Descriptive Statistics of Pilot Study 2

Constructs	Time 1		Time 2		Time 3		All time	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Inclusiveness	5.86	0.55	5.13	0.28	4.91	0.58	5.30	0.60
Fit	4.00	1.00	3.59	0.66	3.90	1.23	3.83	0.89
AUITC	4.93	0.24	4.36	0.40	4.41	0.91	4.57	0.58
Taskwork Mental Model	6.70	0.34	6.60	0.39	6.33	0.80	6.55	0.50
Teamwork Mental Model	6.11	0.78	5.73	1.14	5.04	1.10	5.63	1.26

Figure 2 and Figure 3show the relationships between virtual teams' adaptive use of IT capabilities and taskwork mental models convergence, and between teamwork mental models convergence, respectively. The dotted black lines were the means on AUITC, taskwork mental models convergence, and teamwork mental models convergence, respectively.

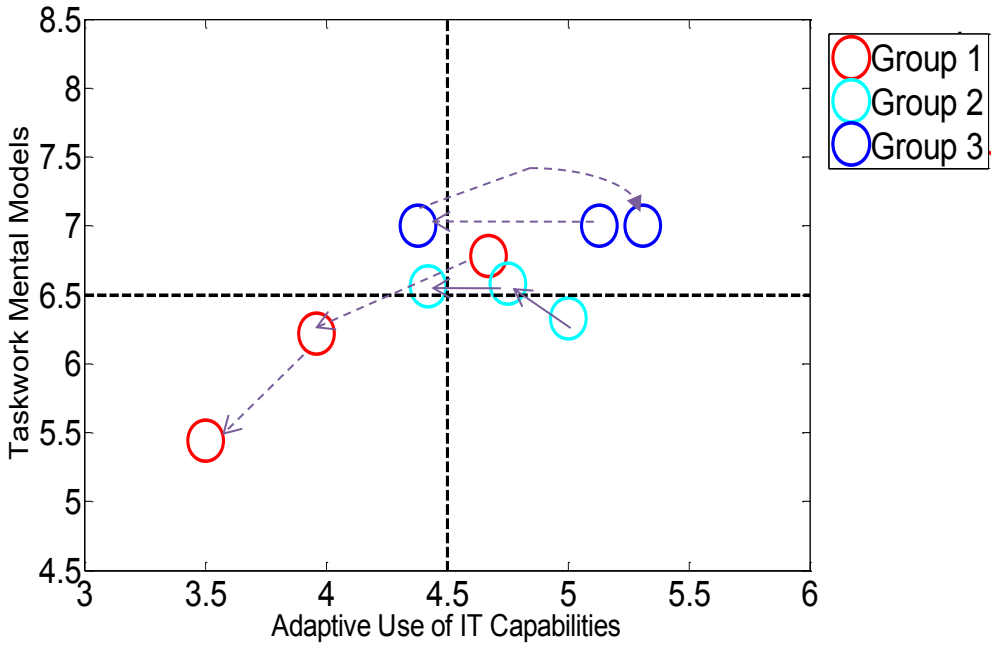

*Figure 2.*Scatter plot of adaptive use of IT capabilities and taskwork mental model convergence.

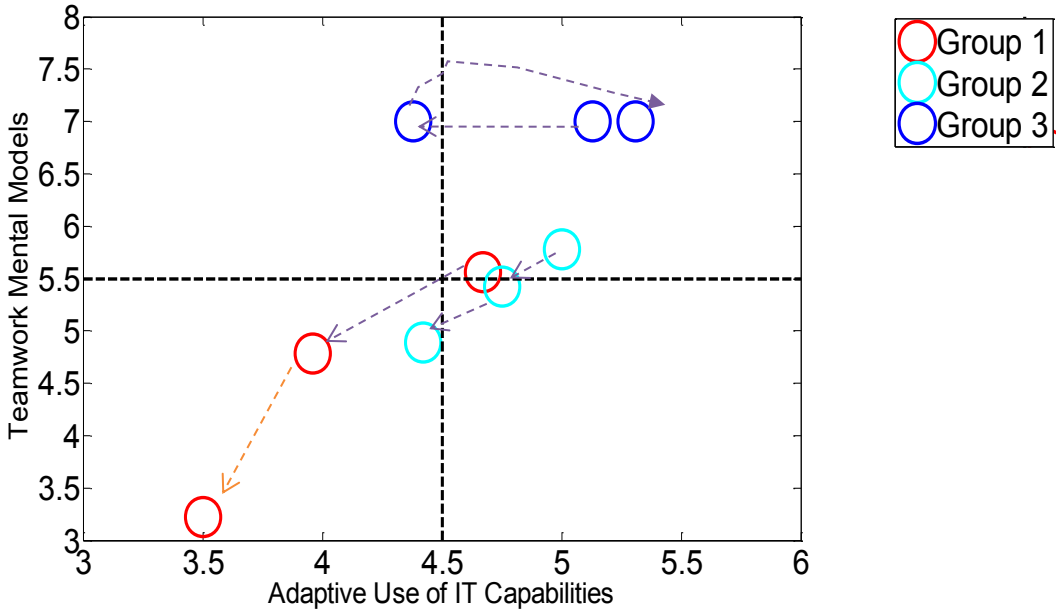

Figure 3. Scatter plot of adaptive use of IT capabilities and taskwork mental model convergence.

When both of the qualitative and the quantitative data of analysis were converged, results revealed an interplay relationship between virtual teams' adaptive use of IT capabilities and virtual teams' shared mental models convergence.

First, virtual teams' adaptive use of IT capabilities affected the development of specific shared mental models. Results showed that virtual teams relied on adaptive use of IT communication, team process, and interaction capabilities to converge on specific contents of shared mental models, such as the technologies' functioning and limitations, the task goals and steps to accomplish the tasks, and the team members' roles, skills, and knowledge background. For example, members of group 1agreed on the usefulness of Skype for synchronous team meeting by commenting:

> *Participate in real time communication with team members; we were able to hold a team meeting using this software and use voice to communicate; it allowed three-way talk which was beneficial; successfully met.*

Virtual team 2 established shared understandings on the task assignments and due dates through using the task management feature in Google Sites. In general,

preliminary findings from the pilot revealed a strong effect of the use of IT capabilities on the convergence of both taskwork mental models convergence, and on the teamwork mental models convergence.

Second, virtual teams' shared mental models convergence affected how virtual teams adaptively use IT capabilities. Specifically, the shared knowledge of how the tasks were to be done affected the choice of technologies to be used. For example, one of the tasks virtual team 3 collectively did was to share with each other about the self-introductions. After an examination of the task, as suggested by one of the team member, the team chose to use Blackboard Wiki for this specific task so that everyone could post and also edit others' posts. In addition, virtual teams' shared mental models on the technology's functioning and limitations influenced whether or not the team continuously used that particular technology. When virtual team 1 found a limitation of the Blackboard email (that is, they could not reply to all), the team turned to Gmav for email communication.

In summary, pilot results showed evidence for the interplay of adaptive use of IT capabilities and shared mental models convergence in virtual teams. The conduct of a full study helped gained an in-depth understanding of the interplay relationships among the constructs of interest.

4.3. Full Research Study

The full study design regarding the case study setup, the technologies, the virtual team project, and the general procedure of case study was the same as previously described in subsection 4.2.1. Thus, the following subsections describe the

data collection and measurement and the data analysis in the full study.

4.3.1. Data Collection and Measurement

To examine the interplay of the adaptive use of IT capabilities and shared mental models convergence in virtual teams, multiple types of data were collected to enrich the understanding of the constructs through data triangulation. Lessons learned from pilot studies in terms of data collection were incorporated in the full study data collection.

The following two subsections present what and how data were collected. In addition, the subsections include explanations of how the study constructs (i.e., AUITC-inclusiveness, AUITC-usage experience, AUITC-fit, SMM-taskwork mental model convergence, and SMM-teamwork mental model convergence) can be measured or assessed through the collected data.

4.3.1.1. Qualitative data collection

In the full study, different types of qualitative data were collected to trace the process of virtual teams' adaptive use of IT capabilities and shared mental models development.

Qualitative Data Source 1: Technology Usage Report

Prior to the beginning of the virtual team project, a template for technology usage report, as well as general description of the purposes of the technology usage report, was provided in a Blackboard assignment folder. Students could download the template from the Blackboard. At the end of each week, each participant was asked to turn in that technology usage report.

The technology usage report contained open-ended questions ranging from what specific IT capability was used during that week to whether the use of that specific IT capability fulfills the initial goal(s).

Based on the lessons learned from pilots, at each week, technology usage reports for the same virtual team were put together at a subfolder of the technology usage report folder.

Qualitative Data Source 2: Communication Data

All textual-based team communication data were collected. Team communication data include emails, Blackboard Discussion Board posts, Blackboard Blog posts, Blackboard Wiki posts, Blackboard Journal posts, and Google Sites-enabled communication. Teams' interactions with IT, such as file attachment, or task assignment activities, were also considered as a special type of communication data. Virtual teams' volunteer use of other technologies, such as cell phone, Google Talk, and Skype were not recorded because of limited control of the study on the subjects.

Qualitative Data Source 3: Google Sites Activities

Google Sites activities log can be obtained through downloading the activities history on the Google Sites.

Examples of Logs in Google Sites are shown in the following:

Nov 7, 2012 5:53 PM XXX edited an item in Tasks
Nov 4, 2012 8:54 PM XXXX edited an item in Tasks
Nov 4, 2012 7:42 PM XXX edited an item in Tasks
Nov 4, 2012 7:36 PM XXXX edited Welcome To Webcolamities
Nov 4, 2012 7:34 PM XXXX edited Welcome To Webcolamities

Constructs were assessed based on examination of all three types of

qualitative data.

4.3.1.2. Quantitative data collection

The quantitative data of the study were collected from three separate surveys administered through Blackboard at three time points, time 1, time 2, and time 3.

Each of the three surveys contained the same questions related to adaptation of IT capabilities (adapted from Sun & Zhang, 2008), and shared mental model convergence (adapted from Entin & Serfaty, 1999; R.L. Wakefield et al., 2008). Based on the literature review on AUITC and SMM, this study adapted Sun's (2009) study to quantitatively assess AUITC of a virtual team. For SMM, the study adapted Wakefield et al.'s (2008) study to measure the taskwork mental model convergence and adapted Entin et al.'s (1999) study to measure the teamwork mental model convergence.

The surveys (Blackboard introduction is shown in Figure 4) were administered online through Blackboard. A brief description of the purpose of the survey, an approximate length of time to be taken to finish the survey, and the ethical considerations of taking the survey were included at the entry page of each survey.

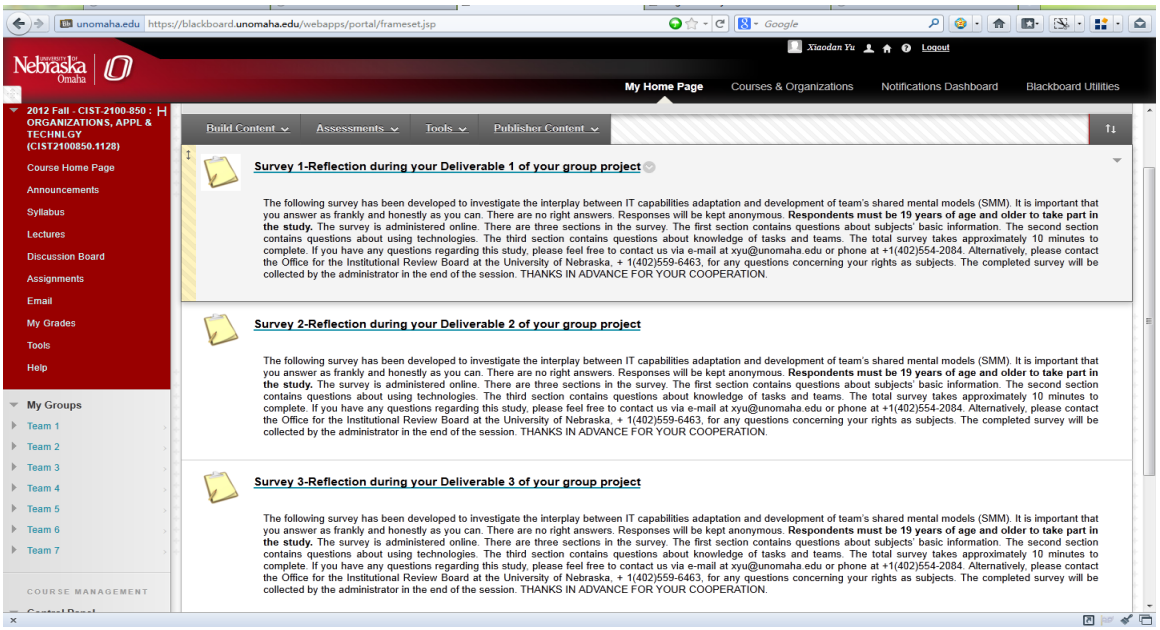

*Figure 4.*Blackboard introductions of the surveys.

Nunnally (1978) suggests that experimental procedure bias is one of the major types of bias that occur in common behavioral research. One major source that can contribute to procedure bias is the timing of when tests are administered. Psychology research found that one's capability of recall information is greatly influenced by the environmental context. This finding is called *context effect*(Brown & Daniel, 1987). Specifically, people recall a piece of information better when they are within the same environment where that piece of information was initially stored into one's mind. Since all three surveys asked participants to respond based on their recall of previous team activities, caution should be taken to address this *context effect* of our human mind about the environment.

To control the procedure bias because of *context effect*, participants of the study were, therefore, encouraged to finish the survey within a short timeframe[21].

The first survey was delivered at the end of week 3 when all teams had just

[21]Most participants submitted the survey within one day after the survey was accessible, and a few turned in the surveys in two days after the surveys had been posted

turned in their first deliverable of the team project. The second survey was given at the end of week 5 when teams finished their second deliverable of the project. The third survey was administered at the end of week 7 when the participants turned in their last deliverable of the project. Administering surveys online has the advantage of easy accessibility for participants who do not have a face-to-face meeting time during the entire project. An example of the online survey is shown in Figure 5.

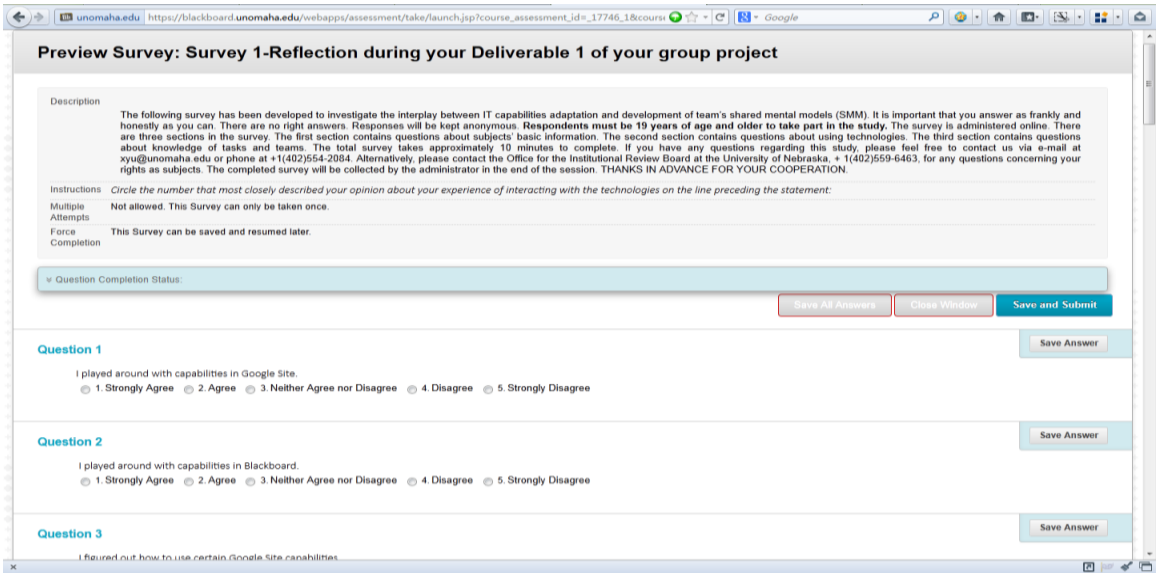

Figure 5. A snapshot of survey administeredin the Blackboard.

4.3.2. Qualitative Data Analysis

General analytical strategies suggested by Miles &Huberman(1994)were followed.

Step 1: Coding

The first step with qualitative data analysis was to code all of the three types of qualitative data, i.e., the technology usage report, the communication data, and the Google Sites activities.

Coding helps to retrieve and organize the large amounts of qualitative data (Miles & Huberman, 1994). The coding scheme was developed based on this study's

conceptual framework and research question. To develop the coding scheme, a list of coding categories was first created and included adapted definitions from previous literature. Then a few changes were made based on observations from the pilot study 2. For example, word or phrase indicators of codes were added to the coding scheme after discussion with the dissertation advisor.

The coding process followed the conventional advice (Miles & Huberman 1994) that suggests researchers go through the documents with a pencil, marking off chunks of words according to the coding rules. The coded documents helped the researcher to quickly find, pull out, and eventually enter the data into a time-ordered matrix, which is discussed in the next step.

Specifically, evidence was collected and organized on each of the constructs.

Step 2: Building out the Time-Ordered Matrix

A time-ordered matrix display was built to analyze the coded data.

Table 7
Template of the Time-Order Matrix

Construct	Sub-Construct	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9
AUITC	AUC-UE							
	AUT-UE							
	AUI-UE							
SMM	Taskwork							
	Teamwork							
CM	Leader							
	VT							
Notes								

As suggested by Miles and Huberman (1994), a time-ordered matrix is useful in building a valid chronology by identifying those salient preceding events for following events. In a time-ordered matrix display, the columns are usually arranged by time period, and the rows depend on the concerns of the researchers. The time-ordered matrix has the advantage of preserving the historical chronological flow and is helpful in getting an understanding of the flow of events of interest rather than getting "snapshots." The chronological flow is important to this study because it helps researchers discover whether the AUITC facilitates the SMM convergence or whether the SMM convergence led to the subsequent AUITC by virtual teams. Moreover, keeping the chronological flow also helps to tell when the influences of AUITC on SMM and the influences of SMM on AUITC occur. Therefore, one can tell whether the interplays of AUITC and SMM randomly occur across the entire duration of team project process or tend to occur at a specific time during the team process.

To apply the time-ordered matrix display to the purpose of this study, the columns were arranged by week, from the first week to the last week of the case study project. According to the pilot study, the time period of week was a good fit in this

dissertation study because "week" can capture the separate events that this dissertation study wants to keep in sequence rather than blending all events together. Choosing "week" as the time period is also doable because collecting data weekly requires reasonable efforts from study subjects and the researcher.

According to the research question, the processes of interest identified in this study included how virtual teams adaptively use IT capabilities over time, how virtual teams' shared mental models converged over time, and how virtual teams' AUITC and SMM convergence interacted with each other over time.

Based on the theoretical framework, two major components were identified and were used as rows of the matrix. The AUITC components captured the virtual teams' adaptive usage behaviors with respect to three types of IT capabilities. The SMM components included two types of SMM contents suggested by previous literature. Besides the above two components, as the pilot study revealed, a third component, virtual team communication characteristics (including the virtual team leader's role and virtual teams' characteristics in general), was added. Furthermore, one row for documenting the field notes was added.

Step 3: Entering Data

Specific rules for entering data to the time-ordered matrix were developed according to the pilot data analysis experience. For each week, if a change in a component occurs, a short description of the change was entered. A blank cell means no change occurred for a specific component at a specific time period. Through this way of displaying data, the flow of events in the study became visible and valid.

This study was at the team level of analysis. Considering the virtual teams in this study have three members in each, this study used the decision rule that if a reported change with respect to AUITC was confirmed by at least one team member and not disconfirmed by the other team members, this change should be entered in the matrix. Further, if at least two team members reached agreement on knowledge about the equipment, the task, the team interaction, and the team, these shared understandings should be entered in the matrix. Such words as "yes, OK, makes sense, I agree, and same here" indicated a shared understanding among the team. This approach of assessing shared mental model convergence is consistent with previous literature (S. McComb et al., 2010).

Step 4: Interpreting Time-Ordered Matrix

Miles and Huberman (1994)suggest that among myriad ways of condensing the time-ordered matrix, one viable approach is to name the several identified drifts or changes in the time-ordered matrix.

4.3.3. Quantitative Data Analysis

First, the raw survey data were converted into numbers on a scale of 1 to 5. An example of the raw survey data is shown in Figure 6.

Question ID 1	Answer 1	Question ID 2	Answer 2
Question ID 1	Agree	Question ID 2	Agree
Question ID 1	Strongly Agree	Question ID 2	Strongly Agree
Question ID 1	Strongly Agree	Question ID 2	Disagree
Question ID 1	Agree	Question ID 2	Agree
Question ID 1	Agree	Question ID 2	Strongly Agree

Figure 6. An example of raw survey data.

The raw survey data contained missing data. The missing data were carefully examined and compared with the non-missing data. No skip pattern was

found. Therefore, I imputed all missing data by using means on the neighbors of that data. Since the number of the missing data was small (less than 1%), the influence of the imputed data on the final results is little to none.

The imputed data were then converted into a SPSS file for further analysis. The complete surveys contained 48 entries with 30 items.

After processing the data into matrix form, I first conducted reliability and validity tests on the survey instruments. Then descriptive statistics and correlation analysis were conducted on the survey data. Scatter plots were used to display the interplay relationship between adaptive use of IT capabilities and shared mental models convergence in virtual teams.

4.4. Summary of Chapter 4

This chapter presented the detailed research method taken in this study. I took the case study as the research method. Pilot cases were conducted for refining of the research design and study procedure. Detailed description of how data were collected and analyzed was presented.

CHAPTER 5: ANALYSIS OF RESULTS

This chapter first presents an overview of the data collected from the dissertation study followed by a description of each case. Results of qualitative data analysis are presented on each of the constructs examined in the study. Next, the analysis of the quantitative data obtained from the survey is presented. Data were triangulated then and key findings were summarized and briefly discussed in the end.

5.1. Overview of Cases

Five cases were examined in the dissertation study. Table 8 summarizes the business goals of e-commerce[22] that each virtual team pursued and provides the Google Sites web site address of each team.

Table 8
Description of Virtual Team Projects

Team	Content	Details
Team 1	Business	Provide both quality and affordable programming services.
	Web site	https://sites.google.com/a/unomaha.edu/team-2-project/
Team 2	Business	Build an online community for people to learn more about plants.
	Web site	https://sites.google.com/a/unomaha.edu/team-4/
Team 3	Business	Gather quality review from university students about teachers.
	Web site	https://sites.google.com/a/unomaha.edu/team-5-site/home
Team 4	Business	Deliver domestic logistics service for vehicles transportation.
	Web site	https://sites.google.com/a/unomaha.edu/cist2100-850-group6-project/home
Team 5	Business	Make customized tablets for health care providers and government officers.
	Web site	https://sites.google.com/a/unomaha.edu/team-7/

Table 9 and Table 10 provide summaries on different types of qualitative

[22]E-commerce (interchangeable with e-business) refers to "the use of digital technology and the Internet to execute the major business processes in the enterprise."(Laudon & Laudon, 2010, p.55)

data collected per each team.

Table 9
Summaries on Technology Usage Reports (TUR)

Team	Team Size	Total TUR(missing TUR)	Total Pages
Team 1	4	25(3)	29
Team 2	3	21	24
Team 3	3	20(1)	21
Team 4	3	18(3)	24
Team 5	4	21(7)	21
Total		105(14)	119

Table 10
Summary of IT tools Usage per Team

IT Tool	Team	Quantity
Email	Team 1	40 emails
	Team 2	26 emails
	Team 3	25 emails
	Team 4	22 emails
	Team 5	31 emails
	Total	146 emails
Google Sites Activities Logs	Team 1	7 pages
	Team 2	6 pages
	Team 3	5 pages
	Team 4	5 pages
	Team 5	7 pages
	Total	30 pages
Blackboard	Team 1	6 posts
	Team 2	41 posts
	Team 3	4 posts
	Team 4	64 posts
	Team 5	2 posts
	Total	117 posts

Qualitative data were organized into three documents respectively, namely technology usage, communication data, and Google Site activities. Table 11 gives the description of the three documents.

Table 11
Total Amount of Qualitative Data

Document	Description	Pages
Technology Usage	Contains technology usage reports for all teams and presents the data week by week for each team.	43
Communication Data	Contains all of the communication data for each team.	60
Google Sites Activities	Contains teams' activities history related to Google Sites.	33

In addition to the qualitative data collected, at the end of the dissertation full study, a total of 48 valid surveys were collected.

For the convenience of discussion, team members' names[23] are as follows:

Virtual team 1: Michael (Leader), Nancy, Tom, and Susan.

Virtual team 2: David (Leader), Mary, and Tom.

Virtual team 3: Matthew (Leader), Ryan and Lisa.

Virtual team 4: Sarah (Leader), Jeff, and Rice.

Virtual team 5: John (Leader), Sam, Dan, Jay.

5.2. Qualitative Case Evidence

The following sections present major results on each of the constructs using the qualitative data analysis steps presented in subsection 4.3.2. Specific questions were used to ensure the qualitative results on each of the constructs were narrated consistently across teams. First, specific questions along with the data sources of the answers are presented and then the results from each of the cases are detailed. This

[23]Original names were not used to assure confidentiality. The pseudonyms do reflect the gender of the actual participants.

way of presenting the qualitative evidence presents a holistic view of each of the constructs and avoids biases from focusing on results from one specific case. These qualitative results provide an important foundation from which the interplay of relationships between the adaptive use of IT capabilities and shared mental models convergence are interpreted.

5.2.1. Construct: AUITC-Usage Experience

Table 12 listed the specific questions used for presenting results on usage experience and the sources where the answers were found.

Table 12
Specific Questions Asked When Condensing Data for Usage Experience

ID	Question	Document
1	What specific technology capabilities did the team use	Technology Usage
2	Is there a(set of) dominant IT tools? Any reasons?	Technology Usage Communication Data
3	When and how often did the team usually use the technology? Did the team keep the level of IT use unchanged over time, increase or decrease?	Communication Data Google Sites Activities
4	Any active participant? Any inactive participant? Was the team's technology use affected by team's interaction?	Communication Data
5	Did the team hold an attitude toward the technology? Enjoyment, dislike, default choice, a surprise?	Communication Data Technology Usage

5.2.1.1. Compiled evidence on usage experience for virtual team 1

Virtual team 1 used six IT tools: email, Google Chat, Google Sites file attachment, Google Sites Task Management, Blackboard Discussion Board, and Blackboard Journal. Prior knowledge and habits of using IT tools influenced how virtual team 1 built up their initial teamwork tool-box. One member explicitly showed a preference for Google Talk in the first week and was actively involved in every Google Talk chat after that. In the beginning week of team project, all members

turned to the Blackboard Discussion Board for information. One team member tried Google Talk herself and thought the tool was useful for future team collaboration. After two weeks' interaction, virtual team 1 collectively established a set of IT tools for managing their teamwork activities and accomplished the task.

The usage of IT capabilities, especially the IT interaction capabilities by which most of the team tasks were done, mostly peaked near the due date of each project deliverable. The intense use of IT interaction capabilities, in Google Sites, was accompanied by constant use of IT team process capabilities (Google Sites Task Management and Email) both before and after each interactive activity with Google Sites, according to the Google Sites activities log. The following example showed team members updated progress on their assigned work through the Google Site Task management.

Example [from Google Sites Activities]:

Oct 7[24], 2012 6:50 PM Nancy created Executive Summary
Oct 7, 2012 6:51 PM Nancy edited Executive Summary
Oct 7, 2012 6:55 PM Susan edited What we do
Oct 7, 2012 6:55 PM Michal edited About the Company
Oct 7, 2012 7:09 PM Nancy edited an item in Tasks
Oct 7, 2012 7:09 PM Michal deleted Email_Page_Untitled
Oct 7, 2012 7:11 PM Susan edited an item in Tasks
Oct 7, 2012 7:44 PM Susan edited What we do
Oct 7, 2012 7:53 PM Michal edited an item in Tasks
Oct 7, 2012 7:50 PM Michal edited About the Company

With regard to the communication capabilities, team 1 preferred to use synchronous chat tools for clarifying task goals and making task plans.

Example [from Communication Data]:

We have a deliverable due on 9/30, and need a way to discuss our online

[24]Due date of first group deliverable.

business and our plans. Michael suggested we use google talk, which works well enough for me. Does that work for everyone?

The team preferred to use asynchronous IT communication capabilities, such as emails and BB Discussion Boards, for coordination tasks, team updates, and team assignments. The following is an example of email message of the team.

Example [from Communication Data]:

The next coordination task is what time and days work for the team? I'm available after 6:30 Central Time Monday - Friday and any time Saturday and Sunday.

Please let me know your preferences.

Over time, the team showed a clear decrease of frequency using the communication capabilities. Meanwhile, virtual team 1 had a relatively low usage on the interaction and team process capabilities at time 1, but a high usage on the use of these two types of IT capabilities at time 2 and 3 (shown in Table 13 and Figure 7).

Table 13

Counts of the Instances on IT Capabilities Usage for Virtual Team 1

Time	Day	Date	Interaction	Team process	Communication
1	7	23-Sep	8	3	3
1	8	24-Sep	0	3	3
1	9	25-Sep	0	2	2
1	11	27-Sep	0	0	1
1	12	28-Sep	0	0	0
1	14	30-Sep	1	0	2
1	17	3-Oct	0	0	3
1	19	5-Oct	2	1	0
1	20	6-Oct	2	5	0
1	21	7-Oct	30	10	5
Total count on time 1			43	24	19
2	22	8-Oct	0	5	0
2	32	18-Oct	0	1	1
2	33	19-Oct	2	0	0
2	34	20-Oct	7	10	1
2	35	21-Oct	104	7	1
2	36	22-Oct	0	4	4
Total count on time 2			113	29	7
3	47	3-Nov	0	11	0
3	48	4-Nov	49	2	1
Total count on time 3			49	13	1

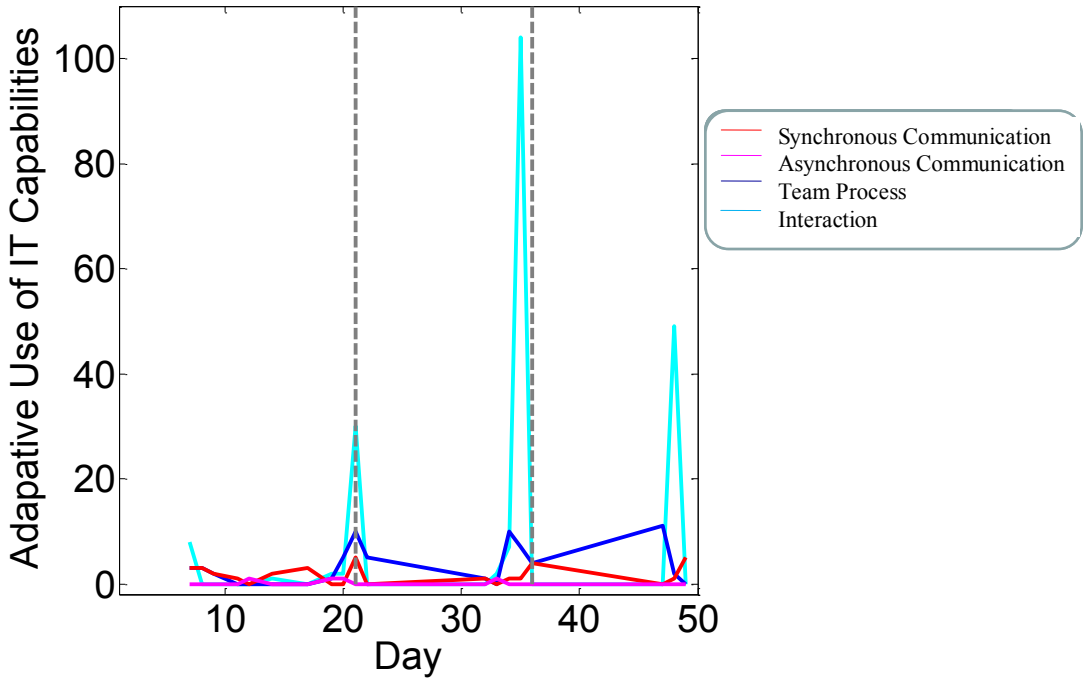

Figure 7.The line chart of the IT capabilities usage for virtual team 1.

5.2.1.2. Compiled evidence on usage experience for virtual team 2

Virtual team 2 mainly used email, Blackboard Discussion Board, Google Sites task management, and Google Sites interactive page editing features to accomplish the project. Blackboard Discussion Board was the most used tool for team process and communication. Google Sites was the dominant tool for interaction capabilities usage. The technology usage during the beginning week of the project was driven by the purpose of getting initial contact and exploring those new capabilities. Mary said Google Sites was a new tool to her, so she explored the features in Google Sites in the first week.

Example [from Technology Usage document]:

> *[Mary]: This technology will be used to keep all of the final information for our projected. My goal is to have this page fully utilized by all team members. I also want to keep this as clutter free as possible. This week's goal was to get to know the features since I have never used this technology before.…My goal is complete. I received the link from my team member and browsed the site. I brainstormed some ideas on how it can be used for the project. Once*

we finalize our overall theme, I'm hoping to put my research into action.

Team members' prior usage with technology and the on-going first-hand experience with technology both affect the amount of time and frequency with using the technology.

First, during the beginning of the project, David explicitly announced his preference over Blackboard for a central place to communicate in a post. Mary then quickly responded to his post and agreed to use Blackboard Discussion Board for team communication and team process.

Example 1 [from Communication Data and Technology Usage Report]:

[David]: I'm open for any form of communication-I'm mostly fond of Discussion Boards, but e-mail or instant messaging is fine too.(a post at BB Discussion Board)

[Mary]: A team member and I both posted on the message board this week to start brainstorming ideas. I like this communication avenue the best because unlike my email, it does not get cluttered with information from my other classes. My goal is met.

Blackboard Discussion Board was consistently used for brainstorming ideas, storing relevant information. Over time, BB Discussion Board's usage had been expanded for making decisions, assigning tasks, and updating team progress.

In addition to prior usage, another factor influencing the usage of technology was the concurrent interacting experiences with technologies. Unsuccessful usage experience of a technology by the team resulted in abandoning that technology eventually. For example, Google Sites calendar was first tried by the team in the beginning weeks of the project in a hope to facilitate the overall team process. But after two of the team members found that updating events on the Google Sites calendar was not successful, Google Sites calendar was not used. Instead, the team

used Google Site Task management to assign tasks and to monitor the progress.

Example [from Google Sites Activities]:

Sep 24, 2012 10:26 PM	*Mary added an item to Tasks*
Sep 24, 2012 10:27 PM	*Mary deleted an item from Tasks*
Oct 6, 2012 11:40 PM	*David edited an item in Tasks*
Oct 6, 2012 11:50 PM	*David attached snip.JPG to Deliverables*
Oct 6, 2012 11:52 PM	*David edited Deliverables*
Oct 6, 2012 11:54 PM	*David added an item to Tasks*

Table 14 shows the usage of IT capabilities during the project at time 1, 2 and 3, respectively. The results show that virtual team 2's usage on IT interaction capabilities steadily increased over time, while the usage of team process capabilities and team communication capabilities both significantly decreased from time 1 to the other two periods of project. The use of team communication capability only increased slightly during the time 3.

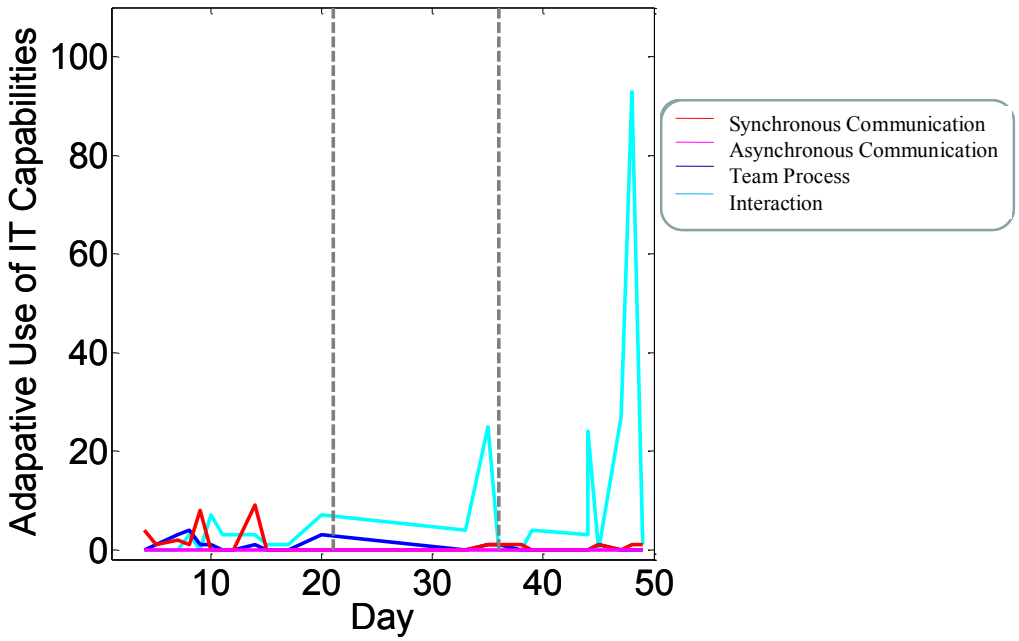

Figure 8. The line chart of the IT capabilities usage for virtual team 2..

Table 14

Counts of the Instances on IT Capabilities Usage for Virtual Team 1

Time	Day	Date	Interaction	Team process	Communication
1	4	20-Sep	0	0	4
1	5	21-Sep	0	1	1
1	7	23-Sep	0	3	2
1	8	24-Sep	3	4	1
1	9	25-Sep	0	1	8
1	10	26-Sep	7	1	0
1	11	27-Sep	3	0	0
1	12	28-Sep	3	0	0
1	14	30-Sep	3	1	9
1	15	1-Oct	1	0	0
1	17	3-Oct	1	0	0
1	20	6-Oct	7	3	0
Total count on time 1			28	14	25
2	33	19-Oct	4	0	0
2	35	21-Oct	25	1	1
2	36	22-Oct	0	1	1
2	38	24-Oct	0	0	1
2	39	25-Oct	4	0	0
2	44	30-Oct	3	0	0
2	44	30-Oct	24	0	0
Total count on time 2			60	2	3
3	45	31-Oct	0	1	1
3	47	3-Nov	27	0	0
3	48	4-Nov	93	0	1
3	49	5-Nov	1	0	1
Total count on time 3			121	1	3

5.2.1.3. Compiled evidence on usage experience for virtual team 3

The dominant communication tool that virtual team 3 used was email. Other tools the teams used were Blackboard Discussion Board, Google Sites calendar, and Google Sites interaction capabilities related to the task.

In the beginning of the project, Sam initiated the first round of team communication through making a post on the Blackboard Discussion Board. However, the post Sam made did not get a quick response.

Example [from Communication Data]:

[Ryan] Hello…! I'm a little late to the game this week but I went ahead and entered my bio on the home page of our site.
[Matthew]Hey Guys, sorry I got on this late. It looks like our first group assignment due this Sunday the 30th.

Observing the delayed response from the team on the posts of Blackboard Discussion Board, Lisa figured this problem out by including the post in an email and sent it out to the rest of the team. The team agreed that email worked the best for the team in terms of team communication. Quick access to email was one of the most important reasons for the adoption of email. A majority of the team acknowledged they had access to email through their cell phones, which made checking emails easier.

Example [from Communication Data]:

[Matthew] I can be contacted by email or phone: [student's email] or [student's phone]. I am a senior in Computer Engineering and am at PKI everyday, usually in the morning. I'd say it would be better to get this assignment done early with effectiveness. Feel free to contact me through email or this thread/forum designated for our group. I look forward to working with you guys.

[Ryan] I am best reached via email. My UNO email address is fine [student's email] to reach me, as I have it linked to my phone. I am comfortable with Google Sitess too so I am happy doing that work, in case either of you has any issues with it.

Let's get started brainstorming on our online business idea (either here in the Discussion Board or via email) and please add your bio to the Google Sitess Homepage (accessible from Gmav.unomaha.edu).

[Matthew] I put mine on blackboard as well, but I think email will work better for me because I get notifications and email through my phone. So email communication works great for me.

[Sam]I check blackboard at least every 48 hours but I check email every hour or so because it links to my personal/work account so I would prefer we use email instead of blackboard for communication (and lets be honest blackboard has a terrible email system)

The team also tried to use Google Sites task management to manage their key deliverables along with the due dates for the project. But the team did not use that feature for task updates.

Another notable pattern for virtual team 3 was the team response time; except for the beginning weeks of the project, the team generally got quick response from their team members. This pattern was consistent with the results shown in Google Sites Activities, in which the team interacted in a smaller number of days on the tasks than the other teams. Figure 9 and Table 15 shows how the use of diverse IT capabilities varied over time. In general, the team communicated more frequently and engaged in more team process tasks during time 1.

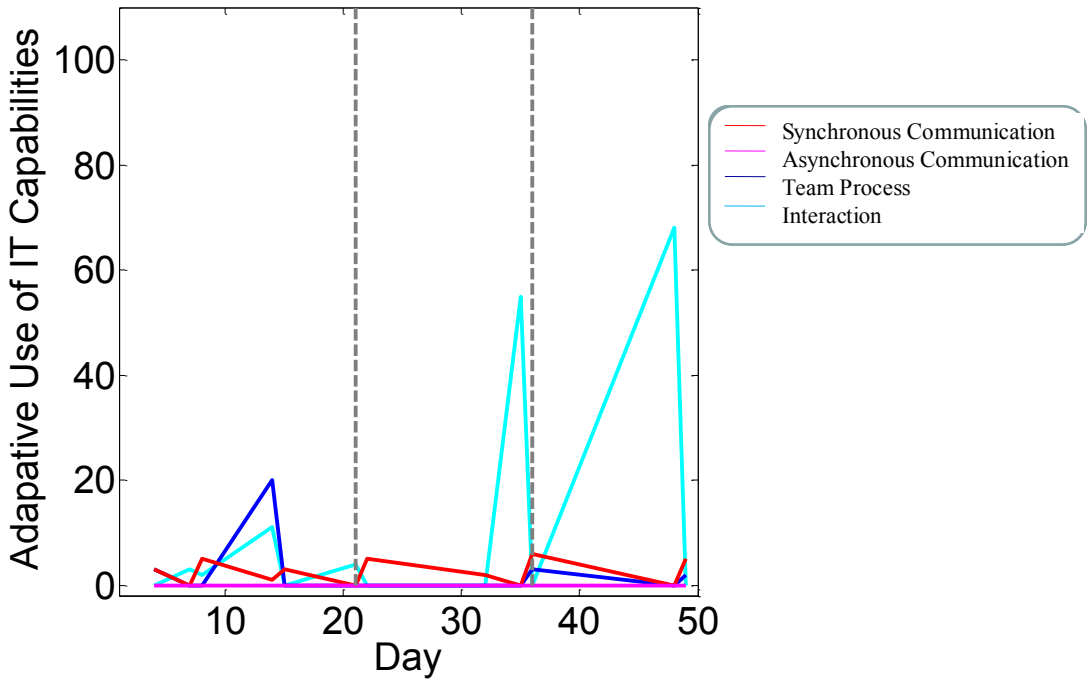

Figure 9. The line chart of the IT capabilities usage for virtual team 3.

Table 15

Counts of the Instances on IT Capabilities Usage for Virtual Team 1

Time	Day	Date	Interaction	Team process	Communication
1	4	20-Sep	0	3	3
1	7	23-Sep	3	0	0
1	8	24-Sep	2	0	5
1	14	30-Sep	11	20	1
1	15	1-Oct	0	0	3
1	21	7-Oct	4	0	0
Total amount			20	23	12
2	22	8-Oct	0	0	5
2	32	18-Oct	0	0	2
2	35	21-Oct	55	0	0
2	36	22-Oct	0	3	6
Total amount			55	3	13
3	48	4-Nov	68	0	0
3	49	5-Nov	0	2	5
Total amount			68	2	5

5.2.1.4. Compiled evidence on usage experience for virtual team 4

During the project, the team used a variety of tools, including email, Blackboard Discussion Board, BB journal (as is shown in Figure 10), BB task management (as is shown in Figure 11), BB file attachment, Google Sites task management, Google Sit file cabinet, and Google Sites interaction capabilities related to accomplishing the tasks.

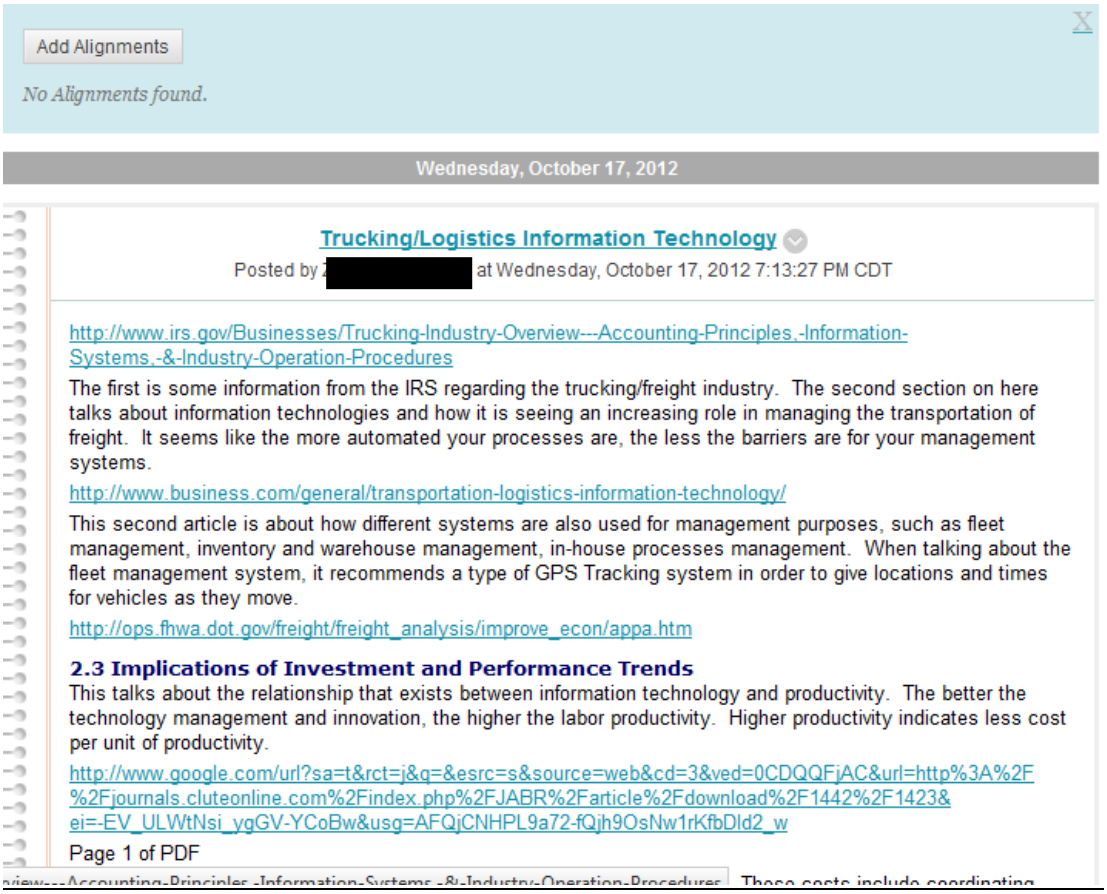

Figure 10.Virtual team 4 used Blackboard Journal.

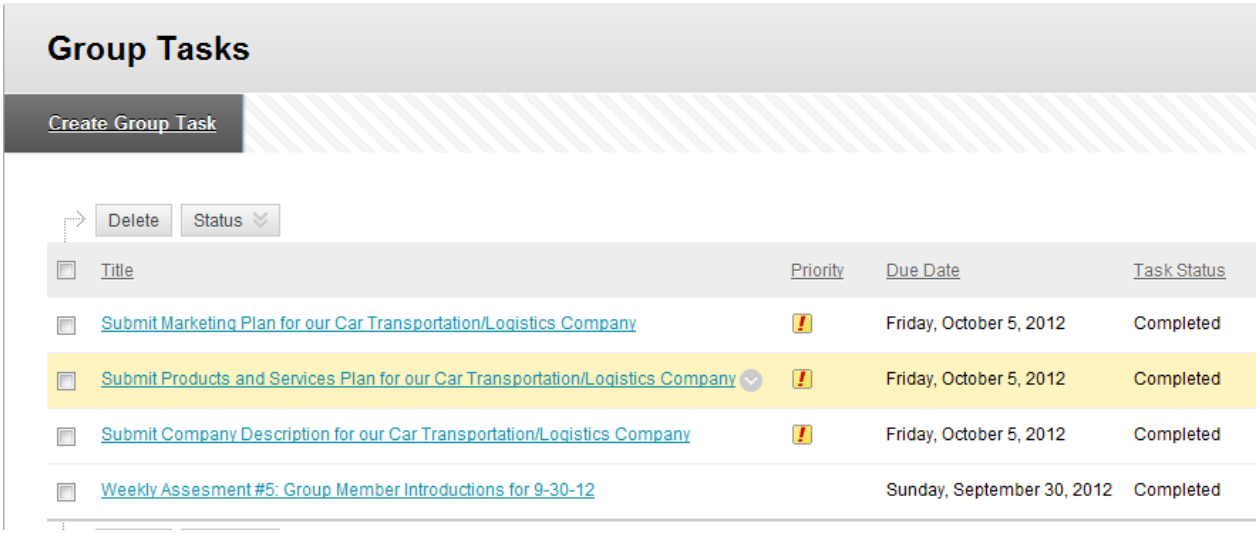

Figure 11. Virtual team 4 used Blackboard Task Management.

A pattern with the technology usage for virtual team 4 is the team's lack of experimentation; they had few to no try-out stages of technology use. Especially for the technology team process and communication capabilities, critical thinking about the technologies' capabilities enabled the team to identify the right tools given the

task at the beginning of the project. For example, the team started the use of BB Discussion Board only for tasks that require contents to be well organized and clearly presented. But an exception occurred with the use of IT interaction capabilities. The team spent a while in figuring out the new tool, Google Sites, in terms of its interaction capabilities, its web page editing and its gadgets, in the beginning weeks of the project. Results showed that the use of Google Sites increased in the later weeks of the project when the team felt more confident with using it.

Not all members of the team equally contributed to the use of IT capabilities, especially the team process and communication capabilities. The examination of the communication data showed most of the team communication occurred between two specific members of the team, the team leader, Sarah, and another member of the team, Jeff. Rice contributed little to the overall team communication but did finish his assigned task on time.

Figure 12 and Table 16 shows the trend of technology usage regarding each of the three types of capabilities over time.

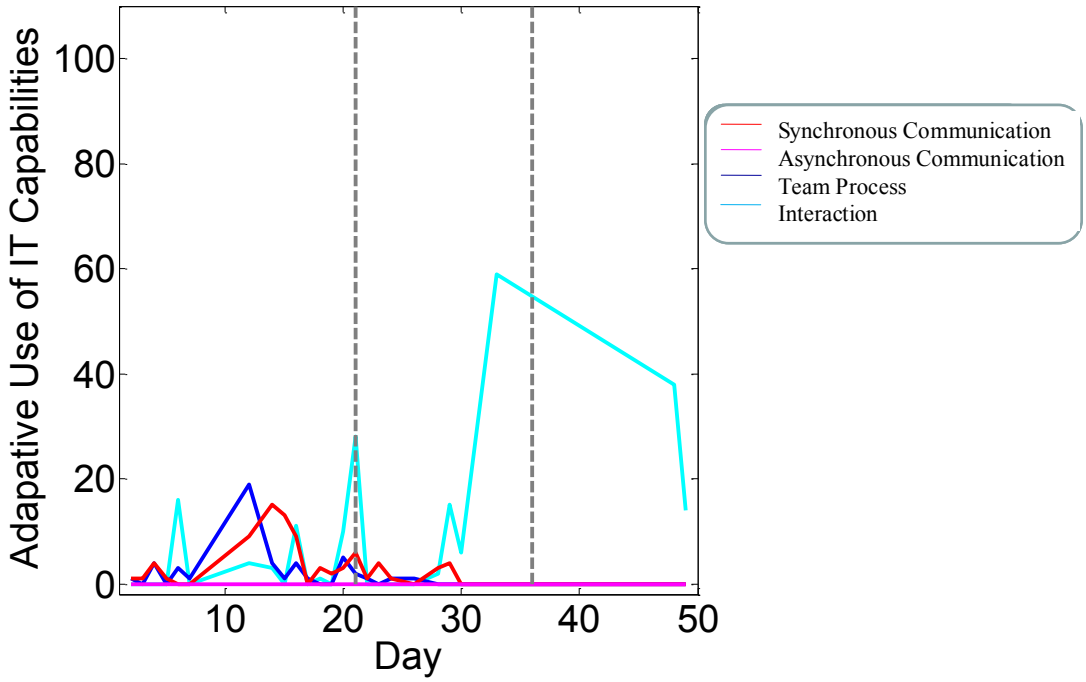

Figure 12.The line chart of the IT capabilities usage for virtual team 4.

Table 16

Counts of the Instances on IT Capabilities Usage for Virtual Team 4

Time	Day	Date	Interaction	Team process	Communication
1	2	18-Sep	0	1	1
1	3	19-Sep	0	0	1
1	4	20-Sep	0	4	4
1	5	21-Sep	0	0	1
1	6	22-Sep	16	3	0
1	7	23-Sep	0	1	0
1	12	28-Sep	4	19	9
1	14	30-Sep	3	4	15
1	15	1-Oct	0	1	13
1	16	2-Oct	11	4	9
1	17	3-Oct	0	1	0
1	18	4-Oct	1	0	3
1	19	5-Oct	0	0	2
1	20	6-Oct	10	5	3
1	21	7-Oct	28	2	6
Total amount			74	43	67
2	22	8-Oct	0	1	1
2	23	14-Oct	0	0	4
2	24	15-Oct	0	1	1
2	26	17-Oct	0	1	0
2	28	19-Oct	2	0	3
2	29	20-Oct	15	0	4
2	30	21-Oct	6	0	0
2	33	24-Oct	59	0	0
Total amount			82	3	13
3	48	3-Nov	38	0	4
3	49	4-Nov	14	0	0
Total amount			52	0	4

5.2.1.5. Compiled evidence on usage experience for virtual team 5

Figure13 showed the usage experience for virtual team 5 across time. Blackboard email was used initially by the team but was stopped from further use because the team discovered the BB email was not capable of replying to all. Email, Google chat, Google Docs, and Google Sites became the common tools that the team used during the project. The team's email exchanges were relatively few due to the use of the synchronous chat tools, Google Chat.

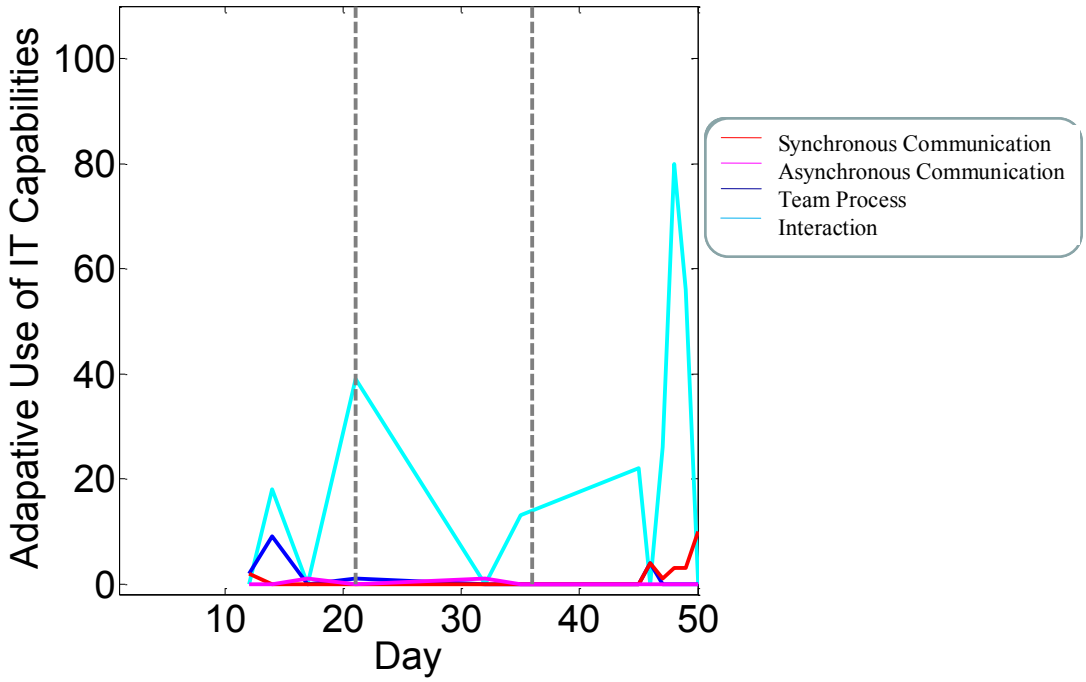

Figure13.The line chart of the IT capabilities usage for virtual team 5.

5.2.2. Construct: AUITC-Inclusiveness

Again, to ensure the consistency among compiled evidence on inclusiveness across virtual teams, I used specific questions to guide the presentation of evidence.

Table 17

Specific Questions Asked When Condensing Data for Inclusiveness

ID	Question	Document
1	Did the team use all IT capabilities; i.e., communication, interaction, team process? What are they?	Technology Usage Google Sites Activities
2	Did the use of specific IT capabilities change over time?	Technology Usage Google Sites Activities Communication Data
3	Were there conditions when the team sought to new IT capabilities?	Communication Data Google Sites Activities
4	Did the team like or dislike the specific IT capabilities?	Technology Usage

5.2.2.1. Compiled evidence on inclusiveness for virtual team 1

In the project, virtual team 1 used all three types of capabilities. For communication capabilities, virtual team 1 used email, Google Talk, BB Discussion Board, and BB journal. For team process capabilities, virtual team 1 used email,

Google Sites task management and Google Sites file management. For interaction capabilities, virtual team 1 relied mostly on the Google Sites to accomplish the main tasks. At times, members used other tools, such as Microsoft Paint, Edraw, and Excel.

In the use of various IT capabilities, some capabilities were used consistently over time because of a necessity for accomplish tasks, easier access and easy to use, or accepted by majority of the team. The following showed two members' comments on Google Talk at two consecutive weeks during the project. The example showed even at times an IT tool may not be fully accessible by all team members, the team would use it unless it provide unique capabilities that were not substitutable.

Example [from Technology Usage]:

Week 2 [Mike]:Made a Google Talk call this week. It was very easy to use and the sound quality was good. No distractions were caused by the technology.
Week 2 [Tom]: Only able to chat with two members at two separate times. Established e-mail as the preferred method of communication.

Week 3 [Mike]:This tool allows the interactive conversations and does not lend itself to delays in communication as long as others are on line.
Week 3 [Tom]: The goal was meet in different way because we were not able meet all at once but we were able to do what we wanted to do as far as naming the company, defining the product and services of the company and individual task assignments.

At times, team 1 would combine one IT capability with another specific capability to establish the shared understanding among the team. For example, when not all team members were able to chat at the same time, Mike summarized the meeting notes and shared those with others in email messages.

Example [from Communication Data]:

[Mike]:Since Friday worked pri(e)tty well with chatting, we should shoot for Friday again.

8:30 PM is the time I was thinking.

[Mike]:The meeting wasn't that successful but I put together what the next deliverable is……..

I thought I'd br(e)ake up the tasks like last time... unless someone already did the work.

The team stopped using some of the IT capabilities, such as the communication capabilities enabled through Blackboard Discussion Board, because of little response from others. Examples of comments on the Blackboard Discussion Board are shown below.

Example [from Technology Usage]:

Week 1: The goal was not necessarily met as there were very few responses.
Week 2: No new updates from my team members.

In the reflections on the technologies the team used, team members tended to evaluate the technology in terms of its usefulness, ease of use, and collectively acceptance by the team.

5.2.2.2. Compiled evidence on inclusiveness for virtual team 2

Virtual team 2 used all three types of IT capabilities during the project. But the team had a notable pattern; virtual team 2 preferred to keep the size of the tool set to a minimum. Specifically, virtual team 2 used Blackboard Discussion Board for multiple capabilities, team process, communication, and interaction. Complementary tools, such as email and Google Sites, were only used when it was necessary to the task accomplishment. The following paragraphs discuss how virtual team 2 made use of each of the three types of IT capabilities.

First, the team used email and Blackboard Discussion Board for communication capabilities. Blackboard Discussion Board was considered as the

main communication capability for the team. Email was considered as the supplementary communication method. This profile for the use of IT communication capabilities was established through active participation from all team members during week 1 and 2. After that, during every week of the project, the team turned to Blackboard Discussion Board for communicating their ideas about how to finish the tasks and at times used emails for emergent contacts when the deadline was close and they did not have time for the team to wait for others' response. The following examples showed a representative comment on the role of Blackboard Discussion Board by the team in the technology usage reports.

Example [from Technology Usage]:

[Mary]: To keep a running record of all brainstorming ideas. To keep all messages in an easy to read chronological order.

After a post was made to the Discussion Board, the team sent out emails for updates. The followings are examples of email exchanges by the team.

Example [from Communication Data]:

[David]:Hello everybody! Just sending out a notice to let you know that I've posted in the Team 4 Discussion Board since I'm not sure you'd receive a notice otherwise.

[Kate]:
Woo hoo! Thank you for the email update and for getting the project started. I also posted in the Discussion Board today.

With regards to the team process capabilities, virtual team 2 used email, Blackboard Discussion Board, and task management in Google Sites. Blackboard Discussion Board was the place for the team to brainstorm ideas and to exchange opinions. Meanwhile, the Discussion Board also helped organize and store the team's discussion. The role of Discussion Board was that of a database in this regard.

Members of the team can constantly refer to this database when working on a task.

Example [from Communication Data]:

[Mary]: I'm working on compiling the information from the boards into information on the IT Platform page of the site. Feel free to change anything that you want as you see fit.

The team also used Discussion Board for task assignments and the task management feature in Google Sites. But the task management feature was only used prior to the start of each deliverable. The team did not assign tasks to members explicitly on the Discussion Board. Nor did the team explicitly assign the due dates to the tasks in the Discussion Board. In general, the team rarely used IT team process capabilities in terms of assigning tasks and determining the due dates.

Finally, both Blackboard Discussion Board and Google Sites provide necessary interaction capabilities for the team to accomplish each task during the project. In the project, the team equally contributed to the Google Sites web page editing shown through the Google Sites activities document. During the period of time 2, only Mary contributed to the edits of the Google Sites.

Example [from Google Sites Activities]:

Oct 21, 2012 9:30 PM Mary edited IT Platform
Oct 21, 2012 9:33 PM Mary edited IT Platform
Oct 21, 2012 9:44 PM Mary edited IT Platform
Oct 21, 2012 9:47 PM Mary edited IT Platform
Oct 21, 2012 9:53 PM Mary edited IT Platform

At the period of time 3, Tom and David dominated the editing work in Google Sites for the third deliverable of the group project.

Example [from Google Sites Activities]:

Nov 3, 2012 9:20 PM David edited Store
Nov 3, 2012 9:20 PM David created Store

Nov 3, 2012 9:20 PM David edited main
Nov 3, 2012 9:20 PM David edited About Us
Nov 3, 2012 9:21 PM David edited main
Nov 4, 2012 12:45 PM Tom edited main
Nov 4, 2012 12:46 PM Tom edited main
Nov 4, 2012 12:47 PM Tom edited about-us
Nov 4, 2012 12:51 PM Tom edited about-us
Nov 4, 2012 12:52 PM Tom edited about-us

5.2.2.3. Compiled evidence on inclusiveness for virtual team 3

Virtual team 3 used IT communication capabilities, team process capabilities and interaction capabilities during the project. For communication capabilities, the team mainly used email, and for team process capabilities, the team used both email and Calendar feature in Google Sites (as shown in Figure). The team also relied on email and Google Sites' interaction capabilities to accomplish the tasks.

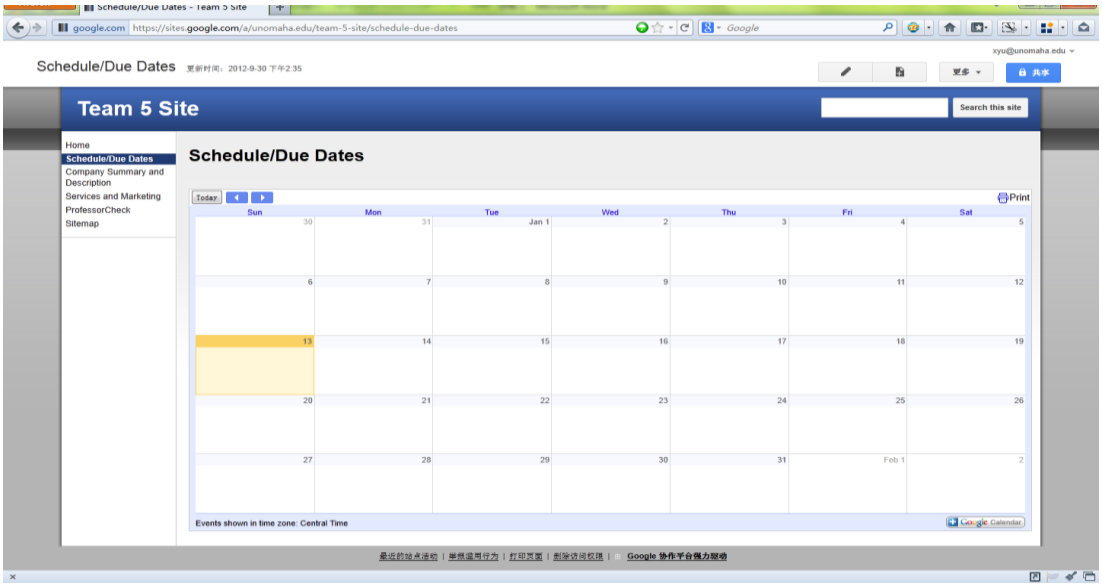

Figure 14.Virtual Team 3 Used Google Sites Calendar.

The team switched from Blackboard to email for communication because of easy access and quick response. Email was used effectively to remind the due dates of the tasks and the task assignments among the team. The Google Calendar feature was used only in the beginning weeks of the group project to manage and edit all the tasks across the project.

Example [from Google Sites Activities]:

Sep 30, 2012 1:29 PM Sam deleted Calendar
Sep 30, 2012 2:16 PM Sam created Schedule/Due Dates
Sep 30, 2012 2:17 PM Sam edited Schedule/Due Dates
Sep 30, 2012 2:18 PM Sam edited Schedule/Due Dates
Sep 30, 2012 2:21 PM Sam edited Schedule/Due Dates
Sep 30, 2012 2:22 PM Sam edited Schedule/Due Dates
Sep 30, 2012 2:23 PM Sam edited Schedule/Due Dates
Sep 30, 2012 2:35 PM Sam edited Schedule/Due Dates

5.2.2.4. Compiled evidence on inclusiveness for virtual team 4

The team used all three capabilities of the technologies to accomplish the project. Table 18 the diverse tools the team used for each of the three types of IT capabilities.

Table 18
Virtual Team 4 Specific IT Capabilities Usage

IT capabilities	Specific IT Tools
Communication capabilities	Email and BB Discussion Board
Team process capabilities	Email, Bb Discussion Board, BB journal, Bb task management, BB file attachment, Google Sites task management, and Google Sites file cabinet.
Interaction capabilities	Google Sites page editing

At times, the team combined technology capabilities to achieve the desired goals. For example, the team used email and Blackboard Discussion Board for project idea generations and team updates.

> *Example [from Technology Usage]: Jeff's reflection on email and BB Discussion Board*
> *[Jeff] Both of these goals have been met, but there may not be a quick response. We started using this first to talk about ideas, but we decided that BB-Discussion Board would be better for ideas, in order to keep ideas more organized. We sent emails to each other to mention that we posted things on the Discussion Board regarding topics or the website. We used email to give some information about ourselves.*

Examples of usage of Google Sites file cabinet feature was shown in the Figure 15.

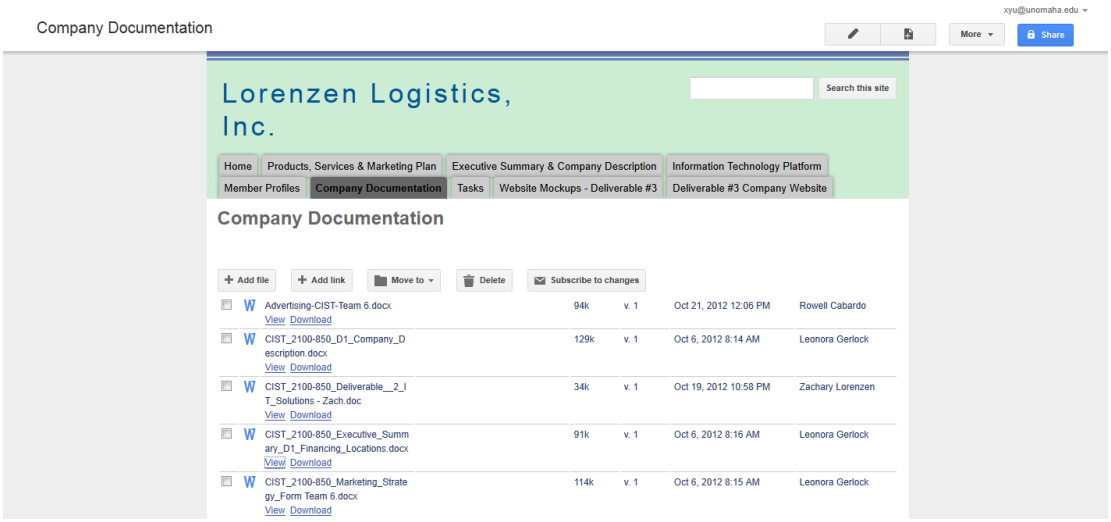

Figure 15.Virtual team 4 used Google Sites file cabinet.

5.2.2.5. Compiled evidence on inclusiveness for virtual team 5

The team used communication, team process, and interaction capabilities during the project. Both asynchronous and synchronous chat tools, email and Google chat were used by the team for various purposes. Email was used primarily for the general team communication on the task updates and planning for the week. The team used Google Chat to discuss requirements of the tasks and assign tasks to individuals. The use of Google Chat reduced both the amount and the frequency of team communication through emails.

5.2.3. Construct: AUITC-Fit

The specific questions that guided the collection of evidence on the fit dimension are summarized as below. The fit dimension was reviewed using the aggregated technology usage reports from all members across the project. Evidence of fit is decided when all members of the team thought the initial goal of using that technology was met.

Table 19

Specific Questions Asked When Condensing Data forFit

ID	Question	Document
1	Did the team find a technology is a good fit to their team and the task or not?	Technology Usage
2	If the technology is a fit, what is the reason?	Technology Usage
3	If the technology is not a fit, what is the reason?	Technology Usage
4	Was the temporal issue a factor to consider? i.e. will a technology become a misfit over time or become a fit over time?	Technology Usage

5.2.3.1. Compiled evidence on fit for virtual team 1

Throughout the project, one common pattern emerged. Virtual team 1 was content with the team process capabilities and the interaction capability provided by the technologies, but was not satisfied with the use of the technology communication capabilities. For example, from the early weeks of the project, the team leader asked the team to post the teamwork update on a feature of Google Sites; i.e., task management. The team consistently used that feature for task updates and task assignment. Occasionally, email was combined to provide more detailed task assignment information or interim task updates. The team was also generally content with the interaction capabilities by which all the tasks were done. Though Susan once had a problem of uploading forms in Google Sites, she turned to her teammate and asked for help.

Example: Perceptions on the use of Google Sites tools

[Michael]: All the widgets are nice and they were simple enough to set up.
[Susan]: The website is very easy to edit and customize. It will be fun to use and customize as the projects start to pick up more.
[Nancy]: I was easily able to make a form that submits to an excel spreadsheet.

According to the team members' reflections, explicitly collective usage on the technology capabilities has a prominent effect on the extent a technology

capability was perceived as a fit profile for the team. The technology capability would be a fit for the team when all team members actively used that technology capability and kept the technology capabilities usage observable to the others. The awareness of the other members using the technology capability at the same time significantly influenced a team member's perception of the technology capability.

Another important factor affecting the teams' assessment of fit of a technology is the expectations of all team members prior to the use of a technology capability. Specifically, when the team had diverse expectations, team members were more likely to have different perceptions on whether the technology was a fit. The following two examples (as shown in Table 20 and Table 21) are excerpts from the technology usage reports and show how the explicitly collective usage and the team members' expectations toward technology influence the team on deciding whether a technology capability is a fit.

Table 20

Virtual Team 1's Reflections on Blackboard Discussion Board Communication and Team Process Capability

VT 1 Member	Expectation	Perception on Fit	Fit?
Michael	Use to contact all team members in order to get it started on the project. Also to set up an upcoming meeting to chat online.	The goal was to getting starting the project and also to get in touch with all team member and get a team leader. All that are meet.	Yes
Susan	Attempting to organize a consistent way in which all communication can be read and shared for the team	The goal was not necessarily met as there were very few responses.	No
Nancy	Introducing myself and address the issue of how the group wants to communicate	Did not get a response	No

Table 21

Reflection on Google Talk Communication Capability

VT 1 Member	Expectation	Perception on Fit	Fit
Susan	Communication with team members	This tool allows the interactive conversations and does not lend itself to delays in communication as long as others are on line.	Yes
Michael	The goal was to meet up and came out with a company name , service, and delegated task to each member	The goal was meet in different way because we were not able meet all at once but we were able to do what we wanted to do as far as naming the company, defining the product and services of the company and individual task assignments.	Somewhat
Nancy	The goals was to meet all team member and discuss about the project	None of the goals was met because since it is an online class, it happens that almost every one of us have different schedule. The maximum number of people that were able to agree on the same chat time is 3.	No

The final observation regarding fit is about the temporal issue of fit. As the team progressed during the project, the study found the team did show adaptation

behaviors in using the technology capabilities to improve the overall fit profile of the technology, the task, and the team. For example, Susan could not use the file attachment feature in the Google Sites initially, but she figured it out herself in the later weeks so that she could actively use this features other team members did. However, there were also capabilities that could not be adapted over time because of the limitations of the virtual team itself. As shown in

Table 21, because of the different individual schedules, all members could not meet and chat at the same time. In fact, all of the synchronous chat sessions only had two members participated. Members who took the chat had to share the summary of the talk with members who were not in the talk.

5.2.3.2. Compiled evidence on fit for virtual team 2

Virtual team 2 had both fit and misfit from the use of diverse IT capabilities.

Using Blackboard Discussion Board for task-related idea exchanging, brainstorming, information storing and organizing was a fit for the team as acknowledged by the team. From week 1, as suggested by the team leader, the team consistently expressed their thoughts on how to finish the tasks in the Discussion Board. These thoughts were organized into relevant forums or threads with appropriate labels. In later weeks of the project, team members showed their satisfaction with using the Discussion Board for team communication and team process (in terms of the information processing aspect).Table 22 shows how the team gradually developed the preference of communicating through Blackboard Discussion Board over email.

Table 22

Virtual Team 2's Reflections on BB Discussion Board in Week 2

Week 2	Expectation	Perception	Fit
Mary	Hold subject oriented discussions;	This communication tool was most important to discussing key points of the project. It helps keep our decisions documented in an orderly format.	Yes
David	Goal: To make this the main communication device. To establish a weekly post where we all put our updates	The goal I made has been met. This week we exclusively used the message board system. At the beginning of the week I made a thread for the weekly updates and we put all of our comments in there. This works the best so that we don't have a ton of little posts scattered everywhere.	Yes

Table 23

Virtual Team 2's Reflections on BB Discussion Board in Week 3

Week 3	Expectation	Perception	Fit
David	Communicate goals and progress. Store communication.	This communication tool was most important to discussing key points of the project. It helps keep our decisions documented in an orderly format.	Yes
Mary	Goal: To have all communication and deliverable information posted on the Discussion Board thread that was set up by our team leader	Mission Accomplished! 3 out of 3! David our team leader posted his expectations on the message board and we delivered our results on the board. I like keeping everything on the message boards because for me it works really well to keep everything in one place. I gave my preference at the beginning of class and so far it's been met 100%.	Yes
Tom	We used this mostly in to keep our team members informed about schedules, expectations, and new ideas. We wanted to work ahead to finish the first Deliverable.	This week was a success – assignments were made distinguishing who would work on which sections, and everyone accomplished their part early. We came to a consensus on what needed to be done and by when, and then we all stuck to it. I've found that the Discussion Board is an effective tool for communication and interaction – often more so than email.	Yes

However, when the virtual team worked on their second group project deliverable, the team did not successfully manage their teamwork with the technology capabilities because of weak leadership. Mary complained about the missing

leadership in the technology usage report.

Example [from Technology Usage]:

[Mary]The goal was met because I used the email system to try and contact a team member that has appeared to have gone missing. David our team leader has not used the message board or email for the majority of the week. He has not assigned any information for the new assignment that is due soon.

Untimely response from other members can also lead to anxiety in the team.

Example [from Technology Usage]

[David]I'd like to find a way to contact Tom so we can all bounce ideas off each other in the Discussion Board.

As the team had more in-depth experience with technology over time, the team held different perceptions on the technology's interaction capabilities, as well as technology's team process capabilities. For example, Mary found that the Google Sites' Task management did not notify changes made to the team. Tom and Mary also found problems with Google Sites' web pages editing.

Example 1[from Technology Usage]:

Comment on the feature of Google Site task management [Mary]:
While this keeps a list of tasks, it doesn't notify when tasks are assigned or due.

Example 2[from Technology Usage and Communication Data]:

Technology Usage
[Tom]:
Multiple people aren't allowed to update pages at once. There are no detailed change logs.

Communication Data
[Mary] Where is the diagram on the site? I just updated another spot of the IT Platform page and it wasn't showing up. Is it linked on another spot? I'm just worried that maybe we updated at the same time and some changes didn't happen. Thanks!

[Tom] I wasn't sure if I should try editing the page when you were so i just uploaded it to the page as a file. I can add it as a picture if you don't see that.

[Mary] Can you add it really quick as an image on the IT Platform site? I'm not seeing the file,

Example 2 [from Technology Usage]:

[Mary] commented on the Google Sites page editing feature:
The website is easy to read and navigate which allows the group to determine the project status visually and easily. There are many flaws with Google Sitess. There are virtually no options to edit specific layout items. I had to edit the HTML code to basically anything important besides headers and columns. Google gadgets are also very lacking in variety and customizability.

5.2.3.3. Compiled evidence on fit for virtual team 3

During the project, virtual team 3 identified an appropriate communication technology for the team. The team initially used Blackboard Discussion Board to communicate to finally accepting using emails as the primary way of communicating and interacting. Easy to use, simple look and quick access were the reasons why the team thought email was a fit for the team.

Another salient example was related to the use of IT interaction capabilities by the team. Over time, as team members had more experience with using the technologies, the team was found to be more fluent at manipulating the Google Sites web pages at their own will.

Example [from Technology Usage]:

[Matthew] I am finding Google Sites easier to work with every time I log in. I was able to create two pages with ease and get them added to the site's navigation menu.

No obvious evidence was found for misfit in virtual team 3. The team was generally happy with what the technology capabilities provide and did not think any improvements could be made on the use of these technologies.

5.2.3.4. Compiled evidence on fit for virtual team 4

The team generally found the technologies provided the fit capabilities for the team. Specifically, the team took a proactive approach in searching for "fit" technology for the team. They thought about what kind of task to be performed and then picked up the appropriate technology. Prior to the use of that technology, announcements were made by the initiator, who started the use of that particular technology, to explicate the reasons and the purposes of using that technology. With this common understanding about the technologies, everyone established common expectations on the role of the technology. For example, Jeff explained the reason of using Blackboard Discussion board in a group email.

> Example [from Communication Data]:
> *[Jeff] I have created a thread in our group discussion page for us to develop product or service ideas. I feel that it would be easier to have all of our ideas in one place, so they do not get lost or scattered throughout emails. We can create additional threads in that area for other questions that we will have to answer and develop as a group. Please visit the discussion and post your ideas.*

Because of this message, the team developed shared expectation on the use of the Blackboard Discussion Board, Sarah reflected on the usage of the Discussion Board in the technology usage report:

> Example [from Technology Usage]:
> *[Sarah] Both of these goals were achieved. The group heavily uses this as our primary method to communicate and post ideas and information needed to complete assignments. We have created forums specific to the individual subject topics. As we add more forums, we will need to make sure that we are keeping everything separated and posted in the correct area.*

One misfit of the technologies the team discovered was about a specific interaction capability by the Discussion Board as the team worked toward the tasks. When virtual team 4 collaboratively worked on a writing task for their project, the

team wished the Discussion Board had an editing feature.

Example [from the Communication Data]:

[Leonora] No problem. I try and proof read my posts before publishing them, but even then I sometimes miss typos. These forums need an edit feature. It would make communication an easier task.

5.2.3.5. Compiled evidence on fit for virtual team 5

The team identified fit tools for the team, especially the IT interaction capabilities as reflected by the team in their technology usage report. For example, the team used Google Docs for co-editing project documents and discussing ideas. The team was also able to use Google Chat for a quick and effective talk.

Example [from Technology Usage]:

[Dan]Google Docs was great in allowing us all to collaborate together in creating content for our deliverable. We were able to use the chat function and work in real-time to be able to get our goals accomplished. It was a success.

As the team had more usage experience with Google Sites, the team was more confident in using the interaction capabilities of the Google Sites to design and edit pages. Figure 16 showed how Google Sites interactive gadget was used by team 5. The team used embedded excel gadget to present the budget analysis.

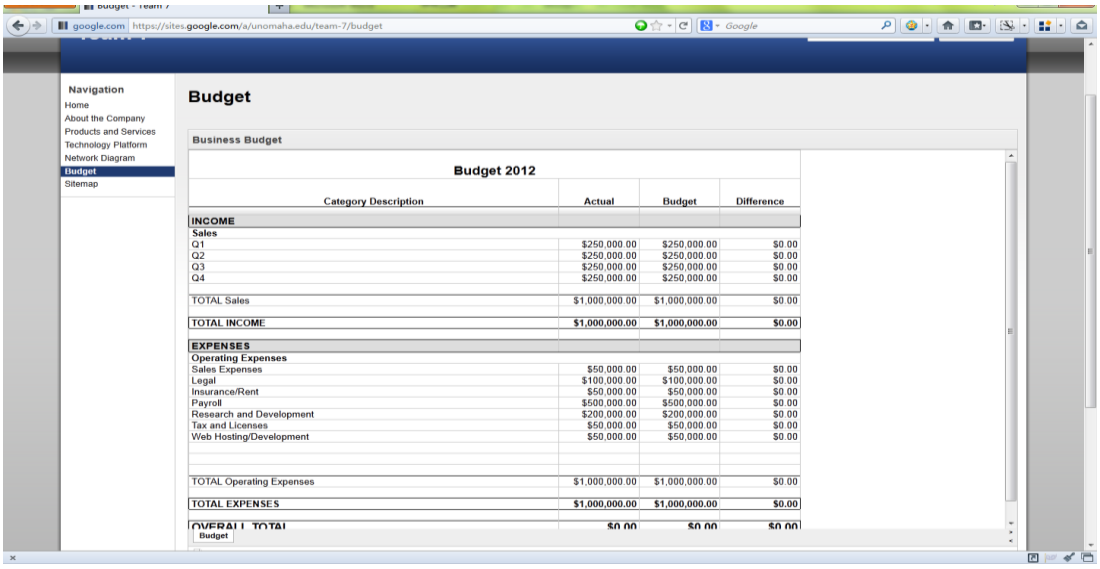

*Figure 16.*Virtual Team 5 Used Google Sites Interactive Gadget.

5.2.4. Construct: SMM-Taskwork Mental Model Convergence

The specific questions that guided the collection of evidence on taskwork mental model convergence are summarized in Table 24.

Table 24
Specific Questions Asked When Condensing Data for Taskwork Mental Model Convergence

ID	Question	Document
1	Did the team converged on knowledge contents related to the technology functioning and the likely failures.	Technology Usage Communication Data Google Sites Activities
2	Did the team converge on knowledge contents related to the task goals, steps to accomplish tasks, and due date of the task	Technology Usage Communication Data Google Sites Activities

5.2.4.1. Compiled evidence on taskwork mental model convergence for virtual team 1

Results showed that the team developed shared mental models on the technologies' usage. Evidence showed the team achieved the convergence on technologies' team process, communication, and technologies' interaction capabilities. Specifically, the team converged on the team process capabilities and communication capabilities through the collective usage experience with those capabilities. For example, during the project, the team consistently used one capability of Google Sites, the Task management, to assign tasks, to clarify task duties, and to track the status of each individual task. The team also established a way to manage all of their collaborative documents by attaching those documents in Google Sites. Excerpt from Google Sites activities provided such evidence.

Example 1[from Google Sites Activities document]:

Oct 6, 2012 5:55 PM Michael edited an item in Tasks
Oct 6, 2012 5:56 PM Michael added an item to Tasks
Oct 6, 2012 5:57 PM Michael added an item to Tasks
Oct 6, 2012 5:58 PM Michael added an item to Tasks

Oct 6, 2012 5:58 PM Michael edited an item in Tasks
Oct 6, 2012 8:09 PM Nancyattached TechShare Services Executive Summary Draft.docx to Release 1.0
Oct 6, 2012 8:12 PM Nancy edited an item in Tasks
Oct 7, 2012 6:17 PM Susancreated General Company Description
Oct 7, 2012 6:17 PM Susanedited General Company Description
Oct 7, 2012 6:20 PM Susancreated General Company Description
Oct 7, 2012 6:20 PM Susan edited General Company Description
Oct 7, 2012 6:21 PM Susan edited Email_Page_Untitled
Oct 7, 2012 6:29 PM Michael edited About the Company
Oct 7, 2012 6:29 PM Michael edited an item in Tasks
Oct 7, 2012 6:32 PM Susan edited What we do
Oct 7, 2012 6:32 PM Nancy edited an item in Tasks
Oct 7, 2012 6:34 PM Susan edited an item in Tasks

The team also established a common expectation on the usage of the technology communication capabilities. Based on other members' responses, the team gradually converged on the fact that email worked the best for asynchronous communication among the team. The team also shared the knowledge that the team members cannot meet all at once because of the difficulty finding a meeting time that would work out for all. So the team had also developed a fair expectation on the use of the synchronous chat tool, the Google Talk. The following example showed the team's reflections on the use of email as their main communication method.

Example [from Technology Usage document]:

[Nancy]: Emails went way smoother on GMAV then they did on Blackboard. Being able to reply to all is a necessary tool when it comes to team collaboration.
[Susan]: This is the teams preferred method of communication.
[Michael]: The goal was to getting starting the project and also to get in touch with all team member and get a team leader. All that are meet.

In contrast to the mental model convergence on team process and communication capabilities, the team developed shared understanding on the technology interaction capabilities, not necessarily through the collective usage

experience, but through some triggering events. Depending on the number of members involved in the triggering events, the team developed different degrees of convergence among the team. The larger the number of people involved in such triggering events, the higher the degree that the team reached convergence on the interaction capabilities. Such triggering events could be either a failure with a technology usage or a successful experience with using a technology. In the project, at most of the time, team members worked on the assigned task individually using some technology capabilities. The team members seemed to like keeping the interacting experiences with the technology to themselves and only sharing the results with the others; the results were the final task deliverable. But when one member encountered a problem or a success, she/he was more willing to share her/his interacting experiences with technologies with the others, either for requesting help or for letting others know about the good news. For example, Susan had found she could not upload a file to the Google Sites, but she did not recount the failure process to the others.

Example [from Communication Data document]:

[Susan]: I for some reason do not have the ability to add files, so I just copied and pasted what I wrote onto the What we do page for the Marketing Plan. Give it a look and let me know if you think I should add or change anything.
[Michael]: That's what were supposed to do. Add to the website.
[Michael]: It looks fine, but you should probably put a header on it so the teach can easily see the 4 sections we did
[Susan]: Will do.

In another example, two members of virtual team 1 communicated on one of the problems with the Google Sites web page design and collectively solved the problem.

Example [from Communication Data document]:

[Nancy]: Thanks Susan and it did look like there was a typo...bellow instead of below, at the end of your page. I have a sample HTML web page on Blizzard, but that seems to be down right now. Do you think the google page is o.k.?
[Susan]:If you are talking about the Sample Web page, the only thing that looks iffy is the donate button. If you can, maybe try adding the donate button as a widget, I think I saw one when I was looking at the widget. Otherwise, just see if you can resize it.
[Nancy]: Hi Susan
The gadget for the donate button requires a valid merchant number, and you have to be a verified non-profit organization before you can use it.
I resized the paint copy of the slogan, just for presentation purposes. Hope that looks better.
Thank you,
[Susan] Looks good to me! Thanks!

Team communication was the means by which the team explicitly established the mental model convergence on task goals, procedure to accomplish the tasks, and the time frame for tasks. Leader briefing was one of the most salient ways of establishing such convergence. In the project, the leader constantly used email to stress the due date of a task and suggest the procedure to accomplish a task.

Example 1 [from Communication Data document]:

[Michael]: If there are any questions, please let me know... You have any problems, I'll be on around 1:00pm Sunday. Let's try to finish this before 10PM Sunday.

Example 2 [from Communication Data document]:

[Michael]: We have a deliverable due on 9/30, and need a way to discuss our online business and our plans. Michael suggested we use google talk, which works well enough for me. Does that work for everyone?
The next coordination task is what time and days work for the team? I'm available after 6:30 Central Time Monday - Friday and any time Saturday and Sunday.
Please let me know your preferences.
Thank you,

Example 3 [from Communication Data document]:

[Michael]: We have the first deliverable due this Sunday; we should probably

find a good time to chat so we can get this done.
With that said, let's work out a time to chat.

At times, after a team meeting, an announcement about the task goals and major decisions made in that meeting would be posted through email to share with all:

Example [from Communication Data document]:

[Nancy]: Tom and I had a quick chat today regarding a online business idea. The idea is a Shared Technological Service company. The business would provide programming services from a pool of resources. For instance, if a company required an XHTML, CSS, Perl programmer to make some modifications to a web page, but does not have the budget to keep a full time programmer on the payroll, they can request this programming need through our web page, and we would provide these programming needs from our pool of programming resources. We develop the solution, and then return to our Business Partner.

5.2.4.2. Compiled evidence on taskwork mental model convergence for virtual team 2

Leader briefing was a notable factor in influencing the development of virtual team 2's taskwork mental models, especially on the use of specific team process and communication capabilities. Influenced by the team leader, David, the team all developed the shared understanding on which tool to use for asynchronous communication. Within two weeks, the team established their way of communicating and team process; that was to use Blackboard Discussion Board to exchange ideas and also to organize all of the ideas meanwhile. Convergence on the technologies key functioning was evident through constant use of the specific capability. For example, the team constantly used Blackboard Discussion Board for ideas brainstorming.

Example [from Communication Data]: Posts on BB Discussion Board

Week 1: Forum-Deliverable 1
[David]: Right, then. I think we should discuss how we want to tackle this, goals and expectations,

[Mary]: Woo hoo! Thanks for getting this started David!

Week 2: Forum-Deliverable 1
[David]: I'm glad you like the idea and I love GROmaha.

[Tom]: Anyway, I think that idea could work! I personally have no interest in plants, but I think it will work out very well in terms of this project.
...
Week 5:Forum-Deliverable 2
[David Le]I guess now would be a good time to start this. The assignment gives a whole heap of questions for us to consider:

The important role of the Discussion Board was acknowledged by the team.

Example [from Technology Usage]

[Tom]: This communication tool was most important to discussing key points of the project. It helps keep our decisions documented in an orderly format.
[David]: The goal I made has been met. This week we exclusively used the message board system. At the beginning of the week I made a thread for the weekly updates and we put all of our comments in there. This works the best so that we don't have a ton of little posts scattered everywhere.

Virtual team 2 seemed to rely heavily on the Blackboard Discussion Board for doing everything related to the tasks. In terms of developing shared mental models on the IT interaction capabilities, a triggering event was an important factor. When discovered problems associated with using specific technology capability, the team members helped each other and then collectively solved the problems. For example, David helped Mary on how to make a post at the Discussion board.

Example [from Communication Data]:

[Mary]: I'm not quite sure where you both posted. Can you direct me to where we are supposed to post?

[David] Sure. When you log in to Blackboard and access this course, on the left side underneath the main sidebar where it lists Assignments and Announcements and the like, you should see the phrase 'Team 4'. Click on it to expand it, and you'll be able to see options for a Discussion Board where

we've posted.

Most of the team communication was oriented toward the specific questions related to task. For example, the team leader posted all the questions[25]about how to build an IT platform for the team's e-business. Then the team shared their answers to these questions in the Discussion Board.

Example [from Communication Data]: The team was discussing questions for the second group project deliverable.

[David]I guess now would be a good time to start this. The assignment gives a whole heap of questions for us to consider:

Based on your analysis in the first deliverable, think about the following the questions:

What transactions are parts of your business processes? - The exchanges between the users of our site; they post what they have and others will respond by email their interest, and the two will work out pick up/delivery, price, or trade. There are also purchases from our online store.

What information will need to be recorded as these transactions take place? - As far as user to user transactions, their information does not need to be recorded - we merely supply a platform for them to advertise what they have/looking for. For the online store, we will need names, credit card information, and addresses. We will also need to keep track of inventory.
....
[Mary] ....
I was actually just about to post these answers anyway!

What transactions are parts of your business processes?

Well, there are the transactions between users which include posting information, buying, selling, and trading.

What information will need to be recorded as these transactions take place?

User information will be stored. The communications will obviously needed to be recorded on the website. It may be desirable to create a specific form for

[25]These questions were contained in the *Guidelines for Group Project*.

trading between users in order to keep the transactions official and avoid trickery. The online store will need to store again user's information such as credit cards and addresses. The store will need to keep track it's supply.
....

However, few efforts were made in terms of discussing task assignments and explicitly making a plan for accomplishing the task. Therefore, the team did not successfully reach a convergence on the steps to finish the task and on the due dates of the task. Consequently, members of the team had to volunteer for doing the task at the last minute, and the team was generally not happy with this approach of doing the project.

5.2.4.3. Compiled evidence on taskwork mental model convergence for virtual team 3

Through communication and interaction, the team developed shared understanding on the strengths or drawbacks of the key communication technologies the team were interacting with. For example, the team knew that email had better capability for quick access (that is accessible through cell phone) and easy to use.

Example [from Technology Usage]:

[Matthew]: Have made contact with all members of group 5 through email and blackboard. The group has determined that email will be most effective.

Results show the team developed shared understanding toward the task goals and due dates of tasks through email exchanges. Members of the team also shared the knowledge about the steps to finish the tasks and the team member responsible for specific tasks.

Example [from Communication Data]:

[Sam]Deliverable 1 includes the following sections of a business plan:
Executive Summary (Sam)
General Company Description (Sam)
Products and Services (Matthew)

Marketing Plan (Ryan)

[Ryan] I think the plan is great! I have created the necessary pages and completed them with the provided Executive Summary and Business Description. I wrote up the Marketing Plan/Industry Review and Products/Services description and included those on the site. Matt, please review and edit as you see appropriate.

The team had a good leadership in terms of task assignments and initiating the team discussion around the project. For each of the deliverables, the team leader, Sam, initiated the first round of discussion by posting his thoughts on those specific questions suggested in the project guidelines. Then the other two team members commented and made suggestions based on the foundations that Sam had provided. The team established their way of accomplishing tasks during the first period of the project when they worked on the first deliverable. After that, the team repeated the pattern for the next two deliverables.

5.2.4.4. Compiled evidence on taskwork mental model convergence for virtual team 4

The team converged on the key roles of technologies, such as Blackboard Discussion Board and emails.

Example [from Technology Usage]:
[Jeff]BB blackboard
1) Be a centralized place to post ideas
2) Keep ideas and topics organized and separated
BB journal
Separate ideas and post information and updates regarding the group website

The team also took a proactive approach to develop a mental model on technologies' interaction capabilities, so all the team knew how to interact on the technologies. No question related to how to post on Blackboard Discussion Board was found during the project:

Example [from Communication Data]:

[Jeff]:
In the blackboard class section, go to "tools" on the left side of your screen, click on groups (top right on the lists), click on "Team 6", under group tools click on "Group Discussion Board". From there, we can post additional forums and ideas for discussion.

[Sarah]:
I have listed the steps below that you can follow in order to submit your own introduction.

1. Navigate to our site homepage.

2. Click the "Edit page(e)" icon at the top, left hand side of your browser screen. It looks like a small black pencil. This icon is not labeled, but if you place your cursor over the icons, a hover state pop up will then indicate an icon's designation.

3. Once the editor loads, you can modify the page by adding your introduction.

The team also proactively converged on the task due dates, goals, and steps. At the beginning of the week, Sarah initiated the discussion on how to accomplish the task. After brainstorming, each team member commented on each other's post and reached the convergence.

Example [from Communication Data]:
[Sarah]: I know we have the first TPU that is due this Sunday, September 23rd by 11:59 PM. I just wanted to touch base with you on this to get an idea of how you would want to handle these assignments as a group.

[Jeff]I am indifferent to who does what as I am motivated for all of us to be as successful as possible with these assignments.

5.2.4.5. Compiled evidence on taskwork mental model convergence for virtual team 5

Virtual team 5 converged on the technologies' key functioning primarily through email exchanges. The team members asked for help when they experienced specific problems with the technologies' interaction capabilities usage. For example, Dan asked John how to add a list on a Google Sites web page.

Virtual team 5 used email to remind the team about the due date of the coming deliverables and the task goals. Specific details of how to accomplish the tasks were discussed through Google Talk. At times, team members exchanged experiences with technology interaction capabilities through emails and sought help.

Example [from Communication Data]:

[Jay]Haha sorry for more trouble, but "Services" should be under products. And Apple/Android/Microsoft also have subpages. Check out our sitemap.. https://sites.google.com/a/unomaha.edu/global-tablets-inc/system/app/pages/sitemap/hierarchy
[Sam]ididnt add the actual tablets as they just redirect from there... but i can...
[Jay] That's fine, but make sure Services is under Products. Also, do you know how to delete lists and the comments box?
[Sam]idont see a way to, site layout wont allow deletion..

5.2.5. Construct: SMM-Teamwork Mental Model Convergence

The specific questions that guided the collection of evidence on teamwork mental model convergence are summarized in Table 25.

Table 25
Specific Questions Asked When Condensing Data for Teamwork Mental Model Convergence

ID	Question	Document
1	Did the team converge on knowledge contents about when and how the team communicates and interacts?	Technology Usage Communication Data Google Sites Activities
2	Did the team converge on knowledge contents about team members' role, knowledge, skills, and other personal background information?	Technology Usage Communication Data Google Sites Activities

5.2.5.1. Compiled evidence on teamwork mental model convergence for virtual team 1

Results showed that the team converged on key aspects related to their teamwork. Specifically, the team developed shared understanding on when and how the team communicates and interacts. The team first converged on the specific technologies they used for team communication at the beginning weeks of the project.

Example [from Communication Data document]:

(September 20, 2012 1:58 PM)BB Discussion Board
[Michael]: Hello Team 2! It seems that we need a way in which we can communicate and begin partnering on our group project. Does anyone have preferences on where we should begin the discussions?

(September 23, 2012 1:10 PM)BB Discussion Board
[Susan]: Hello,
I have no specific preference, but I do like google talk. But this works too i guess

Example [from Communication Data document]:

[Nancy]:I've sent an invite for a Google Chat. Please let me know if I've gone to the wrong place.

Thanks,
[Susan]:Go it
[Susan]: All this looks good so far. Sorry I was so late on the response. Google Talk sounds good to me. I have a night class on Monday and Wednesday and I don't normally get back until about 7:30 from that. Other than that, I'm good with most the times.

Thanks,

After establishing the communication channel, the team exchanged information on the time schedule of the week and the roles.

Example [from Communication Data Document]:

[Michael]: ...Parts 1 and 2 will be on the, "About the company" page, and Parts 3 and 4 will be on, "What we do". Feel free to put it in any order you would like and when you finish your part, please update it on the tasks section where I added your names to the tasks.
If there are any questions, please let me know. The assignment is due tomorrow night.
[Gail]: I did an Executive Summary draft and placed it on the web page for review last night. I can move forward with updating the webpage if there are no changes.

The team converged on their team roles, knowledge, and skills explicitly through using communication capabilities. Specifically, the team converged on team roles through asynchronous communication capabilities, while the knowledge and

skills were converged mainly through synchronous communication capabilities than the asynchronous communication capabilities. The following example shows an example of leader briefing on team roles in one email message.

Example [from Communication Data Document]:

[Michael]: All,
The meeting wasn't that successful but I put together what the next deliverable is.
I thought I'd break up the tasks like last time... unless someone already did the work.
Nancy - Network Diagram- This is mostly done. We just need the diagram for our services. What you have there is fine; can you add it the page and just write a brief description on what the diagram represents. eg,"Network of Team 2 infrastructure".
Susan- Software - we need to list whatever software we need for the company, I was thinking Adobe Dreamweaver and Microsoft office Home/Buisness. You'll need to write a justification for the needing each software.
Tom- Hardware - same as software, Write a justification for each piece of hardware we would need. I was thinking, 4 laptops, 2 servers, 1 router, 1 modem.
Michael-budget- I'll make a budget table with whatever software and hardware you guys want to use.

5.2.5.2. Compiled evidence on teamwork mental model convergence for virtual team 2

Results showed the team did converge on how the team will communicate in the beginning stage of their teamwork. At times, personal schedules were shared with other team members to avoid delays in doing tasks. In general, the team was contented with the asynchronous communicating through Blackboard Discussion Board along with the use of emails for updates.

As the team worked collaboratively on the task, the team exchanged the skills and knowledge to the others and would volunteer for doing specific tasks of self's strengths. The following examples showed how members of the team shared

with the rest of the team their knowledge and skills.

Example [from Communication Data]:

[Mary] I really like the idea for a plant exchange site. My mother-in-law works as a landscape architect so I have some experience with plants. More importantly, I can use her as a reference for ideas :)

[Tom] I think the website is going very well so far. I've been just editing the HTML to make it look nicer since Google Sites preset options suck. If there any parts of the website you think should look differently but you don't know how to properly change them, then let me know.

The team was not proactive in converging on the team roles prior to the task; rather, the team tended to wait until the last minute to determine the team roles based on volunteer.

Example [from Communication Data]:

[Mary] I'm working on compiling the information from the boards into information on the IT Platform page of the site. Feel free to change anything that you want as you see fit. Since the deadline is tonight at midnight I just wanted to make sure that that work that we had on the Discussion Board was added to the site as well. I saw that it was almost 10 and started to panic a little :P

5.2.5.3. Compiled evidence on teamwork mental model convergence for virtual team 3

Through emails, the team first converged on the primary communication tool of the team was email. Each team member also told the others about his/her weekly schedule.

Example [from Communication Data]: The team shared the availability

[Matthew] I can be contacted by email or phone: mtew@unomaha.edu or 402-707-0765. I am a senior in Computer Engineering and am at PKI every day, usually in the morning.
[Sam] I work part time and I'm available every day after 4pm from Monday to Thursday and at 6pm on Friday.
[Ryan] I work full-time and usually get home from work between 4:30 and 5:00 pm Central. I am in Omaha. I like to at least check in to Blackboard on

Monday evening but I don't usually work on every class, every night (I am taking 4 classes this semester, so I have to manage my time).

Virtual team 3 also converged on the team members' knowledge and skills in the beginning weeks of the project. For example, Sam volunteered to do interactive features related to Google Sites page editing if someone in the team needed help. He shared his past experience with using web page design languages, such as HTML/Java Script, with the team in an email message. The communication about each member's knowledge and skills did not occur later in the project. Instead of introducing one's self, after the initial set-up stage of the project passed, the team's communication began to be focused on certain aspects related to the tasks.

5.2.5.4. Compiled evidence on teamwork mental model convergence for virtual team 4

Choosing a communication channel was the first decision the team collectively made. The team was proactive in establishing their team meeting online schedule and set up a timeline for each week. They preferred a structured way of working so they become accountable to each other.

Example [from Communication Data]

[Sarah] Hi Team!

Just wanted to submit a tentative meeting schedule for us to submit work to each other for review. Since we usually go by weeks as far as assignments, we could adopt a similar pattern.
I would recommend that we submit work/check for peer submissions on Mondays. Because our assignments are due on Sunday, this gives us all week to communicate what project components to be addressed. ...

[Jeff] Mondays are not the greatest for me in respects to extra time. I have class starting at 9:00 am to 11:45, then work from 12:15 to 5:15, and then a night class from 6:00 to usually 8:00. Modays are by busy days. Other than that, I can have stuff posted or updated by Tuesday late afternoon/evening, if that works. ....

Just let me know.

[Leonora] Jeff,

Whatever works best per your schedule is fine for me.

[Jeff] That works for me. I feel that we will be most efficient if we stick to a structured schedule that is consistent every week. I will post the forum needed for deliverable #1, so we can get that organized.

[Rice] Mondays are my busy days, but every day after that i'm free after 6pm.

The team was proactive in assigning the team roles by proposing a specific set of roles first, and then each team member selected roles. They also had a clear description to each role. The roles include group leader, webmaster, project manager, marketing, information technologist, and product/service value chain manager. The team members' past work experience played a role in the effectiveness of the teamwork.

The team members shared their knowledge, skills and other personal background only when it was necessary and not all quickly with others at one round of communication. The team knew where to exchange which information specifically according to the setting of specific forums in Blackboard. For example, Sarah shared with others her experience with project management when she tried to facilitate the overall process of the task. Jeff told the others his working experience when he volunteered at a task.

Example [from Communication Data]:
[Sarah]
I do have project management experience with virtual/remote teams so I can offer my skills in this regard. I think it may help us to form a mental model per the third point of the TPU Strategies documentation provided by the instructor if we have an idea of who is doing which kinds of tasks. I'm also creating this post to figure out how to complete this project, so bear with me here if I seem a

tad pendantive at times.
[Jeff] week 2 I am indifferent to what we decide we want to do. I am a business major, so I know that we can find creative ways to market any product or service.
[Sarah]
I would like the role of Project Manager and Webmaster because I have professional experience with virtual team project management and I have experience with website administration.
[Jeff] I would be fine with Group Leader and Products/Service Value Chain Manager, since I have created business plans in the past for school, and have some background in the corporate business world. With the finance role that I have at my job, I mostly work with the supplier side of the house, but I have also interacted with some customers. Also, Union Pacific strives for safety and customer service, so I have some background with customer service actions and views.

5.2.5.5. Compiled evidence on teamwork mental model convergence for virtual team 5

The team did reach the agreement that Blackboard email and Discussion Board should not be used in the project. Email and Google Chat was the main communication channel for virtual team 5.

The team did not engage in much team communication regarding skills, knowledge, and other personal background information through emails. Rather, they communicated through Google Chat and assigned the roles.

5.3. Survey Data Examination

5.3.1. Descriptive Statistics of the Survey

The *unit of analysis* is at the team level. Specifically, responses of participants from the same team were averaged against each item of a particular construct. Table 26 shows the average scores on such variables as inclusiveness, usage experience, fit, taskwork mental model convergence, teamwork mental model convergence, and adaptive use of IT capabilities of each team at three time points, respectively.

Table 26

Complete Data from Surveys

Time	Team	Inclusiveness	Usage Exp	Fit	Taskwork	Teamwork	AUITC
1	1	4.17	4.25	3.42	3.89	1.67	3.94
2	1	3.75	4.42	3.58	3.89	1.78	3.92
3	1	3.25	4.50	2.42	3.78	1.44	3.39
1	2	4.38	3.81	3.25	4.50	3.92	3.81
2	2	4.50	3.69	3.50	4.25	2.33	3.90
3	2	4.06	3.88	3.63	4.17	2.33	3.85
1	3	4.17	3.58	2.50	3.56	2.67	3.42
2	3	3.67	3.75	2.58	4.00	2.67	3.33
3	3	4.00	3.67	2.92	4.00	3.00	3.53
1	4	4.50	3.67	3.50	4.56	3.56	3.89
2	4	4.58	4.00	3.50	4.44	3.78	4.03
3	4	4.67	3.92	3.58	4.22	3.89	4.06
1	5	3.92	3.83	2.75	3.44	2.11	3.50
2	5	3.75	4.00	2.50	3.89	2.33	3.42
3	5	3.67	4.17	2.67	3.33	3.67	3.50

Table 27shows the means and the standard deviations on each construct.

Table 27

Summary of descriptive statistics on variables

Variable	N	Time 1		Time 2		Time 3		All time	
		Mean	Std	Mean	Std	Mean	Std	Mean	Std
INC	5	4.23	0.22	4.05	0.45	3.93	0.52	4.07	0.41
UE	5	3.83	0.26	3.97	0.29	4.03	0.32	3.94	0.28
Fit	5	3.08	0.44	3.13	0.54	3.04	0.54	3.09	0.47
AUITC	5	3.71	0.24	3.72	0.32	3.67	0.46	3.70	0.26
TKMM	5	3.99	0.52	4.09	0.25	3.90	1.00	3.99	0.37
TMMM	5	2.78	0.95	2.58	0.74	2.87	0.28	2.74	0.85

Note.INC = Inclusiveness, UE = Usage experience, AUITC = Adaptive use of IT capabilities, TKMM = Taskwork mental model, TMMM = Teamwork mental model.

The sample size for all these variables is five. Because of the small number of sample size, it is not possible to do parametric tests. However, the examination of these descriptive statistics is still valuable in identifying some interesting hidden patterns. The SPSS syntax is:

ONEWAY

GMeanIncGMeanUsgGMeanFitGMeanTaskworkGMeanTeamworkGMeanAUITC BY time

/STATISTICS DESCRIPTIVES

/PLOT MEANS

/MISSING ANALYSIS.

Results showed that the mean of inclusiveness peaked at Time 1 (*M* = 4.23, *SD* = 0.22) and then decreased over time. The mean of inclusiveness at Time 2 was 4.05, with a standard deviation of 0.45. The mean of inclusiveness at Time 3 was only 3.93 (*SD* = 0.52). This result regarding inclusiveness indicates that virtual teams tend to use more diverse IT capabilities at the beginning of the team's life cycle than the later stage of the teams' life cycle. Considering inclusiveness was measured on a scale of 5, means on inclusiveness (i.e., the average usage of diverse capabilities from all five virtual teams) is relatively high. With regard to usage experience, another component of AUITC, results indicate an ascending trend. The mean of the usage experience at Time 1 was the lowest (*M* = 3.83, *SD* = 0.26) among means on usage experience at all time, and the mean on usage experience at Time 3 was the highest (*M* = 3.83, *SD* = 0.26). Means on the fit dimension of AUICT peaked at time 2 (*M*=3.13, *SD* = 0.54). For all three dimensions of AUITC across different time, results show that the mean on inclusiveness (*M*= 4.07, *SD* = 0.41) is higher than the mean on usage experience (*M*=3.94, *SD* = 0.28), which is, in turn, higher than the mean on fit (*M*= 3.09, *SD* = 0.47). In terms of the composite score of AUITC over the three

dimensions, the results revealed that the means on AUITC at earlier times of the virtual teams' life cycle were higher (Time 1, *M*= 3.71, *SD* = 0.24; Time 2, *M*= 3.72, *SD* = 0.32) than the mean on AUITC at the end of the virtual teams' life cycle (*M*= 3.67, *SD* = 0.46).

Results indicate that over the time virtual teams have higher convergence on taskwork mental model (*M* = 3.99, *SD* = 0.37) than on teamwork mental model (*M* = 2.74, *SD* = 0.85). The pattern of the changes on means of taskwork mental model over time is similar to that of the means of AUITC. The taskwork mental model's means were higher (Time 1, *M*= 3.99, *SD* = 0.52; Time 2, *M*= 4.09, *SD* = 0.25) in the previous life cycle of virtual teams than in the later of the life cycle of the virtual teams (*M*= 3.9, *SD* = 1.0). Results did not show a clear trend regarding the changes on teamwork mental models' convergence based on the means. But the virtual teams did achieve the highest mean on teamwork mental model convergence (*M*= 2.87, *SD* = 0.28) at Time 3, the end of the team's life cycle.

Box plots (Figure 17 and Figure 22) showed that the variations of means on fit across all three times were the highest among all of the constructs, and means on usage experience exhibit the lowest variations consistently throughout the three times. Both of the variations on taskwork mental model convergence and the variations on teamwork mental model convergence at time 1 were relatively much higher than the other two later times.

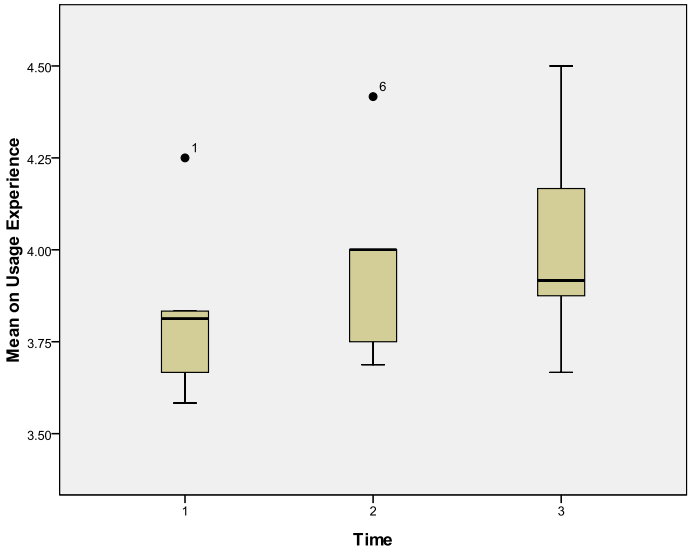

*Figure 17.*A box plot of mean on usage experience by time.

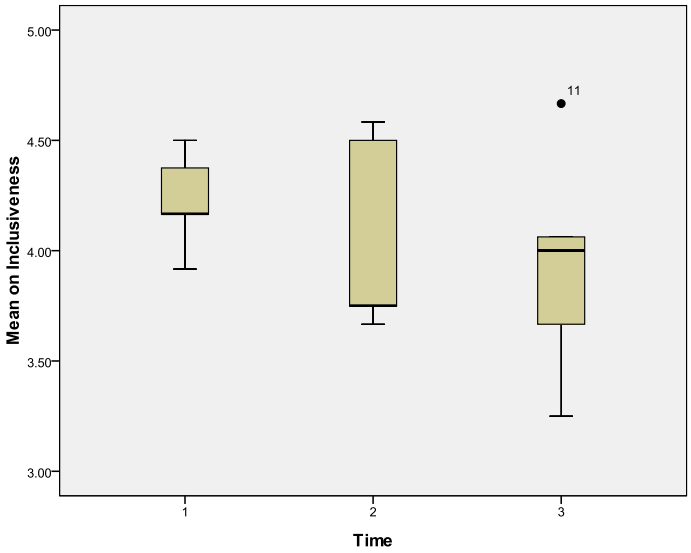

*Figure 18.*A box plot of mean on inclusiveness by time.

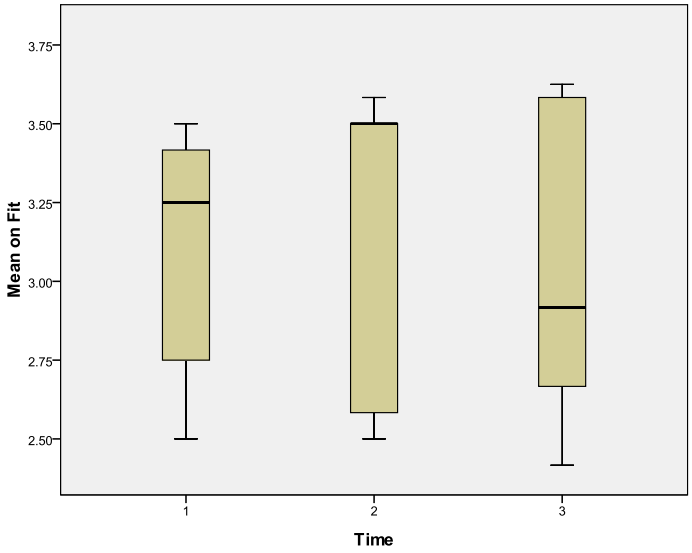

*Figure19.*A box plot of mean on fit by time.

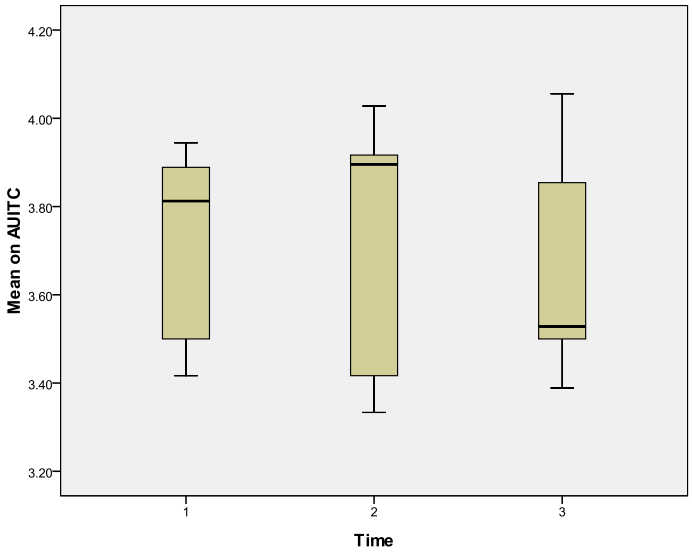

*Figure 20.*A box plot of mean on AUITC by time.

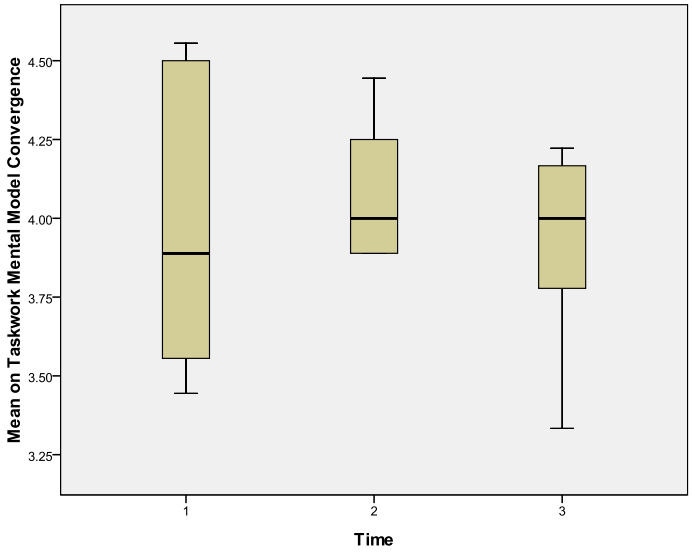

*Figure 21.*A box plot of mean on taskwork mental model convergence by time.

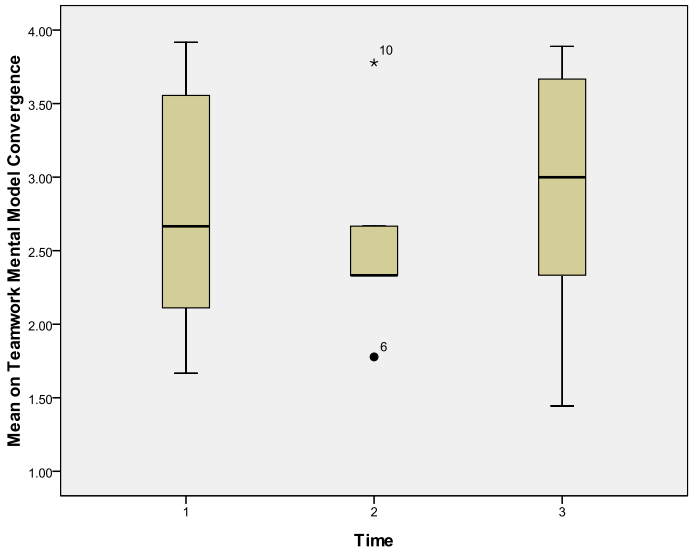

*Figure 22.*A box plot of mean on teamwork mental model convergence by time.

Kruskal Wallis test was used to further examine if there were significant changes on the means of constructs over time (shown in Table 28).

Table 28

Kruskal Wallis test statistics[a]

	INC	UE	Fit	TKMM	TMMM	AUITC
Chi-square	1.19	1.69	.19	.61	.22	.05
df	2	2	2	2	2	2
Asymp. Sig.	.55	.43	.91	.74	.89	.97

Note. a. Grouping Variable: time (1 = low, 3 = high); INC = Inclusiveness, UE = Usage experience, AUITC = Adaptive use of IT capabilities, TKMM = Taskwork mental model, TMMM = Teamwork mental model.

Kruskal Wallis test is a non-parametric test to compare means from more than two groups. The equivalent parametric test of Kruskal Wallis is one way ANOVA. In this study, data were assigned into different groups by time. In each of the groups are five samples, which meet the minimum sample size requirement by Kruskal Wallis test.

The results of analysis did not reveal any significant changes on the means of constructs over time. Specific results for each of the constructs were reported as below. There is not a significant difference in the means on inclusiveness over time, χ^2 (2, N = 15) = 1.19, p = 0.55. There is not a significant difference in the means on usage experience over time, χ^2 (2, N = 15) = 1.69, p = 0.43. There is not a significant difference in the means on fit over time, χ^2 (2, N = 15) = 0.19, p = 0.91. There is not a significant difference in the means on AUITC over time, χ^2 (2, N = 15) = 0.05, p = 0.97. There is not a significant difference in the means on taskwork mental model convergence over time, χ^2 (2, N = 15) = 0.22, p = 0.89. There is not a significant difference in the means on Teamwork mental model convergence over time, χ^2 (2, N = 15) = 0.22, p = 0.89.

5.3.2. Correlation of AUITC and Shared Mental Models Convergence

The correlation between AUITC and shared mental models convergence was examined both visually and statistically. Section 5.3.2.1 describes the results of analysis based on Spearman's correlation coefficient. Section 5.3.2.2 shows the scatter plots of the interplay between AUITC and taskwork mental model convergence, and teamwork mental model convergence.

5.3.2.1. Spearman's correlation coefficient analysis

Given the small size of the data set, I chose to first do a non-parametric test to examine the correlation between the adaptive use of IT capabilities and the convergence on shared mental models.

Non-parametric tests were considered to be not as rigorous as those parametric tests (Siegel & Castellan, 1988). But non-parametric tests were still constantly used in social science research when the data size is small or the key assumptions, such as the data distribution or equal variances, of those parametric tests are violated in the real data set.

Spearman's correlation coefficient is chosen to examine the interplay of AUITC and shared mental models convergence (shown in Table 29). The test was done in SPSS, and the SPSS syntax is

```
NONPAR CORR
  /VARIABLES=time gid GMeanInc GMeanUsg GMeanFit GMeanTask GMeanTeam
AUITC
  /PRINT=SPEARMAN ONETAIL NOSIG
  /MISSING=PAIRWISE.
```

Table 29

Spearman's r on Pairs of Variables

	Variable	1	2	3	4	5	6	7	8
1	Time	1.00							
2	Team	0.00	1.0						
3	Inclusiveness	-0.28	0.07	1.0					
4	Usg. Exp.	0.32	-0.23	-0.38	1.0				
5	Fit	0.10	-0.20	0.61	0.02	1.0			
6	AUITC	-0.10	-0.15	0.75*	0.17	0.86*	1.0		
7	Taskwork MM.	-0.09	-0.12	0.71*	-0.35	0.59*	0.52*	1.0	
8	TeamworkMM.	0.05	0.47	0.52*	-0.41	0.19	0.24	0.51*	1.0

*Note. * Correlation is significant at the 0.05 level (one-tailed).*

The results of analysis indicate that there is a strong correlation between AUITC and taskwork mental model convergence, r = 0.52 (15), *p* (one-tailed) < .05.Specifically, the results reveal a significant correlation between inclusiveness and taskwork mental model convergence, r = 0.71 (15), *p* (one-tailed) < .05. The results do show a strong correlation between fit and taskwork mental model convergence, r = 0.59 (15), *p* (one-tailed) < .05.

The results do not reveal a significant correlation between AUITC and teamwork mental model. However, the teamwork mental model was significantly correlated with one dimension of AUITC, i.e. inclusiveness, r = 0.52 (15), *p* (one-tailed) < .05.

5.3.2.2. Findings from the scatter plots

Although Spearman's r tells us whether there is a correlation between AUITC and each of the two dimensions of shared mental models' convergence, it does not allow an in-depth onto the data to reveal perhaps more interesting hidden patterns. Simply drawing conclusions from the results of Spearman's correlation coefficients has the risk of treating the data as a black box without taking full

advantage of the meaning of the data.

Since the study also collects qualitative data on both of the two key constructs for each of the virtual teams, it is helpful to draw scatter plots for each team on the effects of dimensions of AUITC on two types of shared mental models convergence. Therefore, a linkage between the quantitative data and qualitative data collected is established. In addition, presenting the interplay of AUITC and shared mental models convergence per each virtual team provides an alternative way to examine patterns regarding the effects of AUITC on shared mental models convergence.

In the scatter plots, data were displayed on a two-by-two matrix. The matrix consists of two dimensions, and each of the two dimensions represents a variable of interest. The ranges of the two variables provide the overall border of the matrix. The mean of each of the two variables is used to divide the matrix into four cells.

Displaying data into meaningful matrix is a good way to see the correlation between two variables, and the use of matrix also offers an approach to categorize data into meaningful groups.

An example of such scatter plot is shown in Figure 23.

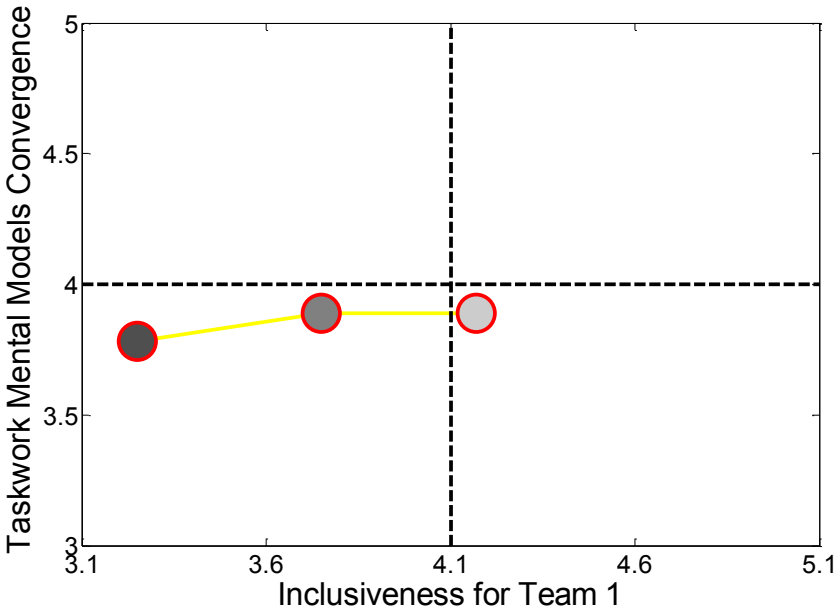

*Figure 23.*Team 1 inclusiveness and taskwork mental model convergence matrix.

Although variations exist, the rest of this subsection focuses on describing the commonalities in terms of the interplay of AUITC and shared mental models development.

The interplay relationships between AUITC and taskwork mental models are discussed in the following three aspects:

First, inclusiveness has a positive role on the development of taskwork models according to the scatter plots. Although virtual teams varied in terms of the interplay between inclusiveness and taskwork mental model convergence over time, the data were mostly in the upper right and lower left cells in the matrix. That means the virtual team is more likely to have an above-average level of taskwork mental models convergence when the virtual team's level on inclusiveness is high. Virtual team 2 and virtual team 4 had high inclusiveness and meanwhile developed more converged taskwork mental models. However, virtual team 5 had the lowest inclusiveness across time and thus developed a below than average level of taskwork

mental models convergence.

Second, the plots do not show an obvious relationship between the usage dimension of AUITC and development of taskwork mental models development. Two teams, virtual team 1 and virtual team 5 experienced below than average level of taskwork mental models' convergence, but had above than average level of IT capabilities usage. On the other hand, virtual team 2 and virtual team 4 had average level of IT capabilities usage, but the two teams developed relatively highly converged taskwork mental models.

Third, the fit dimension of AUITC positively correlated with the development of taskwork mental models as is shown in the scatter plots. Virtual team 2 and virtual team 4 were both high on the fit dimension and they developed relatively high level of taskwork mental model convergence. However, virtual team 1, 3, and 5 were seen as developed relatively low taskwork mental models convergence with below than average level of fit.

The scatter plots also helped reveal the interplay relationships between AUITC and teamwork mental models development.

First, compared with the role of inclusiveness in the development of taskwork mental models, the inclusiveness dimension had a smaller positive effect on the teamwork mental models convergence. The data did not consistently exist only within the upper right and lower left regions of the matrix. In fact, for virtual team 2 and virtual team 5, great variances in terms of the teamwork mental models convergence occur across the time with.

Second, the teamwork mental models' convergence was not seen as strongly positively correlated with teams' usage dimension of AUITC. Virtual team 1 had high level of usage of IT capabilities, but did not experienced high level of teamwork mental models convergence. Virtual team 4 had very high level of teamwork mental models convergence with average level of IT capabilities usage.

Third, the fit dimension did not show an obvious effect on the development of teamwork mental models across teams.

5.4. Summary of Findings on Each Construct

This section summarizes the major findings from the case study evidence by using summary tables (shown in Table 33to Table 38) to show the compiled case study evidence and the major statistics from the surveys. Results of the study were categorized on each of the constructs across cases. To summarize the findings from the case study evidence, the author employed the high-moderate-low index rating to index each of the constructs for each particular case based on the case study evidence. These indices were assigned according to the strength of the evidence related to each construct and to comparisons of the evidence for each case against the evidence for the others[26]. In addition, survey statistics (the means of the construct across a particular team) on each of the constructs were provided in the summary tables (shown in Table 33 to Table 38). In general, results showed that the ordering of case study evidence (such ordering was derived from the qualitative data) was consistent with the relative strength of each of the constructs across cases (the relative strength

[26]An example of using this approach to qualitatively assess constructs in case study can be found in Kirsch and Cummings (1996).

was obtained through the survey responses).A few exceptions were with the assessments of the construct of usage experience for virtual team 1, 2 and 4. For example, the although survey responses showed that virtual team 1 had the highest level of IT usage during the project, the case study evidence suggests that virtual team 1 has a low level of IT usage experience because virtual team 1 had only one active member that contributed significantly to the overall team communication and interaction activities through IT, and most of the IT usage only occurred one day before or on the deadline dates. As an another example, survey response showed that team 2 had a relatively low IT usage, while the case study evidence showed that virtual team 2 had engaged in very good team interactions through the Blackboard Discussion Board on a variety of topics relating to the project, and the team communication only fades out toward the end of the project. Therefore, team 2 was given a high index on the usage experience.

Table 30 to Table 35 showed the summarized findings on each construct across cases.

Table 30

Case Study Evidence and Survey Results for Inclusiveness

Construct	Team 1	Team 2	Team 3	Team 4	Team 5
UE[a]	One member on the team was especially good at recommending IT tools for team communication and she showed the passion of facilitating the essential teamwork through IT. Within the first week interaction, the team learned to use different types IT for different tasks. The team worked intensely right on or just one day before the deadlines.	This team was not a type of team that rushes in the last minute. There were two active members that would suggest an IT and showed the interest at working it around on tasks. The team intensively used Blackboard Discussion Board for many kinds of tasks such as brainstorming, information retrieval, and decision making.	One of the team members tried to initiate the first round of team communication, but failed because not everyone on the team was checking their BB Discussion Board. The team then chose to use email intensively because of the easy access across platforms, such as cell phone, Pads, and desktops. Except for the first week, the team got quick response on everyone and the most intense days that the team interacted were those deliverables' due dates.	Team 4 was a critical-thinking team. This team would think about the characteristics of each IT and weighed their benefits for particular kinds of tasks. The team had the least IT try-out experience and had everyone on the board be happy with the IT they were using.	Team 5 was a fan of synchronous communication IT tools and was not providing many logs for their interactions. The technology reports showed that their team interactions were kept in a minimum level to keep the teamwork running.
	Index = Low (survey = 4.39)	**Index = High** (survey= 3.79)	**Index = Moderate** (survey = 3.67)	**Index = High** (survey = 3.86)	**Index = Low** (survey = 4)

Note. a.UE = Usage experience.

Table 31

Case Study Evidence and Survey Results for Inclusiveness

Construct	Team 1	Team 2	Team 3	Team 4	Team 5
INC[a]	The team identified specific IT features that worked out for communication, team process, and interaction. The level of involvement from each team members was the key factor affecting the IT choices that the team made	Team 2 did most of their team interaction through BB discussion board. The team organized their team communication well through the forums, threads, and replies. Not many explicit team process usage of IT was found	Email was the primary IT tool that team 3 used. Team 3 used email for communication, team process and interaction. Once in a while, the team used Google Calendar for making the due dates of the project.	Team 4 used various features of the three IT tools, email, BB, and Google Site in the project.	Team 5 used emails and Google chat for general team communication, task updates and team planning. Google Chats were also used for brainstorming. The team used various IT features for team interaction.
	Index = Moderate (survey = 3.72)	**Index = Moderate** (survey = 4.3)	**Index = Moderate** (survey = 3.95)	**Index = High** (survey = 4.58)	**Index = Moderate** (survey = 3.78)

Note. a.INC = Inclusiveness.

Table 32

Case Study Evidence and Survey Results for Fit

Construct	Team 1	Team 2	Team 3	Team 4	Team 5
FIT[a]	The team used emails along with the task management feature of Google Site for explicit sharing task due dates, task assignments, and interim task updates. Team members varied regarding the expectations on the level of team involvement in the use of an IT. Visible and collective IT usage were necessary components of the fit dimension.	Team 2 found BB discussion board as a perfect tool for organizing, storing, and retrieving their team interactions. The team was able to collectively discuss and solve problems on Google Site web page editing through emails. For once, the team members reported team leaders not being responsible for the teamwork assignment.	Team 3 was a simple team that was task-oriented and did not want to spend too much time on exploring and using appropriate IT. They chose email for many kinds of tasks because of the easy to use, simple look, and quick access across platforms.	This team found the fit IT tools for their teamwork and was also good at facilitating this seeking-fit process. Every time a new technology was introduced by an initiator, announcements were made to build the common ground on why the team should use this IT feature or IT tool and how to use it.	Team 5 found two IT features that provide them the interaction capabilities. Google Docs and Google Talk together helped the team to work on a single document same time. The team members were not explicitly converged on the use of team process capabilities.
	Index = Moderate (survey = 3.14)	**Index = High** (survey = 3.46)	**Index = Moderate** (survey = 2.67)	**Index = High** (survey = 3.53)	**Index = Low** (survey = 2.64)

Note. a.FIT = Fit.

Table 33

Case Study Evidence and Survey Results for AUITC

Construct	Team 1	Team 2	Team 3	Team 4	Team 5
AUITC[a]	In the beginning, the team did try out various IT tools for communication, team process, and interaction. Then at later time of the project, team used less communication capabilities, but used more team process and interaction capabilities in the project.	Team 2 was able to find an everyone-satisfied IT, BB, for their virtual teamwork. BB discussion board has been exploited throughout the project. One member of the team was good at taking advantage of the BB discussion board by facilitating some in-depth discussions for multiple rounds.	The team figured out what communication tools worked out for them in the beginning week and then just keep using it without any problem. The team liked to keep the number of features of IT in use as small as possible.	Team 4 was very proactive in choosing which feature to be used and for what purposes. The reflective thinking of the characteristics of each IT feature gave the team a step ahead in terms of IT adaptive use for accomplishing the project.	Throughout the project, team 5 engaged in several long-lasted team interactions through the use of synch tools.
	Index = Moderate (survey =3.75)	**Index = High** (survey = 3.85)	**Index = Moderate** (survey = 3.43)	**Index = High** (survey = 3.99)	**Index = Low** (survey = 3.47)

Note. a.AUITC = Adaptive use of IT capabilities.

Table 34

Case Study Evidence and Survey Results for Taskwork Mental Models

Construct	Team 1	Team 2	Team 3	Team 4	Team 5
TKMM	The team converged on how and when to use IT communication and team process capabilities through team interactions.The convergence on the IT interaction capabilities happened when there were technical problems. Task due dates and procedure to accomplish the task was shared across the team through announcements by the team leader. The team did not actively share with one another some references of the project.	Team leader played a significant role in facilitating the process of building shared mental models on the technologies to be used by the team and on the discussion around specific questions about the task per se. But the team lacked the common grounds on the task steps. The low quality shared understanding on the task procedures lead to undesired situations when it had to be someone to volunteer for some tasks of the projection the due dates.	The team built their shared understanding on the drawbacks and strengths of each communicationcapabilities from different tools and made their IT use choice within two weeks. The team also built their shared understandings on essential components of getting the task done, such as the project due dates and procedures to accomplish the project.	The convergence on the use of various IT capabilities was explicit and proactive. Therefore, the team felt confident when they used emails, BB discussion board and Google Sites because the team shared the knowledge about what these tools to be used for and when to use. The team also converged on knowledge contents relating to the project through active and balanced team interactions from all team members.	Team 5 engaged in a few team communication on sharing each one's experience with IT interaction capabilities, such as Google Site. The team used emails to share with the project due dates and steps to accomplish the project.
	Index = Moderate (survey = 3.85)	**Index = Moderate** (survey = 4.31)	**Index = Moderate** (survey = 3.85)	**Index = High** (survey = 4.41)	**Index = Low** (survey = 3.55)

Note. a.TKMM = Taskwork mental model.

Table 35

Case Study Evidence and Survey Results for Teamwork Mental Models

Construct	Team 1	Team 2	Team 3	Team 4	Team 5
TMMM	The team first converged on when and how the team communicates and interacts. The team knew they would communicate through emails and Google Talk regularly. The team converge on the team roles, knowledge, and skills explicitly through using communication capabilities. The team got to know each other's available time and was able to gradually develop shared expectations on the number of people that would attend a virtual group meeting.	The team agreed to combine the use of BB discussion board and emails for asynchronous team communication. The team converged on the team members' personal schedules so team meetings can be arranged and the team developed accurate shared understanding on the general progress for each one. Team members' skills and strengths were proactively shared across teams during team interaction. The team roles were converged lately.	After explore diverse communication capabilities, the team agreed on using emails as the primary methods for communication after the team shared each other the availability during the week. The team was active in sharing the alternative contact ways, the availability during the week so the team had establish a reference to each team members' schedule in the week. The team converge on the team members' knowledge, skills through interaction capabilities.	The team first converge on when and how to communicate in the beginning week of the project. Then the team was proactive in deciding what roles the team needed and who took which roles. The team shared personal knowledge, skills, and other background as needed. The team organized their team discussion well based on each topic. The team's shared understanding around that topic were more accurately and explicitly shared	The team knew they did not like the BB discussion board and BB emails so they used Google emails and Google Chat for general team communication. The team roles, knowledge, and skills were all shared through synchronous tools.
	Index = Low (survey = 1.63)	**Index = Moderate** (survey = 2.86)	**Index = Moderate** (survey = 2.78)	**Index = High** (survey = 3.74)	**Index = Low** (survey = 2.70)

Note. a.TMMM = Teamwork mental model.

Table 30 to Table 35 summarized key findings from case study evidence and the survey responses on each construct examined in the dissertation study. But Table 30 to Table 35 does not show the changes of each construct over time. Table 36 shows the strengths of the constructs across the three time points in the project. Specifically, the Tuckman's group development stages (i.e., forming, storming, norming, and performance) are used as frame of reference to evaluate the constructs over time. The indices are assigned according to a subjective evaluation of the evidence for each stage compared against the evidence for the other stages.

To interpret Table 36, consider the following examples. With respect to usage experience, in virtual teams, all four stages of group development requires the use of three types of IT capabilities: communication, team process, and interaction. However, in contrast to the usage experience at the storming and performing stages, which was innovative, intense, and long, the usage experience at the forming was conservative and short. The quality of usage experience in the norming stage is between that of the storming stage and the forming stage. Thus, as summarized in Table 36, the results of the case studies suggest that there is a *high* degree of usage experience at the storming and the performing stage, that the usage experience at the forming stage is *low*, and that the usage experience at the norming stage is *moderate*.

Consider next the measurement of inclusiveness construct. As detailed in Table 30 and summarized in Table 35, the evidence from the cases suggested that the degree of inclusiveness varied across teams. Team 2 and 3 preferred to keep the list of IT features in use short or to at least keep the list of IT tools in use short. Team 1 and

5 took a more explorative approach regarding the IT capabilities and liked to try diverse IT capabilities for different kinds of tasks. But for all teams, the storming stage had the highest degree of inclusiveness, and the forming stage was associated with a relatively low degree of inclusiveness. Therefore, as is shown in Table 36, the results suggest that there is a low-to-medium level of inclusiveness on the forming stage, that the storming stage has a high degree of inclusiveness, and the norming and performing stages have a medium-to-high level of inclusiveness.

Table 36

A Time-ordered Matrix for Adaptive Use of IT Capabilities and Shared Mental Models Development in Virtual Teams

Construct[a]	Forming	Storming	Norming	Performing
UE	Low	High	Medium	High
INC	Low to Medium	High	Medium to High	Medium to High
FIT	NA	Low	Medium	High
COM	Low	High	High	High
INT	Low	Low to Medium	Low to High	Low to High
PROC	Low	Medium	Medium to High	Medium to High
TKMM	Low	Medium to High	Medium to High	Medium to High
TMMM	Medium	Medium to High	Medium to High	Medium to High

Note: a. UE = Usage experience, INC = Inclusiveness, FIT = Fit, COM = Communication capabilities, INT = Interaction capabilities, PROC = Team processing capabilities, TKMM = Taskwork mental models, TMMM = Teamwork mental models.

5.5. Summary of Chapter5

Chapter 5 presented detailed results from the qualitative data analysis and quantitative data analysis. The next chapter presents discussions based on the results to answer the research questions of the dissertation study.

CHAPTER 6: DISCUSSION OF FINDINGS

This section answers the research question of the dissertation study and is organized by the propositions in the conceptual model. The interplay between

adaptive use of IT capabilities and shared mental models development is accounted by the significant roles of usage experience, inclusiveness, and fit.

6.1. The Role of Usage Experience

Proposition 1a: The interplay of adaptive use of IT capabilities and development of shared mental models is affected by the usage experience dimension of AUITC.

Spearman's correlation did not show a significant correlation between the usage experience and team's quality of shared mental models (including taskwork mental models and teamwork mental models). Results from the scatter plots of the usage experience and shared mental models development also failed to show an obvious relationship between the usage experience and the development of shared mental models.

While the results of the case study provide strong evidence that support P1a, several insights were obtained. First, both the prior and on-going usage experience with IT capabilities show influence on the development of shared mental models in virtual teams. Prior usage experience refers to each team member's prior usage experience with IT features and IT tools. Prior usage experience had a strong influence on the team communication and, thus, on the building of team mind in the beginning or the forming stage of a team. The on-going usage experience includes both of a team's collective usage experience with IT capabilities and each member's unshared usage experience as the team project progress.

Second, the amount of time and frequency of using IT capabilities can have

positive influence on the development of shard mental models only when the usage experience with IT capabilities is quality, which means being visible and reflective. Virtual team 2 used less communication capabilities than team 1 in time 1 but reached high converged shared mental models. Team 2 engaged in more visible and reflective IT capabilities usage by documenting their team activities and being critical of choosing a particular IT tool for storing the important information. Taken together, P1a is supported.

Proposition 1b: The interplay of adaptive use of IT capabilities and development of taskwork mental models is affected by the usage experience dimension of AUITC.

Spearman's correlation did not show a significant correlation between the usage experience and taskwork mental models development in virtual teams. While case study evidence provided valuable insights of the effect of usage experience on the interplay between AUITC and taskwork mental models convergence.

The case study evidence suggests that virtual team members' past usage experience with IT capabilities affected the development of shared mental models on the IT features and IT tools that the teams were interacting with. Prior to being a member of a virtual team, each individual of the team possessed a unique or shared technology applications usage history. The prior use of technology capabilities to a large extent determined the virtual team's initial perceptions of the IT capabilities available for use for a particular virtual team project. In other words, because of the individual differences in prior technology use, virtual teams may initially have

differing attitudes toward a specific IT capability or may make different choices of which specific IT capability to use. Evidence from this research shows that virtual team members are likely to share with other members their positive or negative feelings toward a particular IT capability from their past experience with that IT capability. The information of prior use a virtual team member brought to the team influenced whether a virtual team initially adopted an IT capability. As the virtual team members have more interactions with the technology capabilities they chose, the team will over time continue or abandon the adoption of IT capabilities so that all team members are satisfied with the technology capabilities they used. The converged shared mental models on IT capabilities enabled by different IT tools or features facilitate the development of other mental models relating to accomplishing team tasks.

In addition to the commonly measured amount of time and frequency when assessing usage experience, results of the case study evidence suggest that virtual teams' development of taskwork mental models can benefit from engaging in reflective usage experience. A virtual team has a reflective usage experience when virtual team members consciously reflect on the effectiveness of IT capabilities in supporting team's communication, team process and interaction. The study's virtual teams that were reflective on their use of IT capabilities were more likely to engage in smooth team communication and an effective team process so that accurate and shared taskwork mental models could be established. In the absence of reflective usage experience, the virtual teams unconsciously chose the specific IT capability

based on their past habits and adapted the IT capability to the team when necessary. Without reflective usage experience, virtual teams may still develop taskwork mental models on essential aspects relating to the task, such as the purpose of using specific IT capability, the goal of the task and the steps to accomplish the tasks, but the virtual team members that were not reflective were less likely to develop positive feelings (such as the feelings of like or love) about the IT capabilities for developing taskwork mental models.

The case study evidence also suggests that visible usage experience with IT capabilities positively influences the interplay of AUITC and taskwork mental models development. *Visible* usage experience refers to the use of IT capabilities, including the specific contents and the usage logs, that is observable to all team members.

Shih et al.'s (2013) study suggest visible usage experience can benefit virtual teams in (a) building the communication channel and establishing a short-term or long-term memory system for the team, (b) developing shared understanding of the benefits and limitations of a particular IT capability on given tasks, and (c) enabling the team's shared understanding of the functionalities of IT capabilities and the appropriate time and places for using those IT capabilities.

This dissertation study confirmed Shih et al's findings and also suggests an additional reason why virtual teams should keep their usage experience visible to one another. Making each one's activities visible to the others on the team helps the team to establish intra-team trust. Knowing the others were using a particular IT capability helps one maintain confidence and want to keep using that IT capability. This

intra-team trust is especially important when the task is given with a short period of time.

Taken together the survey results and case study evidence, P1b is supported.

Proposition 1c: The interplay of adaptive use of IT capabilities and development of teamwork mental models is affected by the usage experience dimension of AUITC.

Results from the survey did not show a significant correlation between the usage experience of IT capabilities and the development of teamwork mental models convergence. The qualitative data analysis provides some insights usage experience's effect on the interplay of AUITC and teamwork mental models convergence.

Three characteristics of usage experience were found to be important to the interplay of AUITC and teamwork mental models: reflective, visible, and collective.

First, by a *reflective* usage experience, a virtual team purposefully chose IT capabilities to assign team roles and communicate team members' knowledge and skill background among the team. Failure to reflect on the IT capabilities to be used for team process, for example, can result in ambiguity or even no role assignment in the team. Reflections on the usage of IT capabilities not only help virtual teams quickly establish shared understandings on the team roles and knowledge but also enable virtual teams' objective perceptions toward the usefulness of the IT capabilities and eventually develop more efficient use of that particular IT capability.

Second, a *visible* usage experience is essential to establishing virtual teams' teamwork mental models, especially in terms of the team communication channels. In

the newly formed virtual teams, when, how and where to communicate with the other members of the team are the first set of important decisions a virtual team has to make. Prior use and influence from powerful individuals affect how virtual teams make the initial IT capabilities adoption decision. Visible usage experience is necessary for a virtual team to either maintain or revise initial technology adoption decisions. In fact, the dissertation study showed that an IT capability can be abandoned because of lack of responses from others. But the use of a specific IT capability for team communication was reinforced when all members clearly saw the participation of the team.

Some researchers (Carte & Chidambaram, 2004) argue that visual anonymity of collaboration technologies can help reduce the surface-level diversity among the group and, thus, reduce the relational-based conflicts. This dissertation study found that the effects of visual anonymity are contingent on the type of IT capabilities that a virtual team uses. A visible use experience on IT communication capabilities helps establish trustfulness among the team in the sense that all team members are seen as responsible for the teamwork. A visible use experience with IT team process and interaction capabilities provides essential means by which virtual team members show their knowledge and skills or learn knowledge from others. With the converged mental models on teamwork, a virtual team's use of IT communication and team process capabilities become habitualized.

The third characteristic of usage experience is the *collective* dimension. A *collective* usage experience refers to shared usage experience with IT capabilities by

the virtual teams. The collective usage experience can be obtained either synchronously or asynchronously. For example, a virtual team gained synchronous collective usage experience when team members synchronously edited the web pages through the Google Sites and Google Talk. A virtual team gained asynchronous collective usage experience when they interacted asynchronously, such as through emails or Blackboard Discussion Boards.

At times, the collective usage experience emerges naturally when members of the team accomplish a task together. The collective usage experience can also be a result of leader's briefings. For example, a leader of the virtual team required all members of the team edit parts of the Google Sites. Collective usage experience is found to facilitate the social process of virtual teams and, thus, helps speed up the development of teamwork mental models among the teams. Prior research has found that teams develop shared understandings through essential social processes (Shih et al., 2013).

The dissertation study showed that the interplay of AUITC and teamwork mental models is influenced by whether a virtual team's usage experience with IT capabilities is reflective, visible, and collective. Therefore, P1c is supported

6.2. The Role of Inclusiveness

Proposition 2a: The interplay of adaptive use of IT capabilities and development of shared mental models is affected by the inclusiveness dimension of AUITC.

During the interplay of AUITC and shared mental models convergence,

inclusiveness had a mediating effect on the influence of AUITC on shared mental model development. The positive effect of AUITC on virtual teams' shared mental models convergence was enhanced to the extent that virtual teams explored inclusive and diverse IT capabilities in communication, team process, and interaction. Both survey results and qualitative data analysis provide evidence. Thus, P2a is supported.

Proposition 2b: The interplay of adaptive use of IT capabilities and development of taskwork mental models is affected by the inclusiveness dimension of AUITC.

Survey results showed a significant positive correlation between inclusiveness and taskwork mental models convergence. Qualitative data analysis showed that the more inclusive IT capabilities a virtual team used in terms of communication, team process, and interaction, the more likely that a virtual team reached high convergence on aspects of taskwork mental models. For example, virtual teams used both asynchronous IT communication capabilities and synchronous IT communication capabilities to develop shared understandings on the task goals and procedures to complete the tasks. Virtual teams used diverse IT team process capabilities, such as Blackboard Discussion Board and Google Site Calendar, to clarify the deliverables of the tasks and the specific due dates of the tasks. Important task updates were communicated to team members through emails, Blackboard Discussion Board, or an update on the task management items. In the collaborative work on group tasks, virtual teams sought effective IT interaction capabilities to accomplish the tasks.

The more active a virtual team in purposefully seeking diverse specific IT capabilities in each of the three IT capabilities (communication, team process, and interaction), the increased chance a virtual team would develop converged taskwork mental models. When members failed to use inclusive IT capabilities, a virtual team lacked taskwork mental models convergence and only reached convergence on partial or incomplete taskwork mental models; for example, they might not establish a shared understanding of the due dates of the tasks.

The total number of specific IT capabilities used by virtual teams, such as a technology application features, does not predict the success of virtual teams in converging on taskwork mental models when the following two conditions are violated. First, a virtual team has to be reflective on the specific IT capabilities used. Prior studies have found that people may feel overwhelmed when facing diverse IT capabilities and have difficulty applying IT capabilities to the tasks (Silver, 1990; Trice & Treacy, 1988). Therefore, the team needs to reach a collective agreement on the purpose for using an IT capability. Virtual team 4 explored diverse IT team process capabilities, and they knew exactly what they wanted from each of those specific IT team process capabilities. Therefore, the team found all the IT team process capabilities suited the team and the tasks well and kept using those capabilities throughout the project. Not being reflective on diverse IT capabilities can result in developing subjective perceptions or negative feelings towards certain IT capabilities and, therefore, lead to abandoning some promising IT capabilities for developing taskwork mental models. For example, virtual team 1 abandoned

Blackboard Discussion Board because the members responded less to Discussion Board than they did to emails for the team. Members of virtual team 1 did not recognize the potential of Blackboard Discussion Board as a place to organize their group discussion.

Second, leaders of a virtual team have to be cautious on important leader briefings. Leader briefings are a type of effective management practice in organizations. Leader briefings usually occur before a start of the task by leaders communicating with the team members on important aspects of tasks. In virtual teams, leader briefings not only can help speed up the taskwork mental models convergence but also influence whether all aspects of taskwork mental models are converged. Leaders of the virtual team have to be clear about what contents of the taskwork mental models must be converged. Poor leadership can result in unsuccessful taskwork mental models convergence even with the use of inclusive IT capabilities. For example, virtual team 2 used both Blackboard Discussion Board and Blackboard task management for the team process. The leader of virtual team 2, however, was mostly focused on facilitating the team in discussing the *how* questions relating to completing the tasks. The leader paid little attention in assigning the due dates of the tasks and making that piece of information available to all team members.

A high quality of taskwork mental models convergence is obtained through inclusive use of diverse IT capabilities in the areas of communication, team process, and interaction. Two contingent factors influencing the effects of the inclusiveness on the interplay of AUITC and taskwork mental models convergence are a team's

technology usage (reflective or purposeful) and leadership effectiveness. Taken together, P2b is supported.

Proposition 2c: The interplay of adaptive use of IT capabilities and development of teamwork mental models is affected by the inclusiveness dimension of AUITC.

The extent to which a virtual team uses inclusive IT capabilities, especially in the IT communication and team process capabilities, influences the degree to which virtual teams' teamwork mental models converge. The quantitative data analysis showed a significant positive correlation between the inclusiveness and virtual teams'teamwork mental models convergence. The qualitative data analysis provides in-depth understanding of the role of inclusiveness.

In the dissertation study, not a single IT tool was found to provide all needed communication and team process capabilities. Virtual teams have to combine IT capabilities from diverse IT tools to build trust among the team and to facilitate the development of the teamwork mental models. Using inclusive IT team process capabilities helps virtual teams clarify team roles and establish shared understanding about each member's knowledge and skill sets. In order to achieve the purpose of converging on teamwok mental models, electronic trail of the capabilities is necessary, so that information can be retrieved later by the team. Meanwhile, easy access to the IT capability is required, so the team can easily find out what agreements have been made in the past. Therefore, P2c is supported.

6.3. The Role of Fit

Proposition 3a: The interplay of adaptive use of IT capabilities and development of shared mental models is affected by the fit dimension of AUITC.

Spearman's correlation analysis provided partial support for proposition 3a. The results of Spearman's r correlation indicated a high correlation between fit and the taskwork mental models development. While the correlation between fit and teamwork mental models development is not significant. The case study evidence suggests shared mental models can be developed faster and more accurately through using the fit IT capabilities. Taken together, P3a was supported.

Proposition 3b: The interplay of adaptive use of IT capabilities and development of taskwork mental models is affected by the fit dimension of AUITC.

As virtual teams identified the most appropriate IT capabilities for communication, team process, and interaction for the team, the teams were more likely to feel satisfied with their teamwork experience, engage in a smooth social process, and then reach more convergence on the contents of the taskwork mental models, such as the technology characteristics and task-related elements. Identifying a fit between the use of a specific IT capability and the task of the team helped establish an accurate and accessible shared understanding on tasks. For example, virtual team 2 found Blackboard Discussion Board worked well as a central place for organizing their task-related ideas. Virtual team 2 was capable of retrieving information they had discussed on Blackboard Discussion Board and applying that information when working on their written first part of the business plan.

Results also suggest that expectations made on IT capabilities held in each individual of a virtual team played a significant role in the team's overall assessment on whether an IT capability is a fit to the team and the task. Because of the diverse individual backgrounds, members of the team could hold different expectations on the same IT capability on a given task. When expectations were met after experiencing an IT capability, virtual team members developed a positive attitude toward that particular IT capability and felt that IT capability was a good fit for the team at the given task. However, when the expectations were not met, virtual team members were critical about the IT capability and did or did not think that IT capability is a good fit.

Virtual team members' expectations on the use of particular IT capabilities are influenced by the amount of interactions with the IT capabilities, observations of other members' use of the IT capabilities, and joint interactions using the IT capabilities with other members. When virtual team members have more direct or indirect interactions with the IT capabilities, the initial expectations on the IT capabilities can be altered in both directions, higher and lower.

The sooner the virtual team finds a fit between an IT capability and a given task, the higher the quality the virtual team converge on taskwork mental models. Taken together, P3b was supported.

Proposition 3c: The interplay of adaptive use of IT capabilities and development of teamwork mental models is affected by the fit dimension of AUITC.

Results of surveys did not show an obvious relationship between fit and teamwork mental models development. Case study evidence gave richer

understanding of the role of fit on the interplay between the AUITC and SMM development in virtual teams. Results suggest virtual teams that have explicitly developed shared understanding of the *fit* IT capabilities in all three areas: communication, team process, and interaction have a higher chance of converging on quality teamwork mental models. First, choosing fit IT communication capabilities helps maintain an important team interaction place, which might even give the team a sense of "home," so that all members can actively engage in team interaction and exchange their preferences, skills, and knowledge. For IT communication capabilities, easy access and electronic trace are the two factors affecting how virtual teams assess the degree to which a specific IT capability is a good fit. Virtual teams choose the most accessible ways of communication, and the team considers adopting the IT-enabled communication means that can organize the team communication. .

6.4. Summary of Chapter 6

This chapter discussed the findings from the dissertation research according to the research questions proposed in the beginning of the dissertation. Specifically, effects of the three dimensions(namely usage experience, inclusiveness, and fit) on the interplay of AUITC and shared mental models convergence were discussed in detail.

CHAPTER 7: LIMITATIONS, CONTRIBUTIONS, IMPLICATIONS, AND CONCLUSIONS

This dissertation study identified an important and understudied research

area, namely the interplay between adaptive use of IT capabilities and development of shared mental models in virtual teams. The general goal of the author was to enhance our understanding of the relationship between adaptive use of IT capabilities and development of shared mental models. For this purpose, a theoretical framework and three major propositions based on the review of previous literature were proposed. Usage experience, inclusiveness, and fit are suggested to be the three main dimensions constituting the adaptive use of IT capabilities and affect the interplay between AUITC and shared mental models convergence. Empirical study confirmed the role of these three dimensions in the interplay relationship that was examined.

7.1. Limitations

This dissertation study has three major limitations that should be carefully addressed when generalizing the empirical findings to explain the interplay between the adaptive use of IT capabilities and development of shared mental models (including taskwork mental models and teamwork mental models). First, the educational research setting limits the generalization of the study findings to some degree. Using student teams has been long criticized for its limitations in generalizing the empirical findings. To reduce the negative effects of using student, the author in the dissertation study balanced the non-traditional and traditional students when forming the virtual teams, so that every virtual team had some diverse team members with varied working experience that mimic the real- world composition of a virtual team. To mimic a real virtual team in business, the author chose complex and professional IT tools that simulate the technologies a company purchases or builds for

its employees. But some unique elements of virtual teams in real world, such as work pressure and organizational culture, cannot be replicated in an educational setting. Therefore, when applying the findings of the study to the real-world virtual teams, one must examine the effects from the unique characteristics of the virtual teams on the interplay of adaptive use of IT capabilities and shared mental models development.

The second limitation of the study relates to the methods used for assessing the shared mental models convergence. The development of shared mental models in virtual teams is an elusive process. This dissertation study used surveys to measure the behavior-related observable indicators to shared mental models convergence. Such indicators may not be representative of the shared mental models convergence. In addition, the dissertation study employed the protocol analysis to examine the convergence of taskwork mental models and teamwork mental models. The coding scheme was developed based on the pilot case studies, which used specific virtual team project tasks. When applying the research methods employed in this dissertation study to other settings, one should carefully examine the tasks and refine the coding scheme for assessing shared mental models convergence.

The third limitation of the dissertation study results from the technologies chosen in the study. In this dissertation study, only three specific collaboration technologies were used because they were more accessible in an educational setting than other settings. Although the dissertation study examined the technologies at the capability level to increase the generalizability of the study findings, different

technologies can possess varied specific capabilities belonging to the three general IT capabilities, namely communication, interaction, and team process. These varied specific IT capabilities can influence how the IT capabilities are adapted by teams in organizations. Future study can expand the scope of the technologies to embrace diverse types of technologies.

7.2. Contributions

Studying the effects of IT use on virtual teams' outcomes has been a challenge for the IS field. Using a social-technical perspective, this dissertation study examined the interplay between the adaptive use of IT capabilities and the development of shared mental models in virtual teams. Several contributions have been made.

First, considering the context of virtual teams, the author conceptualized IT as a bundle of capabilities, namely communication capabilities, team processing capabilities, and interaction capabilities. In the empirical study, the dissertation study showed how these three categories of IT capabilities can be operationalized given features of IT, such as email, Blackboard, and Google site.

Second, the dissertation study identified three important components during the process of adaptive use of IT capabilities. The three components are usage experience, inclusiveness, and fit. So our understanding about the IT capabilities adaptation process has been enhanced.

Third, this study contributes to our understanding of why and how a virtual team's adaptive use of IT capabilities interplays with the development of shared

mental models in a virtual team. Prior researchers have noticed that individuals or groups may draw different values from the same set of IT applications by following differing paths over time. However, little is known about why and how the teams are different in choosing and using the technologies. Few studies examined the adoption and continuous use of technology applications from the capability view. Following the socio-technical view, this dissertation study enriches our understanding of how virtual teams adaptively use IT capabilities and how this process interplays with the development of an important team cognitive process, namely the shared mental models converging process.

By collecting data at multiple time points over the longitudinal study, the dissertation study allows capturing the rich context when the interplay of AUITC and shared mental models development occurs.

Fourth, the dissertation study showed a way of triangulating data from multiple sources.

7.3. Implications

7.3.1. Implications for Research

Findings of the dissertation study offer several implications for research as follows.

First, findings revealed that leadership has an influence on the interplay between the adaptive use of IT capabilities and shared mental models development. Strong and proactive leadership not only can help speed up the process of reaching converged taskwork mental models and teamwork mental models but also can make the shared mental models explicit and clear so that everyone in the team knows. A

leader who is capable of identifying the right IT capabilities for the team at a given task can bring even more benefits to the entire team. On the contrary, if a weak leadership exists, a virtual team experiences greater challenge of building trust and communicate effectively. The team might spend more time in choosing an IT tool. Future research can further explore the role of the leader in relation to the development of shared mental models and adaptive use of IT capabilities. A potential research topic is to examine the effects of different types of leadership on the interplay between AUITC and SMM or to study the patterns of AUITC and SMM associated with types of leadership. Future research can also explore the various influence of leadership on the interplay of AUITC and SMM across time.

Second, the examination of the shared mental models convergent process suggests that a virtual team may follow different paths than face-to-face teams in the shared mental models convergence. Specifically, orders of and interrelationships between the types of mental models convergence varied between virtual teams and face-to-face teams because of the characteristics of virtual teams. For example, all five teams examined in the study first converged on the team communication mental models because teams need to know how to keep in touch with one another. Converging on the team communication channel is not a relevant issue for face-to-face teams who meet in personal naturally. A future research topic could be examining the differences on the orders of or interrelationships between specific types of mental models in traditional teams and virtual teams. Therefore, virtual teams can learn to effectively use IT to facilitate the development of different types of mental

models.

Third, although usage experience has been used as a predictor to IT success, measuring usage experience is a challenge. When the author assessed usage experience in this dissertation study, survey responses and case study evidence suggest mixed results. Items adapted from previous studies to measure usage experience focus on measuring the amount of time and frequency; the items did not include measures for assessing the actual effectiveness of the usage experience. Case study evidence suggest that given the shared mental models development as the predictor variable, virtual teams' usage experience should be assessed by considering broader concepts, such as reflection and visibility. A potential future research topic is to further examine what constitutes a quality team usage experience with IT capabilities in relation to the development of shared mental models.

Fourth, this dissertation study offers an example of examining the interplay between adaptive IT capabilities use and a social or cognitive process of virtual teams. A better understanding of the interplay between the IT use and the ongoing non-technical processes within the context of IT use can help untangle the productivity paradox of IT and can also help identify appropriate paths for a better utilization of IT.

Finally, future research direction is to keep, specify, and refine the contents of shared mental models so that our understanding about the relationship between shared mental models and the adaptive use of IT capabilities can be further enriched. Drawing on existing literature on shared mental models, this dissertation study

considered two specific contents of mental models, namely taskwork mental models and teamwork mental models. Consistent with the previous literature, the author found the development of these two types of mental models was an interweaving process. Because of the relationships between the two mental models, the interplay between AUITC and taskwork mental models can be confounding to the interplay between AUITC and teamwork mental models. Future research can explore a refined or a completely different taxonomy of shared mental models contents so that the study of the interplay between adaptive use of IT capabilities and shared mental models development is both relevant and rigorous.

7.3.2. Implications for Practice

Findings of the study also provide several implications for practice.

First, IT provides essential capabilities to virtual teams for communication, team process, and interaction. Through the adaptive use of IT capabilities, virtual teams engage in social processes that are critical to the development of shared mental models. Research from this dissertation reveals that virtual teams' shared mental models development can be facilitated or enhanced through properly managing the three dimensions associated with IT capabilities use. These three dimensions are usage, inclusiveness, and fit.

First, managers of virtual teams should notice that simply increasing the amount of time using IT capabilities or the frequency of using IT capabilities does not directly enhance the development of shared mental models in teams. For a better quality shared mental models, managers can encourage a reflective, visible and

collective usage experience among the virtual teams. By maintaining a reflective usage experience of IT capabilities, virtual teams can avoid unnecessary try-outs on sometimes overwhelming IT capabilities. A visible and collective usage experience increases the confidence and satisfaction of virtual team members on the use of specific IT capabilities. So trust and accountability among the teams are likely to be established.

Second, managers can encourage an open and innovative culture that can make virtual teams willing to try and get to know new IT features. To attain the converged shared mental models on both of the taskwork component and the teamwork component, virtual teams need to use inclusive IT capabilities from the areas of communication, team process, and interaction. A previous research study found that virtual teams[27] still used limited IT tools, such as emails and telephone conferences (Malhotra & Majchrzak, 2012). Findings from this study suggest that managers should encourage virtual teams to use a variety of IT tools to enhance the rich interactions between virtual teams, and thus, quality shared mental models can be developed.

Third, choosing appropriate leaders who are responsible, proactive, and knowledgeable at managing teamwork is important to the development of shared mental models and to the overall virtual team effectiveness.

Fourth, findings of this dissertation study suggest managers should introduce IT capabilities that are easy to access across heterogeneous platforms. The power of

[27]A total of 54 virtual team leaders were interviewed. Most of the virtual teams were international virtual teams.

computer processors increases by Moore's law[28]; the computing cost and information storage cost decreased exponentially over the last decades. We are increasingly connected to the digital word by platforms, such as desktops, laptops, mobile phones, and portable pads. In addition, the operating systems vary among the platforms. As a result, individuals of virtual teams are more likely to have preferences for heterogeneous platforms. Introducing IT applications that have capabilities accessible across platforms is helpful in facilitating the collective adoption and continuing use of the IT capabilities by virtual teams.

In order to maximize the shared mental models convergence quality through fit dimension, managers should also proactively implement training to manage the virtual teams' expectations of the IT capabilities. Objective and shared expectations on IT capabilities facilitate the process of identifying the fit of IT capabilities among the many available IT capabilities. Therefore, the process of developing both taskwork mental models and teamwork mental models can be speeded up through using the right IT capabilities.

Finally, managers should set up clearly team members' expectations for IT in the beginning. People think differently on issues, such as assessing whether an IT is actively used or not, because of prior experience and training. Establishing shared standards on evaluating situations that are related to accomplishing the tasks is important so that conflicts can be avoided.

---

[28]Gordon Moore in 1965 first proposed the Moore's Law. Moore's law suggests that components of a computer chip double every two years. Is it components?

7.4. Conclusions

Virtual teams are important building blocks in organizations. Managing a virtual team well is challenging. Previous studies have suggested that maintaining shared mental models with team trainings and team interventions can help enhance the effectiveness of virtual teams. Little attention has been paid on examining the influence of IT on the development of shared mental models.

This dissertation study examined the interplay between adaptive use of IT capabilities and shared mental models by adopting the multiple cases study approach in an educational setting. Nine propositions were stated in the conceptual model.

Findings from the study suggest three components (i.e., usage experience, inclusiveness, and fit) influence the development of shared mental models, including taskwork mental models and teamwork mental models, in virtual teams. Findings of the dissertation study have implications for both researchers and practitioners.

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APPENDIX A: IRB Approval Letter

University of Nebraska Medical Center

NEBRASKA'S HEALTHSCIENCECENTER Office of Regulatory Affairs (ORA) Institutional Review Board (IRB)

August 17, 2012

Xiao-dan Yu
College of IS&T
UNO – Via Courier

IRB#: 558-10-EX

TITLE OF APPLICATION/PROTOCOL: Adaptive Use of IT Capabilities for the Development of Shared Mental Models in Virtual Teams

Dear Ms. Yu:

The Institutional Review Board for the Protection of Human Subjects has completed its review of your Request for Change dated August 13, 2012 to the title, methods, and develop a consent form.

This letter constitutes official notification of the approval of the updated IRB Application, survey, and consent form. You are, therefore, authorized to implement this change accordingly.

Sincerely,

Gail D. Kotulak

Gail Kotulak, CIP
IRB Administrator
Office of Regulatory Affairs (ORA)

gdk

APPENDIX B: Consent Form

Consent to be a Research Subject

558-10-EX

Introduction:

This research study is conducted by Ms. Xiaodan Yu at College of Information Science and Technology, University of Nebraska at Omaha to determine how virtual team's adaptation of technology capabilities interplays with the shared mental models convergence.

Procedure:

Digital traces of your team's technology usage—namely, Email messages, Blackboard activities, and Google Sites activities--relating to the class group project will be observed by the investigator of the study. Your weekly technology usage reports (TUR), a part of the group project, in the class will be examined. If you decide to meet via skype or face-to-face, you'll be required to record your meeting.

Each of you will be asked to complete three online surveys, consisting of questions about your background, technology use, and four aspects relating to your experience of teamwork. The time commitment for each survey is approximately 10 minutes. Links to the web surveys will be through emails.

Risks/Discomforts:

There are minimal risks for participation in this study. However, you may feel emotional discomfort when answering survey questions about your teamwork experience.

Benefits:

It is hoped that your participation in this research will help you gain an in-depth knowledge of when, why, and how a particular technology feature will be used to support VT collaboration. It is also hoped that your participation can help the researcher learn more about how VT's technology usage experience interplays with VT's shared mental model convergence.

Confidentiality:

All information provided will remain confidential and will only be reported as group data with no identifying information. All data, including surveys will be kept in a secure location and only those directly involved with the research will have access to them.

Compensation:

Participants will receive 100 extra points (unweighted) in CIST2100 for completing the three surveys. For those who do not wish to participate in the research, those 100 extra credit points can be earned by reading an article and providing a summary of that article.

Participation:

Participation in this research study is voluntary. You have the right to withdraw at anytime or refuse to participate entirely without jeopardy to your class status, grade or standing with the college.

Questions about the Research:

If you have questions regarding this study, you may contact Xiaodan Yu at yxd.xiaodanyu@gmail.com or IRB at + 1(402)559-6463.

I have read, understood, and received a copy of the above consent and desire of my own free will and volition to participate in this study.

Signature: _____ Date: _____

APPENDIX C: Survey

SECTION A: DEMOGRAPHIC INFORMATION

Group Number: _____

Gender: Male Female

Status: Freshman Junior Sophomore Senior Graduate or post-baccalaureate.

Age: __under 20__20-24__25-29__30-34___35-39__40-44__over 44

SECTION C: TECHNOLOGY CAPABILITIES ADAPTATION

Circle the number that most closely described your opinion about your experience of interacting with the technologies on the line preceding the statement:

Strongly Disagree --1--2--3--4--5--Strongly Agree

Dimension: Inclusiveness

___1.I played around with features in Google Sites.

___2.I played around with features in Blackboard.

___3.I figured out how to use certain Google Sitesfeatures.

___4.I figured out how to use certain Blackboardfeatures.

Dimension: Usage Experience

___5.Compared to other students, I believe I spent above than average time on Google Sites.

___6.Compared to other students, I believe I spent above than average time on Blackboard.

___7.Compared to other students, I believe I spent above than average time on Google Sites.

___8.Compared to other students, I believe I visited Google Sites more frequently.

___9.Compared to other students, I believe I visited Blackboard more frequently.

___10.Compared to other students, I believe I used Email more frequently.

Dimension: Fit

___12.I created work-a-rounds to overcome system restrictions.

___13.I combined features in Google Sites with features in blackboard to finish a task.

___14.I used some features in Google Sites in ways that are not intended by the developer.

___15.I used some features in blackboard in ways that are not intended by the developer.

SECTION D: SHARED MENTAL MODELS

Circle the number you feel that most closely represents how you feel with each the following statements on the line preceding the statement:

--1—2—3—4—5—

None a lot

Mental Model: Equipment Model

___16. How am I familiar with the capabilities provided by Email.

___17. How am I familiar with the capabilities provided by Blackboard.

___18. How am I familiar with the capabilities provided by Google Sites.

Mental Model: Task Model

___19.How frequently are there conflicts about understanding project goals in your team?

___20.How often do people in your team disagree about opinions regarding the work to be done?

___21.How much conflict is there about the work you do?

___22.How frequently do members disagree about the way to complete a team task?

Mental Model: Team Interaction Model

___23.To what extent did team members alert each other to impending decisions and actions.

___24.To what extent did team members seek out and pass along information to rest of team.

___25.To what extent was the team's behavior coordinated

Mental Model: Team Model

___26.How often do members disagree about who should do what?

___27.How much conflict about delegation of tasks exists in your team?

___28.Did the team members adjust individual task responsibilities to prevent overload?

APPENDIX D: Guidelines for Technology Usage

PURPOSE

Todevelop your skills at adaptively using technologies for successful virtual collaboration.

TECHNOLOGIES

The group project requires you to use one or more of the following three technologies:

- Email
- Blackboard
- Google Sites

BACKGROUND--SUCESSFUL TECHNOLOGY USAGE STRATYGY

The technology usage report is developed based on the successful technology usage strategy, which consists of three parts:

- First, get to know the various capabilities of technologies.
- Second, when any conflicts among the task, the team, and the technology arise, considering change the use of technologies when the task demands and team structure cannot be changed. An alignment between task and technology in teams will significantly improve your team's collaboration effectiveness.
- Third, try using technology capabilities that help building a "group mind" in your team. Teams that have shared understandings about the task, the team, and the technologies they interact with will experience enhanced team communication and collaboration, and thus, the desired team outcomes.

TEMPLATE

The following table is a template of the technology usage report. This form will help you track your technology usage throughout the project. You may use it to identify how you adaptively use IT for virtual projects. Each week (from week 3-week 9) you need to fill out this form and submit it via BB site to the instructor.

- *For IT features in use, you need to specify the features in a particular one of the three technologies. For example, blog in blackboard.*
- *Under Reflection you need to answer the questions: Are there any goals not met? If yes, which goals are not met and why? If no, explain how the goals are met.*
- *Add rows as is necessary.*

IT Feature in Use	**Rate your experience of using the feature from (1-Very Difficult, 2-Difficult, 3-Neutral, 4-Easy, 5-Very easy)**	**List goals of using this feature**	**Reflection**