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AARON C. BECKER
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LEVERAGING GROUP KNOWLEDGE: THE EFFECTS OF COLLABORATIVE TECHNOLOGY APPROPRIATION ON GROUP OUTCOMES

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BY

____
Dr. Laku Chidambaram, Co-Chair

____
Dr. Traci Carte, Co-Chair

____
Dr. Lowell Busenitz

____
Dr. Shaila Miranda

____
Dr. Leon Price

____
Dr. Robert Zmud

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ABSTRACT

Organizations are increasingly relying upon groups aided by information technology to complete tasks requiring coordinated action and knowledge sharing (Jehn and Mannix, 2001; Sarker et al., 2002). As such, the importance of group-level theory and research aimed at understanding the manner in which collaborative technologies can be used to aid these processes and improve group outcomes has also increased. In this study I argue that a group's knowledge of the capabilities of the collaborative technologies at its disposal impacts the manner in which those technologies are appropriated. Further, the manner in which a group appropriates such technologies impacts its ability to effectively tap into the task knowledge embedded in individual group members--a critical factor in determining group outcomes in distributed environments. In short, I argue that a group's knowledge of its collaborative technology can *unlock* its knowledge concerning the task. In order to test these ideas, a longitudinal field study was conducted. Data analysis using partial least squares (PLS) lends strong support to these arguments, suggesting that those organizations which focus on task knowledge while ignoring knowledge of collaborative technologies will fail to fully leverage group capabilities in distributed environments.

CHAPTER I – INTRODUCTION

Organizations are increasingly relying upon information technology-aided groups to complete tasks requiring coordinated action and knowledge sharing (Jehn and Mannix, 2001; Sarker et al., 2002). As such, the importance of group-level theory and research aimed at understanding the manner in which collaborative technologies can be used to aid these processes and improve group outcomes has also increased. Researchers have investigated how groups leverage various technologies in order to accomplish their tasks, and have discovered that a number of factors [e.g., characteristics of the task and technology (Goodhue and Thompson, 1995; Zigurs and Buckland, 1998), social influence (El-Shinnawy and Vinze, 1998; Webster and Trevino, 1995), experience (King and Xia, 1997), and media richness (Trevino et al., 2000)] impact the effective use of technology.

However, researchers have had relatively little success in establishing a link between the use of group technologies and positive group outcomes (Dennis et al., 2001). Specifically, there has been little progress in understanding the problems that groups encounter when trying to leverage the diverse knowledge of their members, and the role that collaborative technologies play in this process. Further, there is a dearth of research aimed at understanding the differences between the way a group appropriates collaborative technologies and the way it appropriates more task-oriented technologies (i.e., technologies that have been designed to accomplish very specific tasks).

While this study was aimed at filling these gaps in the literature, its true genesis lies in a longitudinal field study which was conducted in the second half of

2005. The study took place over a six month period and tracked the progress of three virtual teams from two different companies – a government agency and a publicly traded energy company. Data concerning collaborative technology awareness and choice, relational development, and group performance were captured via surveys administered throughout the six-month period, as well as through telephone interviews conducted with each team leader at the end of the study.

The purpose of the study was to examine how many collaborative technologies each group considered before settling on a solution, and to determine what, if any, impact this had on group outcomes such as task performance and relational development. The study was informed by the argument that groups that consider a larger number of solutions to a problem tend to outperform those that consider fewer solutions, a phenomenon known as the rank-order effect (Hollingshead, 1996). Each virtual team was working toward a different stated objective. One was tasked with developing a reorganization plan for a division within their organization. Another was tasked with developing a divisional budget. Another was an on-going workgroup tasked with negotiating contracts between a software vendor and users within the company.

The results of the study suggested the need for further research concerning the link between group appropriation of collaborative technologies and group outcomes. The highest-performing team was confronted with a new technology which its own team leader acknowledged as a superior tool, but ultimately chose to ignore it in favor of a technology with which its members were more familiar. This team's members collectively considered the fewest number of collaborative technologies among the three virtual teams studied. As such, this team's results directly contradicted the rank-order effect.

The lowest-performing team was never able to overcome differences in the functional backgrounds of its members, and as a result, factions surfaced in the team, with each faction utilizing a different collaborative technology. This resulted in stunted relational development within the team, and necessitated a tremendous coordination effort on the part of the team leader to overcome technology differences in order for the team to submit a quality deliverable. Because this team's members considered the largest number of collaborative technologies among the three virtual teams studied, its results contradicted the rank-order effect.

Finally, the third team chose to rely upon email as their primary collaborative technology. However, they also consistently bolstered these emails with personal phone calls between members, a phenomenon that echoed the work of Chidambaram (1996) and Burke and Chidambaram (1999), which found that while certain negative aspects of technology in computer-mediated groups often diminish over time, gaps in social presence tend to persist.

Dissertation Objective

Each of these cases was interesting enough on an individual basis to warrant further investigation. However, when taken together, they seemed to point to the idea that something more impacted group outcomes than simply the number of collaborative technologies considered, or even which collaborative technology was chosen for use. The fact that two teams directly contradicted the rank-order effect seemed to imply that the link between collaborative technologies and group outcomes is more complex than what is suggested by the perspective of technological determinism, whereby a single "best" technology exists, and group outcomes hinge upon the selection of this technology over other alternatives. This implication was further supported by the fact that the highest-performing team chose not to adopt a collaborative technology that its own members recognized as being superior to the one selected.

One potential source of variance in the outcomes of these groups was the manner in which their members appropriated the collaborative technologies at their disposal. Most of the technologies utilized by work groups are designed to enable the user to accomplish specific tasks. Collaborative technologies, on the other hand, are designed to enable group members to communicate and collaborate on several different projects. Thus, the purpose of collaborative technologies is not to execute specific tasks, but rather to enable group members to leverage their unique individual knowledge so that they can then collectively engage in the execution of tasks, a process which may require the use of other task-oriented technologies. This subtle distinction may go unnoticed by groups who are accustomed to utilizing technologies to accomplish specific tasks. Those groups which fail to grasp this distinction may attempt to appropriate collaborative technologies in the same manner as other technologies (i.e., with an eye towards the task, rather than an eye towards the group), thus never fully taking advantage of the benefits afforded by collaborative technologies.

The complexity of the relationship between a group's use of collaborative technology and subsequent group outcomes suggested by the aforementioned field study illustrate the need for an answer to the research question that I sought to address with this study:

> *How do groups use collaborative technologies to leverage group knowledge in achieving outcomes – both task and relational?*

In this study, I argued that the primary role of collaborative technologies is to enable groups to effectively leverage the task knowledge of their group members, and that the most successful groups will appropriate these technologies with this goal in mind. By doing so, I deviated from the prevalent deterministic models of Task-Technology Fit in order to better account for the distribution of individually-held knowledge within groups.

Additionally, this study provided insight into the manner in which groups appropriate the collaborative technologies that are available to them. I argued that the one of the primary sources of variance in group outcomes is the manner in which groups appropriate the collaborative technology available to them. In addition to making contributions to theory, this research also holds great value for the business community. By focusing on the manner in which groups appropriate collaborative technologies, I uncovered factors which are crucial to unlocking the benefits of diverse knowledge within groups. By using collaborative technology in such a way as to effectively tap the knowledge embedded in their members, groups can make better decisions and generate higher-quality solutions (Kanter, 1988), thus providing justification for the administrative overhead and collaborative technology costs associated with an organization's use of groups, rather than individuals, to complete tasks.

Overview of the Dissertation Document

This dissertation is organized into six different chapters (including this one) and a set of appendices.

Chapter II begins with the presentation of my argument regarding the role of collaborative technology as an enabler, rather than a driver of group outcomes. I then review the literature on Adaptive Structuration Theory and Task-Technology Fit. In order to better account for the notion of collaborative technology as a tool which allows groups to leverage the task knowledge of their members, the information processing perspective is then discussed and subsequently integrated with the aforementioned literatures, as is the recently developed concept of representational gaps. Finally, the chapter culminates with the development of the research model and hypotheses that were tested in this study.

Chapter III articulates the research methodology that was used in this study. This includes details regarding the research design, sample, operational definitions, and measures of each of the variables of interest in this study, as well as a number of control variables.

Chapter IV details the statistical analysis of the data collected during this study, as well the testing of the hypotheses developed in Chapter 2. The chapter includes basic information about the sample, such as demographic information and descriptive statistics. This is followed by details concerning the exploratory factor analysis and subsequent confirmatory factor analysis conducted for the reflective measures. Next, several tests were conducted, included tests of alpha and composite reliability, discriminant validity, aggregation (e.g., R_{wg}) and multicollinearity. This is followed by testing of the actual research model using Partial Least Squares (PLS), and the results of the hypotheses tests. The chapter concludes with the results of several post-hoc tests.

Chapter V summarizes the results of the study and includes a discussion of the contributions of the findings to the various literatures and theoretical bases which served as foundations for this study.

Chapter VI presents a concluding overview of the study and articulates a number of implications of the findings for both theory and business practice. The chapter also includes a discussion of the limitations of the study, as well as suggested directions for future research based on the study results.

The **Appendices** include details concerning the tasks assigned to the study participants, the surveys administered during each time period, the informed consent form to be signed by each participant, the IRB approval form, and other details pertinent to the execution of this study.

Chapter II – Theoretical Development and Research Model

Previous work on group technology choice, such as task-technology fit (Zigurs and Buckland, 1998), has typically adopted the perspective of technological determinism, whereby a group's performance is determined by its ability to select the proper technology to apply to the task at hand. While this work has added to our understanding of group technology use, it fails to substantively consider the impact of individual differences among team members in terms of experience and knowledge of both the group's task and its technology options.

In a situation where the burden of work is borne more by the technology than by the user, the technology characteristics are of chief importance to the success of the project. An example of this is the robotic technology used in a car manufacturing plant. In this context, each piece of technology has a very specific task which it was designed to execute. However, I argued that in situations where the burden of work is borne more by the user than by the technology, technology characteristics become less important. The goal of the technology shifts from executing the task at hand to enabling the users to leverage their expertise. This is *particularly* true of collaborative technologies. Group outcomes depend not only on the characteristics of the technology used, but also upon the group's ability to leverage the technology in ways that help the group tap into the unique distribution of knowledge and expertise among its members. As such, any theory of collaborative technology use should account for individual differences in knowledge.

I attempted to fill this gap in the literature by augmenting the technological determinism perspective prevalent in the task-technology fit literature with a theoretical framework that accounts for the distribution of knowledge within each group. Doing so allowed for a better understanding of how knowledge of both the task and technology impacts the way that collaborative technologies are used. The following sections review the literature on Adaptive Structuration Theory and task-technology fit and then integrate them with the information processing perspective as well as the concept of representational gaps. A research model is then developed which forms the basis for the hypotheses presented later in this chapter.

Adaptive Structuration Theory and Task-Technology Fit

Adaptive Structuration Theory (AST) was developed as a framework for understanding how different groups that adopt the same technology can produce entirely different outcomes. DeSanctis and Poole (1994, pg. 122) explain:

> "…the effects of advanced technologies are less a function of the technologies themselves than of how they are *used* by people…people adapt systems to their particular work needs, or they resist them or fail to use them at all; and there are wide variances in the patterns of computer use and, consequently, their effects on decision making and other outcomes."

In order to account for this, AST utilizes Orlikowski's (1992) notion of the "duality" of structure and posits an interplay between technology and social structures, whereby a given technology impacts the emerging social structures governing its very use, and those same structures impact the attitudes and beliefs of users regarding that technology. While a number of AST's propositions are concerned with features of the technology in question or of the adopting organization, Proposition 6 is particularly salient to the research question at hand:

> *"The nature of AIT [Advanced Information Technology] appropriations will vary depending on the group's internal system."* (DeSanctis and Poole, 1994, pg. 131)

DeSanctis and Poole (1994, pg. 130-131) define a group's internal system as being comprised of the following factors:

- "Members' style of interacting"
- "Members' degree of knowledge and experience with the structures embedded in the technology"
- "The degree to which members believe that other members know and accept the use of the structures"
- "The degree to which members agree on which structures should be appropriated"

AST essentially argues that once a group selects a technology to apply to the scenario at hand, subsequent group outcomes are dependent on each of these factors. These factors encompass not only the knowledge possessed by the group members, but also the communication and coordination necessary to reap the benefits of that knowledge.

The knowledge possessed by individuals is an important factor shared by another area of research aimed at explaining how technology use can impact outcomes: task-technology fit. Dennis, Wixom, and Vandenberg (2001) previously integrated AST with theories of task-technology fit in order to better understand the link between GSS use and performance. However, they operated under the assumption that task-technology fit is a factor which can be objectively determined. I deviated from that assumption in the development of my research model.

Theories of task-technology fit (Goodhue and Thompson, 1995; Zigurs and Buckland, 1998) posit that appropriate matching of technology characteristics to task characteristics will lead to improved performance. Some of this work has focused on individual technology choices (Goodhue and Thompson, 1995), while later work

(Zigurs and Buckland, 1998) has focused on defining 'fit' in a group context. Goodhue (1995) argued that individual perceptions of task-technology fit (TTF) are impacted by both task characteristics and technology characteristics. A major contribution of Goodhue's (1995) model, in comparison to other TTF models, is that it recognized that task-technology fit is a *perception* of the individual, and not a measure which can be determined objectively. In other words, a technology fits the given task context only if the individual perceives that fit. Therefore, task-technology fit is particularly prone to the processes of structuration suggested by AST. Conversely, group-level task-technology fit theories (e.g., Zigurs and Buckland, 1998) have taken a different approach and identified a number of fit profiles that suggest technology choices that best fit different group tasks. However, Zigurs and Buckland's (1998) characterizations of tasks and technology *excluded* perceptual differences among individual team members.

In addition to task and technology characteristics, Goodhue (1995) argued that perceptions of task-technology fit are also influenced by characteristics of the individual such as knowledge and experience. He defined task-technology fit as "the extent that technology functionality matches task requirements *and individual abilities*" (Goodhue, 1995, pg. 1829, emphasis added). The idea that individual differences in knowledge, experience and/or preferences will impact user behavior is not new. Adaptive Structuration Theory proposes that the user's "degree of knowledge and experience with the structures embedded in the technology" is a factor which will ultimately influence technology appropriation (DeSanctis and Poole, 1994, pg. 130). Empirical evidence suggests that people may prefer certain aspects of a given technology, such as the graphical user interface, for reasons ranging from individual differences (Jarvenpaa, 1989) to social norms stemming from national culture differences (Massey et al., 2001), and such individual preferences can ultimately influence user evaluations of that technology. At the root of each of these differences in preference is knowledge, whether it is knowledge of the interface, knowledge of social norms, etc. As such, conceptualizations and empirical examinations of fit perceptions should consider the impact of individual differences in knowledge.

However, most conceptualizations of task-technology fit do not account for the individual's knowledge of the *task* and *technology*. Individuals might not have knowledge of every characteristic of the task they are being asked to accomplish. This view is consistent with Zigurs and Buckland's (1998) characterization of complex tasks. Such tasks can be experienced as ill-structured, ambiguous, or difficult due either to attributes of the task or attributes of the individual. Zigurs and Buckland (1998) provide the example that a software development task may be experienced as "simple" for a veteran programmer but "difficult" for a novice. As such, the novice's differential knowledge of the task – stemming from experiences different from that of an expert – is likely to result in a different fit perception.

Furthermore, individual knowledge of a technology can include *know-what* (knowledge of what capabilities are provided by the technology), *know-how* (knowledge of how to apply these capabilities), and *know-why* (knowledge of the underlying linkage between the use of capabilities and performance) (Jasperson et al., 1999; Kim, 1993; Nonaka, 1994). It is unlikely that most individuals have such a deep and complete knowledge of the collaborative technology being used or of the task at hand. If a collaborative technology contains a certain feature, of which that individual is unaware, then that feature will play no role in determining his/her perceptions of task-technology fit, or the manner in which he/she appropriates the technology. As such, an individual's appropriation of technology is not so much influenced by the characteristics of the task and technology, but rather by his or her *knowledge* of those characteristics.

Combining AST with the contingency structure in Goodhue and Thompson's (1995) model of task-technology fit, I argued that there is an interaction between group members' knowledge of the task and their knowledge of the collaborative technology, and that this interaction impacts the manner in which the group uses the technology, which in turn impacts group outcomes.

Information Processing Perspective and Representational Gaps

The information processing perspective differs from technological determinism in its approach to group outcomes. Rather than an absolute right technology choice, the primary driver of group outcomes in the information processing perspective is the knowledge held by group members. Utilizing this perspective, Cronin and Weingart (2007) recently developed the concept of *representational gaps* as an explanation for why groups sometimes encounter difficulties in capitalizing on the knowledge held by their members. Representational gaps are "inconsistencies between individuals' definitions of the team's problem." (Cronin and Weingart, 2007, pg. 761) Because of these representational gaps, different group members may have different perceptions of task-technology fit (and thus, beliefs about the technologies) not only because of variance in knowledge about those technologies, but also because they might view the task differently, and thus envision different solutions to the problem. As such, representational gaps can negatively affect the process by which a group utilizes a collaborative technology to complete a task, which in turn can negatively impact task outcomes and relational outcomes.

Because group members who utilize a collaborative technology in the execution of a task may have different understandings of what needs to be done, the coordination of tasks to be carried out can be impeded by the presence of representational gaps. Further, if representational gaps are present within the group, then communication may be hindered by information distortion (Cronin and Weingart, 2007). Even in situations where there is considerable overlap in the knowledge held by group members, representational gaps can negatively impact the relational outcomes of the group. Therefore, I expected that by uncovering those factors which counteract the detrimental effects of representational gaps (and their resulting information distortion), I would gain a better understanding of how collaborative technology can be effectively used by groups to leverage the diverse knowledge held by their members.

Overview of the Research Model

The information processing perspective posits that the primary driver of group outcomes will be the knowledge possessed by the group. By layering this argument on top of the contingent structure found in much of the task-technology fit literature, I argued that the *interaction* between a group's task knowledge and its knowledge of the collaborative technology is the primary driver of outcomes for technology-supported groups. Further, I utilized Carte and Chidambaram's (2004) conception of a collaborative technology as a "bundle of capabilities" which can be classified as either additive or reductive. Additive capabilities are those features of the collaborative technology which add elements to normal communication patterns (e.g., an electronic record of all communication), whereas reductive capabilities are features which remove elements of those patterns (e.g., visual anonymity) (Carte and Chidambaram, 2004). I applied these notions to my previous arguments, and viewed a group's knowledge of a collaborative technology instead as knowledge of additive and reductive CT capabilities.

My concept of group outcomes consisted of both task and relational outcomes, as those were the factors which Cronin and Weingart (2007) argued can be negatively impacted by representational gaps. Additionally, DeSanctis and Poole (1994) posited that a group's beliefs about a technology (one of the structures governing the use of a technology) will be impacted by its use of the technology, and will likewise affect future use of the technology – a notion echoed by the task-technology fit literature (Goodhue and Thompson, 1995). Therefore, satisfaction with the collaborative technology was also included as a group outcome in the research model (shown in Figure 2-1 below).

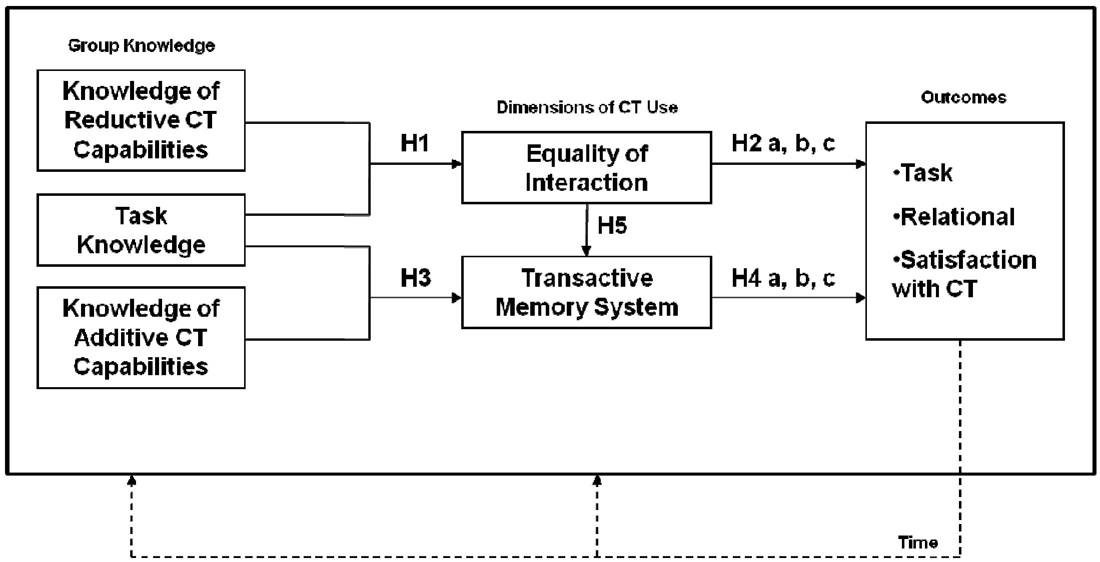

Figure 2-1: Research Model with Hypotheses

Equality of Interaction

Brodbeck, Kerschreiter, Mojzisch, and Schulz-Hardt (2007) utilized the information processing perspective to argue that groups can make better decisions than individuals only when members hold unique information (i.e., when there is diverse knowledge). If all group members possessed the same information, then the group would hold no advantage over an individual. However, in order for the group to take advantage of uniquely held knowledge within the group, the discussion must not be biased towards any particular member or viewpoint. These biases negatively impact both group decisions and group learning (Brodbeck et al., 2007). A group's ability to leverage the knowledge of its members is thus dependent upon its equality of interaction (i.e., the degree to which each member can express their thoughts and opinions openly during group interactions). Because it is a reflection of the group's internal system, the equality of interaction is also reflective of the manner in which the group appropriates the collaborative technology.

Carte and Chidambaram (2004) contend that the reductive capabilities of a collaborative technology can have positive effects on a group's interactions and member participation. Reductive capabilities such as visual anonymity can improve interactions by reducing the "salience of surface-level diversity" and forcing group members to "articulate their ideas in writing" (Carte and Chidambaram, 2004, pg. 455). Similarly, a reductive capability such as asynchronous interaction has the effect of slowing down interactions, a phenomenon which "enables members to think about issues before responding" (Carte and Chidambaram, 2004, pg. 455). As such, I argued that knowledge of these reductive capabilities should reduce some of the anxiety or apprehension that group members might normally feel when interacting in a face-to-face environment, thus increasing a group's equality of interaction. Therefore, I hypothesized:

> *H1: The interaction between a group's task knowledge and its knowledge of the CT's reductive capabilities are positively related to the group's equality of interaction.*

Knowledge of reductive CT capabilities enables group members to circumvent several dynamics which can reduce the effectiveness of group discussions. These include a bias towards discussing shared information (Dennis, 1996; Hollingshead, 1996), domination of discussion by a single member, and the formation of majority/minority factions within the group (Dennis, 1996). Each of these situations allows representational gaps to remain hidden, as only a few members are communicating their representations. Further, each of these scenarios either reduces or entirely eliminates the advantage of group decisions over individual decisions. These arguments are congruent with literature on hidden profile tasks (e.g., Dennis, 1996) and group polarization (e.g., Dennis et al., 1997-98; El-Shinnawy and Vinze, 1998), which argues that a group's failure to account for minority-held viewpoints can result in poor performance.

A group's ability to translate its knowledge into positive task performance is facilitated by appropriating the collaborative technology in such a way as to promote equality of interaction (i.e., the degree to which each member's thoughts and opinions are accounted for during group interactions). As the equality of a group's interaction increases, so does the likelihood of uncovering any representational gaps between members. Only after these gaps have been discovered can group members begin to address them. Because representational gaps can result in coordination problems between members, it was expected that efforts to address those gaps would ultimately improve the group's coordination of effort, and thus task performance. Therefore, I hypothesized:

H2a: The equality of interaction within a group positively impacts the group's task outcomes.

Greater equality of interaction is reflective of group processes that account for the thoughts and opinions of each team member, as opposed to those dominated by only a few members. Such processes are likely to be positively associated with trust and relational well-being (Folger and Konovsky, 1989), as well as satisfaction (Korsgaard and Roberson, 1995). On the other hand, processes that exclude or ignore certain members might result in a shift from beneficial task-based conflict to relational conflict, which can prove detrimental to the group (Eisenhardt et al., 1997; Jehn and Mannix, 2001; Jehn, 1997). Therefore, I hypothesized:

H2b: The equality of interaction within a group positively impacts the group's relational outcomes.

As noted earlier, technology impacts the emerging social structures governing its very use, and those same structures impact the attitudes and beliefs of users regarding that technology (DeSanctis and Poole, 1994). By applying this notion to a group's use of collaborative technology, I argued that the manner in which a group uses a collaborative technology will impact the group's attitudes and beliefs regarding that technology. Given that a group's equality of interaction is reflective of the manner in which the group has appropriated the collaborative technology, I expected that it would also impact the group's satisfaction with the collaborative technology. To sum up, I expected that those groups who use collaborative technology in such a manner as to promote equality of interaction amongst group members would consequently be satisfied with the technology. Therefore, I hypothesized:

H2c: The equality of interaction within a group positively impacts the group's satisfaction with the CT.

Transactive Memory Systems

A group's transactive memory system is a combination of the individual knowledge possessed by group members and a more generalized knowledge of the location of expertise within the group (i.e., who knows what) (Wegner, 1987). Wegner describes transactive memory systems as follows:

> "The transactive memory system in a group involves the operation of the *memory systems of the individuals* and the *processes of communication* that occur within the group. Transactive memory is therefore not traceable to any of the individuals alone, nor can it be found somewhere 'between' individuals. Rather it is a property of a group." (Wegner, 1987, pg. 191, emphasis added)

Therefore, both individual representations (memory systems) and communication are necessary components of a transactive memory system. That is, if a group member's knowledge is never communicated, then that knowledge cannot be a part of the group's transactive memory system. Lewis (2003) argued that a group's transactive memory system was comprised of three basic dimensions: specialization, credibility, and coordination. Because each of these dimensions reflects some aspect of the group's internal system, a group's transactive memory system is indicative of the manner in which the group appropriates the collaborative technology.

Specialization refers to the level of uniquely held knowledge within the group. A group's transactive memory system is thus reflective of the knowledge distribution amongst its members. The coordination dimension of the transactive memory system highlights a key point: even if each group member possesses totally specialized knowledge and expertise, it does not benefit task performance if the members cannot effectively coordinate their efforts to account for this expertise. One of the problems which representational gaps can cause is poor task coordination. The coordination dimension of a group's transactive memory system accounts for the group's ability to negate this problem.

Carte and Chidambaram (2004) contend that the additive capabilities of a collaborative technology can have positive effects on a group's coordination and task performance efforts. Additive capabilities such as an electronic trail can aid coordination by providing a record of all group communications which can be referenced later, i.e., an "audit trail [that] helps in the clarification of issues" (Carte and Chidambaram, 2004, pg. 455). Similarly, additive capabilities such as coordination support allow group members to "keep track of people, projects, and priorities" (Carte and Chidambaram, 2004, pg. 455). As such, I argued that knowledge of these additive capabilities would improve the coordination of effort amongst group members when working on a task, thus promoting the development of the group's transactive memory system. Therefore, I hypothesized:

> *H3: The interaction between a group's task knowledge and its knowledge of the CT's additive capabilities is positively related to the development of the group's transactive memory system.*

Furthermore, because transactive memory systems bring together both specialization and coordination, a group with a well-developed transactive memory system will be able to coordinate tasks in such a manner as to take advantage of group member knowledge related to either the task or the collaborative technology in question. The ability of the group to identify those members to whom they should defer has been shown to positively influence the group's task performance (Baumann and Bonner, 2004; Faraj and Sproull, 2000; Libby et al., 1987; Littlepage et al., 1997). These arguments are further supported by studies which have found transactive memory system development to be positively associated with group performance (e.g., Austin, 2003; Lewis, 2004). Therefore, I hypothesized:

> *H4a: A group's transactive memory system positively impacts the group's task outcomes.*

Another dimension of transactive memory systems is credibility. Credibility in this context refers to the degree to which members feel that they can rely upon the knowledge of other members (Lewis, 2003). A group's transactive memory system is thus also reflective of the level of trust between group members. This trust is a factor which can serve to negate potentially negative effects on relational development which might otherwise arise due to either representational gaps or a lack of overlapping knowledge within the group. This argument is bolstered by the fact that researchers have established a link between transactive memory systems and positive internal group evaluations (Austin, 2003). The specialization dimension of a group's transactive memory system implies that there will be different representations within the group. However, rather than trying to combine these representations to eliminate any differences in knowledge (and thus forfeiting the benefits of diverse knowledge), transactive memory systems allow groups to take advantage of the diverse knowledge of their members by enabling them to coordinate their efforts accordingly. Therefore, I hypothesized:

> *H4b: A group's transactive memory system positively impacts the group's relational outcomes.*

I previously noted that the manner in which a group uses a collaborative technology will impact the group's attitudes and beliefs regarding the collaborative technology (DeSanctis and Poole, 1994). Because I have argued that a group's transactive memory system is reflective of the manner in which the group has appropriated the collaborative technology, I expected that it would impact the group's satisfaction with the collaborative technology. Given the aforementioned benefits associated with transactive memory systems, as well as the hypothesized outcomes, I expected that those groups which use a collaborative technology in such a manner as to promote the development of their transactive memory system would consequently be satisfied with the collaborative technology. Therefore, I hypothesized:

> *H4c: A group's transactive memory system positively impacts the group's satisfaction with the CT.*

Equality of Interaction and Transactive Memory Systems

To date, the vast majority of research on transactive memory systems has examined the effects of its development within groups on outcomes such as task performance and relational development. Very few studies, however, have sought to uncover antecedents to transactive memory system development. One notable exception is a study conducted by Prichard and Ashleigh (2007) which found team-skills training to be an antecedent to transactive memory system development. Given Wegner's (1987) assertion that communication is a necessary component of any transactive memory system, it follows that group dynamics which improve communication would likely have an impact on the development of the group's transactive memory system. After all, if a group member's knowledge is never communicated, then that knowledge will not become a part of the group's transactive memory system. Therefore, I hypothesized:

> *H5: The equality of interaction within a group positively impacts the development of the group's transactive memory system.*

The Role of Time

Though not explicitly hypothesized, time played an important role in the research model. Because a group's satisfaction with the collaborative technology can be impacted by its use of the technology as well as impact future use of the technology, I expected that it could change over time. This is certainly congruent with other research that suggests that technology perceptions can change over time (Burke and Chidambaram, 1999). Furthermore, certain elements of transactive memory systems, such as credibility and coordination, can only be developed over time, through the performance of various tasks. Hence, time was represented in the research model as a feedback loop. I accounted for the role of time through the use of a longitudinal research design, which is described in Chapter III.

CHAPTER III – RESEARCH DESIGN AND METHODS

This chapter describes the research design and methods that were used to test the research model that was developed in Chapter 2. The following sections articulate the purpose of the research design, an overview of the design itself, the operational definitions and measures for each variable in the research model, and the procedures for data collection.

Purpose of the Research Design

This study focused on how groups leverage collaborative technologies to utilize the group knowledge at their disposal. I have argued that a group's task knowledge interacts with its knowledge of both the additive and reductive capabilities of the collaborative technology in use, and that these interactions impact the manner in which the group appropriates the technology. High-performing groups are those that are able to use collaborative technology in such as way as to capitalize on their task knowledge, while lower-performing groups are those that encounter problems in doing so. Cronin and Weingart (2007) presented a picture of what those problems might be when they developed the concept of representational gaps, arguing that these gaps will result in coordination problems and conflict between group members. A group's ability to capitalize on the knowledge held by its members and generate positive group outcomes is dependent on its ability to use collaborative technology in such as way as to uncover representational gaps and counteract the negative effects stemming from their presence within the group. I argued that a group's equality of interaction and transactive memory system development are both reflective of the manner in which the group has appropriated the collaborative technology. As such, I argued that these dimensions of use positively impact group outcomes such as satisfaction with the collaborative technology, relational outcomes (such as conflict and cohesion), and task performance. The purpose of the research design was to enable me to test these ideas.

Research Design

For this study, I chose to utilize a longitudinal repeated-measures field study with two waves of data collection. The repeated-measures aspect of the studies allowed me to capture the robust data associated with some of the more process-oriented factors (e.g., the development of a group's transactive memory system). Furthermore, the longitudinal design allowed me to track changes in satisfaction with the collaborative technology which have been suggested by prior studies (Burke and Chidambaram, 1999).

The sample for the two studies was drawn from an undergraduate MIS course (MIS 2113 – Computer-Based Information Systems) that is required of all majors in the College of Business. In addition to a lecture section, each student was required to participate in a laboratory section, in which they learned applied computer skills such as programming their own webpage using HTML, spreadsheet basics in Microsoft Excel 2007, and relational database basics in Microsoft Access 2007. Due to the applied nature of the work in these laboratory sections, the studies took place in this environment, rather than in the lectures. The first wave of data collection took place during the fall semester of 2007 and comprised 11 different laboratory sections. The second wave of data collection took place during the spring semester of 2008 and also comprised 11 different laboratory sections.

One of the recurring themes throughout the theoretical development in Chapter 2 is a deviation from the perspective of technological determinism. Congruent with this line of thought, I assigned roughly half of the students to Desire2Learn, and the other half to a different collaborative technology, Yahoo! Groups. Desire2Learn was a technology with which most of the students had some familiarity, though none had used the discussion interface which served as the primary collaborative tool. Yahoo! Groups, on the other hand, was a tool with which most of the students had no familiarity. Rather than a manipulation intended to increase variance, the use of two different collaborative technologies was instead intended as a design element that allowed me to test the robustness of the research model across different collaborative technologies.

Before each data collection began, the students were arranged into groups of four or five students each. They then worked on a training exercise designed to get them acquainted with the process of working with their groups using the collaborative technology to which they were assigned. Before beginning this assignment, all students were administered a training session which covered the basic operations of the collaborative technology to which they had been assigned. The groups were then assigned four staged assignments pertaining to database design in Microsoft Access 2007 (covering table creation, form creation, modification of tables and forms, and queries and reports). These assignments constitute the four group tasks used in this study, and were adapted from Araujo (2004). The details of each task are included in

Appendix A. Each group member was given unique information about the assignment, but the group was required to submit a single deliverable. Thus, interdependence was built into the tasks, requiring group members to collaborate in order to effectively complete each assignment. As each deliverable was completed, group members were administered a web-based survey which captured individual responses to each of the items described in the next section. This resulted in a total of four surveys and four deliverables. Figure 3-1 provides a timeline which illustrates this process.

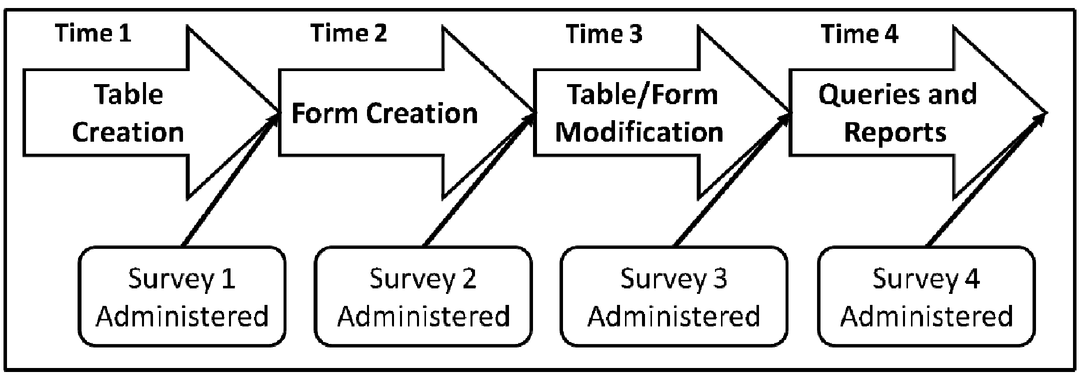

Figure 3-1: Timeline for Field Studies

Operational Definitions

The following sections articulate the operational definitions and the operationalizations of each of the variables of interest in this study. Because the structure of the research model mirrored a basic Input-Process-Output (IPO) model, the variables are organized as such. The "input" variables (Task Knowledge, Knowledge of Additive CT Capabilities, and Knowledge of Reductive CT Capabilities) are presented first, followed by the "process" variables (Equality of Interaction and Transactive Memory System) and the "output" variables (Satisfaction with the CT, Conflict, Cohesion, and Task Performance). The chapter concludes with an overview of the control variables used in the study. The items used for each variable are shown in Appendix B.

Input Variables

Task Knowledge

A group's task knowledge is the sum total of the knowledge pertaining to the completion of the task that is collectively held by a group's members. Extant literature on IT appropriation and technology choice offers much in the way of tests and scales regarding task knowledge. Barki, Rivard, and Talbot (2001) asked their study participants to rate their *expertise* with a given task on a seven point Likert-type scale. However, a more straightforward way to measure an individual's task knowledge is to test him/her directly. Marcolin, Compeau, Munro, and Huff (2000) utilized this approach to capture user knowledge of both word processing and spreadsheet applications. They simply administered a ten-item multiple choice test for each of the applications to determine the level of the user's knowledge of each. This is the method that I chose to implement. At the beginning of each of the four surveys, I administered ten multiple choice questions aimed at capturing the students' knowledge of how to complete the assigned task. Summing the results of these questions across group members gave me an indication of the level of task knowledge within each group.

Knowledge of Additive CT Capabilities

A group's knowledge of additive CT capabilities is the sum total of the knowledge pertaining to the additive capabilities of the CT that is collectively held by a group's members. Additive capabilities are those features of the collaborative technology which add elements to normal communication patterns (e.g., an electronic record of all communication) (Carte and Chidambaram, 2004). Among the most important additive CT capabilities are those that support the tracking of people, projects, and priorities within the group, those that support group decision making, and the those that support the retrieval of communication (i.e., messages or files) (Carte and Chidambaram, 2004). I developed three items which sought to capture the students' knowledge of the CT's capabilities with regard to these specific dimensions. Each of the items was developed using a seven point Likert-type scale.

Knowledge of Reductive CT Capabilities

A group's knowledge of reductive CT capabilities is the sum total of the knowledge pertaining to the reductive capabilities of the CT that is collectively held by a group's members. Reductive capabilities are those features of the collaborative technology which remove elements from normal communication patterns (e.g., visual anonymity) (Carte and Chidambaram, 2004). Among the most important reductive CT capabilities are those that enable visual anonymity and asynchronous communication (Carte and Chidambaram, 2004). I developed three items which sought to capture the students' knowledge of the CT's capabilities with regard to these specific dimensions. Two of the items were developed to capture the dimension of asynchronous communication, because Carte and Chidambaram (2004, pg. 452) note that this particular capability "can be viewed as one with dichotomous values – some CTs support real-time communication while others support deferred communication." Each of the items was developed using a seven point Likert-type scale.

Process Variables

Equality of Interaction

A group's equality of interaction is the degree to which each member's thoughts and opinions are accounted for during group interactions. In order to capture the equality of interaction within a group, I utilized an objective measure. Because the postings were electronically archived within each collaborative technology, I was able to capture the number of postings submitted by each group member. As such, only those interactions which occurred on the assigned collaborative technology were captured. From there, I calculated a coefficient of variance based on the number of contributions per member as an objective measure of equality of interaction. Coefficients of variance theoretically range anywhere from 0 (indicating perfect equality of interaction) to infinity. As the coefficient increases, the equality of interaction within a group decreases.

Transactive Memory System

Transactive memory has been described as an awareness of what other people know (Wegner, 1987). A Transactive Memory System (TMS) is therefore a system by which people make use of this awareness of other's knowledge, and is not traceable to any single group member (Lewis, 2003; Wegner, 1987). Lewis (2003) developed a scale for measuring TMS's that captures three different dimensions of a group's TMS: 1) specialization, 2) credibility, and 3) coordination. Each of these dimensions is captured via its own five-item scale. However, Lewis (2003) also included a single omnibus measure for each dimension in each of the five-item scales. Due to the threat of respondent fatigue, as well as the fact that several of the items did not translate well to a student context, the three omnibus measures were used to capture the dimensions of TMS rather than the entire 15-item battery.

Output Variables

Task Performance

A group's task performance is a measure of how well the group performed the task at hand. Each group submitted a single deliverable for each of the four Access assignments. Each of these deliverables was rated (on a scale from 0 to 100 percent) according to specific grading criteria (adapted from Araujo (2004) and shown in Appendix C) by the instructor for the section in which each group was enrolled. As the two studies comprised a total of 22 sections taught by 9 different instructors, this resulted in 9 different raters, with each deliverable rated by one of the 9. While the instructors rated the deliverables according to a very specific set of criteria, in order to ensure the reliability of their ratings, I rated a few of the deliverables from each instructor during each time period and compared my ratings to those of the instructor. I found no discrepancies between the ratings. As such, I felt comfortable that these ratings were a consistent and reliable measure of how well the group performed each task. In addition to this objective measure of task performance, I also captured individual perceptions of the group's performance, using modified versions of Chidambaram's (1996) scale for Satisfaction with Outcome, which demonstrated a reliability of .95 (Cronbach's α) in the original study. Chidambaram's original scale comprised four items. However, because I felt that there could be some disagreement between what the students perceived as effective and valuable, I split one of the items into two separate items, resulting in a total of five items.

Relational Development

Congruent with other studies concerning the relational development of groups (e.g., Carte and Chidambaram, 2004), relational development was captured by using measures of both conflict and cohesion.

Conflict

Because researchers have begun to empirically verify distinctions between different types of conflict (c.f., Jehn and Mannix, 2001; Jehn, 1995; Jehn, 1997), I used Jehn and Mannix's (2001) measure of intragroup conflict, which is capable of capturing those distinctions. While the original scale is a nine-item measure which captures Task Conflict, Relationship Conflict, and Process Conflict, the Process Conflict measures did were not adaptable to a student context. As such, I used the six items for Task Conflict and Relationship Conflict, which both demonstrated construct reliabilities of .94 in the original study (Jehn and Mannix, 2001). Further, I modified this scale to reflect the context of virtual teams rather than work groups.

Cohesion

Given its widespread use and acceptance in literature concerning group dynamics, I decided to use Seashore's (1954) five-item measure of group cohesion. Several researchers have argued for the treatment of group cohesion as a multi-dimensional construct (Bernthal and Insko, 1993; Chang and Bordia, 2001; Widmeyer et al., 1985), and some have developed more complex scales in attempts to empirically capture such distinctions. However, due to both concerns of respondent fatigue and the fact that the dimensionality of the group cohesion construct is not central to the underlying arguments of this study, I felt comfortable using Seashore's (1954) concise measure.

Satisfaction with the Collaborative Technology

Adaptive Structuration Theory (DeSanctis and Poole, 1994) has suggested and studies have confirmed that a user's beliefs about a technology, such as satisfaction with the technology (Burke and Chidambaram, 1999), can change over time. In order to assess the degree to which group members were satisfied with their assigned collaborative technology, I developed a three-item measure.

Control Variables

Collaborative Technology

In order to account for such issues as familiarity or comfort with a given collaborative technology as possible alternative explanations for variance in the constructs of interest, I included collaborative technology as a binary control variable (as each group was assigned to either Desire2Learn or Yahoo! Groups).

Measures of Diversity

In order to rule out alternative explanations for variance in measures such as performance and equality of interaction, I captured a number of measures of group diversity, including gender, race, age, and GPA. I calculated group diversity along the lines of gender and race by using Blau's (1977) diversity index, while I calculated group diversity along the lines of age and GPA by using a coefficient of variance.

Manipulation Checks

In the first wave of data collection, there arose some concerns regarding the validity of the data due to the nature of a student-based study sample. Therefore, in addition to the control variables, a number of other variables were captured in the second field study in an attempt to assess the validity of the study results by determining the degree to which students adhered to the prescribed study context. These manipulation checks are discussed below.

Level of Engagement

In the first wave of data collection, there arose some concerns that given the student population perhaps a lack of engagement on the students' part could negatively impact the validity of their survey responses. In order to better assess the validity of their survey responses, each participant responded to questions that asked them to what degree they were engaged in the completion of both the assignment and the survey itself.

Amount of Face-to-Face Contact

In order to assess the degree to which team members actually used the assigned collaborative technology (as opposed to meeting face-to-face), each participant responded to a question asking them to what degree they met face-to-face to work on the assigned task.

Use of Other Collaborative Technologies

In order to assess the degree to which team members actually used the assigned collaborative technology, and not other collaborative technologies (such as email or Instant Messenger), each participant responded to a question asking them to what degree they completed the assignment using collaborative technologies (such as email) other than the one to which they were assigned.

CHAPTER 4 – DATA ANALYSIS

Introduction

This chapter contains data analysis of the two field studies conducted in order to test the hypotheses detailed in Chapter 2. The data analysis reveals differential impacts of Knowledge of Additive and Reductive CT Capabilities. While Knowledge of Reductive CT Capabilities initially impacted group CT use through an interaction with the group's Task Knowledge (as hypothesized in H1), this effect disappeared in later time periods. In contrast, Knowledge of Additive CT Capabilities consistently impacted CT use through an interaction with the group's Task knowledge (as hypothesized in H3) in all time periods.

Further, I found strong support for the hypothesis that a group's Equality of Interaction impacts its TMS (H5). I also found moderate support for the hypotheses that a group's Equality of Interaction impacts the group's task outcomes (H2a) as well as its Satisfaction with the CT (H2c). Interestingly, I found no support for the hypothesis that a group's Equality of Interaction impacts its relational outcomes (H2b). Finally, I found strong support for the hypotheses that a group's TMS impacts the group's relational outcomes (H4b) as well as its Satisfaction with the CT (H4c), and only minimal support for the hypothesis that a group's TMS impacts the group's task outcomes (H4a).

The remainder of this chapter describes the processes by which I conducted this data analysis. First, some basic demographic information and descriptive statistics are presented. This is followed by the results of an exploratory factor analysis conducted on the data from the first wave of data collection and a confirmatory factor analysis conducted on the data from the second wave of data collection. Next, results of hypothesis tests performed on the research model using partial least squares (PLS) analysis are shown. The chapter concludes with a number of post-hoc tests conducted in order to better understand the results of the PLS analysis. A discussion of the research findings can be found in Chapter 5.

Sample

The first wave of data collection comprised 398 students assigned to four and five member teams. This resulted in a total of 84 groups. However, those groups who did not have at least two members respond in each of the surveys were dropped from the study. This elimination process yielded 75 usable groups from the first data collection (comprising a total of 355 students). The second wave of data collection comprised 352 students assigned to four and five member teams, resulting in a total of 77 groups. However, the criteria that was applied to the first data collection (i.e., at least two members respond in each survey) yielded 68 usable groups (comprising a total of 318 students) from the second data collection. Therefore, a total of 143 usable groups (comprising a total of 673 students) were obtained from both waves of data collection.

Demographic Information

Summary information regarding the ethnicity of the students comprising the usable groups in the two waves of data collection is shown in Table 4-1.

Table 4-1: Ethnicity of Students

Data Collection 1			Data Collection 2		
Ethnicity	**Count**	**Percentage**	**Ethnicity**	**Count**	**Percentage**
White/Caucasian	251	70.70%	White/Caucasian	229	72.01%
Did Not Respond	53	14.93%	Did Not Respond	32	10.06%
Hispanic	15	4.23%	Asian/Pacific Islander	21	6.60%
Asian/Pacific Islander	14	3.94%	Native American	12	3.77%
African/African-American	11	3.10%	African/African-American	10	3.14%
Native American	8	2.25%	Hispanic	10	3.14%
Middle Eastern	3	0.85%	Middle Eastern	4	1.26%

Table 4-2 contains summary information regarding the gender of the students comprising the usable groups in the two waves of data collection.

Table 4-2: Gender of Students

Data Collection 1			Data Collection 2		
Gender	**Count**	**Percentage**	**Gender**	**Count**	**Percentage**
Male	188	52.96%	Male	219	68.87%
Female	167	47.04%	Female	99	31.13%

Table 4-3 contains the mean and standard deviation of the age of the students comprising the usable groups in the two waves of data collection.

Table 4-3: Age of Students (in Years)

Data Collection 1		Data Collection 2	
Average	Standard Deviation	Average	Standard Deviation
20.33	3.33	21.05	3.47

Table 4-4 contains the mean and standard deviation of the GPA of the students comprising the usable groups in the two waves of data collection.

Table 4-4: GPA of Students

Data Collection 1		**Data Collection 2**	
Average	Standard Deviation	Average	Standard Deviation
3.34	0.41	3.13	0.42

Descriptive Statistics

Tables 4-5 through 4-8 contain basic descriptive statistics concerning the data collected during each of the time periods. This data includes sample size, means, standard deviations, and correlation matrices. Significant correlations are shown in bold. Table 4-9 contains the results of t-tests conducted in order to evaluate any systematic differences between the data in the two waves of data collection. Significant t-tests are shown in bold. The results of these t-tests suggested that the significant differences between the data in the two collections were minimal and most appeared in the first time period. Therefore, I felt justified in combining the results of the two data collections for the purpose of further data analysis. By doing so, I increased the sample size to 143 usable groups.

Table 4-5: Correlation Matrix for Time Period 1

	N	Mean	Std Dev	1	2	3	4	5	6	7	8
1. TK	143	17.664	5.516								
2. CTREDKNW	143	4.688	0.544	0.040							
3. CTADDKNW	143	4.672	0.642	0.014	**0.185**						
4. EOI	143	0.570	0.251	0.052	0.159	-0.085					
5. TMS	143	4.273	1.143	**0.323**	0.067	**0.333**	**0.228**				
6. CTSAT	143	4.658	1.126	**0.314**	0.112	**0.573**	0.151	**0.576**			
7. CONF	143	2.012	0.783	**-0.241**	-0.132	**-0.240**	-0.139	**-0.581**	**-0.427**		
8. COH	143	3.160	0.548	**0.426**	-0.001	**0.271**	**0.248**	**0.781**	**0.500**	**-0.549**	
9. PERF	143	94.436	14.108	0.087	0.123	0.076	**0.287**	0.085	0.082	-0.123	0.127

Note: TK = Task Knowledge; CTREDKNW = Knowledge of Reductive CT Capabilities; CTADDKNW = Knowledge of Additive CT Capabilities; EOI = Equality of interaction; TMS = Transactive Memory System; CTSAT = Satisfaction with CT; CONF = Conflict; COH = Cohesion; PERF = Performance

Table 4-6: Correlation Matrix for Time Period 2

	N	Mean	Std Dev	1	2	3	4	5	6	7	8
1. TK	143	10.490	3.931								
2. CTREDKNW	143	4.615	0.576	0.119							
3. CTADDKNW	143	4.803	0.603	0.087	**0.231**						
4. EOI	143	0.608	0.289	0.029	-0.019	-0.071					
5. TMS	143	4.252	1.205	**0.286**	-0.055	0.150	**0.313**				
6. CTSAT	143	4.852	1.121	0.161	-0.036	**0.383**	**0.267**	**0.518**			
7. CONF	143	2.183	0.860	**-0.197**	0.032	**-0.202**	**-0.167**	**-0.665**	**-0.443**		
8. COH	143	3.212	0.618	**0.278**	-0.031	**0.197**	**0.290**	**0.849**	**0.548**	**-0.671**	
9. PERF	143	96.878	10.619	**0.179**	-0.037	0.053	0.024	**0.216**	**0.264**	-0.087	**0.218**

Note: TK = Task Knowledge; CTREDKNW = Knowledge of Reductive CT Capabilities; CTADDKNW = Knowledge of Additive CT Capabilities; EOI = Equality of interaction; TMS = Transactive Memory System; CTSAT = Satisfaction with CT; CONF = Conflict; COH = Cohesion; PERF = Performance

Table 4-7: Correlation Matrix for Time Period 3

	N	Mean	Std Dev	1	2	3	4	5	6	7	8
1. TK	143	12.811	4.059								
2. CTREDKNW	143	4.571	0.558	0.047							
3. CTADDKNW	143	4.833	0.600	0.127	**0.265**						
4. EOI	143	0.609	0.274	-0.010	-0.074	-0.068					
5. TMS	143	4.496	1.213	**0.301**	-0.009	**0.233**	**0.402**				
6. CTSAT	143	5.059	1.086	**0.240**	0.088	**0.331**	**0.337**	**0.576**			
7. CONF	143	2.105	0.811	**-0.283**	-0.014	**-0.216**	**-0.261**	**-0.542**	**-0.486**		
8. COH	143	3.239	0.631	**0.372**	0.071	**0.277**	**0.325**	**0.788**	**0.606**	**-0.646**	
9. PERF	143	93.164	12.907	0.043	0.038	0.083	0.016	0.077	0.127	**-0.166**	0.113

Note: TK = Task Knowledge; CTREDKNW = Knowledge of Reductive CT Capabilities; CTADDKNW = Knowledge of Additive CT Capabilities; EOI = Equality of interaction; TMS = Transactive Memory System; CTSAT = Satisfaction with CT; CONF = Conflict; COH = Cohesion; PERF = Performance

Table 4-8: Correlation Matrix for Time Period 4

	N	Mean	Std Dev	1	2	3	4	5	6	7	8
1. TK	143	11.797	4.210								
2. CTREDKNW	143	4.599	0.554	0.059							
3. CTADDKNW	143	4.853	0.641	0.067	**0.228**						
4. EOI	143	0.704	0.439	0.063	-0.076	-0.043					
5. TMS	143	4.562	1.231	**0.302**	-0.118	**0.295**	**0.379**				
6. CTSAT	143	5.164	1.088	0.067	0.051	**0.478**	**0.232**	**0.537**			
7. CONF	143	2.216	0.893	**-0.208**	-0.012	**-0.351**	**-0.173**	**-0.553**	**-0.425**		
8. COH	143	3.240	0.701	**0.258**	-0.149	**0.320**	**0.313**	**0.846**	**0.532**	**-0.572**	
9. PERF	143	92.448	14.788	0.108	0.094	0.040	**0.173**	0.117	0.114	-0.109	**0.182**

Note: TK = Task Knowledge; CTREDKNW = Knowledge of Reductive CT Capabilities; CTADDKNW = Knowledge of Additive CT Capabilities; EOI = Equality of interaction; TMS = Transactive Memory System; CTSAT = Satisfaction with CT; CONF = Conflict; COH = Cohesion; PERF = Performance

Table 4-9: Results of t-tests Comparing Data from Collections 1 and 2

	Time 1			Time 2			Time 3			Time 4		
	t	df	p-value	t	df	p-value	t	df	p-value	t	df	p-value
GENDER	-0.188	141	0.851	*	*	*	*	*	*	*	*	*
RACE	-1.211	141	0.228	*	*	*	*	*	*	*	*	*
AGE	-0.631	141	0.529	*	*	*	*	*	*	*	*	*
GPA	-1.445	141	0.151	*	*	*	*	*	*	*	*	*
TK	*2.726*	*140.452*	***0.007***	-0.243	141	0.809	0.048	141	0.962	-0.786	141	0.433
CTREDKNW	1.997	141	**0.048**	1.508	141	0.134	1.189	141	0.236	0.567	141	0.572
CTADDKNW	1.714	141	0.089	-0.395	141	0.693	0.481	141	0.631	0.411	141	0.682
EOI	*-1.429*	*110.581*	*0.156*	-0.229	141	0.819	0.450	141	0.653	-0.597	141	0.552
TMS	3.950	141	**0.000**	2.303	141	**0.023**	1.569	141	0.119	1.676	141	0.096
CTSAT	1.968	141	0.051	-0.288	141	0.774	0.059	141	0.953	-0.082	141	0.935
CONF	-1.693	141	0.093	-0.678	141	0.499	-0.858	141	0.392	-0.025	141	0.980
COH	2.753	141	**0.007**	1.718	141	0.088	2.016	141	**0.046**	1.530	141	0.128
PERF	*1.415*	*82.437*	*0.161*	-0.580	141	0.563	0.048	141	0.962	-1.014	141	0.312

Note: * indicates that the data did not change from one time period to another; *italics* indicate that the assumption of equal variances was not met; TK = Task Knowledge; CTREDKNW = Knowledge of Reductive CT Capabilities; CTADDKNW = Knowledge of Additive CT Capabilities; EOI = Equality of interaction; TMS = Transactive Memory System; CTSAT = Satisfaction with CT; CONF = Conflict; COH = Cohesion; PERF = Performance

As referenced in Chapter 3, a number of variables were captured in the second data collection for the purpose of assessing the validity of the student responses. The descriptive statistics for these manipulation checks are shown in Table 4-10 below.

Table 4-10: Descriptive Statistics for Manipulation Checks

		Time 1		Time 2		Time 3		Time 4	
Variable	**N**	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**
ENGSURV	68	5.251	0.827	5.506	0.718	5.588	0.914	5.655	0.760
ENGTASK	68	5.970	0.676	5.826	0.709	5.958	0.724	6.007	0.707
FFMEET	68	1.462	0.626	1.686	0.881	1.864	0.957	1.895	1.077
OTHERCT	68	2.323	1.046	2.514	1.345	2.260	1.091	2.212	1.036

Note: ENGSURV = Level of Engagement in the Survey; ENGTASK = Level of Engagement in the Task; FFMEET = Amount of Face-to-Face Contact; OTHERCT = Use of other Collaborative Technologies

Given the high means and low standard deviations associated with the measures of engagement, I feel reasonably confident that the students were engaged in both the task and survey completion. Given the low means and low standard deviations associated with the measures of face-to-face contact and use of other collaborative technologies, I feel reasonably confident in the notion that the students engaged in very few face-to-face meetings and primarily used their assigned collaborative technology for communicating with other group members. It should be noted that there is certainly the possibility that these results were impacted by a social desirability bias. However, given the sample size combined with the means and standard deviations shown above, I feel confident that these results are indicative of the fact that the students generally behaved in accordance with the prescriptions of the research design.

Exploratory Factor Analysis

Next, in order to test for construct validity, I conducted an exploratory factor analysis on the reflective constructs using only the data from the first data collection. I used an oblique rotation for this factor analysis. Orthogonal rotations assume no correlations between the resultant factors. Oblique rotations, on the other hand, allow for correlation between the resultant factors. Because I expected certain constructs in the model to be correlated (e.g., conflict and cohesion), I chose to use an oblique rotation (Promax). Further, I utilized the Eigenvalue>1 rule to determine the number of generated factors. Tables 4-11 through 4-14 contain the resultant pattern matrices from the exploratory factor analyses from each time period. Factor analysis using an oblique rotation typically generates three factor matrices, the combination of which is typically taken into account in order to properly interpret the resultant factors.

However, in this case the pattern matrices generated by the exploratory factor analysis for each time period displayed simple structure. Because the pattern matrix is typically the most useful in interpreting the generated factors (Hatcher, 1994) those are the only matrices shown here. Based on the fact that the first Cohesion item (COH1) never loaded higher than .38 on any factor in any time period, I chose to eliminate this item from further analysis.

Table 4-11: Collection 1 Time Period 1 Pattern Matrix (a)

	Component			
	1	2	3	4
RCONF1	.869	-.022	.009	-.018
RCONF2	.870	-.047	.010	-.012
RCONF3	.857	-.098	.051	-.035
TCONF1	.911	-.006	.013	.077
TCONF2	.880	.032	-.058	-.022
TCONF3	.934	.105	-.023	.022
COH1	-.109	-.068	.381	.256
COH2	-.087	.353	-.064	.467
COH3	-.026	-.091	.023	.924
COH4	.023	.080	-.002	.870
COH5	.061	.005	.009	.937
CHIDSAT1	.009	.941	.001	.019
CHIDSAT2	.014	.966	.007	-.012
CHIDSAT3	.037	.967	.012	-.007
CHIDSAT4	-.132	.847	.030	-.057
CHIDSAT5	.047	.958	.007	.028
CTSAT1	.009	-.025	.934	.002
CTSAT2	.007	.060	.908	-.027
CTSAT3	.017	.032	.950	-.019

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.
a Rotation converged in 5 iterations.

Table 4-12: Collection 1 Time Period 2 Pattern Matrix (a)

	Component			
	1	2	3	4
RCONF1	.796	-.252	.069	.057
RCONF2	.892	-.041	.124	-.066
RCONF3	.894	-.059	.019	.020
TCONF1	.929	.185	-.090	-.032
TCONF2	.902	.028	-.047	.020
TCONF3	.919	.083	-.067	.024
COH1	-.114	.206	.331	.069
COH2	-.136	.280	-.051	.525
COH3	-.058	-.075	-.022	.943
COH4	.090	.068	.043	.899
COH5	.033	.040	.020	.911
CHIDSAT1	.005	.873	.015	.098
CHIDSAT2	.021	1.035	.023	-.102
CHIDSAT3	.031	.954	.008	-.007
CHIDSAT4	-.031	.865	.028	.023
CHIDSAT5	.030	.946	-.016	.048
CTSAT1	.031	-.033	.948	.024
CTSAT2	.005	.015	.927	.011
CTSAT3	-.031	.051	.915	-.037

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.
a Rotation converged in 5 iterations.

Table 4-13: Collection 1 Time Period 3 Pattern Matrix (a)

	Component			
	1	2	3	4
RCONF1	.797	-.029	-.065	-.049
RCONF2	.874	-.003	-.076	.021
RCONF3	.937	.055	-.035	-.045
TCONF1	.936	-.052	.039	.045
TCONF2	.974	.057	.033	-.004
TCONF3	.970	-.040	.113	.031
COH1	-.151	.241	.139	.064
COH2	-.201	.093	.609	-.005
COH3	.032	-.029	.943	-.004
COH4	.010	.054	.890	.005
COH5	.080	.000	.936	.000
CHIDSAT1	-.023	.903	.028	.020
CHIDSAT2	.001	.978	-.034	-.008
CHIDSAT3	.008	.958	.030	-.053
CHIDSAT4	.007	.914	-.050	.050
CHIDSAT5	.023	.924	.059	.002
CTSAT1	.030	.002	.016	.948
CTSAT2	-.030	-.003	.002	.957
CTSAT3	.005	.023	-.018	.962

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.
a Rotation converged in 5 iterations.

Table 4-14: Collection 1 Time Period 4 Pattern Matrix (a)

	Component			
	1	2	3	4
RCONF1	.877	-.095	-.039	.059
RCONF2	.905	-.060	.023	-.025
RCONF3	.932	-.002	-.009	-.009
TCONF1	.986	.051	.041	.003
TCONF2	.958	.046	.045	-.028
TCONF3	.973	.074	-.005	-.006
COH1	-.094	.263	.261	.139
COH2	-.220	.232	.545	-.044
COH3	.070	.000	.941	.013
COH4	.028	.014	.933	.000
COH5	.045	-.005	.947	.003
CHIDSAT1	.004	.918	.063	-.003
CHIDSAT2	.074	.992	-.081	.074
CHIDSAT3	.020	.967	-.013	-.002
CHIDSAT4	-.063	.913	.014	-.047
CHIDSAT5	.030	.970	.019	-.031
CTSAT1	.010	-.023	.031	.961
CTSAT2	-.035	.029	.021	.907
CTSAT3	.013	.010	-.035	.985

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.
a Rotation converged in 5 iterations.

Confirmatory Factor Analysis

Next, I used PROC CALIS in SAS to conduct a confirmatory factor analysis on the data from the second data collection using the relationships between items and factors suggested by the exploratory factor analysis on the data from the first data collection. I used multiple fit statistics to assess the fit of the confirmatory factor analysis. These included the goodness of fit index (GFI), Bentler's comparative fit index (CFI), Bentler and Bonett's non-normed fit index (NNFI), the root mean square residual (RMR), and the root mean square error of approximation (RMSEA). Table 4-15 provides a summary of these fit statistics for the confirmatory factor analysis from each time period, as well as the recommended values for each statistic. While the RMSEA values in particular were not ideal, the overall picture generated by these fit statistics indicated an acceptable level of fit.

Table 4-15: CFA Fit Statistics

Test Statistic	Time Period	Study Value	Recommended Value
GFI	1	0.8509	>= .80
	2	0.8271	>= .80
	3	0.8018	>= .80
	4	0.9040	>= .80
CFI	1	0.9506	>= .95
	2	0.9449	>= .95
	3	0.9399	>= .95
	4	0.9830	>= .95
NNFI	1	0.9414	>= .90
	2	0.9347	>= .90
	3	0.9287	>= .90
	4	0.9798	>= .90
RMR	1	0.0466	<= .10
	2	0.0558	<= .10
	3	0.0471	<= .10
	4	0.0519	<= .10
RMSEA	1	0.0826	<= .07
	2	0.0921	<= .07
	3	0.1040	<= .07
	4	0.0567	<= .07

Alpha and Composite Reliability

In order to test construct reliability, both Cronbach's alpha and composite reliability were calculated for each of the reflective constructs for each of the four time periods. In the interest of brevity, these calculations were averaged across all four time periods and are summarized in Appendix E. All of the reflective constructs exhibited an average reliability of .90 or greater. Because these numbers exceeded the recommended cutoff of .80 (Carmines and Zeller, 1979; Nunnally, 1978), I concluded that our reflective constructs demonstrated adequate reliability.

Discriminant Validity

Next, I tested for discriminant validity by calculating the square root of the average variance extracted (AVE) for each construct and comparing it to the correlations between constructs (Fornell and Larcker, 1981; Igbaria et al., 1997). Tables 4-16 through 4-19 show the correlation matrices for each time period, with the square root of the AVE shown on the diagonal. Even though there are some large correlations between constructs, all were hypothesized. However, the comparison between the square root of the AVE for Satisfaction with Performance (CHIDSAT) and the correlation between CHIDSAT and TMS revealed an issue with discriminant validity between these two constructs. CHIDSAT was originally included in order to provide a perceptual measure of performance to go along with an objective performance rating. However, because I captured performance elsewhere, through a more objective measure, the discriminant validity issues between CHIDSAT and TMS caused me to drop the CHIDSAT measure from further analysis.

Table 4-16: Correlation Matrix (with Square Root of AVE) – Time 1

	TK	CTREDKNW	CTADDKNW	CONF	COH	CHIDSAT	TMS	CTSAT	EOI	PERF
TK	**1.000**									
CTREDKNW	0.221	**0.580**								
CTADDKNW	0.014	0.340	**0.650**							
CONF	-0.270	-0.248	-0.225	**0.905**						
COH	0.433	0.209	0.273	-0.574	**0.902**					
CHIDSAT	0.371	0.256	0.348	-0.605	0.795	**0.961**				
TMS	0.323	0.239	0.333	-0.602	0.794	0.901	**0.912**			
CTSAT	0.308	0.363	0.564	-0.438	0.518	0.606	0.582	**0.963**		
EOI	0.052	0.153	-0.085	-0.137	0.238	0.237	0.228	0.150	**1.000**	
PERF	0.087	0.107	0.076	-0.123	0.114	0.147	0.085	0.089	0.287	**1.000**

Table 4-17: Correlation Matrix (with Square Root of AVE) – Time 2

	TK	CTREDKNW	CTADDKNW	CONF	COH	CHIDSAT	TMS	CTSAT	EOI	PERF
TK	**1.000**									
CTREDKNW	0.196	**0.652**								
CTADDKNW	0.087	0.367	**0.632**							
CONF	-0.187	-0.278	-0.215	**0.920**						
COH	0.279	0.250	0.192	-0.672	**0.912**					
CHIDSAT	0.266	0.188	0.216	-0.640	0.866	**0.963**				
TMS	0.286	0.267	0.150	-0.670	0.860	0.928	**0.924**			
CTSAT	0.175	0.282	0.368	-0.449	0.568	0.549	0.540	**0.956**		
EOI	0.029	0.130	-0.071	-0.173	0.275	0.261	0.313	0.265	**1.000**	
PERF	0.179	0.109	0.053	-0.084	0.227	0.286	0.216	0.271	0.024	**1.000**

Table 4-18: Correlation Matrix (with Square Root of AVE) – Time 3

	TK	CTREDKNW	CTADDKNW	CONF	COH	CHIDSAT	TMS	CTSAT	EOI	PERF
TK	**1.000**									
CTREDKNW	0.124	**0.585**								
CTADDKNW	0.127	0.462	**0.615**							
CONF	-0.280	-0.291	-0.224	**0.926**						
COH	0.379	0.363	0.288	-0.636	**0.912**					
CHIDSAT	0.330	0.337	0.275	-0.647	0.860	**0.973**				
TMS	0.301	0.319	0.233	-0.539	0.798	0.898	**0.923**			
CTSAT	0.248	0.323	0.339	-0.503	0.629	0.671	0.593	**0.973**		
EOI	-0.010	0.067	-0.068	-0.265	0.335	0.385	0.402	0.340	**1.000**	
PERF	0.043	-0.037	0.083	-0.164	0.118	0.161	0.077	0.125	0.016	**1.000**

Table 4-19: Correlation Matrix (with Square Root of AVE) – Time 4

	TK	CTREDKNW	CTADDKNW	CONF	COH	CHIDSAT	TMS	CTSAT	EOI	PERF
TK	**1.000**									
CTREDKNW	0.118	**0.647**								
CTADDKNW	0.067	0.417	**0.627**							
CONF	-0.199	-0.331	-0.367	**0.947**						
COH	0.257	0.252	0.340	-0.566	**0.935**					
CHIDSAT	0.264	0.269	0.393	-0.551	0.858	**0.971**				
TMS	0.302	0.253	0.295	-0.545	0.855	0.919	**0.929**			
CTSAT	0.073	0.339	0.474	-0.411	0.548	0.585	0.539	**0.969**		
EOI	0.063	0.084	-0.043	-0.164	0.304	0.327	0.379	0.234	**1.000**	
PERF	0.108	0.000	0.040	-0.120	0.185	0.169	0.117	0.114	0.173	**1.000**

Tests for Aggregation – Rwg(j) and Rwg

In order to assess interrater agreement and justify aggregation from the individual level to the group level of analysis, I computed $R_{wg(J)}$ for the reflective constructs and R_{wg} for the items associated with formative constructs (Lindell et al., 1999). Table 4-20 summarizes these computations for each time period. The $R_{wg(J)}$ computations for the reflective constructs all exceeded the typical cutoff value of .70, while almost none of the R_{wg} computations cleared this benchmark. However, recent research suggests that interrater agreement values greater than .70 indicate strong to very strong agreement, while values between .50 and .70 indicate moderate agreement, and values between .30 and .50 indicate weak agreement (LeBreton and Senter, 2008). Given these revised standards, I felt justified in aggregating to the group level of analysis.

Table 4-20: $R_{wg(J)}$ and R_{wg} Values

	Construct/Item	T1	T2	T3	T4
Reflective $R_{wg(J)}$	CONF	0.8271	0.7972	0.8149	0.7931
	COH	0.7792	0.7684	0.8028	0.7782
	CHIDSAT	0.7137	0.7406	0.7799	0.7652
	CTSAT	0.7127	0.7446	0.7547	0.7617
Formative R_{wg}	TK	0.7326	0.7261	0.6856	0.7494
	TMSSPEC	0.2766	0.2147	0.2888	0.3322
	TMSCRED	0.2434	0.3314	0.3416	0.3855
	TMSCOORD	0.3071	0.4078	0.4240	0.3736
	CTREDKNW1	0.0176	0.0537	0.0131	0.0436
	CTREDKNW2	0.5766	0.5909	0.5730	0.5651
	CTREDKNW3	0.1500	0.1715	0.1573	0.0713
	CTADDKNW1	0.3386	0.2827	0.2321	0.2263
	CTADDKNW2	0.4513	0.5538	0.5061	0.5199
	CTADDKNW3	0.3345	0.2468	0.1790	0.1833

Multicollinearity

I tested for multicollinearity by analyzing the variance inflation factors (VIFs) associated with each item. In general, VIFs of over 10 indicate potential problems with multicollinearity (Hair et al., 1998, pg. 221). The following table shows the VIFs for each item in each time period.

Table 4-21: Variance Inflation Factors for All Time Periods

	Variance Inflation Factors (VIF's)			
	Time 1	Time 2	Time 3	Time 4
Intercept	0.0000	0.0000	0.0000	0.0000
TK	1.6178	1.3400	1.3185	1.3189
CTADDKNW1	1.6510	1.4928	1.9021	1.9731
CTADDKNW2	3.0413	3.5644	5.0786	5.3903
CTADDKNW3	1.4761	1.6418	1.7237	2.0611
CTREDKNW1	1.6332	1.6656	1.7520	2.2463
CTREDKNW2	2.1490	3.1241	3.6426	4.2772
CTREDKNW3	2.2233	1.9556	2.0698	2.0830
EOI	1.5221	1.3921	1.4476	1.5315
TMSCRED	5.3629	6.3915	7.3258	8.3528
TMSCOORD	6.4915	9.3797	8.7448	9.5869
TMSSPEC	2.8914	3.7041	4.0930	4.1530
RCONF1	6.1178	8.3830	6.9823	6.0344
RCONF2	5.7255	10.4653	6.3599	10.9276
RCONF3	7.1954	6.5285	9.7523	15.3594
TCONF1	4.8287	7.0936	7.9326	8.7973
TCONF2	5.3557	5.5657	10.9731	14.5124
TCONF3	4.8673	7.6739	10.6974	8.4313
COH2	3.6190	3.5680	3.4386	3.8057
COH3	3.1842	4.6931	5.5028	7.0751
COH4	7.0197	9.1597	10.6993	10.0295
COH5	4.8444	6.9227	7.9636	9.5186
CTSAT1	7.1457	5.7239	9.9469	9.7769
CTSAT2	9.9702	9.4943	13.8864	8.4868
CTSAT3	10.6579	7.1135	13.1498	11.6570
PERF	1.3828	1.4053	1.1243	1.2037

Because a few items had VIFs of greater than 10, I decided to remove the third relational conflict item (RCONF3), the second task conflict item (TCONF2), the fourth cohesion item (COH4), and the third satisfaction with CT item (CTSAT3). After removing these items, I recalculated the VIFs for each time period to ensure that no remaining items were greater than 10. These VIFs are shown in the table below.

Table 4-22: Recomputed Variance Inflation Factors (After Item Removal)

	Variance Inflation Factors (VIF's)			
	Time 1	Time 2	Time 3	Time 4
Intercept	0.0000	0.0000	0.0000	0.0000
TK	1.5628	1.2608	1.3033	1.2912
CTADDKNW1	1.6355	1.4553	1.6985	1.8162
CTADDKNW2	2.9383	3.4944	4.8421	5.1185
CTADDKNW3	1.4681	1.5246	1.6674	1.9803
CTREDKNW1	1.5693	1.6082	1.7353	2.0426
CTREDKNW2	2.0790	2.9728	3.3376	4.2119
CTREDKNW3	2.0731	1.7726	1.9957	1.9948
EOI	1.5158	1.3345	1.4226	1.5146
TMSCRED	5.2665	5.8607	7.0504	7.8788
TMSCOORD	6.0772	8.1482	7.6571	8.6146
TMSSPEC	2.7882	3.2300	3.9175	3.9030
RCONF1	5.5819	7.9469	4.8943	5.8254
RCONF2	3.9825	8.0427	5.6992	7.2809
TCONF1	4.3312	6.5763	6.8645	7.0131
TCONF3	4.3808	6.4703	7.4092	7.7843
COH2	3.5661	3.2751	2.8766	3.7664
COH3	2.7814	4.0211	4.3578	5.8949
COH5	3.2610	4.2400	5.6254	7.0268
CTSAT1	5.2734	5.2705	8.9910	6.3793
CTSAT2	5.8267	6.2286	7.6213	5.9734
PERF	1.3293	1.3734	1.0938	1.1488

Because none of these recomputed VIFs exceeded 10, I believed there to be no problems with multicollinearity, and thus decided to proceed with this set of items.

Model Testing

Next, I tested the research model using Partial Least Squares (PLS). The PLS results for each of the four time periods is shown in Figures 4-1 through 4-4 below. Consistent with other group-level research involving interaction effects, I included the main effects along with the interaction effects (c.f., Montoya-Weiss et al., 2001). Independent variables (whether manifest or latent) for these main effects are shown in a lighter shade and control variables are shown with dashed borders in order to distinguish them from variables in the research model. Paths with a p-value of less than .05 are shown with a single asterisk. Paths with a p-value of less than .01 are shown with two asterisks. For the sake of brevity, paths with a p-value greater than or equal to .05 are not shown. However, Appendix D contains a complete list of path coefficients and associated T-statistics. Appendix E contains summary information about the items and constructs used in the research model, including PLS loadings/weights for each item. Appendix F contains information about the formation of the interaction terms (TKRK and TKAK), as well as the PLS weights associated with those terms.

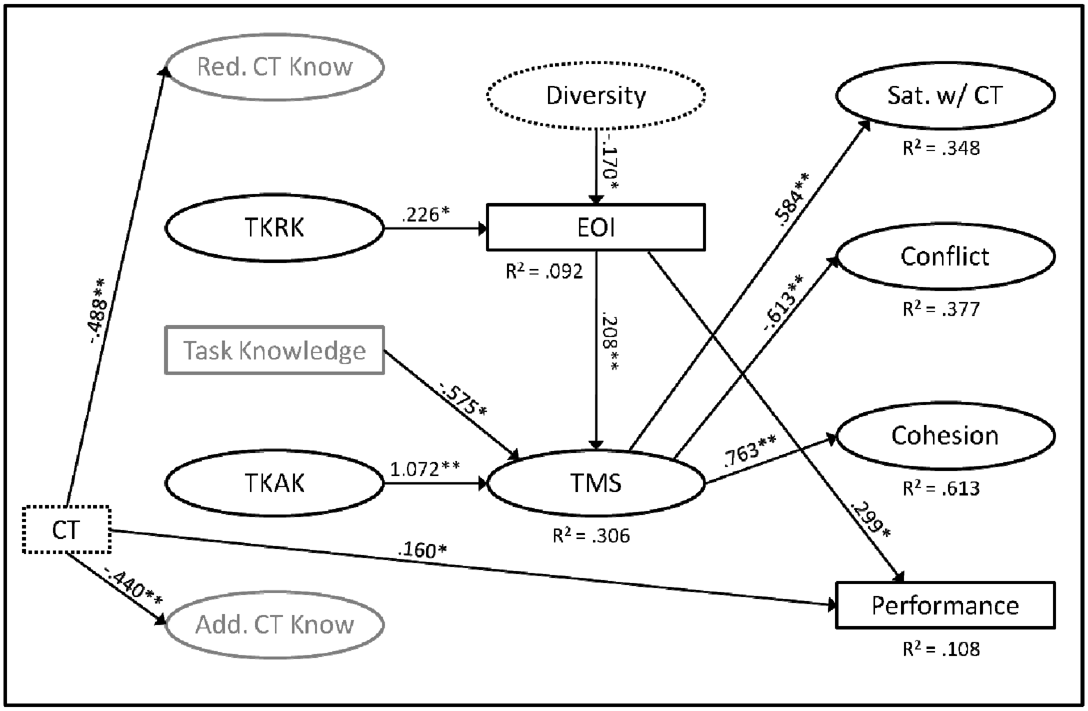

Figure 4-1: PLS Results Time 1

In time period 1 (Figure 4-1) I found support for the interaction between Task Knowledge and Knowledge of Reductive CT Capabilities (TKRK) impacting a group's Equality of Interaction. I also found solid support for the interaction between Task Knowledge and Knowledge of Additive CT Capabilities (TKAK) impacting TMS. The hypothesized relationship between Equality of Interaction and TMS was supported, as was the impact of TMS on Satisfaction with the CT and the relational outcome measures (Conflict and Cohesion). However, no relationship was found between TMS and Performance. The hypothesized relationship between Equality of Interaction and Performance was supported. However, Equality of Interaction impacted neither Satisfaction with the CT nor (perhaps more interestingly) the relational outcomes.

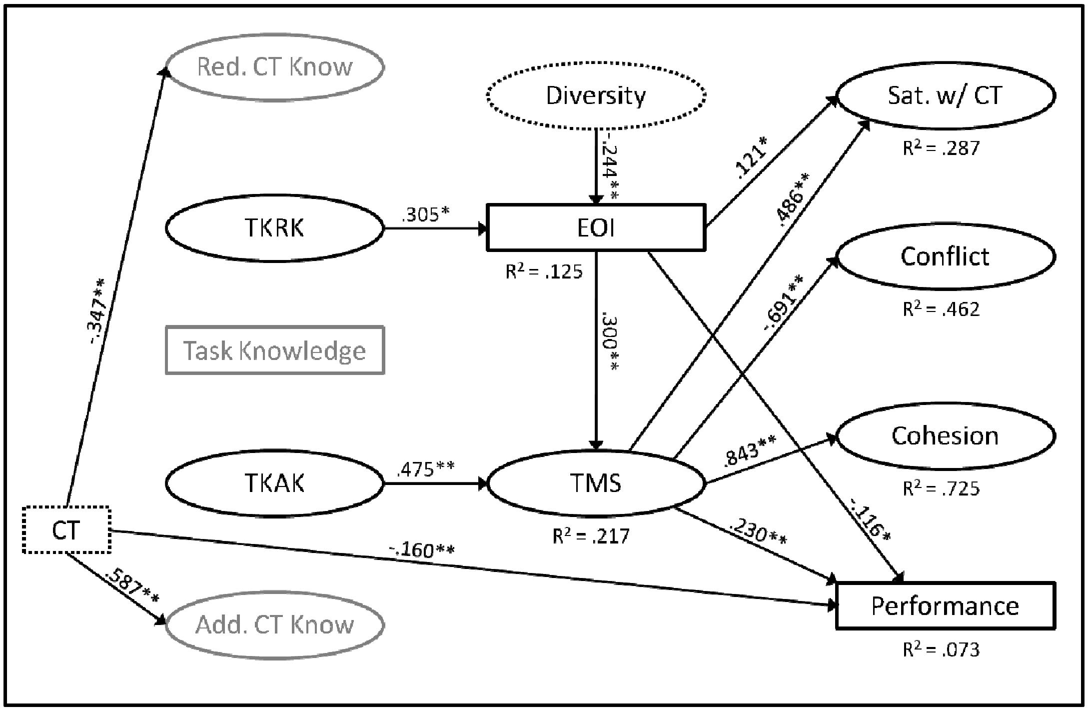

Figure 4-2: PLS Results Time 2

In time period 2 (Figure 4-2), I again found support for both of the interaction effects. The hypothesized relationship between Equality of Interaction and TMS was again supported, as were the relationships between TMS and Satisfaction with the CT and the relational outcomes. As opposed to time period 1, the hypothesized relationship between TMS and Performance was supported in this time period. Equality of Interaction impacted Satisfaction with the CT in this time period, and again impacted performance; however, it still had no significant impact upon the relational outcomes.

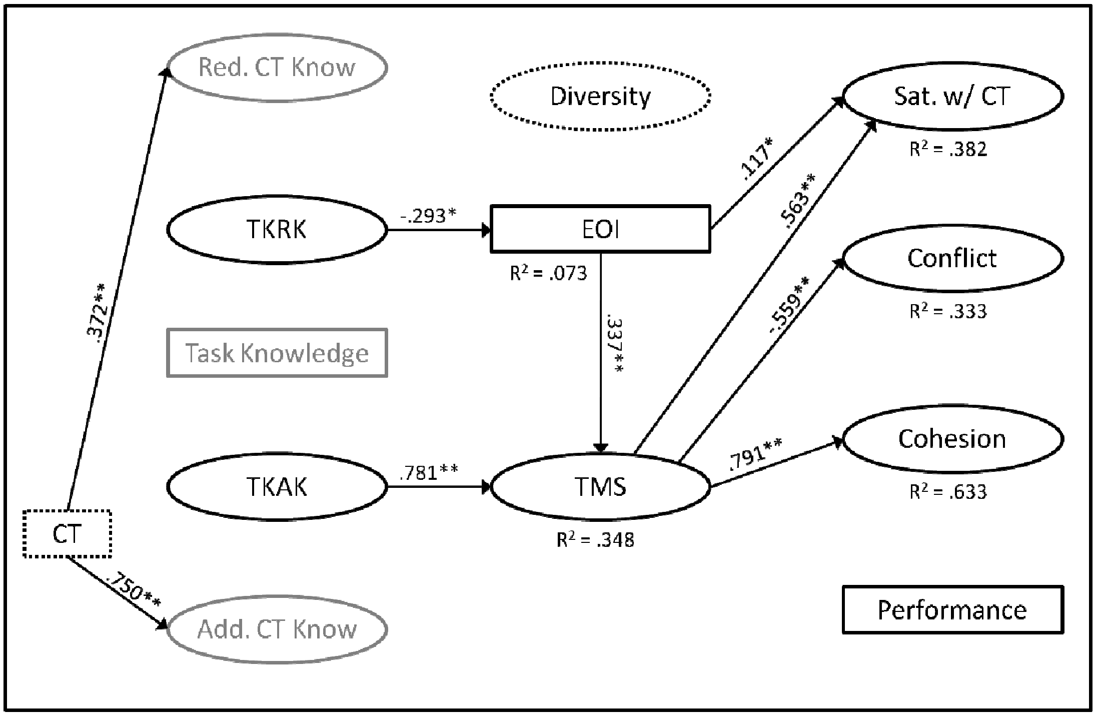

Figure 4-3: PLS Results Time 3

In time period 3 (Figure 4-3), both interaction effects were again found to be significant. However, the direction of the relationship between the interaction of Task Knowledge and Knowledge of Reductive CT Capabilities (TKRK) and Equality of Interaction was counter to the hypothesis, as well as the findings in the first two time periods. The hypothesized relationship between Equality of Interaction and TMS was again supported, as were the relationships between TMS and Satisfaction with the CT and the relational outcomes. As opposed to time period 2, the relationship between TMS and Performance was not supported. Similar to time period 2, Equality of Interaction was found to significantly impact Satisfaction with the CT and still had no significant impact upon the relational outcomes. However, the relationship between Equality of Interaction and Performance was not supported in this time period.

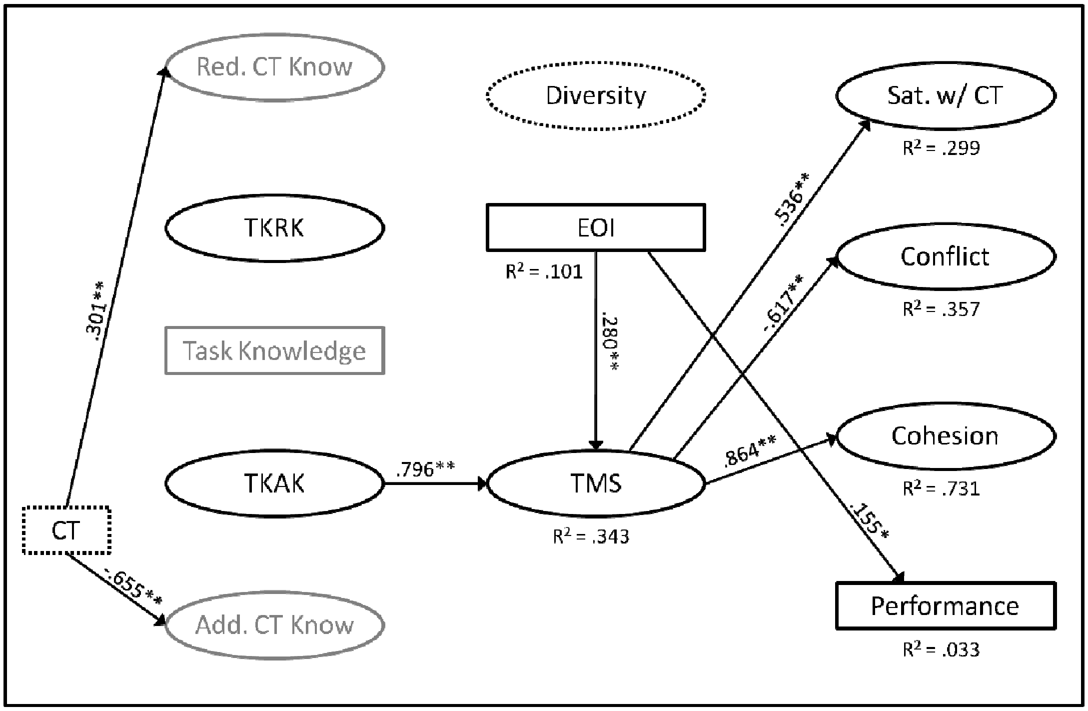

Figure 4-4: PLS Results Time 4

In time period 4 (Figure 4-4), I found strong support for the interaction between Task Knowledge and Knowledge of Additive CT Capabilities (TKAK) impacting TMS. However, there was no longer any significant relationship found between the interaction of Task Knowledge and Knowledge of Reductive CT Capabilities (TKRK) and Equality of Interaction. The hypothesized relationship between Equality of Interaction and TMS was again supported, as were the relationships between TMS and Satisfaction with the CT and the relational outcomes. Once again, TMS did not significantly impact Performance. Similar to time periods 1 and 2, the hypothesized relationship between Equality of Interaction and Performance was supported. However, Equality of Interaction impacted neither Satisfaction with the CT nor the relational outcomes.

Hypothesis Results

Table 4-23 shows the results of each of the hypotheses for each of the time periods, based on the PLS results.

Table 4-23: Summary of Hypothesis Results

Hypotheses	Supported?			
	T1	T2	T3	T4
H1: The interaction between a group's task knowledge and its knowledge of the CT's reductive capabilities will be positively related to the group's equality of interaction.	Y	Y	N	N
H2a: The equality of interaction within a group will positively impact the group's task outcomes.	Y	Y	N	Y
H2b: The equality of interaction within a group will positively impact the group's relational outcomes.	N	N	N	N
H2c: The equality of interaction within a group will positively impact the group's satisfaction with the CT.	N	Y	Y	N
H3: The interaction between a group's task knowledge and its knowledge of the CT's additive capabilities will be positively related to the development of the group's transactive memory system.	Y	Y	Y	Y
H4a: A group's transactive memory system will positively impact the group's task outcomes.	N	Y	N	N
H4b: A group's transactive memory system will positively impact the group's relational outcomes.	Y	Y	Y	Y
H4c: A group's transactive memory system will positively impact the group's satisfaction with the CT.	Y	Y	Y	Y
H5: A group's equality of interaction will be positively related to the development of the group's transactive memory system.	Y	Y	Y	Y

Robustness Tests

In order to better understand these results, a number of robustness tests were conducted. The following sections summarize these tests.

Robustness Test 1: Sub-group PLS

Earlier, I justified my decision to combine the data from the two data collections through the t-tests that are summarized in Table 4-9. However, there were a few significant differences between the two data collections. In order to further test the appropriateness of my decision to combine the data from the two collections, I conducted a sub-group PLS analysis, whereby the research model was run for each time period using only the data from the first data collection and was compared to the results of a model run for each time period using only data from the second data collection. Using the Smith-Satterthwait test suggested by Chin (http://disc-nt.cba.uh.edu/chin/plsfaq/multigroup.htm) I generated t-tests based on a comparison of the coefficients and standard errors associated with each path. In order to determine the p-value associated with each of these t-tests, two different methods were used. The first method is associated with the Smith-Satterthwait test, and is recommended where equal variances between the two groups are not assumed. The second method involves simply adding the sizes of each of the two samples and subtracting two, and is appropriate where equal variances are assumed. Because Levene's test of equal variances turned up a few cases where the assumption of equal variances was invalid, I used both methods for calculating the degrees of freedom. The t-tests and their associated p-values (computed using each of the two degrees of freedom calculation methods) are shown in Table 4-24 below. P-values of less than .05 are shown in italics. Using the degrees of freedom calculation associated with the Smith-Satterthwait test, none of the paths were significantly different. Using the alternate degrees of freedom calculation, eight paths (out of 76) were significantly different. However, only three of those eight paths were actually hypothesized, and none of those were different in more than one time period. Given the minimal number of differences between the paths in this sub-group PLS analysis, I felt that this test further validated the decision to combine the data from the two collections.

Table 4-24: Sub-group PLS Analysis Results

Path	T-Statistic				p-value (unequal variances)				p-value (equal variances)			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
EOI to TMS	1.368	0.833	4.256	0.413	0.402	0.558	0.147	0.751	0.173	0.406	***0.000***	0.680
EOI to Conflict	0.054	0.101	0.408	1.264	0.966	0.936	0.753	0.426	0.957	0.920	0.684	0.208
EOI to Performance	2.067	1.133	0.222	1.579	0.287	0.460	0.861	0.359	***0.041***	0.259	0.825	0.117
EOI to CTSAT	0.128	0.365	1.347	1.170	0.919	0.777	0.407	0.450	0.898	0.716	0.180	0.244
EOI to Cohesion	0.245	1.120	0.247	0.028	0.847	0.464	0.846	0.982	0.807	0.265	0.805	0.978
TMS to Conflict	0.247	1.201	0.839	0.427	0.846	0.442	0.556	0.743	0.805	0.232	0.403	0.670
TMS to Performance	1.063	0.276	0.317	1.830	0.399	0.829	0.805	0.318	0.290	0.783	0.752	0.069
TMS to CTSAT	0.256	1.380	1.503	0.935	0.841	0.399	0.374	0.521	0.799	0.170	0.135	0.351
TMS to Cohesion	0.097	2.285	1.162	0.678	0.939	0.263	0.452	0.621	0.923	***0.024***	0.247	0.499
TKAK to TMS	1.021	0.094	0.322	0.557	0.324	0.928	0.751	0.591	0.309	0.925	0.748	0.578
TKRK to EOI	1.883	1.078	1.347	1.389	0.089	0.309	0.226	0.190	0.062	0.283	0.180	0.167
TK to EOI	0.366	0.083	0.068	0.655	0.749	0.941	0.957	0.631	0.715	0.934	0.946	0.513
TK to TMS	0.511	0.475	0.725	0.938	0.625	0.660	0.482	0.385	0.610	0.635	0.470	0.350
AK to TMS	0.049	1.172	0.669	0.122	0.963	0.450	0.525	0.909	0.961	0.243	0.504	0.903
RK to EOI	0.597	0.532	0.371	0.126	0.582	0.611	0.724	0.902	0.551	0.596	0.712	0.900
Diversity to EOI	0.441	0.930	0.703	1.929	0.735	0.450	0.610	0.149	0.660	0.354	0.483	0.056
CT to Performance	0.482	1.220	0.340	1.476	0.714	0.437	0.756	0.379	0.631	0.225	0.734	0.142
CT to AK	0.985	9.561	0.745	7.582	0.429	0.066	0.593	0.083	0.327	***0.000***	0.458	***0.000***
CT to RK	1.069	4.644	5.026	4.127	0.479	0.135	0.125	0.151	0.287	***0.000***	***0.000***	***0.000***

Robustness Test 2: Fixed-Weight TMS

Next I conducted an analysis where I fixed the weight of each item associated with TMS. I accomplished this by computing a simple average of the three TMS items (TMSSPEC, TMSCRED, and TMSCOORD) and running the PLS model using this average in place of the three items. This analysis was prompted by the heterogeneous PLS weights of the TMS items shown in Appendix E. Once I ran this fixed-weight TMS model, I compared it to the original model using the same method of path comparison utilized in the aforementioned sub-group PLS analysis. The results of this comparison are shown in Table 4-25 below. None of the t-tests were significant at the .05 level. As such, I felt confident that the heterogeneous weights of the TMS items did not significantly impact the original PLS results.

Table 4-25: Fixed-Weight TMS Analysis Results

Path	T-Statistic				p-value (unequal variances)				p-value (equal variances)			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
EOI to TMS	0.061	0.042	0.051	0.115	0.961	0.973	0.967	0.927	0.951	0.967	0.959	0.908
EOI to Conflict	0.009	0.018	0.068	0.176	0.994	0.989	0.957	0.889	0.993	0.986	0.946	0.860
EOI to Performance	0.000	0.022	0.000	0.008	1.000	0.986	1.000	0.995	1.000	0.982	1.000	0.994
EOI to CTSAT	0.031	0.039	0.085	0.051	0.980	0.975	0.946	0.968	0.975	0.969	0.933	0.959
EOI to Cohesion	0.077	0.110	0.080	0.074	0.951	0.930	0.949	0.953	0.938	0.913	0.936	0.941
TMS to Conflict	0.441	0.219	0.295	0.451	0.736	0.863	0.818	0.730	0.660	0.827	0.769	0.652
TMS to Performance	0.016	0.120	0.011	0.000	0.990	0.924	0.993	1.000	0.987	0.905	0.991	1.000
TMS to CTSAT	0.126	0.012	0.324	0.094	0.920	0.993	0.801	0.940	0.900	0.991	0.746	0.925
TMS to Cohesion	0.023	0.056	0.101	0.230	0.985	0.964	0.936	0.856	0.982	0.955	0.919	0.818
TKAK to TMS	0.148	0.059	0.054	0.162	0.885	0.957	0.958	0.876	0.882	0.953	0.957	0.872
TKRK to EOI	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TK to EOI	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TK to TMS	0.065	0.080	0.101	0.138	0.950	0.944	0.923	0.895	0.949	0.936	0.919	0.890
AK to TMS	0.018	0.104	0.075	0.074	0.987	0.934	0.947	0.953	0.986	0.917	0.940	0.941
RK to EOI	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Diversity to EOI	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CT to Performance	0.018	0.033	0.011	0.007	0.989	0.979	0.993	0.995	0.986	0.974	0.991	0.994
CT to AK	0.000	0.000	0.018	0.056	1.000	1.000	0.989	0.965	1.000	1.000	0.986	0.956
CT to RK	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Robustness Test 3: Hierarchical Regression

Finally, in an attempt to gain a better understanding of the results of the PLS model, I ran a hierarchical regression analysis for each of the four time periods. Given the heterogeneous weights that PLS assigned to the items associated with Knowledge of Additive CT Capabilities, Knowledge of Reductive CT Capabilities, the resultant interaction terms (TKAK and TKRK), and TMS, I felt that this hierarchical regression analysis might provide some verification of the findings from the PLS analysis. A summary of the hypothesis tests based on this analysis presented in Table 4-26 below. Bold letters were used to indicate those results which differed from the PLS analysis.

Table 4-26: Summary of Hypothesis Results Based on Hierarchical Regression Analysis

Hypotheses	Supported?			
	T1	T2	T3	T4
H1: The interaction between a group's task knowledge and its knowledge of the CT's reductive capabilities will be positively related to the group's equality of interaction.	Y	**N**	N	N
H2a: The equality of interaction within a group will positively impact the group's task outcomes.	Y	**N**	N	**N**
H2b: The equality of interaction within a group will positively impact the group's relational outcomes.	N	N	N	N
H2c: The equality of interaction within a group will positively impact the group's satisfaction with the CT.	**Y**	**N**	**N**	N
H3: The interaction between a group's task knowledge and its knowledge of the CT's additive capabilities will be positively related to the development of the group's transactive memory system.	**N**	**N**	**N**	**N**
H4a: A group's transactive memory system will positively impact the group's task outcomes.	N	**N**	N	N
H4b: A group's transactive memory system will positively impact the group's relational outcomes.	Y	Y	Y	Y
H4c: A group's transactive memory system will positively impact the group's satisfaction with the CT.	Y	Y	Y	Y
H5: A group's equality of interaction will be positively related to the development of the group's transactive memory system.	Y	Y	Y	Y

This hierarchical regression analysis provided some verification for a number of the results from the PLS analysis. Of the differences that arose between the two analyses, most stem from a lack of confirmation of the hypothesized interaction effects (Hypothesis 1 and Hypothesis 3) in the hierarchical regression analysis. While Hypothesis 1 was supported in time periods 1 and 2 in the PLS analysis, it was only supported in time period 1 in the hierarchical regression analysis. Hypothesis 3, on the other hand, was supported in all four time periods in the PLS analysis, but was not supported in any time period in the hierarchical regression analysis. Hierarchical regression represents a more conservative test of interaction, and the sample size might not have provided enough power to detect interaction effects. This seems likely, because while the interaction effect suggested by Hypothesis 3 was not supported in the hierarchical regression analysis, the main effects (from Task Knowledge and Knowledge of Additive CT Capabilities to TMS) were supported in the 2nd-stage models (i.e., the stage immediately preceding the stage where the interaction variable was entered). Another interesting point to emerge from this analysis is that it supports the same pattern for Hypothesis 1 that was suggested by the PLS analysis: the interaction leading to EOI is present at first, but subsequently disappears. These results are discussed in greater detail in Chapter 5.

CHAPTER 5 – DISCUSSION

Introduction

This chapter contains a discussion of the findings from the data analysis conducted in Chapter 4. Because the structure of the research model mirrored the basic Input-Process-Output (IPO) model, the discussion of the study results is presented as such. First, an overview of the results concerning those hypotheses related to group knowledge of both the task and collaborative technology (i.e., the "inputs" of the model) is presented. Next, the results of the hypothesis concerning the relationship between equality of interaction and transactive memory systems (i.e., the "processes" related to the appropriation of collaborative technology) are presented. Then an overview of the results concerning those hypotheses related to the group outcomes of satisfaction with the CT, relational development (conflict and cohesion), and task performance (i.e., the "outputs" of the model) is presented. Each of these prior sections concludes with a discussion of the impact of time as it relates to each of the hypotheses discussed. Finally, the chapter closes with a summary of the conclusions that can be drawn from this study.

Input Hypotheses (Hypotheses 1 and 3)

Hypothesis 1 argued that the interaction of a group's task knowledge with its knowledge of the CT's reductive capabilities would be positively related to the group's equality of interaction. The results of the study provided weak support for this hypothesis. These findings suggest that group members' knowledge of the task was *unlocked* by their knowledge of the reductive capabilities of the CT, resulting in more equal participation within the group. This finding is congruent with Carte and Chidambaram's (2004) assertion that the reductive capabilities of a collaborative technology can have positive effects on group interactions and member participation.

This finding is also congruent with my assertion that an individual's appropriation of technology is not so much influenced by the characteristics of the task and technology, but rather by his or her *knowledge* of those characteristics. Because I have argued that a feature of which the user is unaware will not influence his/her perceptions of task-technology fit, it follows that reductive features of which the user is unaware will not influence his/her appropriation of the technology. In this instance, the dimension of appropriation is the equality of interaction within a group. This finding suggests that possession of task knowledge alone was not enough to ensure that a group would actually enjoy the benefits of that knowledge. But if group members had knowledge of the reductive capabilities of the collaborative technology that they were using, they were more willing to share their task knowledge. In this manner, the task knowledge held by group members was *unlocked* by their knowledge of the reductive capabilities of the CT.

Further, the significance of the interaction suggests that knowledge of the reductive CT capabilities not only led to more participation, but also more meaningful participation, because task knowledge was a required component. That is, members were more likely to participate when they had *both* knowledge of the reductive CT capabilities *and* task knowledge. As such, it appears that the participation that was stimulated by the interaction was not simply chatter (in which case equality of interaction would be considerably less desirable) but rather meaningful contributions by knowledgeable group members.

Figure 5-1 illustrates this interaction effect in each of the four time periods of the study. These graphs were generated by performing a mean split on both Task Knowledge and Knowledge of Reductive CT Capabilities (CTREDKNW). The top and bottom 33% of the groups represent the high and low categories for these two constructs. Given the heterogeneous weights assigned to CTREDKNW items by PLS, I chose to set the weights of each of the items to be equal to generate the CTREDKNW measure for the purposes of this illustration (for ease of interpretation). Hypothesis 1 was supported in Times 1 and 2, but unsupported in Times 3 and 4.

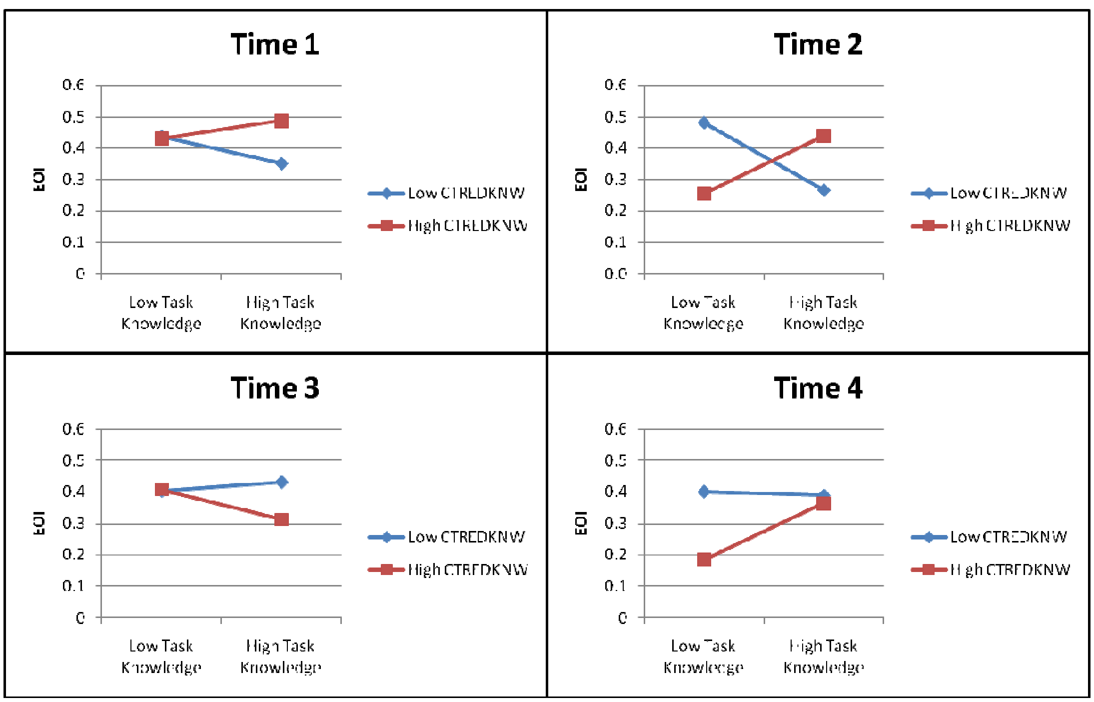

Figure 5-1: Interaction Graphs for Hypothesis 1

The other interaction hypothesis (Hypothesis 3) argued that the interaction between a group's task knowledge and its knowledge of the CT's additive capabilities would be positively related to the development of the group's transactive memory system. The results of the study provided modest support for this interaction. This finding is congruent with Carte and Chidambaram's (2004) assertion that the additive capabilities of a collaborative technology can have positive effects on a group's coordination and task performance efforts.

This finding is also consistent with my assertion that an individual's appropriation of technology is influenced by his or her knowledge of both task and technology characteristics, and that this knowledge impacts his/her appropriation of the technology. In this instance, the dimension of appropriation is the development of the group's transactive memory system. This finding once again suggests that possession of task knowledge alone was not enough to ensure that a group would actually enjoy the benefits of that knowledge. But if group members had knowledge of the additive capabilities of the collaborative technology that they were using, they were more likely to develop a system for leveraging their understanding of who knew what within the group, thus improving the group's coordination efforts. The interaction between task knowledge and knowledge of additive CT capabilities suggests that group members were more likely to develop a system for leveraging their understanding of who knew what within the group when they possessed both knowledge pertinent to the task *and* knowledge about how to use the technology to either share task knowledge or retrieve it from other members. In this manner, the task knowledge held by group members was *unlocked* by their knowledge of the additive capabilities of the CT.

It is worth noting here that the results of the hierarchical regression analysis did not support this hypothesis. One explanation for this is that PLS represents a fairly low bar for an interaction effect to pass, and the relatively small sample size might not have lent enough power to the analysis for the interaction effects to surface in the more conservative hierarchical regression analysis. This explanation is bolstered by the fact that the main effects were significant in the 2^{nd}-stage models (i.e., the stage immediately preceding the stage where the interaction variable was entered).

One other possible explanation for the lack of support for Hypothesis 3 in the hierarchical regression analysis is the lack of fullness of the TMS measure used. A quick perusal of the PLS weights associated with each of the TMS dimensions (Specialization, Credibility, and Coordination) reveals that both the Specialization and (to some degree) the Credibility dimensions were under-represented in the TMS construct. This is not particularly surprising, given the background and expertise of the subjects, as well as the context of the study. The subjects were each presented with the same set of materials regarding the capabilities of the CT as well as the tasks to which they were assigned. This provided little room for the development of specialized knowledge within the studied groups. In situations where there is little specialization of knowledge, the development of the transactive memory system tends to be stunted (Lewis, 2004). Lewis (2004, pg. 1521) explains this effect:

> "When expertise is distributed among members, members will be able to rely on their initial perceptions and use interactions to *refine* rather

than *define* member-expertise associations. In contrast, if members' actual knowledge is initially overlapping, members may need to spend more time together to resolve ambiguities about who knows what. The more members' actual knowledge is consistent with members' likely expectations for distributed expertise, the more quickly a TMS will emerge."

The context of the study didn't really provide the students with reasons to distrust any of the information provided by fellow group members, so the lack of a development of credibility isn't entirely surprising. However, research suggests that the lack of credibility within the TMS measure may actually be related to the lack of specialization of knowledge. Lewis (2003, pg. 590) explains:

> "Specialized knowledge alone is not sufficient for defining TMSs because members may develop distinctly different knowledge for other reasons (e.g., a lack of understanding or lack of communication about their respective expertise domains). Members will only develop different knowledge if they can rely on others to remember other task-critical information. Absent this, members would likely develop overlapping or redundant knowledge instead of differentiated expertise."

Therefore, the lack of specialization of knowledge within the groups could have been caused, at least to some degree, by a lack of credibility. These contextual factors might help to explain why the interaction effect suggested by Hypothesis 3 was detected in all four time periods by the PLS analysis, but was unable to clear the higher hurdle of the hierarchical regression analysis in any time period.

Figure 5-2 illustrates the interaction effect suggested by Hypothesis 3 in each of the four time periods of the study. These graphs were generated by performing a mean split on both Task Knowledge and Knowledge of Additive CT Capabilities (CTREDKNW). The top and bottom 33% of the groups represent the high and low categories for these two constructs. Given the heterogeneous weights assigned to

CTADDKNW and TMS items by PLS, I chose to set the weights of each of the items to be equal to generate the CTADDKNW and TMS measures for the purposes of this illustration (for ease of interpretation). Hypothesis 3 was supported in all four time periods.

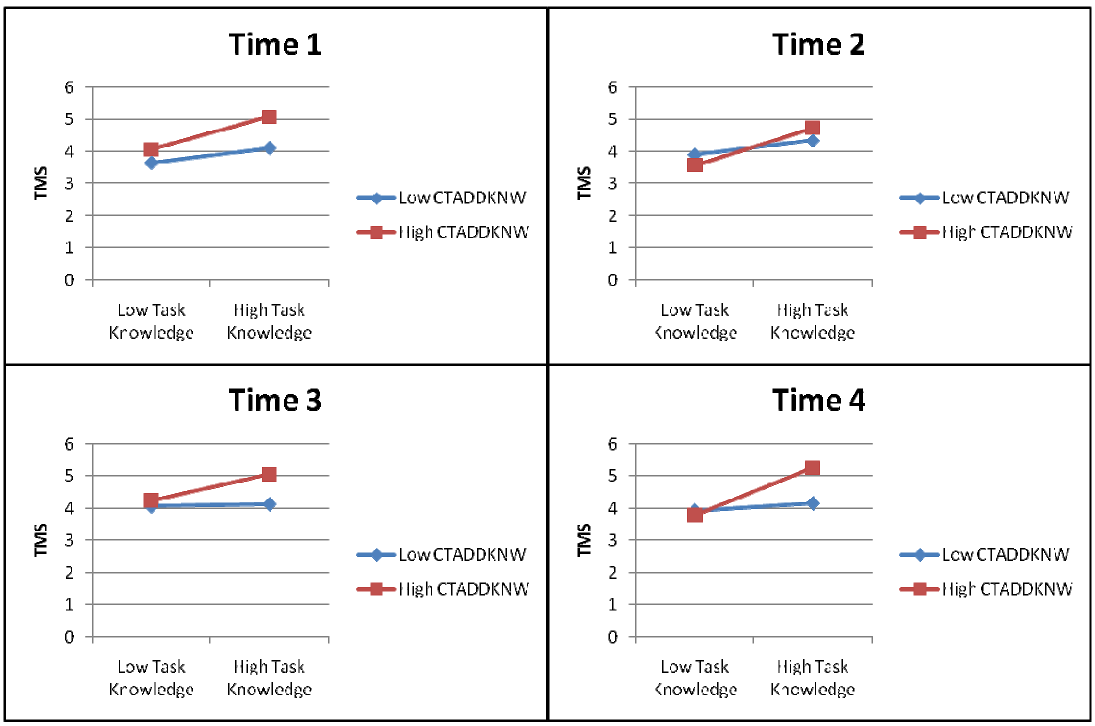

Figure 5-2: Interaction Graphs for Hypothesis 3

The Impact of Time on the Input Hypotheses

The longitudinal study design provided some insight into the impact of time on Hypothesis 1 and Hypothesis 3. Hypothesis 1 was supported in Times 1 and 2, but unsupported in Times 3 and 4. I expected that support for this hypothesis might wane in later time periods as group members became accustomed to working with one another and established certain work behaviors and patterns of using the collaborative technology. This notion is supported by the assertion in previous research that the time during which the appropriation of a technology is malleable is actually limited (Tyre and Orlikowski, 1994). As such, I expected that this interaction effect might eventually dissipate. This pattern clearly emerges in the PLS analysis. Additionally, the hierarchical regression analysis, which represents a more conservative test of the interaction effect (i.e., the interaction effect would have to be stronger to register in the hierarchical regression analysis than it would in the PLS analysis), supported a similar pattern. In this analysis, Hypothesis 1 was supported in Time 1, but unsupported in any of the other time periods, again indicating a dissipation of the hypothesized interaction effect.

The interaction effect argued by Hypothesis 3 was supported in all four time periods. This suggests that the interaction between a group's knowledge of additive capabilities and its task knowledge impacts the development of the group's transactive memory system in a consistent fashion. As a group's transactive memory system is indicative of the manner in which the group appropriated the technology, one might expect to see the same dissipation effect with this interaction as was witnessed in Hypothesis 1. It is possible that the time frame for this study simply wasn't long enough to incur the dissipation of this interaction effect. Over time, it is conceivable that a group could utilize alternative means of developing their transactive memory system (e.g., through repeated communication of ideas). However, the results of this study seem to indicate that doing so would be less efficient than simply leveraging the additive capabilities of the CT.

In summary, there appears to be evidence of differential impacts of reductive and additive capabilities of collaborative technologies on dimensions of group use. Over time, the interaction effect between a group's knowledge of the task and its knowledge of the reductive capabilities of the CT upon the appropriation of the technology tends to dissipate fairly quickly, while the interaction effect between a group's knowledge of the task and its knowledge of the additive capabilities of the CT upon the appropriation of the technology tends to persist longer. The dissipation of any interaction effect appears to be due to the fact that a group's appropriation of a collaborative technology is only malleable for a limited amount of time, as suggested by Tyre and Orlikowski (1994). This suggests a pattern of group development whereby group members quickly develop a collective understanding of how to collaborate with one another through the use of technology, and from that point forward, continue to operate based on that initial understanding.

One ramification of this pattern of group development is the potential harm associated with a lack of knowledge of the capabilities of the collaborative technology. The pattern that emerged from this study suggests that knowledge of the technology needs to be possessed by all group members at the beginning of the project, as subsequent acquisition of knowledge of the technology will be less likely to impact group technology use in later time periods. These findings also suggest that a lack of knowledge concerning the capabilities of the collaborative technology in use can be a considerable hindrance to a group's ability to effectively leverage the task knowledge embedded in its members.

Collectively, the findings concerning these two hypotheses suggest that current models of Task-Technology Fit (e.g., Goodhue and Thompson, 1995; Zigurs and Buckland, 1998) are insufficient to explain the fit between a particular technology and task, primarily because these models do not adequately account for the human element in the equation. Specifically, these models need to be adapted to appropriately account for the limitation represented by individual knowledge (or lack thereof) of characteristics of both the task and technology in question. Further, these findings forward Carte and Chidambaram's (2004) conception of collaborative technology as a "bundle of capabilities" by demonstrating a differential impact of the knowledge of additive and reductive CT capabilities.

Process Hypothesis (Hypothesis 5)

Hypothesis 5 argued that a group's equality of interaction would be positively related to the development of the group's transactive memory system. The results of the study provided strong support for this hypothesis. This finding emphasizes the importance of good communication in the development of a group's transactive memory system, and echoes Wegner's (1987) assertion that communication is a necessary component of any transactive memory system. After all, if a group member's knowledge is never communicated, then that knowledge will not become a part of the group's transactive memory system.

This finding is congruent with the information processing perspective, which argues that group dynamics which don't account for every member's knowledge can ultimately impact performance in a negative fashion. These dynamics can include a bias towards discussing only shared information (Dennis, 1996; Hollingshead, 1996), the domination of discussion by a single member and the formation of majority/minority factions within the group. Each of these scenarios either reduces or entirely eliminates the advantage of group decisions over individual decisions. These arguments are also congruent with literature on hidden profile tasks (e.g., Dennis, 1996) and group polarization (e.g., Dennis et al., 1997-98; El-Shinnawy and Vinze, 1998), which argues that a group's failure to account for minority-held viewpoints/knowledge can result in poor performance.

Ultimately, the strong support for Hypothesis 5 suggests that a group's equality of interaction impacts the manner in which the group appropriates a collaborative technology. Further, it suggests that a group's transactive memory system is a potential mechanism through which communication dynamics can ultimately impact a group's performance. Because transactive memory systems bring together both specialization and coordination, a group with a well-developed transactive memory system will be able to coordinate tasks in such a manner as to take advantage of group member knowledge related to either the task or the collaborative technology in question. For instance, the ability of a group to identify those members to whom they should defer has been shown to positively influence the group's task performance (Baumann and Bonner, 2004; Faraj and Sproull, 2000; Libby et al., 1987; Littlepage et al., 1997). These arguments are further supported by studies which have found transactive memory system development to be positively associated with group performance (e.g., Austin, 2003; Lewis, 2004).

The Impact of Time on the Process Hypothesis

While the longitudinal study design allowed me to potentially gain some insight into the impact of time on Hypothesis 5, there was strong support for the hypothesis in all four time periods. This suggests that the effect of a group's equality of interaction upon the transactive memory system within the group does not diminish over time. Given that the communication of knowledge between group members is an element that is essential to the development of the group's transactive memory system, a consistent reliance of the transactive memory system on the group's equality of interaction makes good sense. While one might expect transactive memory system improvements to become more incremental over time, those improvements can (at least hypothetically) persist indefinitely, as no group member will ever have a complete awareness of the knowledge possessed by other members.

To date, the vast majority of research on transactive memory systems has examined the effects of its development within groups on outcomes such as task performance and relational development. One notable exception is a study conducted by Prichard and Ashleigh (2007) which found team-skills training to be an antecedent to transactive memory system development. The strong findings concerning Hypothesis 5 significantly contribute to this literature by positing and empirically verifying the reliance of a group's transactive memory system development on the equality of interaction within the group. Stated simply, what a group member knows about the knowledge possessed by other group members is a function of the extent to which members participate freely in group interactions.

Output Hypotheses (Hypotheses 2 and 4)

Hypothesis 2 argued that a group's equality of interaction would be positively related to the group's task outcomes (Hypothesis 2a) relational outcomes (Hypothesis 2b) and satisfaction with the CT (Hypothesis 2c). The results of the study provide mixed overall support for this hypothesis. Hypothesis 2a was based on the premise that counteracting the negative effects of representational gaps within a group would improve that group's performance. I argued that the equality of interaction within a group would help that group to identify any representational gaps. Only after the group identifies these gaps can it begin to properly address them. This hypothesis was supported in Time Periods 1, 2, and 4, lending support to this line of reasoning. These findings suggest that the equality of interaction within a group serves to prevent the kind of negative communication dynamics (e.g., bias towards discussion of only shared information, domination of communication by a single member, and the formation of majority/minority factions within the group) that allow representational gaps to remain hidden.

Hypothesis 2b was based on the premise that by accounting for the thoughts and opinions of every group member, a group's equality of interaction would serve to counteract the conflict caused by representational gaps within the group, thus improving relational outcomes. However, this hypothesis was not supported in any time period. There are a number of potential explanations for this finding. One possibility is that there is some mediating mechanism (such as the development of the group's transactive memory system) through which a group's equality of interaction impacts relational outcomes. Another possibility is that there are temporal patterning issues which are preventing me from capturing the relationship between the two constructs. For instance, there might be a lagged effect of equality of interaction whereby a group's equality of interaction in one time period impacts their relational outcomes in the next time period. Yet another possibility is that the relationship between a group's equality of interaction and its relational outcomes is actually reciprocal, rather than unidirectional.

Hypothesis 2c was based on the premise that groups which appropriate collaborative technology in such a way as to promote equality of interaction will be more satisfied with the technology in the end. There was some support of this hypothesis in the data analysis, as the hypothesized relationship was found to be significant in Time 2 and Time 3. It is possible that after Time 3, group appropriation of the collaborative technology was no longer malleable and beliefs about the technology began to reify; a possibility suggested by Tyre and Orlikowski's (1994) work. Regardless, this finding suggests that the degree to which a group is satisfied with a collaborative technology is in some way dependent upon the group using the technology in a manner which promotes equality of interaction.

Hypothesis 4 argued that the development of a group's transactive memory system would be positively related to the group's task outcomes (Hypothesis 4a) relational outcomes (Hypothesis 4b) and satisfaction with the CT (Hypothesis 4c). The results of the study provide modest support for this hypothesis. Hypothesis 4a was based on the premise that a well-developed transactive memory system would counteract the coordination problems caused by representational gaps within a group, thus improving group performance. Rather than homogenizing the knowledge of group members, transactive memory systems counteract the effects of representational gaps by enabling group members to coordinate tasks in such a manner as to take advantage of their unique knowledge. Unfortunately, Hypothesis 4a was only supported in Time 2. The lack of a consistent finding across time periods is potentially due to a lack of variance within the performance measure. However, the hypothesized relationship between equality of interaction and performance was supported in three of the four time periods. Even so, a link between transactive memory system development and group performance has previously been established by other researchers (e.g., Austin, 2003; Lewis, 2004).

Hypothesis 4b was based on the premise that a well-developed transactive memory system will create an environment where group members feel comfortable relying on one another both for knowledge pertaining to the task at hand and for the actual execution of various contributory tasks. This hypothesis was supported in all four time periods. The high R-squared values associated with both the Conflict and Cohesion measures in the PLS models suggest that there might have been some issues with discriminant validity between the measures of transactive memory system development and the relational outcomes. Tests for discriminant validity (discussed in Chapter 4) revealed fairly high correlation amongst the constructs in question. However, each construct passed the square root of the AVE test, and every one of the correlations was actually hypothesized. Further, the findings are supported by prior research which has established a link between transactive memory systems and positive internal group evaluations (Austin, 2003). The fact that the results from this study (which used student-based groups) align so well with the results from Austin's

(2003) study (which used mature and continuing industry-based groups) also speaks favorably of the generalizability of other results from this study.

Hypothesis 4c was based on the premise that groups which appropriate collaborative technology in such a way as to promote the development of their transactive memory system will ultimately be more satisfied with the technology. This hypothesis was supported in all four time periods. Again, the high R-squared values associated with the Satisfaction with CT measure in the PLS models suggest that there might have been some issues with discriminant validity between the measures of transactive memory system development and satisfaction with the CT. As with the relational outcomes, tests for discriminant validity revealed fairly high correlation between TMS and Satisfaction with CT. However, these constructs passed the square root of the AVE test, and that correlation was hypothesized. This result adds to the literature on transactive memory systems by uncovering another positive outcome associated with the development of a group's transactive memory system: satisfaction with the collaborative technology. It also forwards Adaptive Structuration Theory by articulating a specific mechanism (the group's transactive memory system) through which the group's beliefs about and feelings toward a technology are modified.

The Impact of Time on the Output Hypotheses

The longitudinal study design provided some insight into the impact of time on Hypothesis 2 and Hypothesis 4. There were three hypotheses that were unaffected by time (i.e., the results were the same across all four time periods of the study).

Hypothesis 2b received no support in any time period, indicating that time had no effect on the relationship between a group's equality of interaction and the group's relational outcomes, short of the potential temporal patterning issues mentioned in the previous section. On the other hand, Hypothesis 4b was supported in all four time periods, suggesting that the amount of conflict and cohesion within a group are to some degree consistently dependent upon the group using the collaborative technology in such a way as to foster the development of a transactive memory system. Finally, Hypothesis 4c was supported in all four time periods, suggesting that at least for the duration of this study, a group's satisfaction with the collaborative technology was dependent upon the group using the technology in such a way as to foster the development of a transactive memory system.

The three remaining hypothesis exhibited inconsistent results across the four time periods. Two of these three hypotheses (Hypothesis 2a and Hypothesis 4a) concern the group's task outcomes (i.e., performance). As previously noted, these inconsistent findings might be due to the lack of variance in the Performance measure. Additionally, the task outcomes construct was hurt by the removal of Chidambaram's (1996) Satisfaction with Outcomes measures (described in Chapter 4) due to discriminant validity issues concerning a potential overlap with the measure of transactive memory system development. I had intended this measure to provide a perceptual counterbalance to the objectively determined performance measure, in order to generate a more robust understanding of task outcomes.

Hypothesis 2c (concerning the impact of a group's equality of interaction on its satisfaction with the collaborative technology) was supported in Time 2 and Time

3. It was previously argued that the lack of support for this hypothesis in Time 4 might be due to the reification of the group's appropriation of the collaborative technology. The only point I'd like to add here is that Hypothesis 4c (concerning the impact of a group's transactive memory system development on its satisfaction with the collaborative technology) was actually supported during Time 4. In Time 2 and Time 3, both Hypothesis 2c and Hypothesis 4c were supported, but in the final time period only Hypothesis 4c was supported. This lends further support to the notion that appropriation had begun to reify. However, it also suggests that the development of a group's transactive memory system might be more important than its equality of interaction in determining the group's satisfaction with the collaborative technology. This potentially differential impact between dimensions of collaborative technology use on satisfaction with the technology might prove useful in informing future collaborative technology design and training.

Conclusions

Individually, the findings of this study have contributed to the literature on Task-Technology Fit and transactive memory systems. The findings have also forwarded Carte and Chidambaram's (2004) conception of collaborative technology as a "bundle of capabilities." Collectively, however, these findings serve to improve our understanding of how groups use collaborative technology to leverage the knowledge possessed by their constituents. To summarize, the degree to which a group takes advantage of the level playing field offered by collaborative technology is a function of what the group knows about both the task and the reductive capabilities of the technology. How group members leverage what they know about the knowledge possessed by other group members is a function of the extent to which members participate freely in group interactions and what they know about both the task and the additive capabilities of the collaborative technology. More generally, a group's knowledge of the capabilities of the collaborative technology impacts the manner in which the group appropriates the technology. In this manner, a group's knowledge of the collaborative technology *unlocks* the task knowledge embedded within group members.

CHAPTER 6 – CONCLUSIONS

The concluding chapter of this study begins with a brief reprisal of the research model, followed by a summary of the study outcomes. Next, the contributions of this study to both theory and practice are discussed. This is followed by a discussion of some of the limitations of the study. Finally, the chapter concludes with a discussion concerning the direction of future research based on the results of this study.

Summary of Research

One of the primary assertions of this study has its roots in Adaptive Structuration Theory (DeSanctis and Poole, 1994): namely, that what a group knows about a collaborative technology will ultimately influence the manner in which a group appropriates the technology, and that this appropriation will determine the extent to which a group is able to take advantage of the task knowledge embedded in its members. In order to evaluate this assertion, I developed a research model that was heavily influenced by the contingent structure present in current models of Task-Technology Fit (e.g., Goodhue and Thompson, 1995; Zigurs and Buckland, 1998), as well as Carte and Chidambaram's (2004) conception of collaborative technologies as bundles of additive and reductive capabilities. In my model, however, task and technology characteristics were replaced by knowledge of those characteristics in order to better account for limited understanding on the part of technology users. This research model is shown in Figure 6-1 below.

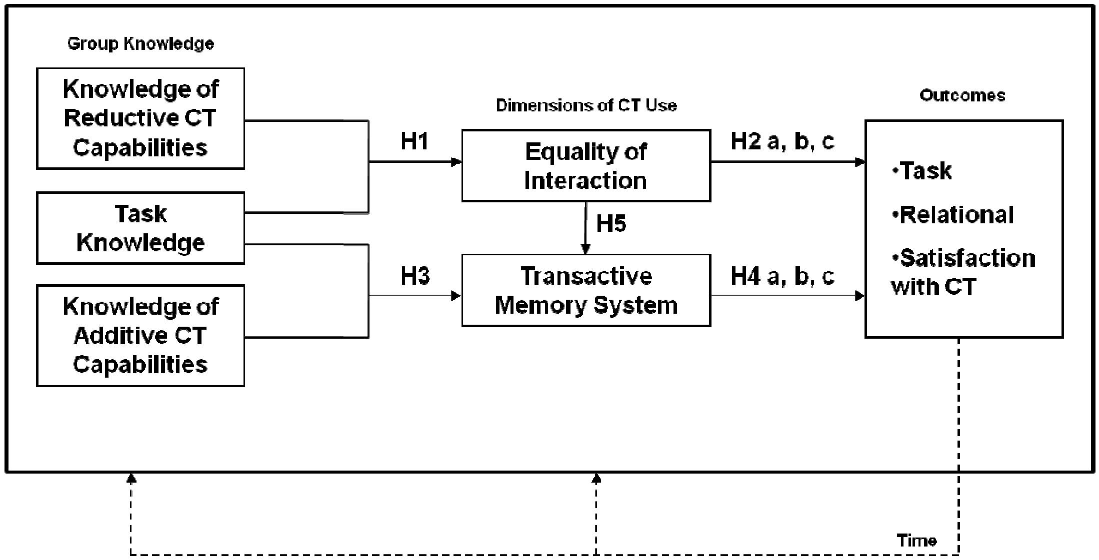

Figure 6-1: Research Model with Hypotheses

This model was tested through Partial Least Squares (PLS) analysis using data collected from 143 different 4- and 5-member groups. An overview of the results of this analysis is presented in the following section.

Research Outcomes

Table 6-1 (shown below) provides a summary of the various hypotheses and whether or not they were supported by the PLS analysis in each of the four time periods.

Table 6-1: Summary of Hypothesis Results

Hypotheses	Supported?			
	T1	T2	T3	T4
H1: The interaction between a group's task knowledge and its knowledge of the CT's reductive capabilities will be positively related to the group's equality of interaction.	Y	Y	N	N
H2a: The equality of interaction within a group will positively impact the group's task outcomes.	Y	Y	N	Y
H2b: The equality of interaction within a group will positively impact the group's relational outcomes.	N	N	N	N
H2c: The equality of interaction within a group will positively impact the group's satisfaction with the CT.	N	Y	Y	N
H3: The interaction between a group's task knowledge and its knowledge of the CT's additive capabilities will be positively related to the development of the group's transactive memory system.	Y	Y	Y	Y
H4a: A group's transactive memory system will positively impact the group's task outcomes.	N	Y	N	N
H4b: A group's transactive memory system will positively impact the group's relational outcomes.	Y	Y	Y	Y
H4c: A group's transactive memory system will positively impact the group's satisfaction with the CT.	Y	Y	Y	Y
H5: A group's equality of interaction will be positively related to the development of the group's transactive memory system.	Y	Y	Y	Y

The PLS analysis supported the hypothesized impact of the interaction of task knowledge and knowledge of reductive CT capabilities on a group's equality of interaction. However, support for this hypothesis dissipated over time. The analysis also supported the hypothesized impact of the interaction of task knowledge and knowledge of additive CT capabilities on the development of a group's transactive memory system. Support for this hypothesis was consistent across all four time periods. Combined, these findings suggest a differential impact between a group's knowledge of additive and reductive CT capabilities.

The PLS analysis strongly supported the link between a group's equality of interaction and the development of its transactive memory system. However, the analysis revealed only moderate support for the hypothesized impacts of a group's equality of interaction upon group outcomes. Combined, these findings suggest the potential for a mediating mechanism, such as the development of a group's transactive memory system, between a group's equality of interaction and group outcomes.

Finally, the PLS analysis strongly supported the hypothesized links between the development of a group's transactive memory system and group outcomes. These findings are congruent with other literature which has argued for (and in some cases found) transactive memory system development to be associated with positive group outcomes such as high task performance and positive internal evaluations.

Theoretical Contributions

This study has made theoretical contributions to a number of different literature bases. First, the findings concerning the interaction of task knowledge and knowledge of the additive and reductive capabilities of the collaborative technology contribute to the literature on Task-Technology Fit. This study suggests that current models (e.g., Goodhue and Thompson, 1995; Zigurs and Buckland, 1998) are insufficient to explain the fit between a particular technology and task, primarily because these models do not adequately account for the human element in the equation. Specifically, these models need to be adapted to appropriately account for the limitation represented by individual knowledge (or lack thereof) of characteristics of both the task and technology in question.

Next, this study forwards Carte and Chidambaram's (2004) conception of collaborative technology as a "bundle of capabilities." In this study, I developed measures to capture user knowledge of both additive and reductive CT capabilities. Further, I argued for and empirically verified a differential impact of knowledge of additive and reductive CT capabilities on a group's appropriation of the technology.

This study also contributes to the literature on transactive memory systems by positing and empirically verifying the reliance of a group's transactive memory system development on the interaction between the group's task knowledge and its knowledge of additive CT capabilities as well as the equality of interaction within the group. Simply stated, the degree to which group members are able to make use of what they know about the knowledge possessed by other group members is a function of 1) the group's knowledge of both the task and the additive capabilities of the CT and 2) the extent to which members participate freely in group interactions. Further, because of the positive impacts of transactive memory system development upon group outcomes, I have identified transactive memory systems as a potential mediating mechanism through which group dynamics (either positive or negative) can impact group outcomes.

Overall, the findings of this study paint a clearer picture of how groups use collaborative technology to leverage the knowledge embedded in their members. To summarize, the degree to which a group takes advantage of the level playing field offered by collaborative technology is a function of what the group knows about both the task and the reductive capabilities of the technology. The degree to which group members are able to make use of what they know about the knowledge possessed by other group members is a function of the extent to which members participate freely in group interactions and what they know about both the task and the additive capabilities of the collaborative technology. Further, a group's knowledge of the capabilities of the collaborative technology impacts the manner in which the group appropriates the technology. In this manner, a group's knowledge of the collaborative technology *unlocks* the task knowledge embedded within group members.

Contributions to Practice

One of the main findings of this study is that a group's knowledge of the collaborative technology serves to unlock the task knowledge embedded within group members. This has some significant ramifications for practice. Groups are often assembled based on their expertise relative to the actual task at hand. This finding indicates that a group's knowledge of the collaborative technology can actually serve as a bottleneck which prevents the group from fully taking advantage of the task knowledge which serves as the basis for inclusion in the group.

A number of strategies might be adopted to account for this potential limitation. One would be to ensure that expertise with the collaborative technology is taken into consideration while forming the group. That is, the group's knowledge of the collaborative technology can be manipulated based on membership/inclusion requirements. Another strategy might be to seed the groups with one or two members who have expertise with the collaborative technology. They could demonstrate the features of the collaborative technology by taking the lead in group interactions. Another strategy, of course, would be to provide some basic training for groups on the collaborative technologies at their disposal. It is worth noting that the additive and reductive capabilities that were tracked in this study were not particularly esoteric. In other words, it would take very little training on the technology to effectively communicate these capabilities to users. The simple fact of the matter is that a group's knowledge of collaborative technology is often an afterthought, while the primary focus tends toward expertise relative to the task at hand. This study suggests that focusing on task knowledge while ignoring knowledge about the collaborative technology can limit the degree to which groups can effectively translate their task knowledge into positive group outcomes.

Limitations

There were some limitations to this study, including statistical and design limitations. As such, the generalizability of the findings of this study should be viewed with some degree of caution.

Low R-squared Values for Performance

One of the limitations of this study is that even when the research model resulted in significant paths leading to performance, the model, on average, still explained less than 10 percent of the variance in group performance. One of the problems here is a lack of variance in the Performance measure. This is further compounded by the fact that the distribution was highly skewed (the average varied between 91 and 97 percent, depending on the time period), thus violating assumptions of normality. While PLS does not require any assumptions to be made about variable distributions, these factors likely contributed to the low R-squared values associated with performance. The Performance measure was also hurt by the removal of Chidambaram's (1996) Satisfaction with Outcomes items, which were intended as a perceptual counter-balance to the subjective performance measures. As such, I was left with a somewhat less than full understanding of Performance.

Low R-squared Values for Equality of Interaction

It is also worth noting that, on average, the research model explained only around 10 percent of the variance in a group's equality of interaction. In contrast, the other process variable (TMS) typically had over 30 percent of its variance explained by the model. This isn't as easily explained by a lack of variance in the measure (the average varies between .5 and .7, depending on the time period) because, as a coefficient of variance, the measure can (at least theoretically) vary between 0 and infinity, thus rendering the interpretability of the distribution a bit more difficult.

One limitation of the research design pertaining to equality of interaction is the fact that the only interactions that were captured for this measure are those that occurred between group members using the assigned collaborative technology. It is possible that group members interacted face-to-face, interacted with members of other groups, or interacted using other technologies (such as email). While I included some measures in the second data collection in an effort to account for these scenarios, interpretation of the results concerning equality of interaction might still warrant a measure of caution.

Student Sample

Finally, the sample used for this study was comprised of student groups, which calls into question the generalizability of the findings to more business-oriented environments. In an attempt to alleviate this concern, the students were given tasks that were consistent with the context of the material with which they were being presented in class. As such, they were not being asked to comment upon or act within a context with which they were completely unfamiliar (e.g., they weren't asked to think and make decisions like a plant manager).

Further, their performance on the tasks played a significant role in determining their overall course grade, so that each student had a vested interest in performing the tasks to the best of their abilities. There is some evidence from the study that these safeguards preserved the generalizability of the results. For example, the finding of a positive relationship between transactive memory system development and group outcomes is consistent with the results other studies that have been conducted using industry-based groups. However, the use of student-based groups might still warrant some level of caution for anyone wishing to apply the findings of this study to a business context.

Future Research

There were a couple of findings in this study which appear to warrant further investigation. The finding of strong relationship between a group's equality of interaction and the development of their transactive memory system combined with the positive relationship between transactive memory system development and group outcomes suggests a possible mediation effect of transactive memory system development between a group's equality of interaction and outcomes. The discovery of a group's transactive memory system as a potential mediating mechanism between group dynamics and group outcomes would contribute significantly to the literature on transactive memory systems, as well as any research aimed at understanding group performance.

This study also uncovered a differential impact between a group's knowledge of additive and reductive CT capabilities, which suggests the possibility of a differential impact between additive and reductive CT capabilities themselves. The impact of the interaction of task knowledge and knowledge of reductive CT capabilities on a group's equality of interaction tended to dissipate over time, while the impact of the interaction of task knowledge and knowledge of additive CT capabilities tended to persist over time (at least for the duration of this study). Future work might investigate whether or not the impact of additive CT capabilities (or a group's knowledge thereof) eventually dissipates. Further, it is possible that the respective importance of the capabilities (or a group's knowledge thereof) shifts at discernable stages in the group's development, such as those suggested by Tuckman (1965) or Gersick (1988). Further investigation and theoretical development might make significant contributions to our understanding of group dynamics and provide greater insight into group work processes in virtual contexts.

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APPENDIX A: ACCESS TASKS

Access Task 1

Hi Everyone!

My name is Laura and I am the president of All You Need, Inc. As you all already know I am improving my business and have hired several groups to develop a database project for my company. Based on your instructor's recommendations your group has been selected. Therefore, I believe that your group has all the skills necessary to compete for the best project.

I have developed a project plan for your group. The project will involve four tasks. After each task, Mr. David – my manager - and I will evaluate your work and will report your grade. Now that you have learned how to use the collaborative technology you have been assigned and have also gotten acquainted with your fellow team members let's start our mission.

In this task we need your group to create several tables (along with their fields) and the relationships between them. Every table is part of the conceptual model developed by Mr. David who has sent an email to each member of your group describing the tables to be created. Details regarding the table you need to create are included on the next page.

At the end of this meeting, your group needs to submit a single database with all of the required tables and the appropriate relationships between them. You will have to communicate with your group members in order to select the person who will be responsible for putting all of the tables together into a single database file called **AllYouNeedFinal.accdb**, establishing the relationships between the tables, and uploading it.

Thank you and Good Luck!
Laura

Task 1: Part A
Table Details:

In this task Mr. David needs you to create the CUSTOMER table containing all the fields, their names, and data types exactly as it is described in the figure below.

CUSTOMER	
Field	**Data Type**
CustomerID	Number
Name	Text
Phone	Text
Street	Text
City	Text
State	Text
Zip	Text

Instructions:

a) Create a new blank database with the appropriate file name (e.g., AllYouNeedpartA.accdb).
b) Create the table shown in figure 1.
c) The CustomerID field should be defined as the primary key.
d) Communicate with your team members and share information on your table's primary key field so that they can add this field to their tables if they need to.
e) Once you have created this table, remember that you need to find out what other tables Mr. David has asked your group members to create so that at the end of this assignment your group can turn in a single database containing all of the tables.
f) Once you have all of the necessary tables combined in a single database, you need to create the appropriate relationships between the tables. When creating the relationships, make sure to select the checkboxes to enforce referential integrity, cascade updates, and cascade deletes.
g) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.

<u>Task 1: Part B</u>
Table Details:

In this task Mr. David needs you to create the ORDER table containing all the fields, their names, and data types exactly as it is described in the figure below.

In addition, you need to add a field (as shown in red) identical to the primary key field in the customer table. To do so, you need to communicate with your team members to find out who is working on the customer table so that they can provide information on this field. It will have the same name and data type as in the customer table, but <u>this field should not be defined as a primary key of your ORDER table</u>.

ORDER	
Field	**Data Type**
OrderNumber	Number
OrderDate	Date/Time
SubTotal	Number
Tax	Number
TotalDue	Number
Commission	Number
Insert Here: Primary Key of Customer	

Instructions:

a) Create a new blank database with the appropriate file name (e.g., AllYouNeedpartB.accdb).
b) Create the table shown in figure 1.
c) The OrderNumber field should be defined as the primary key.
d) Communicate with your team members and share information on your table's primary key field so that they can add this field to their tables if they need to.
e) Once you have created this table, remember that you need to find out what other tables Mr. David has asked your group members to create so that at the end of this assignment your group can turn in a single database containing all of the tables.
f) Once you have all of the necessary tables combined in a single database, you need to create the appropriate relationships between the tables. When creating the relationships, make sure to select the checkboxes to enforce referential integrity, cascade updates, and cascade deletes.
g) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.

Task 1: Part C

Table Details:

In this task Mr. David needs you to create the ORDERLINE table containing all the fields, their names and data types exactly as it is described in the figure below.

In addition, you need to add two extra fields (as shown in red): one field identical to the primary key field of the order table and one field identical to the primary key of the product table. To do so, you need to communicate with your team members to find out who is working on the order and product tables so that they can provide information on these fields. They will both have the same name and data type as in the product and order tables and will be defined as primary keys of your ORDERLINE table as well.

ORDERLINE	
Field	**Data Type**
Insert Here: Primary Key of Order	
Insert Here: Primary Key of Product	
QtySold	Number
PriceSold	Number
Discount	Number
TotalPrice	Number
Message	Text

Instructions:

a) Create a new blank database with the appropriate file name (e.g., AllYouNeedpartC.accdb).
b) Create the table shown in figure 1.
c) The primary keys of the Order and Product tables should be jointly defined as the primary key.
d) Communicate with your team members and share information on your table's primary key field so that they can add this field to their tables if they need to.
e) Once you have created this table, remember that you need to find out what other tables Mr. David has asked your group members to create so that at the end of this assignment your group can turn in a single database containing all of the tables.
f) Once you have all of the necessary tables combined in a single database, you need to create the appropriate relationships between the tables. When creating the relationships, make sure to select the checkboxes to enforce referential integrity, cascade updates, and cascade deletes.
g) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.

<u>Task 1: Part D</u>

Table Details:

In this task Mr. David needs you to create the PRODUCT table containing all the fields, their names, and data types exactly as it is described in the figure below.

In addition, you need to add a field (as shown in red) identical to the primary key field in the vendor table. To do so, you need to communicate with your team members to find out who is working on the vendor table so that they can provide information on this field. It will have the same name and data type as in the vendor table, but <u>this field should not be defined as a primary key of your PRODUCT table</u>.

PRODUCT	
Field	**Data Type**
ProductNumber	Number
UnitPrice	Number
Description	Text
ProductName	Text
ProductType	Text
QtyOnHand	Number
Insert Here: Primary Key of Vendor	

Instructions:

a) Create a new blank database with the appropriate file name (e.g., AllYouNeedpartD.accdb).
b) Create the table shown in figure 1.
c) The ProductNumber field should be defined as the primary key.
d) Communicate with your team members and share information on your table's primary key field so that they can add this field to their tables if they need to.
e) Once you have created this table, remember that you need to find out what other tables Mr. David has asked your group members to create so that at the end of this assignment your group can turn in a single database containing all of the tables.
f) Once you have all of the necessary tables combined in a single database, you need to create the appropriate relationships between the tables. When creating the relationships, make sure to select the checkboxes to enforce referential integrity, cascade updates, and cascade deletes.
g) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.

Task 1: Part E
Table Details:

In this task Mr. David needs you to create the VENDOR table containing all the fields, their names, and data types exactly as it is described in the figure below.

VENDOR	
Field	**Data Type**
VendorID	Number
Name	Text
Phone	Text
Street	Text
City	Text
State	Text
Zip	Text

Instructions:

a) Create a new blank database with the appropriate file name (e.g., AllYouNeedpartE.accdb).
b) Create the table shown in figure 1.
c) The VendorID field should be defined as the primary key.
d) Communicate with your team members and share information on your table's primary key field so that they can add this field to their tables if they need to.
e) Once you have created this table, remember that you need to find out what other tables Mr. David has asked your group members to create so that at the end of this assignment your group can turn in a single database containing all of the tables.
f) Once you have all of the necessary tables combined in a single database, you need to create the appropriate relationships between the tables. When creating the relationships, make sure to select the checkboxes to enforce referential integrity, cascade updates, and cascade deletes.
g) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.

Access Task 2

Hi Everyone!

Mr. David and I have analyzed the work your group has done in the last meeting. In order to continue your work, Mr. David entered several records into the tables so that your group can use them in the next phases of the project. Thus, an updated version (**AllYouNeed2.accdb**) of your work has been zipped in with this document. You will need to use that file to complete the task listed below.

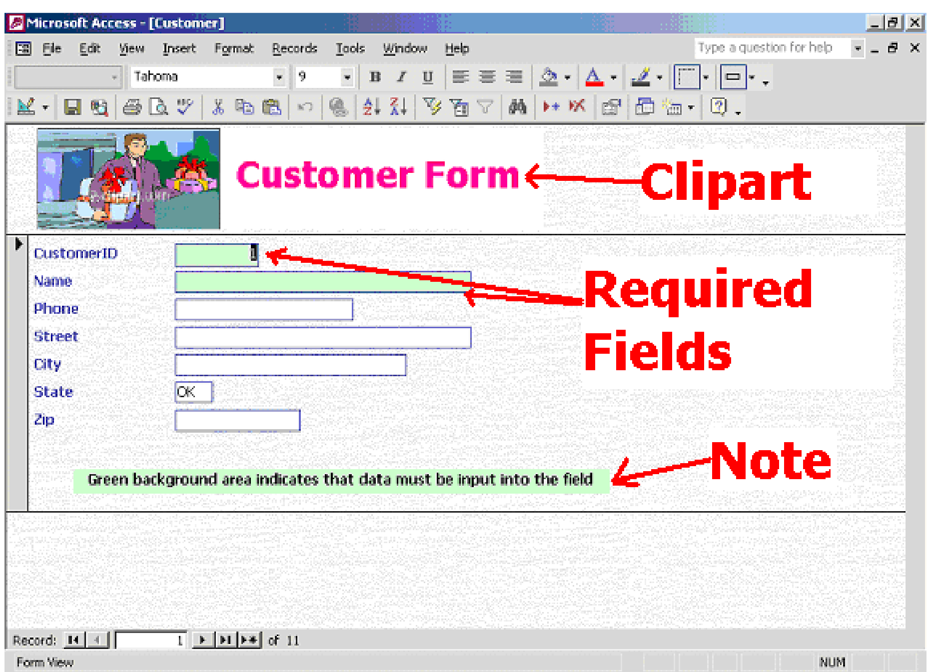
At the end of this task, your group needs to submit a single database with all **tables and forms**. You will have to communicate with your group members in order to select the person who will be responsible to put all forms together into a single database file called **AllYouNeed2Final.accdb**.

Thank you and Good Luck!
Laura

Task 2: Part A
Task Details:
Mr. David needs you to create a form for the Customer table similar to the one in the figure below.

Use the database that was included in the zip file (e.g., AllYouNeed2.accdb) and create a form with the following elements:

a) A clip art image in the form header. Note that Mr. David has mistakenly sent you a clipart that needs to be inserted into a form being developed by one of your group members. So, please communicate with your group members so that you can exchange cliparts until you all have the appropriate clipart for all forms. The header of your form should have a clip art saying "**Customer Form**".
b) A different background color for the required fields CustomerID and Name, to emphasize that the data for these fields must be entered. Your team can chose any background color, but the background color needs to be the same for all forms. Thus, please communicate with your team members to decide which color to use so that all of you will have the same background color.
c) Include a note on the form that indicates the meaning of the color change. Please use the same color and format you used previously. Note: All forms need to have the same message. So, communicate with your team members to type the same message.
d) Once you have created the form, remember that your group needs to upload a final database (AllYouNeed2Final.accdb) containing all forms as described in the previous page.
e) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



Task 2: Part B

Task Details:

Mr. David needs you to create a form for the Order table similar to the one in the figure below.

Use the database that was included in the zip file (e.g., AllYouNeed2.accdb) and create a form with the following elements:

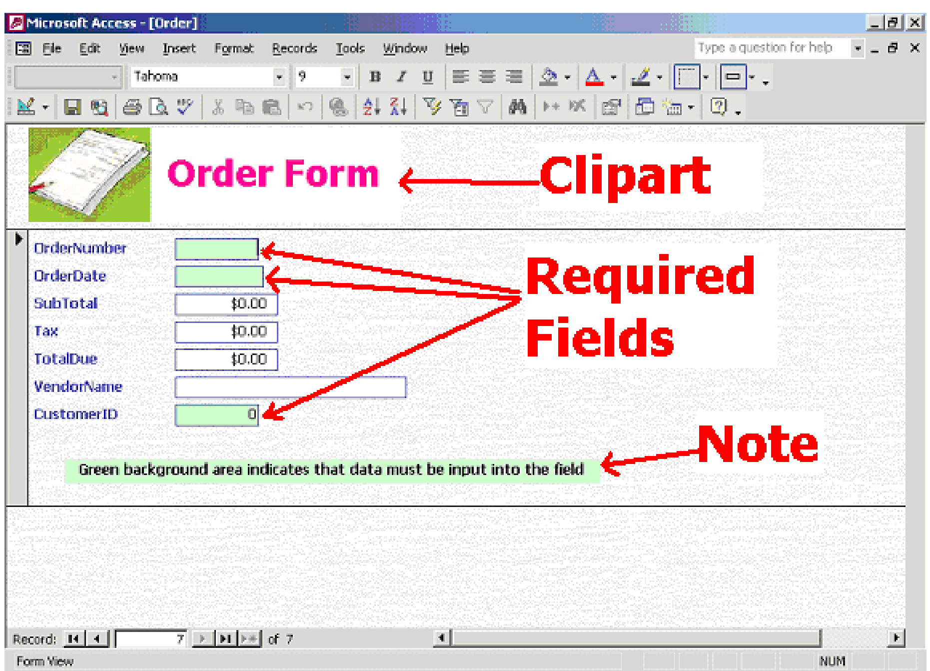
a) A clip art image in the form header. Note that Mr. David has mistakenly sent you a clipart that needs to be inserted into a form being developed by one of your team members. So, please communicate with them members so that you can exchange clipart until you all have the appropriate clipart for all forms. The header of your form should have a clip art saying "**Order Form**".

b) A different background color for the required fields **OrderNumber, OrderDate**, and **CustomerID** to emphasize that the data for these fields must be entered. Your team can chose any background color, but the background color needs to be the same for all forms. Thus, please communicate with your team members to decide which color to use so that all of you will have the same background color.

c) Include a note on the form that indicates the meaning of the color change. Please use the same color and format you used previously. Note: All forms need to have the same message. So, communicate with your team members to type the same message.

d) Once you have created the form, remember that your group needs to upload a final database (AllYouNeed2Final.accdb) containing all forms as described in the previous page.

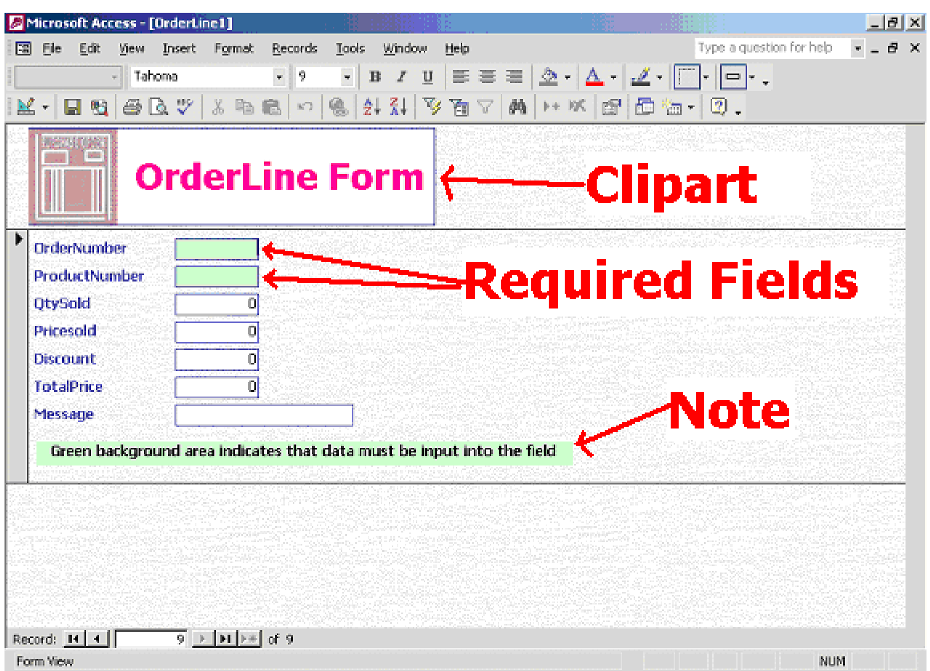
e) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



Task 2: Part C
Task Details:
Mr. David needs you to create a form for the OrderLine table similar to the one in the figure below.

Use the database that was included in the zip file (e.g., AllYouNeed2.accdb) and create a form with the following elements:

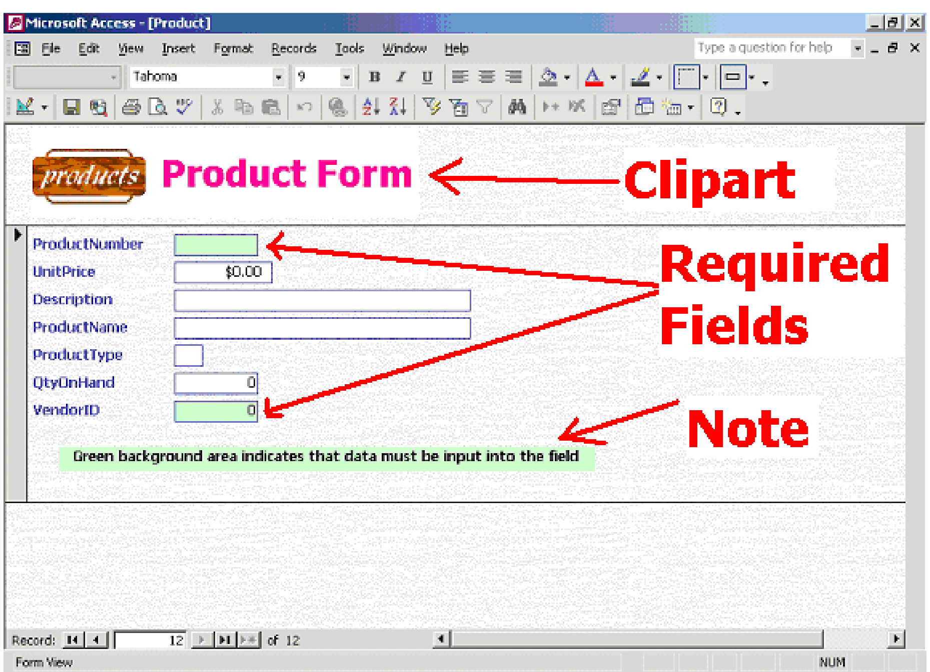
a) A clip art image in the form header. Note that Mr. David has mistakenly sent you a clipart that needs to be inserted into a form being developed by one of your team members. So, please communicate with them members so that you can exchange cliparts until you all have the appropriate clipart for all forms. The header of your form should have a clip art saying "**OrderLine Form**".
b) A different background color for the required fields **OrderNumber** and **ProductNumber**, to emphasize that the data for these fields must be entered. Your team can chose any background color, but the background color needs to be the same for all forms. Thus, please communicate with your team members to decide which color to use so that all of you will have the same background color.
c) Include a note on the form that indicates the meaning of the color change. Please use the same color and format you used previously. Note: All forms need to have the same message. So, communicate with your team members to type the same message.
d) Once you have created the form, remember that your group needs to upload a final database (AllYouNeed2Final.accdb) containing all forms as described in the previous page.
e) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



Task 2: Part D
Task Details:
Mr. David needs you to create a form for the Product table similar to the one in the figure below.

Use the database that was included in the zip file (e.g., AllYouNeed2.accdb) and create a form with the following elements:

a) A clip art image in the form header. Note that Mr. David has mistakenly sent you a clipart that needs to be inserted into a form being developed by one of your team members. So, please communicate with them members so that you can exchange cliparts until you all have the appropriate clipart for all forms. The header of your form should have a clip art saying "**Product Form**".
b) A different background color for the required fields **ProductNumber** and **VendorID**, to emphasize that the data for these fields must be entered. Your team can chose any background color, but the background color needs to be the same for all forms. Thus, please communicate with your team members to decide which color to use so that all of you will have the same background color.
c) Include a note on the form that indicates the meaning of the color change. Please use the same color and format you used previously. Note: All forms need to have the same message. So, communicate with your team members to type the same message.
d) Once you have created the form, remember that your group needs to upload a final database (AllYouNeed2Final.accdb) containing all forms as described in the previous page.
e) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



<u>Task 2: Part E</u>

Task Details:

Mr. David needs you to create a form for the Vendor table similar to the one in the figure below.

Use the database that was included in the zip file (e.g., AllYouNeed2.accdb) and create a form with the following elements:

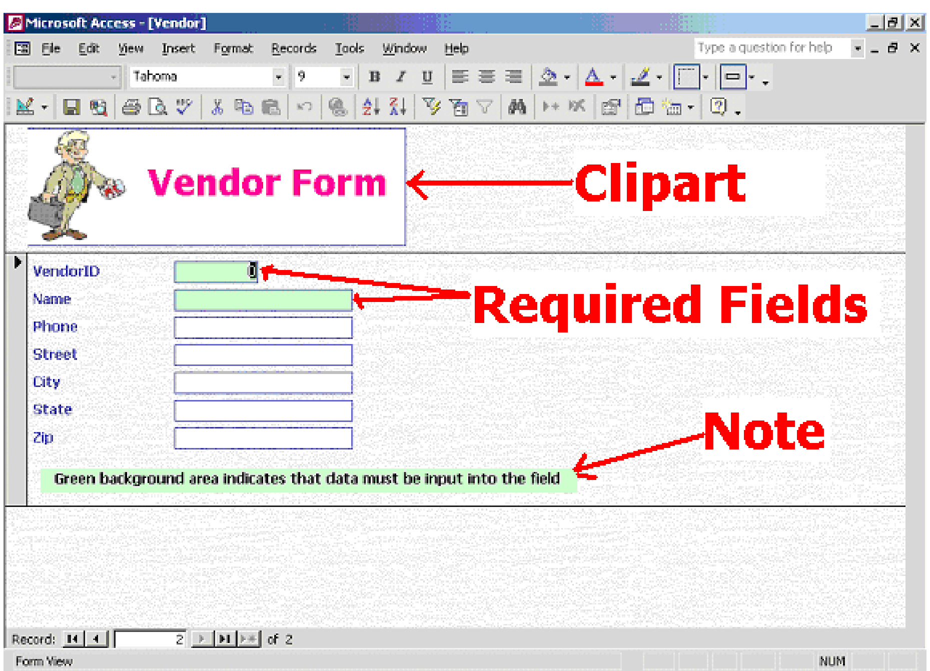
a) A clip art image in the form header. Note that Mr. David has mistakenly sent you a clipart that needs to be inserted into a form being developed by one of your team members. So, please communicate with them members so that you can exchange cliparts until you all have the appropriate clipart for all forms. <u>The header of your form should have a clip art saying "**Vendor Form**".</u>

b) A <u>different background color</u> for the required fields <u>**VendorID**</u> and <u>**Name**</u>, to emphasize that the data for these fields must be entered. Your team can chose any background color, but <u>the background color needs to be the same for all forms</u>. Thus, please communicate with your team members to decide which color to use so that all of you will have the same background color.

c) Include a note on the form that indicates the meaning of the color change. Please use the same color and format you used previously. <u>Note: All forms need to have the same message</u>. So, communicate with your team members to type the same message.

d) Once you have created the form, remember that your group needs to upload a final database (AllYouNeed2Final.accdb) containing all forms as described in the previous page.

e) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



Access Task 3

Hi Everyone!

Mr. David and I have analyzed the work your group has done in the last meeting. In order to continue your work, Mr. David applied a unique format to all forms so that we can have a standardized system across different groups that are working in this project. Thus, an updated version (**AllYouNeed3.accdb**) of your work has been zipped in with this document. You will need to use that file to complete the task listed below.

At the end of this task, your group needs to submit a single database with all **tables and updated forms with added buttons.** You will have to communicate with your group members in order to select the person who will be responsible to put all forms together into a single database file called **AllYouNeed3Final.accdb**.

Thank you!
Laura

Task 3: Part A

Task Details:

Mr. David needs you to perform the following tasks on the Customer Form:

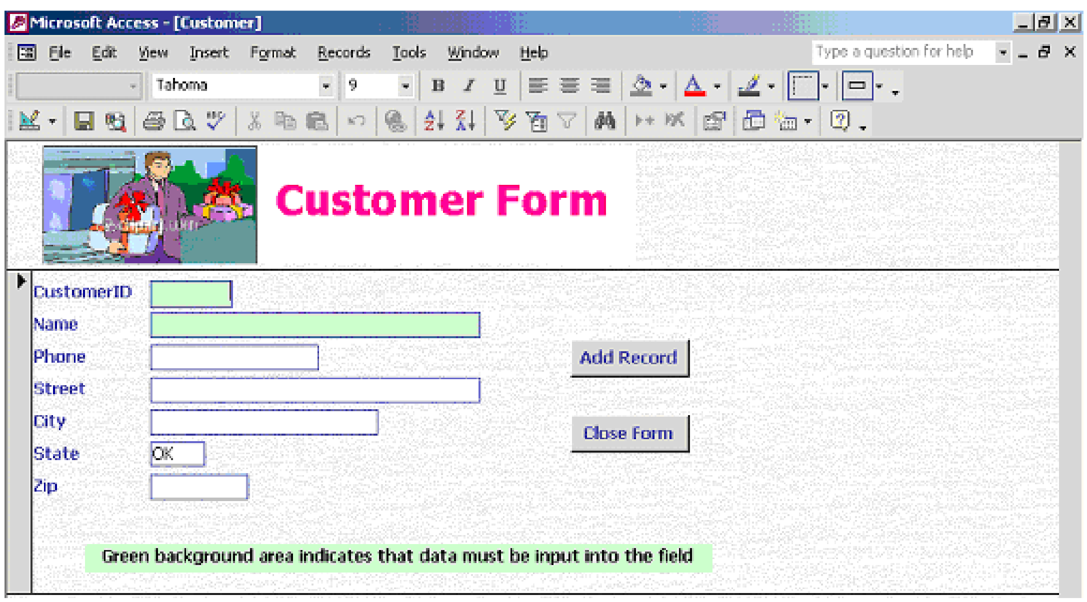
a) Add the following command buttons: **Add Record** and **Close Form**.

b) A different font color for the text displayed in the buttons. Your team can choose any color, but the color needs to be the same for all buttons in all forms. Thus, please communicate with your team members to decide which color to use.

c) Using the Add Record button you have just created, please enter a new record into the **CUSTOMER TABLE**. The content of this new record has been sent to one of your group members. So, you need to communicate with them to get this information.

d) Once you have appropriately modified the form and added the record to your table, remember that your group needs to upload a final database (AllYouNeed3Final.accdb) containing all updated tables and forms as described in the previous page.

e) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



<u>Task 3: Part B</u>

Task Details:

Mr. David needs you to perform the following tasks on the Order Form:

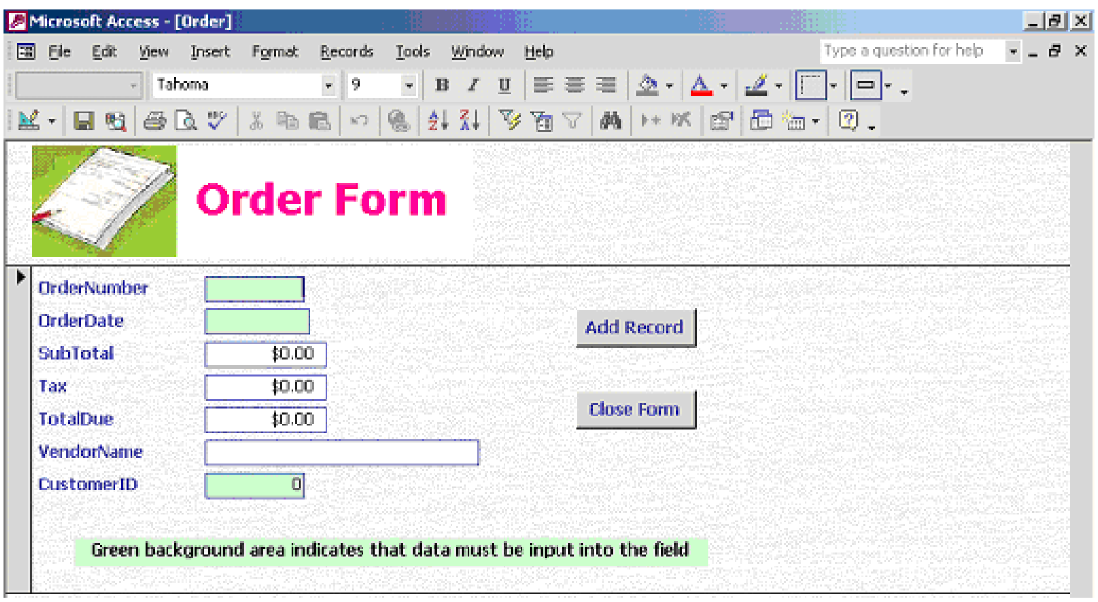
a) Add the following command buttons: **<u>Add Record</u>** and **<u>Close Form</u>**.

b) A <u>different font color</u> for the text displayed in the buttons. Your team can choose any color, but <u>the color needs to be the same for all buttons in all forms</u>. Thus, please communicate with your team members to decide which color to use.

c) Using the Add Record button you have just created, please enter a new record into the **<u>ORDER TABLE</u>**. The content of this new record has been sent to one of your group members. So, you need to communicate with them to get this information.

d) Once you have appropriately modified the form and added the record to your table, remember that your group needs to upload a final database (AllYouNeed3Final.accdb) containing all updated tables and forms as described in the previous page.

e) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



Task 3: Part C

Task Details:

Mr. David needs you to perform the following tasks on the OrderLine Form:

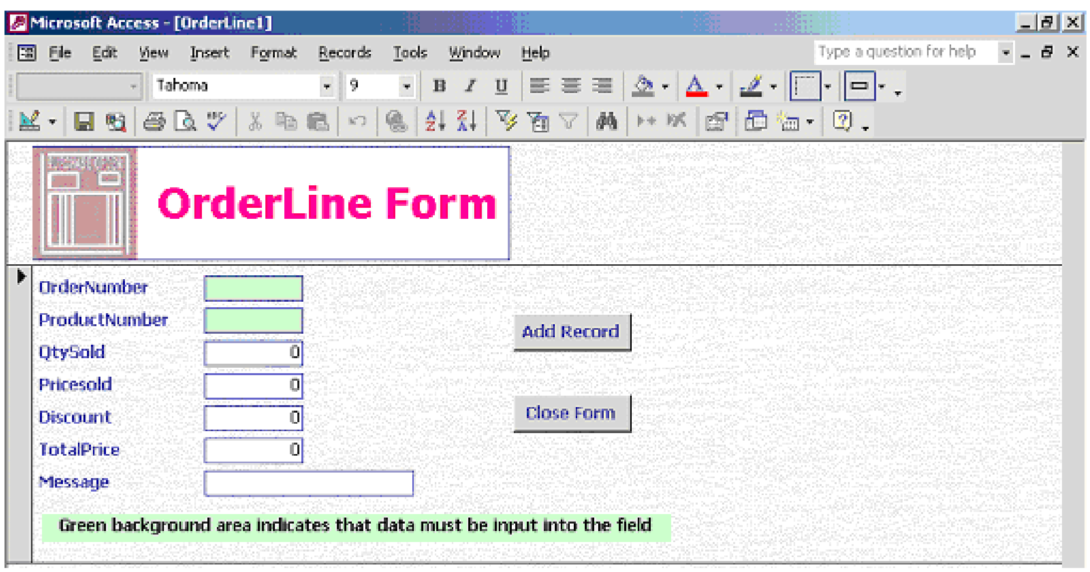
a) Add the following command buttons: **Add Record** and **Close Form**.

b) A different font color for the text displayed in the buttons. Your team can choose any color, but the color needs to be the same for all buttons in all forms. Thus, please communicate with your team members to decide which color to use.

c) Using the Add Record button you have just created, please enter a new record into the **ORDERLINE TABLE**. The content of this new record has been sent to one of your group members. So, you need to communicate with them to get this information.

d) Once you have appropriately modified the form and added the record to your table, remember that your group needs to upload a final database (AllYouNeed3Final.accdb) containing all updated tables and forms as described in the previous page.

e) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



<u>Task 3: Part D</u>

Task Details:

Mr. David needs you to perform the following tasks on the Product Form:

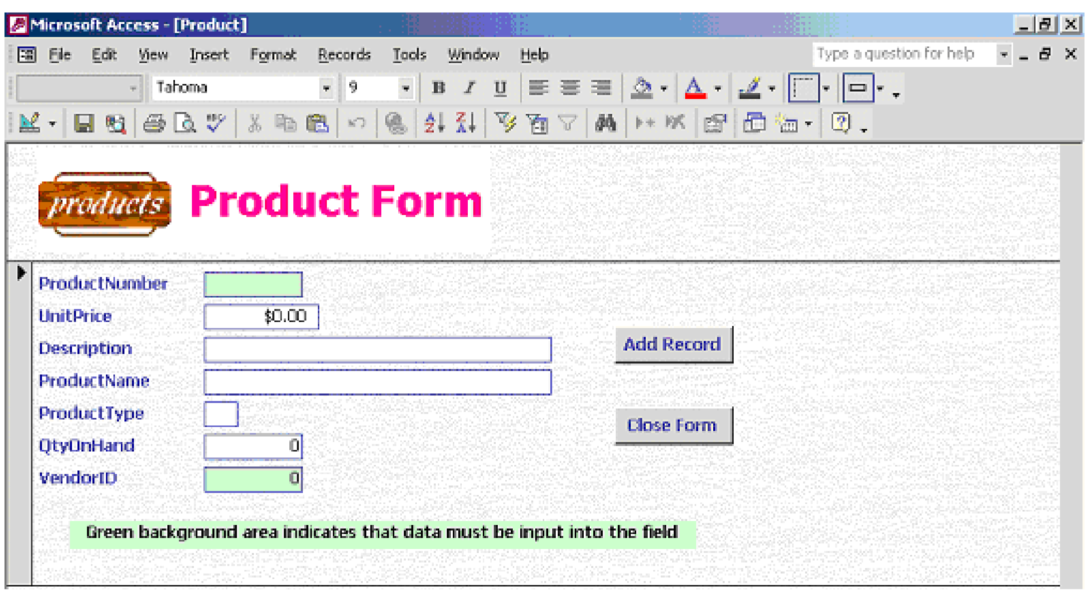
a) Add the following command buttons: **<u>Add Record</u>** and **<u>Close Form</u>**.

b) A <u>different font color</u> for the text displayed in the buttons. Your team can choose any color, but <u>the color needs to be the same for all buttons in all forms</u>. Thus, please communicate with your team members to decide which color to use.

c) Using the Add Record button you have just created, please enter a new record into the **<u>PRODUCT TABLE</u>**. The content of this new record has been sent to one of your group members. So, you need to communicate with them to get this information.

d) Once you have appropriately modified the form and added the record to your table, remember that your group needs to upload a final database (AllYouNeed3Final.accdb) containing all updated tables and forms as described in the previous page.

e) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



Task 3: Part E

Task Details:

Mr. David needs you to perform the following tasks on the Vendor Form:

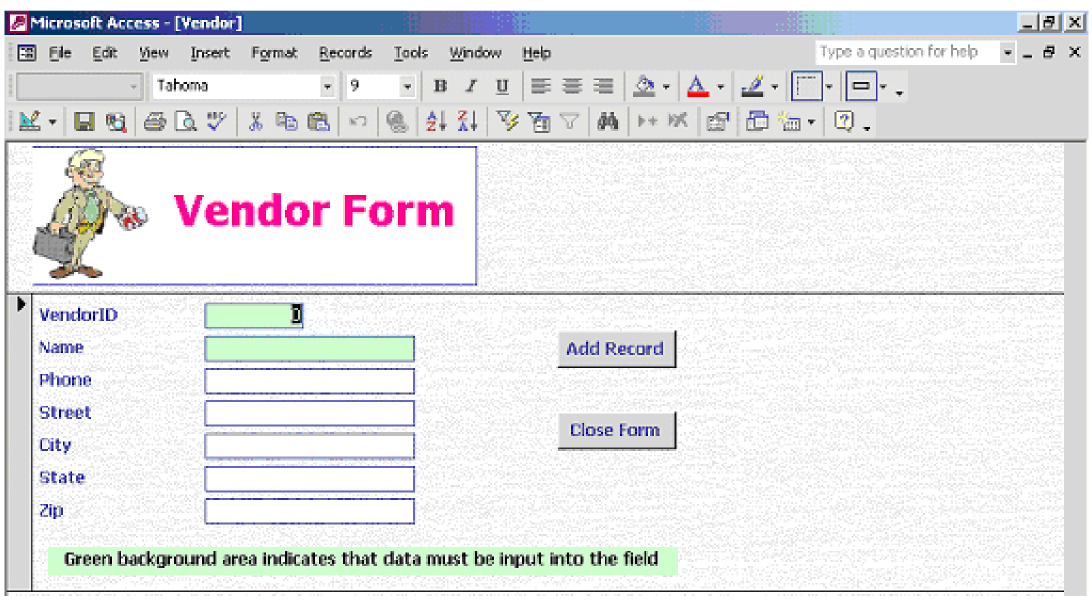
a) Add the following command buttons: **Add Record** and **Close Form**.

b) A different font color for the text displayed in the buttons. Your team can choose any color, but the color needs to be the same for all buttons in all forms. Thus, please communicate with your team members to decide which color to use.

c) Using the Add Record button you have just created, please enter a new record into the **VENDOR TABLE**. The content of this new record has been sent to one of your group members. So, you need to communicate with them to get this information.

d) Once you have appropriately modified the form and added the record to your table, remember that your group needs to upload a final database (AllYouNeed3Final.accdb) containing all updated tables and forms as described in the previous page.

e) Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



Access Task 4

Hi Everyone!

David and I have analyzed the work your group has done in the last meeting and we have zipped an updated version (**AllYouNeed4.accdb**) of your work in the same file as this assignment. You will need to use that file to complete the task listed below. In order to save space, the updated version does not contain the forms you have developed in the previous assignments. So, don't worry, you will not need them for this assignment.

At the end of this meeting, your group needs to submit a single database with all **new queries and reports**. You will have to communicate with your group members in order to select the person who will be responsible to put all of the information together into a single database file called **AllYouNeed4Final.accdb**.

Thank you!
Laura

Task 4: Part A

Task Description:

Mr. David needs you to create a report similar to the one in the figure below. The design of your report can be slightly different from ours, but it needs to list **ONLY** customers that live in the state of Georgia, i.e., 'GA'.

You should create a query which returns all customers that live in the state of Georgia and save that query as **GA-CUSTOMERS**. Once you have created and saved the query, you can now generate a report using the query as your data source.

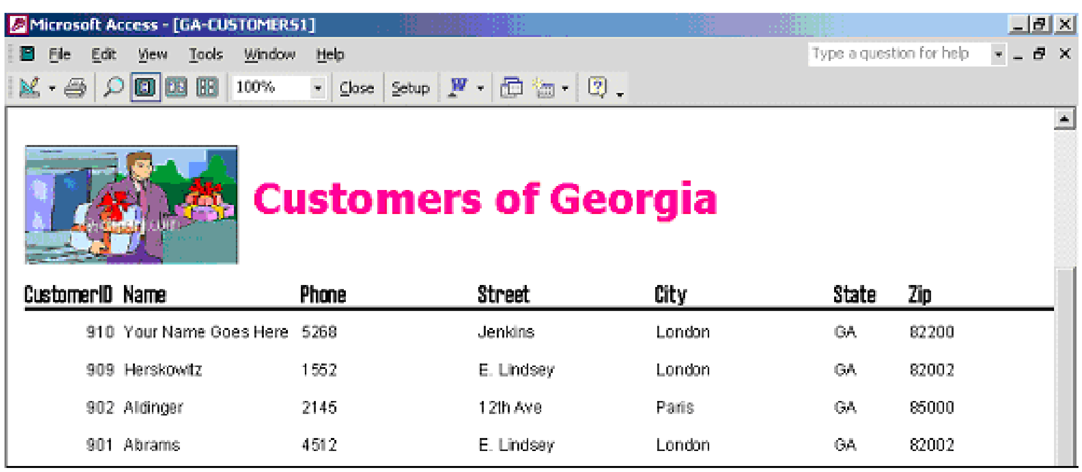
1. Insert the appropriate clipart image in the report header. The clipart you have received belongs to a report being developed by another member of your team. So, communicate with your team members so that you all can have the appropriate clipart for every report.

2. Communicate with your team members to choose **one standard color for the labels in the page header** (e.g., CustomerID, Name, Phone, ProductNumber, OrderNumber, etc.) in all reports. You do not need to change the color of the clipart.

3. The report should contain ALL fields of the table.

4. List customers in DESCENDING ORDER of CustomerID.

5. Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



<u>Task 4: Part B</u>
Task Description:

Mr. David needs you to create a report similar to the one in the figure below. The design of your report can be slightly different from ours, but it needs to list **<u>ONLY</u>** <u>products with UnitPrice greater than US$ 1,000.00</u>.

You should create a query which returns only products with a UnitPrice greater than US$ 1,000.00 and save that query as **PRODUCTS1000**. Once you have created and saved the query, you can now generate a report using the query as your data source.

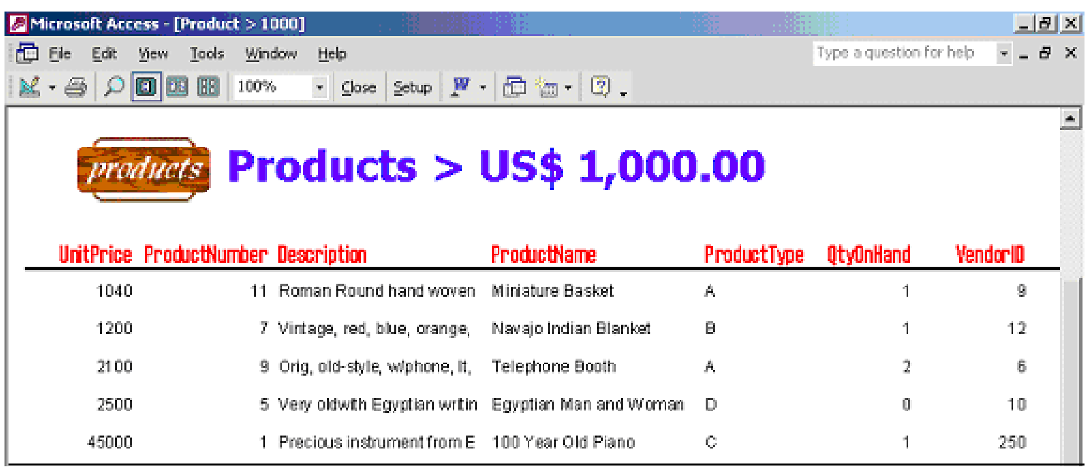
1. Insert the appropriate clipart image in the report header. The clipart you have received belongs to a report being developed by another member of your team. So, communicate with your team members so that you all can have the appropriate clipart for every report.

2. Communicate with your team members to choose **<u>one standard color for the labels in the page header</u>** (e.g., CustomerID, Name, Phone, ProductNumber, OrderNumber, etc.) in all reports. You do not need to change the color of the clipart.

3. The report should contain <u>ALL</u> fields of the table.

4. List products in ASCENDING ORDER of UnitPrice.

5. Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



UnitPrice	ProductNumber	Description	ProductName	ProductType	QtyOnHand	VendorID
1040	11	Roman Round hand woven	Miniature Basket	A	1	9
1200	7	Vintage, red, blue, orange,	Navajo Indian Blanket	B	1	12
2100	9	Orig, old-style, w/phone, lt,	Telephone Booth	A	2	6
2500	5	Very oldwith Egyptian writin	Egyptian Man and Woman	D	0	10
45000	1	Precious instrument from E	100 Year Old Piano	C	1	250

<u>Task 4: Part C</u>
Task Description:

Mr. David needs you to create a report similar to the one in the figure below. The design of your report can be slightly different from ours, but it needs to list <u>**ONLY** orders with TotalDue less than US$ 4,000.00</u>.

You should create a query which returns only orders with a TotalDue less than US$ 4,000.00 and save that query as **ORDERS4000**. Once you have created and saved the query, you can now generate a report using the query as your data source.

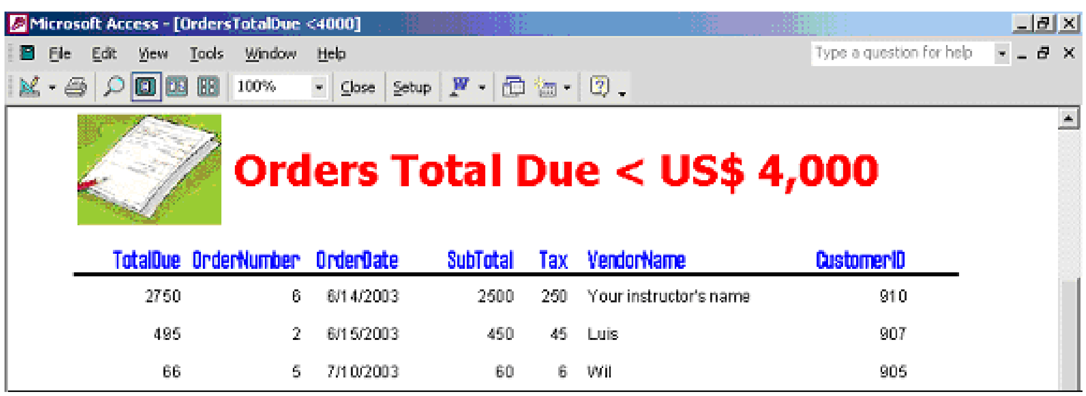
1. Insert the appropriate clipart image in the report header. The clipart you have received belongs to a report being developed by another member of your team. So, communicate with your team members so that you all can have the appropriate clipart for every report.

2. Communicate with your team members to choose <u>**one standard color for the labels in the page header**</u> (e.g., CustomerID, Name, Phone, ProductNumber, OrderNumber, etc.) in all reports. You don't need to change the color of the clipart.

3. The report should contain <u>ALL</u> fields of the table.

4. List orders in DESCENDING ORDER of TotalDue.

5. Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



<u>Task 4: Part D</u>
Task Description:

Mr. David needs you to create a report similar to the one in the figure below. The design of your report can be slightly different from ours, but it needs to list <u>**ONLY** products with ProductType = 'A'</u>.

You should create a query which returns only products with Type = 'A' and save that query as **PRODUCTA.** Once you have created and saved the query, you can now generate a report using the query as your data source.

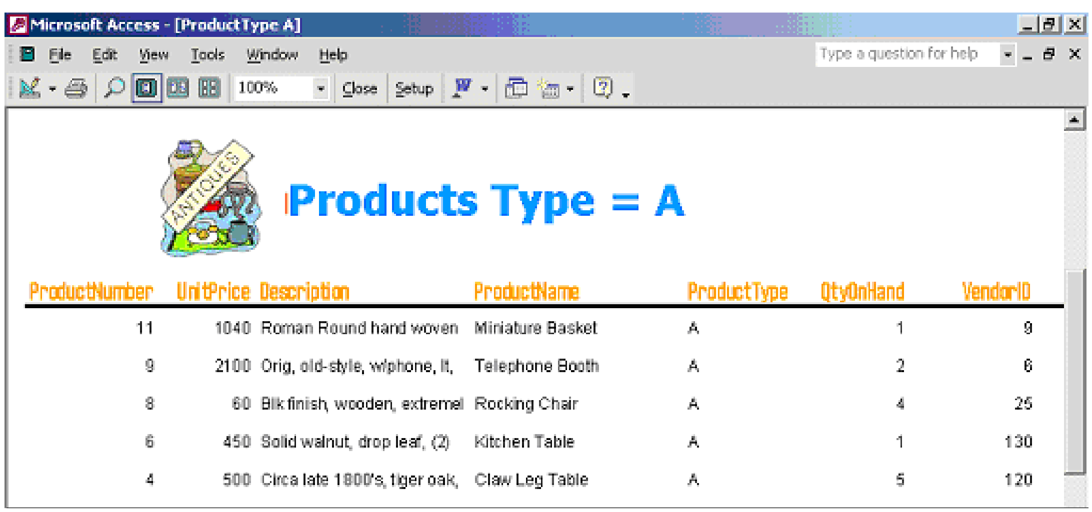
1. Insert the appropriate clipart image in the report header. The clipart you have received belongs to a report being developed by another member of your team. So, communicate with your team members so that you all can have the appropriate clipart for every report.

2. Communicate with your team members to choose <u>**one standard color for the labels in the page header**</u> (e.g., CustomerID, Name, Phone, ProductNumber, OrderNumber, etc.) in all reports. You do not need to change the color of the clipart.

3. The report should contain <u>ALL</u> fields of the table.

4. List products in DESCENDING ORDER of ProductNumber.

5. Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



ProductNumber	UnitPrice	Description	ProductName	ProductType	QtyOnHand	VendorID
11	1040	Roman Round hand woven	Miniature Basket	A	1	9
9	2100	Orig, old-style, w/phone, lt,	Telephone Booth	A	2	6
8	60	Blk finish, wooden, extremel	Rocking Chair	A	4	25
6	450	Solid walnut, drop leaf, (2)	Kitchen Table	A	1	130
4	500	Circa late 1800's, tiger oak,	Claw Leg Table	A	5	120

<u>Task 4: Part E</u>
Task Description:

Mr. David needs you to create a report similar to the one in the figure below. The design of your report can be slightly different from ours, but it needs to list <u>**ONLY** orders with CustomerID = 905</u>.

You should create a query which returns only orders with CustomerID = 905 and save it as **ORDERSCUSTOMER905**. Once you have created and saved the query, you can now generate a report using the query as your data source.

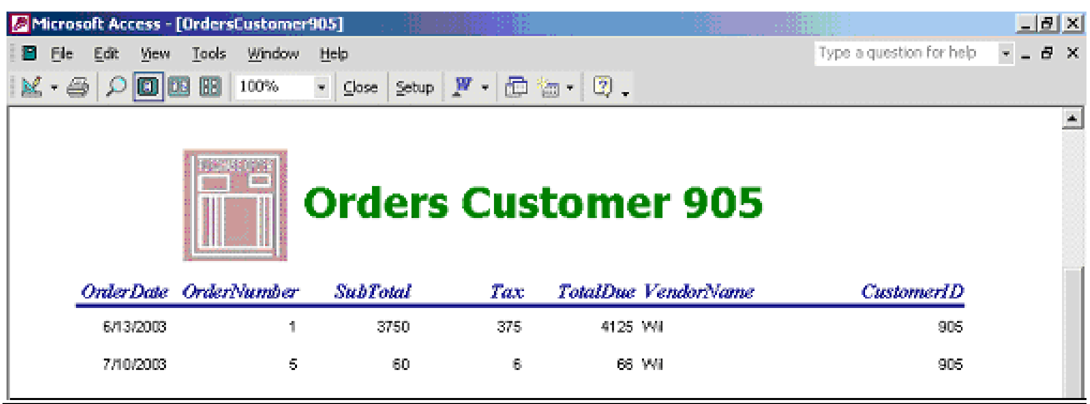
1. Insert the appropriate clipart image in the report header. The clipart you have received belongs to a report being developed by another member of your team. So, communicate with your team members so that you all can have the appropriate clipart for every report.

2. Communicate with your team members to choose <u>**one standard color for the labels in the page header**</u> (e.g., CustomerID, Name, Phone, ProductNumber, OrderNumber, etc.) in all reports. You do not need to change the color of the clipart.

3. The report should contain <u>ALL</u> fields of the table.

4. List orders in ASCENDING ORDER of OrderDate.

5. Note: you may share any information you want with your teammates, BUT DO NOT POST THIS DOCUMENT.



APPENDIX B: SURVEY ITEMS

Construct	Item	Question
Conflict	*Please answer each of the following questions regarding your experience working with your group on the assignment (anchored "Not at All" to "A Lot" (1-7))*	
	RCONF1	How much tension was there in your team?
	RCONF2	How often did people get angry while working in your team?
	RCONF3	How much conflict was there in your team?
	TCONF1	How much conflict of ideas was there in your team?
	TCONF2	How frequently did you have disagreements within your team about the task of the assignment you were working on?
	TCONF3	How often did people in your team have conflicting opinions about the assignment you were working on?
Cohesion		
	COH1	Did you feel you were a part of your group during this assignment? (anchored "Didn't Feel I Belonged at All" to "Really a Part of My Group" (1-5))
	COH2	If you had a chance to do the same kind of work in another group, how would you feel about moving? (anchored "Would Want Very Much to Move" to "Would Want Very Much to Stay Where I Am" (1-5))
		How did this group compare to other groups on each of the following points? (anchored "Very Much Worse" to "Very Much Better" (1-5))
	COH3	Getting along together
	COH4	Working together
	COH5	Helping each other
Satisfaction with Outcome	*Please answer each of the following questions regarding your experience working with your group on the assignment. (anchored "Strongly Disagree" to "Strongly Agree" (1-7))*	
	CHIDSAT1	Overall, I was personally satisfied with this group's performance during this assignment

Construct	Item	Question
	CHIDSAT2	This group produced effective results during this assignment
	CHIDSAT3	This group produced valuable results during this assignment
	CHIDSAT4	I agreed with the decisions made by this group during this assignment
	CHIDSAT5	Overall, the quality of this group's output was high during this assignment
Satisfaction with CT	*Please answer the following questions regarding your experience using the CT during the assignment.*	
	CTSAT1	Please assess how satisfactory you found the CT to be in meeting your collaboration needs for this assignment. (anchored "Very Unsatisfactory" to "Very Satisfactory" (1-7))
	CTSAT2	To what extent did the CT help you collaborate with your group members on this assignment? (anchored "To a Little Extent" to "To a Great Extent" (1-7))
	CTSAT3	How well did the CT meet your needs for collaborating with your group members on this assignment? (anchored "Not at All" to "Very Well" (1-7))
Knowledge of Additive CT Capabilities	*Please answer the following questions about the CT (anchored "Strongly Disagree" to "Strongly Agree" (1-7))*	
	CTADDKNW1	The CT has tools (e.g., calendar, member monitoring) which can aid me in tracking the people, projects, and priorities within my group.
	CTADDKNW2	Using the CT, I can easily retrieve messages and files I posted or my group members posted.
	CTADDKNW3	The CT has tools (e.g., voting, ranking) which can aid my group in making decisions.
Knowledge of Reductive CT Capabilities	*Please answer the following questions about the CT (anchored "Strongly Disagree" to "Strongly Agree" (1-7))*	
	CTREDKNW1	Using the CT, I can post a message or file without my group members knowing who posted it.
	CTREDKNW2	Using the CT, I can post messages or files whenever I want.

Construct	Item	Question
	CTREDKNW3	Using the CT, I can get immediate (real-time) feedback from my group members.
Transactive Memory System	*Please answer each of the following questions regarding your experience working with your group on this assignment (anchored "Strongly Disagree" to "Strongly Agree" (1-7))*	
	TMSSPEC	I knew which group members had information about specific aspects of this assignment.
	TMSCRED	I was confident relying on the information that other group members brought to the discussion.
	TMSCOORD	Our group worked together in a well-coordinated fashion.
Task Knowledge (Time 1)	*Please answer the following questions to the best of your ability. I remind you, none of these responses will be made available to your instructors.*	
	TK1	What is a primary key?
	TK2	Which of the following conditions must be met in order to create a relationship?
	TK3	Which of the following types of relationships CANNOT be implemented in Microsoft Access?
	TK4	When is it a good idea for you to save your changes to a Microsoft Access database?
	TK5	Which of these tables might need a concatenated (or joint) primary key, consisting of more than one field?
	TK6	Where can you NOT add a field to a table in Microsoft Access?
	TK7	Should every table have a primary key?
	TK8	Which data type in Microsoft Access should be used to store a Customer's date of birth?
	TK9	Should every table have a foreign key?
	TK10	Where can you change the name of a field in Microsoft Access?
Task Knowledge (Time 2)	*Please answer the following questions to the best of your ability. I remind you, none of these responses will be made available to your instructors.*	

Construct	Item	Question
	TK1	Which of the following controls has a data source?
	TK2	Which type of control is a label?
	TK3	Is the number displayed in a calculated control stored in Microsoft Access?
	TK4	What does the Save Record button in a Microsoft Access form do?
	TK5	How do you change a control's data source in a Microsoft Access form?
	TK6	How might you indicate a required field in a Microsoft Access form?
	TK7	How can you insert an image into a form in Microsoft Access?
	TK8	What is the purpose of using a form?
	TK9	Which of the following can you NOT do within the Data Grid view in Microsoft Access?
	TK10	How can you display URL's as hyperlinks within a form in Microsoft Access?
Task Knowledge (Time 3)	*Please answer the following questions to the best of your ability. I remind you, none of these responses will be made available to your instructors.*	
	TK1	Which of the following controls has a data source?
	TK2	Which type of control is a command button?
	TK3	Is the number displayed in a calculated control stored in Microsoft Access?
	TK4	What does the Save Record button in a Microsoft Access form do?
	TK5	In which of the following views can you add a record to a Microsoft Access table?
	TK6	Can you change the font of a command button in a Microsoft Access form?
	TK7	How can you insert an image into a form in Microsoft Access?
	TK8	What is the purpose of using a form?
	TK9	Which of the following can you NOT do within the Design view in Microsoft Access?
	TK10	In which of the following views can you add a command button to a Microsoft Access form?

Construct	Item	Question
Task Knowledge (Time 4)	*Please answer the following questions to the best of your ability. I remind you, none of these responses will be made available to your instructors.*	
	TK1	What tool can you use to generate calculated fields in the Query By Example (QBE) grid?
	TK2	In order to use an aggregate function in a query, what must first be done in the Query By Example (QBE) grid?
	TK3	Which of the following logical operators IS NOT recognized by Microsoft Access?
	TK4	Which of the following conditions can be applied to a query in Microsoft Access?
	TK5	Which of the following IS NOT an aggregate function in Microsoft Access?
	TK6	Which of the following operations can be performed with queries, but not with filters?
	TK7	Which of the following SHOULD NOT be used as a criterion (condition) for a text field?
	TK8	Which of the following is a valid criterion for a query?
	TK9	Which of the following criteria could be used to report all leases which end in 2005 (i.e., have an EndDate in 2005)?
	TK10	Which of the following can be used to create a report in Microsoft Access?
Manipulation Checks	*Please answer the following questions regarding your experience working with your group on this assignment (anchored "To a Little Extent" to "To a Great Extent" (1-7))*	
	ENGSURV	To what extent were you actively engaged/involved in the completion of this survey?
	ENGTASK	To what extent were you actively engaged/involved in the completion of this assignment?
	FFMEET	To what extent did you meet face-to-face with your group members while working on this assignment?

Construct	Item	Question
	OTHERCT	To what extent did you use other collaborative technologies (such as email or instant messaging) to communicate with your group members while working on this assignment?

Appendix C: Task Grading Criteria

Task 1

TASK A – CUSTOMER TABLE

Task	Possible Points	Received Points
Enter field CustomerID	1	
Enter field Name	1	
Enter field Phone	1	
Enter field Street	1	
Enter field City	1	
Enter field State	1	
Enter field Zip	1	
CustomerID defined as Primary Key	1	
Total	8	

TASK B– ORDER TABLE

Task	Possible Points	Received Points
Enter field OrderNumber	1	
Enter field OrderDate	1	
Enter field SubTotal	1	
Enter field Tax	1	
Enter field TotalDue	1	
Enter field Commission	1	
Enter field CustomerID	1	
OrderNumber defined as Primary Key	1	
Total	8	

TASK C– ORDERLINE TABLE

Task	Possible Points	Received Points
Enter field OrderNumber	1	
Enter field ProductNumber	1	
Enter field QtySold	1	
Enter field PriceSold	1	
Enter field Discount	1	
Enter field TotalPrice	1	
Enter field Message	1	
OrderNumber and ProductNumber defined as Primary Key	1	
Total	8	

TASK D– PRODUCT TABLE

Task	**Possible Points**	**Received Points**
Enter field ProductNumber	1	
Enter field UnitPrice	1	
Enter field Description	1	
Enter field ProductName	1	
Enter field ProductType	1	
Enter field QtyOnHand	1	
Enter field VendorID	1	
ProductNumber defined as Primary Key	1	
Total	8	

TASK E– VENDOR TABLE

Task	**Possible Points**	**Received Points**
Enter field VendorID	1	
Enter field Name	1	
Enter field Phone	1	
Enter field Street	1	
Enter field City	1	
Enter field State	1	
Enter field Zip	1	
VendorID defined as Primary Key	1	
Total	8	

FINAL GRADING

Task	**Possible Points**	**Received Points**
Task A	8	
Task B	8	
Task C	8	
Task D	8	
Task E	8	
Sub-Total	40	
Relationships between tables in the final database (2.5 each)	10	
Total	50	
Adjusted Total ((Total / 50) * 5)	5	

Task 2

TASK A – CUSTOMER FORM

Task	**Possible Points**	**Received Points**
Form Created with all fields (if not all fields, take out half point)	1	
Clipart Inserted (Customer Form) (must be Customer Form clipart, if not number of points = 0)	1	
Background Color for CustomerID	1	
Background Color for Name	1	
Background Color for the required fields must be the same as the other forms (if not, take out half point)	1	
Note indicating the meaning of color change must be the same message as the other forms (if not take out half point)	1	
Total	6	

TASK B– ORDER FORM

Task	**Possible Points**	**Received Points**
Form Created with all fields (if not all fields, take out half point)	1	
Clipart Inserted (Order Form) (must be Order Form clipart, otherwise number of points = 0)	1	
Background Color for OrderNumber	1	
Background Color for OrderDate	1	
Background Color for the required fields must be the same as the other forms (if not, take out half point)	1	
Note indicating the meaning of color change must be the same message as the other forms (if not take out half point)	1	
Total	6	

TASK C– ORDERLINE FORM

Task	**Possible Points**	**Received Points**
Form Created with all fields (if not all fields, take out half point)	1	
Clipart Inserted (OrderLine Form) (must be OrderLine Form clipart, otherwise number of points = 0)	1	
Background Color for OrderNumber	1	
Background Color for ProductNumber	1	
Background Color for the required fields must be the same as the other forms (if not, take out half point)	1	
Note indicating the meaning of color change must be the same message as the other forms (if not take out half point)	1	
Total	6	

TASK D– PRODUCT FORM

Task	**Possible Points**	**Received Points**
Form Created with all fields (if not all fields, take out half point)	1	
Clipart Inserted (Product Form) (must be Product Form clipart, otherwise number of points = 0)	1	
Background Color for ProductNumber	1	
Background Color for VendorID	1	
Background Color for the required fields must be the same as the other forms (if not, take out half point)	1	
Note indicating the meaning of color change must be the same message as the other forms (if not take out half point)	1	
Total	6	

TASK E– VENDOR FORM

Task	**Possible Points**	**Received Points**
Form Created with all fields (if not all fields, take out half point)	1	
Clipart Inserted (must be Vendor Form clipart, otherwise number of points = 0)	1	
Background Color for VendorNumber	1	
Background Color for Name	1	
Background Color for the required fields must be the same as the other forms (if not, take out half point)	1	
Note indicating the meaning of color change must be the same message as the other forms (if not take out half point)	1	
Total	6	

FINAL GRADING

Task	**Possible Points**	**Received Points**
Task A	6	
Task B	6	
Task C	6	
Task D	6	
Task E	6	
Sub-Total	30	
Number of FORMs in the final database (2 each)	10	
Total	40	
Adjusted Total = ((Total / 40) * 5)	5	

Task 3

TASK A – CUSTOMER FORM

Task	Possible Points	Received Points
Add Button Created and Working	1	
Close Form Button Created and Working	1	
Font Color for buttons same as in other forms	1	
New Record Entered (see other Word file)	1	
Form appearance (does it look good?)	1	
Total	5	

TASK B– ORDER FORM

Task	Possible Points	Received Points
Add Button Created and Working	1	
Close Form Button Created and Working	1	
Font Color for buttons same as in other forms	1	
New Record entered with the appropriate information (see other Word file)	1	
Form appearance (does it look good?)	1	
Total	5	

TASK C– ORDERLINE FORM

Task	Possible Points	Received Points
Add Button Created and Working	1	
Close Form Button Created and Working	1	
Font Color for buttons same as in other forms	1	
New Record entered with the appropriate information (see other Word file)	1	
Form appearance (does it look good?)	1	
Total	5	

TASK D– PRODUCT FORM

Task	Possible Points	Received Points
Add Button Created and Working	1	
Close Form Button Created and Working	1	
Font Color for buttons same as in other forms	1	
New Record entered with the appropriate information (see other Word file)	1	
Form appearance (does it look good?)	1	
Total	5	

TASK E– VENDOR FORM

Task	**Possible Points**	**Received Points**
Add Button Created and Working	1	
Close Form Button Created and Working	1	
Font Color for buttons same as in other forms	1	
New Record entered with the appropriate information (see other Word file)	1	
Form appearance (does it look good?)	1	
Total	5	

FINAL GRADING

Task	**Possible Points**	**Received Points**
Task A	5	
Task B	5	
Task C	5	
Task D	5	
Task E	5	
Sub-Total	25	
Number of FORMs in the final database (2 each)	10	
Total	35	
Adjusted Total = ((Total / 35) * 5)	5	

Task 4

TASK A – CUSTOMERS OF GEORGIA

Task	**Possible Points**	**Received Points**
Query GA-CUSTOMERS Created and Working	1	
Clipart **"Customers of Georgia"** Inserted	1	
Color for labels the same as in other reports	1	
List all fields of the table	1	
List customers in Descending Order of CustomerID	1	
Total	5	

TASK B– PRODUCTS > US$ 1,000.00

Task	**Possible Points**	**Received Points**
Query PRODUCTS1000 Created and Working	1	
Clipart **"Products > Us$ 1,000.00"** Inserted	1	
Color for labels the same as in other reports	1	
List all fields of the table	1	
List products in Ascending Order of UnitPrice	1	
Total	5	

TASK C– ORDERS TOTAL DUE < US$ 4,000

Task	**Possible Points**	**Received Points**
Query ORDERS4000 Created and Working	1	
Clipart **"Orders Total Due < Us$ 4,000"** Inserted	1	
Color for labels the same as in other reports	1	
List all fields of the table	1	
List orders in Descending Order of TotalDue	1	
Total	5	

TASK D– PRODUCTS TYPE = A

Task	**Possible Points**	**Received Points**
Query PRODUCTA Created and Working	1	
Clipart **"Products Type = A"** Inserted	1	
Color for labels the same as in other reports	1	
List all fields of the table	1	
List products in Descending Order of ProductNumber	1	
Total	5	

TASK E– ORDERS CUSTOMER 905

Task	**Possible Points**	**Received Points**
Query ORDERSCUSTOMER905 Created and Working	1	
Clipart **"Orders Customer 905"** Inserted	1	
Color for labels the same as in other reports	1	
List all fields of the table	1	
List orders in Ascending Order of OrderDate	1	
Total	5	

FINAL GRADING

Task	**Possible Points**	**Received Points**
Task A	5	
Task B	5	
Task C	5	
Task D	5	
Task E	5	
Sub-Total	25	
Number of Reports in the final database (2 each)	10	
Total	35	
Adjusted Total = ((Total / 35) * 10)	10	

APPENDIX D: PATH COEFFICIENTS AND T-STATISTICS FOR PLS MODELS

Path	Path Coefficients				T-Statistics			
	Time 1	Time 2	Time 3	Time 4	Time 1	Time 2	Time 3	Time 4
EOI to TMS	0.208	0.300	0.337	0.280	2.467	4.391	4.594	3.837
EOI to CONF	-0.005	0.043	-0.043	0.060	0.069	0.539	0.518	0.805
EOI to PERF	0.299	-0.116	-0.028	0.155	1.947	1.821	0.386	1.741
EOI to CTSAT	0.024	0.121	0.117	0.027	0.351	1.706	1.760	0.324
EOI to COH	0.076	0.027	0.011	-0.024	1.199	0.649	0.212	0.505
TMS to CONF	-0.613	-0.691	-0.559	-0.617	13.706	15.825	7.624	9.540
TMS to PERF	0.037	0.230	0.077	0.061	0.289	3.668	1.242	0.799
TMS to CTSAT	0.584	0.486	0.563	0.536	10.013	8.054	6.980	7.384
TMS to COH	0.763	0.843	0.791	0.864	24.952	34.286	18.864	30.316
TKAK to TMS	1.072	0.475	0.781	0.796	3.403	2.809	2.659	2.850
TKRK to EOI	0.226	0.305	-0.293	0.246	1.978	1.685	1.879	1.179
TK to EOI	-0.004	0.007	0.025	-0.007	0.080	0.099	0.337	0.085
TK to TMS	-0.575	-0.122	-0.314	-0.350	2.123	0.800	1.320	1.384
AK to TMS	-0.172	0.119	0.187	-0.157	1.084	1.495	1.078	1.074
RK to EOI	0.028	-0.060	0.043	-0.049	0.510	0.346	0.265	0.231
Diversity to EOI	-0.170	-0.244	-0.116	0.080	2.127	2.765	0.734	0.609
CT to PERF	0.160	-0.160	-0.043	0.016	1.940	2.361	0.349	0.169
CT to AK	-0.440	0.587	0.750	-0.655	5.055	11.391	18.899	9.690
CT to RK	-0.488	-0.347	0.372	0.301	6.656	4.773	4.726	3.789

APPENDIX E: QUESTIONS, LOADINGS/WEIGHTS, AND RELIABILITIES

Item	Question	Mean	S.D.	CFA Loading (Time 1)	CFA Loading (Time 2)	CFA Loading (Time 3)	CFA Loading (Time 4)	PLS Loading / Weight (Time 1)	PLS Loading / Weight (Time 2)	PLS Loading / Weight (Time 3)	PLS Loading / Weight (Time 4)	Composite Reliability (avg)	Alpha (avg)
Conflict (reflective)												**0.9915**	**0.9552**
	Please answer each of the following questions regarding your experience working with your group on the assignment (anchored "Not at All" to "A Lot" (1-7))												
RCONF1	How much tension was there in your team?	2.31	1.53	0.8714	0.7704	0.8867	0.9014	0.9413	0.9277	0.922	0.9332		
RCONF2	How often did people get angry while working in your team?	2.08	1.44	0.8264	0.8662	0.9189	0.9571	0.9064	0.9406	0.9348	0.9519		
RCONF3	How much conflict was there in your team?	2.15	1.44	0.86	0.8793	0.9236	0.9612	Dropped					
TCONF1	How much conflict of ideas was there in your team?	1.96	1.3	0.7684	0.9142	0.9043	0.8733	0.9021	0.9214	0.9185	0.9379		
TCONF2	How frequently did you have disagreements within your team about the task of the assignment you were working on?	1.96	1.33	0.8388	0.9033	0.8983	0.948	Dropped					
TCONF3	How often did people in your team have conflicting opinions about the assignment you were working on?	1.98	1.3	0.8135	0.8795	0.8511	0.8765	0.8877	0.9229	0.9145	0.9445		
Cohesion (reflective)												**0.9834**	**0.9017**
COH1	Did you feel you were a part of your group during this assignment? (anchored "Didn't Feel I Belonged at All" to "Really a Part of My Group" (1-5))	Dropped											

Item	Question	Mean	S.D.	CFA Loading (Time 1)	CFA Loading (Time 2)	CFA Loading (Time 3)	CFA Loading (Time 4)	PLS Loading / Weight (Time 1)	PLS Loading / Weight (Time 2)	PLS Loading / Weight (Time 3)	PLS Loading / Weight (Time 4)	Composite Reliability (avg)	Alpha (avg)
COH2	If you had a chance to do the same kind of work in another group, how would you feel about moving? (anchored "Would Want Very Much to Move" to "Would Want Very Much to Stay Where I Am" (1-5))	3.39	1.17	0.708	0.675	0.6476	0.6573	0.893	0.8944	0.8538	0.9053		
	How did this group compare to other groups on each of the following points? (anchored "Very Much Worse" to "Very Much Better" (1-5))												
COH3	Getting along together	3.3	0.85	0.7998	0.82	0.8851	0.8879	0.8831	0.9188	0.91	0.9523		
COH4	Working together	3.08	1.01	0.9143	0.9012	0.9396	0.9538	Dropped					
COH5	Helping each other	3.12	1.02	0.8737	0.8803	0.9318	0.912	0.911	0.9149	0.9368	0.9476		
Satisfaction with Outcome (reflective)												**0.9957**	**0.97**
	Please answer each of the following questions regarding your experience working with your group on the assignment. (anchored "Strongly Disagree" to "Strongly Agree" (1-7))												
CHIDSAT1	Overall, I was personally satisfied with this group's performance during this assignment	4.69	1.83	0.935	0.9171	0.9427	0.9687	Dropped					
CHIDSAT2	This group produced effective results during this assignment	4.82	1.75	0.9381	0.9554	0.9605	0.9623	Dropped					
CHIDSAT3	This group produced valuable results during this assignment	4.77	1.76	0.9074	0.9323	0.9477	0.9571	Dropped					
CHIDSAT4	I agreed with the decisions made by this group during this assignment	5.05	1.64	0.8452	0.8414	0.8932	0.888	Dropped					
CHIDSAT5	Overall, the quality of this group's output was high during this assignment	4.72	1.8	0.9447	0.9482	0.9323	0.9689	Dropped					
Satisfaction with CT (reflective)												**0.9868**	**0.9505**
	Please answer the following questions regarding your experience using the CT during the assignment.												

Item	Question	Mean	S.D.	CFA Loading (Time 1)	CFA Loading (Time 2)	CFA Loading (Time 3)	CFA Loading (Time 4)	PLS Loading / Weight (Time 1)	PLS Loading / Weight (Time 2)	PLS Loading / Weight (Time 3)	PLS Loading / Weight (Time 4)	Composite Reliability (avg)	Alpha (avg)
CTSAT1	Please assess how satisfactory you found the CT to be in meeting your collaboration needs for this assignment. (anchored "Very Unsatisfactory" to "Very Satisfactory" (1-7))	4.96	1.74	0.8939	0.9195	0.9384	0.932	0.9603	0.9656	0.9755	0.9671		
CTSAT2	To what extent did the CT help you collaborate with your group members on this assignment? (anchored "To a Little Extent" to "To a Great Extent" (1-7))	5.01	1.67	0.9407	0.9302	0.9462	0.9582	0.9706	0.9747	0.9799	0.9757		
CTSAT3	How well did the CT meet your needs for collaborating with your group members on this assignment? (anchored "Not at All" to "Very Well" (1-7))	4.99	1.66	0.9446	0.9628	0.9554	0.9294	Dropped					
Knowledge of Additive CT Capabilities (formative)												**N/A**	**N/A**
	Please answer the following questions about the CT (anchored "Strongly Disagree" to "Strongly Agree" (1-7))												
CTADDKNW1	The CT has tools (e.g., calendar, member monitoring) which can aid me in tracking the people, projects, and priorities within my group.	4.51	1.76	N/A	N/A	N/A	N/A	-0.3225	0.6023	0.4392	-0.3471		
CTADDKNW2	Using the CT, I can easily retrieve messages and files I posted or my group members posted.	5.59	1.49	N/A	N/A	N/A	N/A	1.1047	-0.8417	1.2113	0.8345		
CTADDKNW3	The CT has tools (e.g., voting, ranking) which can aid my group in making decisions.	4.24	1.86	N/A	N/A	N/A	N/A	-0.1788	0.6109	-0.3818	-0.6022		

Item	Question	Mean	S.D.	CFA Loading (Time 1)	CFA Loading (Time 2)	CFA Loading (Time 3)	CFA Loading (Time 4)	PLS Loading / Weight (Time 1)	PLS Loading / Weight (Time 2)	PLS Loading / Weight (Time 3)	PLS Loading / Weight (Time 4)	Composite Reliability (avg)	Alpha (avg)
Knowledge of Reductive CT Capabilities (formative)												**N/A**	**N/A**
	Please answer the following questions about the CT (anchored "Strongly Disagree" to "Strongly Agree" (1-7))												
CTREDKNW1	Using the CT, I can post a message or file without my group members knowing who posted it.	4.28	1.99	N/A	N/A	N/A	N/A	0.855	0.2462	-0.1558	0.2064		
CTREDKNW2	Using the CT, I can post messages or files whenever I want.	5.9	1.34	N/A	N/A	N/A	N/A	0.1801	0.2659	-0.3127	-0.6382		
CTREDKNW3	Using the CT, I can get immediate (real-time) feedback from my group members.	3.64	1.93	N/A	N/A	N/A	N/A	-0.3651	-0.8191	0.8215	0.5976		
Transactive Memory System (formative)												**N/A**	**N/A**
	Please answer each of the following questions regarding your experience working with your group on this assignment. (anchored "Strongly Disagree" to "Strongly Agree" (1-7))												
TMSSPEC	I knew which group members had information about specific aspects of this assignment.	4.41	1.88	N/A	N/A	N/A	N/A	0.0349	0.1392	-0.0414	-0.0221		
TMSCRED	I was confident relying on the information that other group members brought to the discussion.	4.69	1.83	N/A	N/A	N/A	N/A	0.4188	0.245	0.4449	0.5743		
TMSCOORD	Our group worked together in a well-coordinated fashion.	4.39	1.88	N/A	N/A	N/A	N/A	0.5885	0.6642	0.6161	0.4696		

APPENDIX F: PLS WEIGHTS FOR INTERACTION TERMS

In order to model the interaction hypotheses (H1 and H3) in PLS, interaction terms were created. TKAK was created from the product of Task Knowledge and Knowledge of Additive CT Capabilities and TKRK was created from the product of Task Knowledge and Knowledge of Reductive CT Capabilities. These interaction terms were modeled as formative indicators, as the constituent items measured knowledge of different CT capabilities. The PLS weights for these interaction terms are shown in the table below.

Item	Created as	PLS Weight (Time 1)	PLS Weight (Time 2)	PLS Weight (Time 3)	PLS Weight (Time 4)
TKAK					
TKAK1	Task Knowledge * CTADDKNW1	0.0393	0.4121	0.0113	0.3100
TKAK2	Task Knowledge * CTADDKNW2	0.9328	0.9060	1.2113	1.0478
TKAK3	Task Knowledge * CTADDKNW3	0.0471	-0.3725	-0.3818	-0.5151
TKRK					
TKRK1	Task Knowledge * CTREDKNW1	1.3557	0.7949	-0.6106	-0.1858
TKRK2	Task Knowledge * CTREDKNW2	-1.3435	0.3690	-0.2998	1.2582
TKRK3	Task Knowledge * CTREDKNW3	0.5830	-1.1760	1.2197	-1.0685