TESTING THE INFLUENCE OF COLLECTIVE EFFICACY BELIEFS ON GROUP LEVEL PERFORMANCE METRICS: AN INVESTIGATION OF THE VIRTUAL TEAM EFFICACY—PERFORMANCE RELATIONSHIP IN INFORMATION SYSTEMS PROJECT MANAGEMENT TEAMS

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Abstract

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Virtual teams are a valuable resource for many organizations. As the utilization of distributed teams by organizations increases, so does the need to better understand their mechanisms and ultimate performance. While numerous theoretical frameworks have been employed by researchers interested in the performance of virtual teams, one framework that has not been applied is social cognitive theory (SCT). The failure to apply SCT in virtual team research is regrettable as the triadic reciprocal relationship of the person, the environment, and the behavior may provide a theoretical framework broad enough to encompass many of the previously established virtual team success factors, allowing for the development of a more comprehensive model of virtual team performance. Central to the person component of the SCT framework is the concept of collective efficacy—or a belief in a team's collective abilities—which can be used as a centerpiece in such a model of virtual team performance. In this research, a measure of virtual team efficacy—a domain specific measure of collective efficacy—is validated using established psychometric and instrument validation procedures. A conceptual

model is then proposed relating virtual team efficacy to factors known to influence virtual team performance. A theoretically developed research model of virtual team efficacy is also developed and tested. At the group level of analysis, over 46% of the variance in actual performance was accounted for. In addition, virtual team efficacy was found to exert a significant positive influence on the established virtual team success factors of trust and communication. These findings reveal that the concept of virtual team efficacy is an important component missing from many studies of virtual team performance.

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Chapter 1 – Introduction

This chapter introduces the dissertation. First a discussion of virtual teams and their importance to modern organizations is presented. Second, definitions important to the dissertation are introduced. Third the research questions associated with the study are stated and explained. Fourth the theoretical importance and practical relevance of the research is considered. Fifth, the structure of the dissertation is presented. Lastly, the chapter is summarized.

1.1 Introduction

Organizations continue to employ virtual teams (Townsend, DeMarie and Hendrickson 1998). The trend of employing teams of individuals who are geographically distributed is not only predicted to continue, but to also grow (Lipnack and Stamps 2000). Among the many reasons for this trend are savings associated with travel costs, taking advantage of the most talented employees regardless of location (Duarte and Snyder 2001), and the ability to form teams comprised of members from multiple organizations (Cairncross 2001). Providing a specific example of the cost savings realized through the use of virtual teams, Microsoft's vice president of real time collaboration reports that by replacing one in every five face-to-face meetings, a savings of $70 million in travel costs can be realized in a single year (Lohr 2004).

Based on obvious benefits such as the one experienced by Microsoft, virtual teams continue to grow in importance at many organizations. Because of this growing importance, information systems researchers continue their investigation into the various factors that may be related to virtual team performance. Trust (Jarvenpaa and Leidner

1999; Jarvenpaa, Shaw and Staples, 2004; Paul and McDaniel 2004), conflict management (Montoya-Weiss, Massey and Song 2001; Maruping and Agarwal 2004), leadership (Kayworth and Leidner 2002), temporal constraints (Massey, Montoya-Weiss and Hung 2003), communication (Davison, Fuller and Hardin 2003; Jarvenpaa et al. 2004), and behavioral control (Ives and Piccoli 2003), have all been demonstrated to have a positive influence on the performance of technology-mediated groups working across time and space. In addition, various outcome variables have also been investigated, including technology adaptation (Majchrzak, Rice, Malhotra, King and Ba 2000), decision effectiveness (Schmidt, Montoya-Weiss and Massey 2001), decision quality (Montoya-Weiss, Massey and Song 2001), leadership effectiveness (Kayworth and Leidner 2002), team performance (Sarker and Sahay 2003), and negotiation agreement (Davison, Fuller and Hardin 2003).

While these studies clearly illustrate the plurality of research that exists in the area of virtual teams, a theoretically based model broad enough to capture the potential relationships among the many factors established as predictors of virtual team performance has yet to be proposed. One factor that may be limiting such an undertaking is the proposal of an applicable theoretical framework broad enough to support such a model.

One suitable framework that may be broad enough to support this type of model is social cognitive theory (SCT). SCT presents an ideal meta-theoretical basis from which a small t-theory can be developed relating the previously established virtual team success factors. Specifically, these factors can be included within a theoretically developed model of virtual team performance in terms of the person, the environment and the behavior

elements of SCT. Further, given that the virtual team context relies on groups of individuals performing as teams, collective efficacy—an integral component of SCT—can be used as a centerpiece in such a model. Providing evidence towards the suitability of the collective efficacy construct as a centerpiece in such a model is the previously established relationship between collective efficacy and many of the virtual team success factors identified by information systems researchers. For example, Bandura (1997) has suggested that how groups and their activities are structured (e.g., temporal constraints), how groups are led (e.g., leadership) and whether members interact without undermining each other (e.g., communication, trust), all contribute to the interactive effects influencing, or influenced by, collective efficacy. Additional evidence towards the viability of such a model is provided by previous research findings relating collective efficacy to traditional group performance, and the theoretical connections between virtual teams and traditional groups (Jarvenpaa et al. 1999).

1.2 Definitions

Before a discussion of the research questions associated with this dissertation is presented, it is important to establish our definition of virtual teams. In addition, an explanation is presented regarding the use of the terms "team" and "group" in this study. Both are discussed separately below

1.2.1 Virtual Teams

In the process of defining virtual team efficacy, an additional complexity arises through the competing definitions of virtual teams presented in the academic and practitioner literature. Lipnack and Stamps (2000, p. 18) for example define virtual teams

as “a group of people who work interdependently with a shared purpose across space, time, and organization boundaries using technology.” Duarte and Snyder (2001, p. 13), although not strictly posing a definition, state “Virtual teams, unlike traditional ones, however must accomplish this by working across distance, time, and/or organizational boundaries and by using technology to facilitate communication and collaboration.” Alternatively, Schmidt, Montoya-Weiss and Massey (2001) state that “virtual teams can be described as dispersed across space and time, with members brought together through communication technologies to complete a task.” Montoya-Weiss, Masey and Song (2001, p. 1251) interestingly define *global* virtual teams in much the same manner, “A global virtual team is a group of geographically and temporally dispersed individuals who are assembled via technology to accomplish an organizational task” and cite Jarvenpaa, Knoll and Leidner (1999) and Townsend, De Marie and Hedrickson (1998) in support. Jarvenpaa and Leidner (1999, p. 791) however add an additional cultural component to the definition of virtual teams “The concept of virtual implies permeable interfaces and boundaries; project teams that rapidly form, reorganize, and dissolve when the needs of a dynamic marketplace change; and individuals with differing competencies who are located across time, space and cultures.” Davison, Fuller and Hardin (2003) in their study of e-negotiations in virtual teams also implicate a cross-cultural component by using the definition of virtual teams purported by Maznevski and Chudoba (2000, p. 473) "Global virtual teams are groups that (a) are identified by their organization(s) and members as a team; (b) are responsible for making and/or implementing decisions important to the organization's global strategy; (c) use technology-supported communication substantially more than face-to-face communication; and (d) work and live in different countries.” In

the current study, we base our definition on the literature above and define virtual teams as:

> *A virtual team is a group of people, often culturally diverse, most of who are not collocated, who work interdependently with a shared purpose across space, time, and organizational boundaries using technology.*

1.2.2 Teams versus Groups

While some authors have attempted to define differences between teams and groups, in the current study, we use the terms "team" and "group" interchangeably. The following quotation by Parks and Sanna (1999) illustrates the similarities in the definitions of these respective entities by some group researchers:

> *We favor the approach taken by Guzzo and Dickson (1996), who, rather than deal with the nuances of team versus group, proposed a general definition of a work group as a distinct collection of interdependent individuals who are part of a larger system and who perform tasks that affect others involved in the system. This definition encompasses just about all of the various types of teams that have been described in the research literature, yet also describes the types of groups we have been discussing throughout this book. To this end, then, the study of teamwork is really just the study of work group performance (Parks and Sanna 1999, p. 151).*

1.3 Research Questions

This study is guided by five research questions. Each question is discussed individually below.

RQ1: What is Virtual Team Efficacy?

Although a litany of research has been conducted in the area of virtual teams (e.g., Jarvenpaa and Leidner 1999; Kayworth and Leidner 2002; Sarkar and Sahay 2003, Davison, Fuller and Hardin 2003), no research that we are aware of has examined virtual teams in terms of SCT or the collective efficacy perceptions of team members. Although much of the research involving SCT and efficacy has focused on individual human agency, Bandura (1997) has called for the further investigation of efficacy at the group level of analysis. This call has been made primarily in an attempt to address the growing interdependence of human interaction. Bandura's (1997) recommendation for the continued investigation of the group level phenomena associated with efficacy beliefs has been acknowledged by researchers conducting studies that have been reported in various literatures, including the areas of management, education, sports, and small groups. Within the management literature for example, collective efficacy—or the collective belief in the group's ability—has been suggested to influence a number of factors, including team satisfaction and performance (e.g., Gibson, Randel and Earley 2000).

Although collective efficacy has not been applied within virtual teams, it has often been used to study the behavior of teams that are collocated (Gibson 1999; Gibson et al. 2000; Zellars, Hochwarter, Perrewe, Miles and Kiewitz 2001). Given that virtual teams must still function as teams, and the growing trend of applying established collocated team success factors within such an environment (Jarvenpaa et al. 2004), the

application of collective efficacy within a virtual team context makes sense conceptually. Specifically, it is important for academic researchers to understand how collective efficacy may differ in its influence on the performance of non-collocated teams versus collocated teams, and further, how the established virtual team success factors may react in such a model.

Virtual team efficacy represents a domain specific application of the broader concept of collective efficacy. That is, collective efficacy is a general term used to refer to more specific constructs used to measure a group's belief in its ability to perform in a specific domain or context. In the current case, the context of interest is virtual teams and therefore, we use the term *virtual team efficacy*.

RQ2: What are the antecedents of Virtual Team Efficacy?

Bandura (1997) introduces enactive mastery, vicarious experience, verbal persuasion, and physiological and affective states as four potential sources of efficacy information. While recognizing the significance of the sources of efficacy information suggested by Bandura, we are also cognizant that other variables may act as antecedents to efficacy beliefs (Marakus, Yi and Johnson 1998). This research will attempt to categorize specific antecedent variables, and further, establish their placement within the boundaries of the virtual team efficacy conceptual framework. For example, since virtual team efficacy beliefs are developed in a technological environment, the ability to use technology is necessary and as such, a measure of computer collective efficacy will be considered in the dissertation research model. Additionally, as the need to work collectively is also a necessary condition for virtual team efficacy beliefs to develop, group potency is also considered.

Other potential antecedent variables include the previously established virtual team success factors identified by academic researchers. The influence of these variables on the collective efficacy beliefs of virtual teams will be discussed in detail in later chapters.

RQ3: What is the influence of Virtual Team Efficacy on performance?

Research question three represents the fundamental question addressed in this dissertation. Without establishing the influence of collective efficacy beliefs on virtual team performance, the remaining research questions being proposed are both uninteresting and unimportant. The impact of collective efficacy beliefs on team performance has been routinely established by academic researchers however, the influence of group efficacy beliefs on technology-mediated, distance-based teams has to our knowledge not been previously investigated. This represents a gap in the scientific inquiry of both collective efficacy and virtual teams, as it cannot be assumed that collective efficacy beliefs will influence the performance of virtual teams in the same manner as traditional teams. Further, given collective efficacy's known influence on collocated group performance, it would be naïve to assume that efficacy beliefs will have no influence on virtual team performance, and thus to exclude it from consideration.

This research will attempt to take the first step in examining the effects of efficacy beliefs on the performance of technology-mediated, geographically-distributed teams. This examination will involve measures of both perceived and actual performance. Once this relationship has been initially investigated, further research can be conducted (provided a positive relationship is established between efficacy and performance) to further refine the virtual team efficacy theoretical model.

RQ4: What variables mediate the Virtual Team Efficacy – performance relationship?

Previous efficacy research has identified that cognitive, motivational, affective, and situational processes may mediate the relationship between self-efficacy perceptions and performance (Bandura 1997; Locke 1986; Marakus, Yi and Johnson 1998). Given that collective efficacy beliefs are proposed to operate on the same socio-cognitive principals as do self-efficacy beliefs, these mediating processes may also influence models of efficacy at the collective level. Therefore, this dissertation takes the first step in analyzing the influence of potential mediating factors in the virtual team efficacy-performance relationship. This adds additional importance to this work as most efficacy research, while acknowledging that these mediating processes are important to the efficacy – performance relationship, have rarely explicitly considered such factors (Bandura 1997).

RQ5: What influence will the previously established virtual team success factors have within a theoretical model of virtual team efficacy?

As mentioned in the introduction, the interactive effects of previously established virtual team success factors and collective efficacy have been acknowledged (Bandura 1997). While we have recognized that some success factors may act as antecedents and/or mediators in a model of virtual team efficacy, other success factors may act as outcomes, environmental influences, or even partial mediators. For example, in the current study team trust and communication level are investigated within a larger model of virtual team efficacy. While trust has been shown to be important in virtual team development (Jarvenpaa et al. 1999), it has also been proposed that trust has an equivocal influence on

actual performance (Jarvenpaa et al. 2004). Therefore, rather than place trust as a mediator of the virtual team efficacy—performance relationship, it was placed as a potential outcome of virtual team efficacy. Team communication level is also investigated. Communication level has been shown to influence virtual team performance (Jarvenpaa et al. 2004) however its role within a model of virtual team efficacy has not been previously investigated. In this dissertation it will be proposed that a virtual team's collective efficacy will influence that same team's willingness to use communication technology to work together in a virtual environment. The role of team trust and communication level within the research model will be discussed in some detail in Chapter 3.

1.4 Theoretical and Practical Relevance of the Research

The proposed research is relevant and important to both academia and practice. In terms of academia, the application of collective efficacy within a virtual team context represents an important contribution to the information systems discipline. Though there has been some research involving the collective efficacy of electronic work groups (Salanova, LLorens, Cifre, Martinez and Schaufeli 2003), collective efficacy research involving geographically dispersed virtual teams is noticeably absent from the information systems literature. This lack of attention is regrettable due to the known positive relationship between collective efficacy and collocated team performance (e.g., Early 1999), and the similarities between traditional and virtual teams (Jarvenpaa et al. 1999). Further, although computer efficacy has been studied at the individual level (e.g., Compeau and Higgins 1995a) the computer efficacy of collectives has largely been ignored. This neglect exists even though the use of collaborative technology by groups

has repeatedly been addressed by IS researchers (Griffith, Fuller and Northcraft 1998; Nunamaker, Dennis, Valacich, Vogel and George 1991).

Problems associated with the measurement of collective efficacy (Jung and Sosik 2003) including those specific to the measurement of collective efficacy among teams who are unable to physically meet (Gibson, Randel and Earley 2000), are also addressed. This is also an important contribution to academia as the problems with the measurement of collective efficacy have previously been acknowledged (e.g., Whiteoak et al. 2004).

Finally, once the role of collective efficacy beliefs in virtual team performance is established, additional research will be needed to identify and/or develop technological solutions that can be used to build the collective efficacy of virtual teams. The investigation of such potential technology mediated intercessions is consistent with the study of the IT artifact as suggested by Benbasat and Zmud (2003).

In terms of practical significance, the development of a theory to explain the relationship between virtual team efficacy perceptions and performance will provide organizational managers with an additional tool for diagnosing virtual team performance. Further, if virtual team efficacy is found to directly determine virtual team performance, managers can use that information to more successfully structure, lead, and monitor virtual teams. For example, managers may be instructed on how to construct technology delivered interventions based upon the previously established antecedents of efficacy as a method for improving the performance of geographically dispersed virtual teams. In addition, this research will address the relationship of virtual team efficacy beliefs to established success factors such as trust and communication level. Possessing the

knowledge that virtual team efficacy beliefs may have a positive influence on such factors will allow managers to target these factors through the efficacy of teams.

1.5 Structure of the Dissertation

Chapter 1 provides an introduction to the dissertation. During the introduction, important definitions are presented, and the research questions associated with the dissertation are discussed in some detail. Further the implications and the relevance of the research are discussed in terms of both academic research and practice. Chapter 2 provides a detailed review of the relevant prior literature for virtual teams and the concept of efficacy with the framework of social cognitive theory. Chapter 3 introduces the conceptual model and then provides a discussion of the research model and its associated hypotheses. Chapter 4 presents the research methodology and the construct definitions. Chapter 5 discusses the instrument development procedures and the analyses and results associated with the research model. Finally, Chapter 6 provides a discussion of the results of the analyses, and also explicates the limitations and future research. Table 1-1 shows the list of chapters and relevant topics.

Chapter #	Chapter Description
Chapter 1	Introduction, definitions, research questions, implications, structure of dissertation
Chapter 2	Review of relevant prior virtual team, social cognitive theory, self-efficacy and collective efficacy literature
Chapter 3	Conceptual model, research model, and hypotheses
Chapter 4	Research methodology and procedures
Chapter 5	Instrument development procedures and analyses results
Chapter 6	Discussion, limitations, and future research
Appendix A	Support of Group Level Aggregation
Appendix B	Survey Instrument 1
Appendix C	Survey Instrument 2
Appendix D	Survey Instrument 3
Appendix E	Final Instrument Items

Table 1-1 Dissertation Structure

1.6 Summary

This chapter has provided a brief introduction to the dissertation topic, important definitions, a discussion of the research questions, an iteration of the implications and relevance of the research, and the structure of the dissertation document. Next, Chapter 2 provides a literature review for the relevant virtual team, social cognitive theory, and self and collective efficacy literatures.

Chapter 2 – Significant Prior Research

This chapter provides an overview of the significant prior research in the areas of Social Cognitive Theory (SCT) and virtual teams. Within the review of SCT, both the self and collective efficacy literatures are considered and discussed at length. The consideration of both the self-efficacy and collective efficacy literatures is necessary due to the known similarities of the socio-cognitive mechanisms associated with these constructs (Bandura 1997), and the greater body of literature associated with self-efficacy. The review of the virtual team literature is presented as supporting evidence for the suitability of SCT as a theoretical framework for studying virtual teams.

This chapter is structured as follows. First the definition of virtual teams presented in chapter one is reviewed. Second a discussion of the virtual team literature is presented. Third, SCT is discussed. Fourth, the self-efficacy and collective efficacy literature is considered. Fifth, the terminology and measurement of collective efficacy is reviewed. Lastly, a summary of the chapter is presented.

2.1 Virtual Teams

An extensive body of virtual team research has been reported within the academic literature (Manzevski and Chudoba 2000). An exhaustive review of this literature would be counterproductive however, as the focus of this dissertation is on the application of SCT, and specifically the concept of collective efficacy, to virtual teams. It is important, however, to establish why SCT, and more specifically collective efficacy, represents a suitable theoretical framework for studying virtual teams, and further, how the established virtual team success factors may be affected by a theoretical model of virtual

team efficacy. That is, it is important to establish how the existing virtual team success factors identified by previous researchers may fit within the theoretical framework proposed in this dissertation. Thus, the following literature review of the virtual team literature is presented.

2.1.1 Definition

Before embarking on a dilation of the virtual team literature, it is important to once again establish our working definition of virtual teams. In line with the discussion included as part of Chapter 1, we define virtual teams as:

> *A group of people, often culturally diverse, most of who are not collocated, who work interdependently with a shared purpose across space, time, and organizational boundaries using technology.*

2.1.2 Relevance of SCT and Collective Efficacy to Virtual Teams

To lay the groundwork for the review of the virtual team literature it is important to provide a brief discussion of SCT and its associated framework. Although this triadic relationship will be discussed in some detail during the review of SCT, it is important at this juncture to further support the suitability of SCT and collective efficacy as a theoretical framework for studying virtual teams.

SCT is represented by the triadic reciprocal relationship of the person, the environment, and the behavior (Bandura 1982; 1986; 1997). Bandura argues that social theories claiming human behavior is driven by environmental factors, and social theories purporting the sole influence of human cognition on human behavior, are incomplete (Bandura 1978). Rather, Bandura states that human behavior is shaped by both the

environment and the person and further, that the environment and the person are in turn influenced by behavior in a triadic reciprocal fashion. There is much empirical evidence to support Bandura's assertions and examples of this evidence will be discussed in greater detail later in this chapter. However, for our current purposes the triadic relationship put forth by Bandura provides the theoretical lens for examining virtual teams in terms of their behavior, their environment, and their collective cognitions (i.e., the person).

Playing a central role in the SCT framework, as well as a major role in the current dissertation, is efficacy. Efficacy is represented as a cognitive function within the person element in the SCT triadic relationship, and has been established repeatedly as a substantial predictor of performance, or specifically in terms of the triadic relationship, behavior. For the purposes of the current work, (due mainly to the interdependence of the task), collective efficacy is the cognitive variable of interest within the person entity, and plays a crucial role in the establishment of SCT as a viable framework for the study of virtual teams. The apparent contradiction in the last statement should not go unnoticed. That is, that collective efficacy acts as a cognitive function within the person entity of the SCT framework. Yet this is precisely what Bandura has proposed, specifically, that a collective cognition takes place within the group which leads to common conceptions of efficacy. Bandura further proposes that this collective cognition is greater than the sum of the individual efficacies or abilities of the individual members (Bandura 1986; 1997).

Providing perhaps the most direct evidence of the relevance of SCT and collective efficacy beliefs for examining virtual team performance is the noticeable similarities between factors known to influence, or be influenced by, collective efficacy (Bandura

1997) and the factors shown to influence virtual team performance. Specifically, Bandura states that how groups and their activities are structured (e.g., temporal constraints), how groups are led (e.g., leadership) and whether members interact without undermining each other (e.g., communication, trust), all contribute to the interactive effects that influence collective efficacy. Further, as will be argued in later chapters, collective efficacy may also influence these same factors in a reciprocal fashion. Figure 2-1 graphically illustrates these relationships.

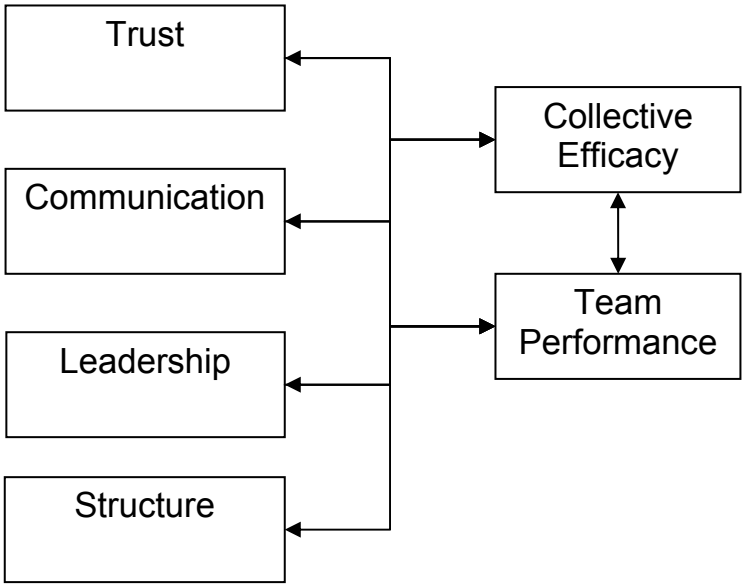

Figure 2-1 Relationship of collective efficacy to team performance factors

Based on Figure 2-1 we can see that several of the same factors previously established as predictors of virtual team performance have also been suggested to be influential within models of collective efficacy. While additional factors may also have a role in models of virtual team efficacy, because of the specifically acknowledged relationship between collective efficacy and trust, leadership, communication, and structure, the review of the virtual team literature will focus specifically on these factors. The first factor to be reviewed is trust.

2.1.2.1Trust

Trust has been studied often by IS researchers interested in the dynamics of virtual teams (e.g., Ives and Piccoli 2003; Jarvenpaa and Leidner 1999; Paul and McDaniel 2004). The influence of trust on virtual team performance represents a natural extension of the trust research as trust has been previously shown to influence various forms of organizational performance (Mayer et al. 1995).

One of the most widely cited papers in terms of the application of trust to virtual teams, is based on the work of Jarvenpaa and Leidner (1999). In their 1999 study, Jarvenpaa and Leidner investigated the challenges associated with creating and maintaining trusting relationships within a virtual team environment. To address these challenges, the authors attempted to integrate the literature on work teams, computer mediated communication, cross-cultural communication, and both interpersonal and inter-organizational trust.

Noting the difficulties of building trust within temporal, dispersed teams, who lack a shared social context, Jarvenpaa and Leidner (1999) acknowledge that prior literature would suggest that trust should not exist in such a context. More specifically, the authors suggest that based on McGrath's (1991) Time, Interaction, and Performance (TIP) theory, virtual teams would need to progress through each of the four modes (inception and acceptance, problem solving, conflict resolution, and execution respectively) to be successful, yet in virtual teams the use of communication technology may impede the virtual team's functions and modes, inhibiting trust development. The authors' further site similar limiting factors based on theories of media-richness and social identification. However, regardless of such impediments, the authors remain

steadfast in their assertion that trust is crucial for overcoming the high levels of uncertainty associated with the global and technology based environments of virtual teams.

To conduct their investigation, Jarvenpaa and Leidner (1999) based their case study analysis on data collected from electronic mail archives and questionnaires generated from three hundred and fifty master's students during a multi-country virtual team project. Three separate deliverables were required as part of the virtual team assignment. The first two assignments were individual based deliverables consisting of an introduction and a one paragraph analysis of an existing web presence. The third deliverable was the proposal and development of a WWW site providing a service to IS World Net and was to be a mutual effort of each team. The technology used for communication was electronic mail. The measures used for the study were based on studies of trust reported by Mayer (1995) and Pearce et al. (1992).

Statistical analyses were used to classify teams into four categories of trust at time 1 and time 2. The categories used by Jarvenpaa and Leidner (1999) were, low-low, low-high, high-low, and high-high where low was representative of below the mean level of trust for all teams, and high representing above the mean. Following this categorization, three teams were selected from each category and used for an in-depth case analysis. Results revealed that specific communication patterns facilitated team trust, and further, that although trust was found to exist among the temporary virtual teams, it was fragile, and in a form more consistent with "swift trust" as suggested by Meyerson, Weick and Kramer (1996).

Ives and Piccoli (2003) also studied trust in virtual teams using behavioral control as a theoretical framework. Using a methodology similar to that used by Jarvenpaa and Leidner (1999) the authors used statistical analyses to evaluate the data collected from the pre and post-test team trust questionnaires. Specifically, the authors selected ten of the 51 teams for a case study analysis. From this qualitative analysis the authors found that perceptions of incongruence and reneging, two components associated with behavioral control, led to trust decline, and that conversely team trust was maintained in those teams experiencing no instances of incongruence or reneging. This finding also held in teams where instances of incongruence or reneging went undetected. The authors relied on previous research for the establishment of the relationship between trust and performance and made no attempt to make such a connection in their work.

A recently published paper by Paul and McDaniel (2004) further investigated the role of trust in virtual teams. In that paper, the authors used facet theory as a theoretically based methodology to investigate the influence of four types of interpersonal trust on virtual team performance. Through the study of 10 telemedicine projects the authors found that three main types of interpersonal trust, calculative, competence, and relational, were positively related to performance. While these three types of trust are similar to the trustworthiness constructs of benevolence, integrity, and ability reported by Mayer (1995), the authors suggest that unlike previous trust research, trust was only positively related to performance when all three types of trust were present.

While other studies of trust have been reported in the virtual team literature (e.g., Morris, Marshall and Rainer 2002; Jarvenpaa et al. 2004), the three studies outlined above represent some of the most well-known and most recent works. The work cited

above clearly establishes the importance of trust in virtual teams, and the importance of trust's relationship to collective efficacy beliefs will be established in the theory development chapter.

2.1.2.2 Communication

Communication has also been shown to influence the effectiveness of virtual teams. Several studies have directly examined this influence, including two of the studies discussed during the previous section on trust.

The first study to be reviewed is that of Jarvenpaa and Leidner (1999). As discussed earlier in the section on trust in virtual teams, Jarvenpaa and Leidner (1999) conducted a study to investigate trust within global virtual teams. As part of this study, the authors also investigated team communication, and found that specific communication patterns helped facilitate trust within virtual teams. Specifically, the authors found that social, enthusiastic, predictable, and timely communication facilitated trust early in the group's life, while coping, individual initiative, task focused, and leadership forms of communication facilitated trust later in the group's life.

Using structuration theory as a meta-theoretical framework Sarker and Sahay (2003) also investigated the influence of communication in virtual teams. Using an interpretive methodology, Sarker and Sahay (2003) studied 12 information systems development teams comprised of students attending universities in the US and Canada. In that study Sarker and Sahay (2003) found that successful teams passed from the phases of initiation, exploration, collaboration, and culmination, and further, that micro-level communication processes were instrumental in the progression of teams through the respective phases.

Finally, Jarvenpaa et al. (2004) also investigated the influence of communication in virtual teams. Providing the data for this research were ninety four students from 11 universities who participated in study one, and one hundred and fifty students from 13 universities who participated in study two. Deliverables for the study included researching critical success factors for enterprise resource planning systems, and the development of a business plan by each team. Standard measures were used to evaluate team trust and performance, while communication level was measured by summing the number of email message sent through the listserv by each team. Results from this study reveal that early communication level predicted early trust, and that late trust mediated the relationship between communication level and group outcomes.

2.1.2.3 Leadership

Another factor linked to both virtual team performance and collective efficacy is leadership. Many theories of leadership have been proposed by academic researchers, among them trait theory, behavioral theory, and contingency theory, each of which has its own strengths and weaknesses. One additional leadership theory designed to address some of the purported weaknesses of other theories of leadership is behavioral complexity theory.

Using behavioral complexity theory as a framework, Kayworth and Leidner (2002) studied leadership effectiveness in virtual teams. In that study, Kayworth and Leidner (2002) found that effective leaders were able to perform multiple leadership roles simultaneously in a manner consistent with the tenets of behavioral complexity theory. For example, the authors found that highly effective leaders were able to act in a mentoring role using empathetic action, while simultaneously asserting their authority,

without appearing inflexible. In addition, Kayworth and Leidner (2002) found that virtual team leaders were able to provide regular, prompt, and detailed communication in accordance with the findings of other authors (e.g., Davison, Fuller and Hardin 2003).

In a separate study, Sarker, Grewal and Sarker (2002) investigated leadership emergence in virtual teams. The focus of Sarker, et al. (2002) was not on the influence of leadership on virtual team performance per se, but rather on how leaders emerge in such an environment. Using a sample of seventy-five students comprising 8 virtual teams, Sarker and her colleagues investigated the emergence of virtual team leaders based upon the perceptions of the individual team members (thus the individual level sample of seventy-five). Findings from the study revealed that factors such as culture, trust, and collocation with the client explained leader emergence in the early stages of project, while culture and information systems development ability explained leader emergence in later stages of the project.

These two studies are representative of the importance of leadership in virtual teams. Perhaps less studied than other virtual team success factors (Sarker et al. 2000), leadership remains an important consideration for studies in this area.

2.1.2.4 Structure

Several research efforts have been conducted in an effort to investigate the influence of structure on virtual teams. For example, a study by Montoya-Weiss, Massey and Song (2001) was conducted to determine the influence of temporal constraints on conflict management within virtual teams. In that study, the authors found that conflict management behaviors have varied effects on virtual team performance and in addition, that the temporal constraint manipulations imposed by the researchers moderated those

effects. That is, by constraining virtual teams through the use of temporal based deliverables, the researchers were able to moderate the effects of conflict management on virtual team performance.

Separately, Massey, Montoya-Weiss and Hung (2003), investigated the influence of temporal constraints on virtual team performance. In this study, McGrath's (1991) time, interaction, and performance theory (TIP) was used as a theoretical lens for understanding the complexities associated with the temporal patterns of virtual teams. Using cluster analysis the authors found that while temporal coordination influenced virtual team performance, the main driver was the coordination of the interaction between team members.

2.1.3 Summary of Virtual Team Literature

The virtual team literature review outlined above serves as an introduction to the literature that is relevant to our connection between virtual teams and collective efficacy within the greater confines of Bandura's social cognitive theory. The review of the virtual team literature above, while brief, specifically targets the connection between collective efficacy beliefs and several virtual team success factors. As stated previously, an exhaustive review of the virtual team literature would be counterproductive as the focus of the current dissertation is on the application of SCT and collective efficacy within virtual teams. It is also important to note that many other factors may influence the efficacy—virtual team performance relationship (e.g., conflict management, resource allocation, extrinsic motivation) and have also been addressed in the virtual team literature. Some of these factors will be discussed during the conceptual model development in Chapter 3. Some additional discussion of the virtual team literature will

also be presented in the next section whenever it is necessary to strengthen the theoretical connection between SCT, collective efficacy, and virtual team performance.

2.2 Social Cognitive Theory

A further elaboration of social cognitive theory is now necessary to provide a theoretical grounding for the discussion of self-efficacy and collective efficacy literature. Bandura's (1982) social cognitive theory (SCT) is rooted in his earlier conceptions of social learning theory (Bandura 1978). Social learning theory was proposed by Bandura to address what he felt were the shortcomings associated with earlier behavioral theories of environmental and personal determinism. Rather than concede that human behavior was driven solely by either environmental or personal determinants, or even through the interaction of the person and the environment, Bandura proposed a triadic reciprocal relationship of the person, the environment, and behavior. This relationship is shown in Figure 2-2.

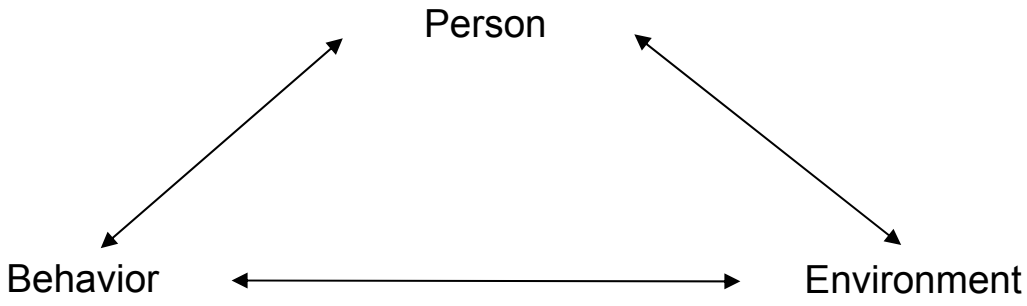

Figure 2-2 Triadic Reciprocal Relationship of Social Cognitive Theory

The following excerpt from Bandura's (1978) discussion of the self-system in reciprocal determinism outlines the tenets of the triadic reciprocal relationship:

Television-viewing behavior provides an everyday example. Personal preferences influence when and which programs from among the available alternatives, individuals choose to watch on television. Although the potential televised environment is identical for all viewers, the actual televised environment that impinges on given individuals depends on what they select to watch. Through their viewing behavior, they partly shape the nature of the future televised environment. Because production costs and commercial requirements also determine what people are shown, the options provided in the televised environment partly shape the viewers preferences. Here, all three factors – viewer preferences – viewing behavior, and televised offerings – reciprocally affect each other (Bandura 1978, p. 346).

This simple example characterizes the important reciprocal relationship among the person, the behavior and the environment, and further illustrates how SCT can be applied in many contexts. For example, in the case of the current research, it is easy to imagine how the environment of virtual teams (e.g., media, organizational structure, resource allocation) may affect the team member's collective cognitions (e.g., group efficacy, trust) as well as their behavior (e.g., performance, communication level), in a reciprocal fashion.

Included in social cognitive theory is the concept of self-efficacy. Self-efficacy is proposed as a cognitive process that takes place within the person element of the triadic reciprocal relationship. Purported to operate on the same socio-cognitive determinants,

collective efficacy is suggested by Bandura (1997) to be a manifestation of efficacy at the collective level. Both self-efficacy and collective efficacy are discussed in detail below.

2.2.1 Self-Efficacy

Self-efficacy has been defined by Bandura as "the belief in one's capabilities to organize and execute the course of action required to produce given attainments" (Bandura 1997, p. 3). This self-belief is suggested by Bandura (1997) to be based on four primary sources of information, enactive mastery, vicarious experience, verbal persuasion, and physiological and affective processes.

Enactive mastery is purported to provide the most influential source of efficacy information due to its basis on the performance of a given behavior. As individuals experience success or failure during the performance of a given behavior, their efficacy beliefs may be raised or lowered, dependent on their interpretation of the performance. That is, it is not as simple as merely stating that successful experience will raise efficacy beliefs and failure will reduce efficacy beliefs, for several reasons. One simple illustration is provided by a person who invests an enormous amount of effort during a successful performance, and then believing that s/he may be unable to muster that level of effort again. In this case, a successful performance may lead to a reduction in the efficacy beliefs associated with the behavior in question. Many other factors may also affect the influence of enactive mastery on performance as outlined in the following passage:

> *The extent to which people will alter their perceived efficacy through performance experiences depends upon, among other factors, their preconceptions of their capabilities, the perceived difficulty of the tasks, the amount of effort that they expend, the amount of external aid they*

receive, the circumstances under which they perform, the temporal patterns of their successes and failures, and the way these enactive experiences are cognitively organized and reconstructed in memory. Performance alone thus leaves uncertainty about the amount of information it conveys about personal capabilities (Bandura 1997, p. 81).

A second source of efficacy information is vicarious experience. Vicarious experience is generally gained through the observation of others, or the visualization of oneself, performing a given behavior. Although suggested to be a less influential form of efficacy information than enactive mastery, in cases where efficacy must be gauged in relation to the performance of others, it has been reported to have a noticeable effect. As was the case with enactive mastery information, the interpretation of vicarious experience is dependent on many factors. For example, during the interpretation of vicarious experience, an individual will consider his/her likeness to the model demonstrating the behavior (Bandura 1997). If a person perceives a model as similar, then the behavioral performance of the model will increase in salience. Further, if a person views the model as similar and observes them easily complete a given behavior, efficacy associated with that behavior should be raised. Alternatively, if the person sees the model as similar, and the model struggles during the performance of the behavior, the efficacy of the person may be lowered. Finally, if a person views the model as dissimilar, the effects on efficacy beliefs may be varied. For example, if the model is observed to easily complete a given task, yet the person sees the model as superior in expertise, efficacy beliefs may still be lowered. These varying effects make the study of vicarious experience and its influence on efficacy all the more challenging.

A third source of efficacy information suggested by Bandura (1997) is verbal persuasion. This form of efficacy information is generally delivered in the form of performance feedback, and dependent on how that feedback is provided, may either raise or lower efficacy beliefs. Once again, multiple factors must be considered when determining how this source of efficacy information will be interpreted by the person. For example, if an individual is repeatedly told that their performance is due to their high effort, their perceptions of their ability may be eventually lowered as they come to believe that the need for a high level of effort is due to their lack of ability. In addition, the knowledgeableness and credibility of the person providing the feedback will also be considered by the individual.

Finally, physiological and affect states are also proposed by Bandura (1997) as sources of efficacy building information. Physiological information is considered most relevant during the accomplishment of physical activities, and factors such as muscle soreness in such a context may be construed as a form of performance feedback. Affective information is associated with the influence of certain states of arousal such as anxiety. The influence of anxiety on cognition can be best understood through the concept of cognitive capacity, or the limited amount of attention that an individual has available at any one time. That is, states of arousal such as anxiety demand resources that would otherwise be needed for attentional processes (Eysneck 1983; Nicholson, Hardin and Nicholson 2003).

These four separate sources of efficacy have been purported by Bandura (1997) to be aggregated during a cognitive integration process. This process is described below:

In forming their efficacy judgments, not only do people have to deal with different configurations of efficacy-relevant information conveyed by a given modality but they also have to weight and integrate efficacy information form these diverse sources. To complicate matters, the weights assigned to different types of efficacy information may vary across different domains of functioning. For example, the set of indicants most diagnostic of cognitive capabilities will differ in important respects from those most relevant to physical capabilities (Bandura 1997, p. 114).

2.2.1.1 The Influence of Self-Efficacy on Outcomes

Self-efficacy has been shown to influence performance in a multitude of areas including education, sports, organizational management, and of specific relevance to the current study, information systems. Within the educational arena self-efficacy has been shown to influence academic performance through various domain specific forms of efficacy. For example, Collins (1982) was able to demonstrate that children who judged themselves high in mathematical efficacy were more likely to not only solve more problems, but also to discard failed strategies for solving problems more quickly than children with a low sense of mathematical efficacy. The findings of the Collins (1982) study have been repeated, and have been demonstrated regardless of the students' level of cognitive ability (Bouffard-Bouchard, Parent and Larivee 1991).

Self-efficacy has also been reported to influence performance within the sports environment and has been shown to have an effect on almost every facet of athletic functioning (Bandura 1997). The influence of efficacy beliefs on sports has been referred to through several famous quotes such as "more matches are won internally than

externally" by Billy Jean King, and "Baseball is ninety percent physical and the other half is mental" by Yogi Berra (Bandura 1997).

Several areas of organizational management have also been demonstrated to be affected by self-efficacy. For example, researchers have recognized the influence of self-efficacy beliefs on a person's ability to fulfill academic requirements and job functions on a range of career choices (Betz and Hacket 1981; Lent et al. 1986; Matusi, Ikeda, & Ohnishi 1989), while other studies have established the influence of self-efficacy beliefs on responsiveness to training orientations (Jones 1986). In addition, managerial decision making has been shown to be influenced by fluctuations in efficacy beliefs caused by experimental manipulation (Bandura and Jourden 1991). Interestingly, a potentially detrimental effect of organizational efficacy beliefs is the reluctance of senior executives to change the way they conduct their organizational operations in the face of changing business environments (Audia 1995).

Finally, within the information systems literature a host of research has been conducted repeatedly finding computer self-efficacy to be predictive of performance and other computer related outcomes. Perhaps the most well known paper in this regard is Compeau and Higgins (1995a). In their paper, Compeau and Higgins (1995a) report the development and validation of a well known measure of general computer self-efficacy. During that study, Compeau and Higgins (1995a) tested the measure's relationship with several other variables including outcome expectancies, computer anxiety, and computer usage. In each case, computer self-efficacy was found to be significantly related to the respective variables. Many other studies have been conducted by information systems researchers that have connected self-efficacy to computer related outcomes, including

Compeau and Higgins (1995b) who not only found a positive relationship between computer self-efficacy and performance, but also found that behavioral modeling training (a form of vicarious experience) raised individuals computer self-efficacy beliefs. In a separate study, Johnson and Marakus (2000) developed an instrument to measure Excel self-efficacy and established its relationship with both computer anxiety and performance.

2.2.1.2 Mediators in the Self-Efficacy—Performance Relationship

While the above discussion clearly establishes the direct relationship between self-efficacy beliefs and performance, it is important to acknowledge that various mediating processes are also suggested to influence this relationship. Bandura (1997) proposes four major mechanisms that may influence the relationship between efficacy beliefs and performance. These are cognitive, motivational, affective, and selective processes. Cognitive processes are purported to influence the efficacy—performance relationship in two primary ways, through cognitive constructions, and inferential thinking. During the process of cognitive constructions, courses of action may shape thoughts associated with the performance of a given behavior. For example, individuals with high levels of efficacy may visualize successful scenarios, while those with a low sense of efficacy may visualize failure. Inferential thinking may also mediate the efficacy-performance relationship by allowing individuals to predict what outcomes are most likely associated with available courses of action (Bandura 1997).

Motivational processes are much more complex in their relationship with efficacy and performance due to the competing theories regarding the role of motivation on performance. Bandura (1997) reports three main forms of cognitive motivators, causal

attributions, outcome expectancies, and cognized goals. The theories which accompany these cognitive motivators are respectively, attribution theory (Weiner 1985), expectancy-value theory (Vroom 1964), and goal-theory (Lock and Latham 1990). Causal attributions serve as a mediator in the efficacy—performance relationship by providing individuals with a method for attributing their successes and failures to outside sources. For example, individuals who attribute performance success to ability, and failure to a lack of effort, will generally persist in challenging endeavors (Bandura 1997). While causal attributions are known to be directly predictive of performance attainments (Weiner 1985), they have also been shown to be mediated by efficacy, or alternatively, to mediate the efficacy-performance relationship. Expectancy-value theory proposes that individuals are motivated through the expectancy associated with performance outcomes. In other words, greater effort will be exerted by individuals when they are certain that a specific outcome will occur and that the outcome is valued (Feather 1982). Efficacy beliefs contribute to this process in that individuals with high efficacy beliefs tend to put forth higher effort (Bandura 1997). Finally, goal theory has been routinely established as a key motivator of performance (Lock and Latham 1990). By setting clear, challenging, obtainable goals, coupled with performance feedback, researchers have increased participant motivation and thus performance (Bandura and Cervone 1983). Efficacy beliefs are suggested by Bandura (1997) to influence the level of goals set by individuals.

Affective processes are also purported by Bandura (1997) to mediate the efficacy—performance relationship. For example, those individuals who possess high levels of efficacy more often engage in stressful situations, and are more able to shape those situations to their liking (Bandura 1997). In addition, researchers have shown that it

is not the aversive cognitions that cause anxiety but rather the strength of efficacy to control or dismiss those thoughts. A series of studies involving subjects possessing snake phobias were conducted by Bandura in the establishment of the relationship between self-efficacy, anxiety and behavior (Bandura 1997).

Individuals also often base their choice of pursuits based on their perceived efficacy to successfully carry out those actions (Bandura 1997). This relationship was discussed previously in the section on organizational efficacy. The following quote reiterates the importance of efficacy in the choice of pursuits by individuals.

> *Even when perceived efficacy is entered last in hierarchical regression analyses, it predicts the range of career options seriously considered and persistence and academic success in chosen options above and beyond the other predictors (Bandura 1997, p. 161).*

The above discussion establishes the sources of efficacy information, the relationship of self-efficacy to various outcome variables, and the mediating process that occur during the efficacy–performance relationship. In the next section, research associated with efficacy at the collective level will be discussed.

2.2.2 Collective Efficacy

Collective efficacy represents Bandura's (1986) conception of efficacy at the group level. While obviously operating at a different level of analysis, collective efficacy has been purported to be based upon the same socio-cognitive determinants as self-efficacy beliefs and has been defined as

A group's shared belief in its conjoint capabilities to organize and execute the courses of action required to produce given levels of attainments (Bandura 1997, p. 477).

Like self-efficacy, collective efficacy is influenced by the sources of efficacy information suggested by Bandura (1997). However, these sources of information may interact in a group much differently than in individuals. For example, enactive mastery information may be gained by the group as a whole, or by the individual group members. As a result this information may be interpreted differently by the individual group members, which may result in variance among the group members' perceptions of the group's collective abilities. The variance of group member perceptions will become a topic for further discussion in later chapters, as the agreement among team members must be sufficient before any aggregation of team member responses can occur (Jung and Sosik 2003).

2.2.2.1 The Influence of Collective Efficacy on Outcomes

Collective efficacy, like self-efficacy, has been studied in a number of areas including, education, sports, and organizational settings. Within the area of education, Bandura (1993) demonstrated the mediating role of collective efficacy in a more comprehensive model of school level achievement in reading and mathematics. The educational environment has been suggested as an especially suitable area for the study of collective efficacy as school districts often include multiple schools that are administered centrally and are generally assessed with standardized instruments (Bandura 1997).

Sports settings are also well suited for studying the efficacy of collectives, due in part to the large number of team sports in existence. For example, Kozub and McDonnell (2000) in a study involving ninety-six members of seven rugby union clubs, found that collective efficacy accounted for 32% of the variance in group cohesion. The *mechanisms* of collective efficacy development have also been investigated within the sports literature. In a study by Magyar, Feltz and Simpson (2004), rowers were asked to complete a survey questionnaire 24 hours prior to competing in a regional championship regatta. Results revealed that self-efficacy perceptions were predictive of individual collective efficacy perceptions, and perceptions of mastery were predictive of the team's collective efficacy perceptions reached by averaging the individual responses.

A large amount of collective efficacy research has also been conducted within the organization literature (Bandura 1997). The influence of collective efficacy within an organizational setting is explained by Bandura (1997):

> *Most organizational goals are directed at group goals achieved in organizational structures through collective effort. The effective exercise of collective action involves more complex, socially mediated paths of influence than does self-direction, People have to depend upon one another in performing tasks and carrying out their complementary roles. Group success requires effective interdependent linkage of tasks, skills, and roles. Group members not only have to coordinate what they are doing individually with the work of others, but they are affected by the beliefs, motivation, and quality of performance of their coworkers. These*

interactive effects make collective efficacy and emergent group attribute (Bandura 1997, p. 468).

As a specific example of the role of collective efficacy within an organizational setting, Prussia and Kinicki (1996) found that the collective efficacy beliefs of organizational groups performing brainstorming activities mediated the relationship between both behavioral modeling training and performance feedback on group performance.

2.2.1.2 Mediators in the Collective Efficacy—Performance Relationship

Bandura (1997) suggests that the collective efficacy-performance relationship operates through mediating mechanisms in a manner similar to the self-efficacy-performance relationship. However, unlike his research in the area of self-efficacy, Bandura provides limited guidance on the specific mechanisms of collective efficacy.

It can be surmised however that additional complexities arise in efficacy studies conducted at the collective level. For example, cognitive processes such as the integration of the sources of efficacy information are now operating at the group level of analysis. In this case, additional factors such as transactive memory (Moreland and Myaskovsky 2000), and group think (Whyte 1998) must be considered. Motivational factors also provide additional complexity at the collective level. For example, in the current study group effort was considered. Here, rather than measuring perceptions of individual effort, perceptions of the team's collective effort were accounted for, necessitating calculations of team member agreement (Whiteoak et al. 2004). When considering affective states, group anxiety rather than anxiety at the individual level must be considered in studies of collective efficacy. Finally, selection processes are made by the group rather than the

individual, yet individual factors may also play a role in the group's decisions to undertake a task in a given environment. These additional group level processes provide additional complexity to analyses conducted in this area.

The above discussion establishes the sources of collective efficacy information, the relationship of collective-efficacy to various outcome variables, and the mediating process that may occur during the collective efficacy–performance relationship. In the next section, a discussion of the measurement of collective efficacy is presented.

2.2.2.1 The Measurement and Terminology of Collective Efficacy

Many studies of collective efficacy have been also reported within the small group literature (e.g., Baker 2001; Pescosolido 2001; Salanova, LLorens, Cifre, Martinez and Schaufeli 2003; Sargent and Sue-Chan 2001; Whiteoak, Chalip and Hort 2004), yet despite this frequency, disagreement remains regarding the most appropriate terminology and measurement methods for the collective efficacy construct. For example, the term group efficacy has been coined by some researchers as a reference to both group potency—a group's belief in its general ability—and collective efficacy—a group's belief in its task specific ability (Jung and Sosik 2003). Similarly, some authors have separated out the idea of efficacy in groups from the efficacy of more general collectives, and have used the term team efficacy when referring to the efficacy of groups (Gully et al. 2002). However, collective efficacy, group potency, group efficacy, and team efficacy all refer to Bandura's (1997) conception of a group's shared belief in its conjoint capabilities (Gibson et al. 2000), and adhere to the associated theory's principles. For the purposes of this dissertation we will use the term group efficacy when referring simultaneously to both collective efficacy and group potency. Collective efficacy will be used when our

reference is to a domain specific form of a group's efficacy. Finally, group potency will be used when our reference is to the group potency construct developed by Guzzo et al. (1993).

In addition to the variations on the terminology used to refer to the efficacy of groups, disagreement remains on how best to measure the group efficacy construct (Whiteoak et al. 2004). As the measurement of our domain specific measure of collective efficacy is central to the current study, a further dilation of the research accompanying the measurement debate is necessary.

The **aggregated self-efficacy beliefs** of group members' have been used to predict the performance of groups completing tasks with limited interdependence (Whiteoak 2004). Here, summing the individual self-efficacy beliefs of group members for the prediction of team performance makes sense conceptually as the ability of each group member to complete his or her task independently is central to the overall success of the team. This measurement method has seen limited use however, as much of the existing group research in this area has been focused on the performance of groups completing tasks that are interdependent. Nonetheless, when used in this specific capacity, the predictive properties of the aggregated self-efficacy beliefs of group members have been previously established (Whiteoak et al. 2004).

The **non-aggregated group efficacy beliefs** of the individual group members have also been used as an indicant of group efficacy (Zellars et al. 2001). When using this method, researchers are generally interested in the prediction of individual level outcome variables such as team or job satisfaction (Zellars et al. 2001). Further, these non-aggregated individual perceptions of the team's ability have been generally used for

predicting perceptual outcome measures rather than objective measures such as actual group performance. It should be noted however, that the development of measures of group efficacy are generally done in a manner that allows the measure to be used in studies at both the individual and collective level of analysis. For example, the group potency measure (Guzzo et al. 1993) was developed in terms of the individual group member's perceptions of the group's general abilities to work together. This development was done with the knowledge that the responses to the measures would be eventually aggregated to the group level and used to predict group level outcomes. This development is consistent with the development of the VTE measure in the current study.

The **aggregated group efficacy beliefs** of team members (Jung and Sosik 2003) have also been used for predicting group level performance variables. This method is most recommended by Bandura (1997). Here, as was the case with the non-aggregated perceptions of the team members, group members are asked to indicate their individual perceptions of the team's ability. However, when using this method, team member perceptions are aggregated and used to predict group level outcome variables such as group performance. The use of this measure is more commonly used in models exploring actual group level outcomes such as the team's objective performance. One caveat associated with the use of the aggregation method is that it necessitates the use of some type of test for establishing inter-rater agreement among the team members to insure the data is meaningful at the group level of analysis (Jung and Sosik 2003: Whiteoak et al. 2004).

Holistic group efficacy beliefs reached through group discussion have also been proposed as a method for measuring the efficacy of groups. The group efficacy consensus

is then used to predict group level performance variables such as outcome effectiveness or group performance (Gibson, 1999; Gist 1987; Guzzo, Yost, Campbell and Shea, 1993). One benefit of this more holistic approach is that it avoids the need to calculate inter-rater reliability (Whiteoak et al. 2004). However, a drawback of this method is the potential for social persuasion by dominant members of the group which may result in inflated group efficacy responses (Bandura 1997). In fact, Bandura discourages the use of this method.

2.2.2.2 Studies Investigating the Measurement of Group Efficacy

Several studies have been specifically designed to compare the methods for measuring group efficacy that were just described (Gibson et al. 2000; Jung and Sosik 2003; Whiteoak, Chalip and Hort 2004). For example Gibson et al. (2000) evaluated multiple methods for measuring group efficacy in order to empirically establish which measure was most predictive of group performance. During that study, Gibson and her colleagues found that although all three measurement methods they considered were positively related to group outcomes, the group discussion method was most predictive. In addition, Gibson et al. (2000) found that general level efficacy measures such as group potency were more predictive of general performance indicators, while specific collective efficacy measures were more predictive of task-specific measures. This second finding is in accordance with Bandura (1997) who declares that general level efficacy beliefs may be less predictive than measures designed for use within a more task specific domain, and is consistent with the hypotheses of the research model associated with this dissertation. However the first finding by Gibson and her colleagues is in direct contradiction to the recommendations of Bandura (1997), who cautions against measuring collective efficacy

using group discussion because of the potential for social persuasion by dominant members of the group.

Interestingly, in a similar study, Jung and Sosik (2003) found that group efficacy beliefs garnered through group discussion were less predictive of group performance than were the aggregated group efficacy responses of the individual team members. This finding is in direct contrast to the findings of Gibson et al. (2000) however corroborates the recommendations of Bandura (1997) as discussed previously. In addition, in accordance with Bandura (1997), Jung and Sosik (2003) found that the means associated with the group efficacy responses using the group discussion method were significantly greater than the means associated with the aggregated individual responses.

Finally, a recent study by Whiteoak et al. (2004) compared three measures of group efficacy; the aggregation of self-efficacy beliefs, the aggregation of individual group efficacy beliefs, and group consensus. During that study, Whiteoak et al. (2004) found that all three measures were comparable when used to predict group goal setting. However, a potential limitation associated with the Whiteoak et al. (2004) findings is that a task with low interdependence was used during the study. The issue of low task interdependence is problematic as the sum of the participants' individual level self-efficacy beliefs are generally known to have limited predictive ability for tasks with high interdependence (Bandura 1997). Table 1-1 provides a summary of the disadvantages, advantages, and important findings related to each of these measurement methods.

Measurement Method	Advantages	Disadvantages	Important Findings
Assessment of individual level group efficacy beliefs	Predictive of individual level outcome variables such as satisfaction with the group. Eliminates the need for inter-rater reliability.	Potential cross-level analysis when predicting group level actual outcome variables such as performance.	Found to predict individual level variables such as job satisfaction (Zellars et al. 2001).
Aggregation of individual self-efficacy beliefs for use in studies at group level	Predictive of group performance for tasks with low interdependence.	Generally recognized to be less predictive of group performance for tasks with high interdependence.	Found to not differ from other methods in terms of task difficulty or the magnitude of the relationship with goal setting. However study task had low interdependence (Whiteoak et al. 2004).
Aggregation of group efficacy beliefs to the group level	Is predictive of group level outcome variables such as group performance.	Requires the use of some form of interrater reliability test.	Was found to be superior to group discussion method for predicting group performance. Group means were found to be higher for responses using discussion method than aggregation method (Jung and Sosik 2003).
Group level consensus of group efficacy beliefs reached through discussion	Eliminates need for inter-rater reliability.	Potential for efficacy inflation due to social persuasion factors (Bandura 1997).	Found superior to aggregation method when predicting group performance. Found task specific measures were predictive of tasks, while general measures were predictive of the general ability of the group (Gibson et al. 2000)

Table 2-1 Collective Efficacy Measurement Methods

2.3 Summary

This chapter provided a review of the virtual team, social cognitive theory, self-efficacy, and collective efficacy literature. During this review, an attempt was made to demonstrate the relevance of social cognitive theory, and specifically collective efficacy, as a framework suitable for studying virtual team performance. The measurement of

group efficacy was also discussed. The following chapter, Chapter 3, presents an integration of the relevant literature discussed in the current chapter and proposes a conceptual model that forms the basis of this work. In addition, a research model and associated hypotheses is proposed.

Chapter 3 – Research Framework and Hypotheses

This chapter integrates the literature reviewed in Chapter 2, and further, uses this integration to propose a conceptual model that forms the foundation for this research. A research model is then developed and specific hypotheses are proposed.

This chapter is structured as follows. First the conceptual framework will be developed and discussed and length. During the development and discussion of the conceptual framework, both the paradigm of scientific inquiry held by the researchers, and a discussion of how little-t theory was developed as part of this research are presented. The formation of collective efficacy and virtual team efficacy beliefs is then discussed. Following, a research model is proposed. Finally, the hypotheses to be tested during this dissertation are presented.

3.1 Conceptual Framework

This research is grounded in the tradition of positivism, which is defined as the philosophical view that "it is only by shoring up explanations with empirical facts that we can arrive at an exact understanding of objective reality" (Rosenthal and Rosnow 1991, p. 33). Here, research is designed to be objectively grounded at the ontological level. That is, at the ontological level, the positivist paradigm assumes a belief in an objective physical and social world that exists independently of humans (Orlikowski and Baroudi 1991). In addition, this objective world is proposed to be easily appreciated, characterized, and measured. It is also assumed that a one-to-one correspondence exists between the researcher's model and the actual events or objects which are of interest in the world (Hirschheim and Klien 1989). The researcher maintains a passive role, and

remains neutral in all investigations rendering the research investigation value free. In addition, researchers following the positivist ontology assume human action is rational, or at the very least, bounded by rationality, and further, assume that the social reality of humans is mostly stable and orderly, and that conflict and/or contradiction are not indigenous to organizations and society. Therefore, conflict under the ontology of positivism is seen as dysfunctional and measures should be taken to overcome it (Orlikowski and Baroudi 1991).

Epistemologically, positivist researchers are concerned with the empirical testing of specific theories, whether those theories are to be refuted or accepted. This belief is proposed as the hypothetic-deductive account of scientific explanation, and has two known consequences. The first is the use of universal laws (i.e., big T theory) from which lower-level hypotheses may be proposed and tested (Lee 1991). Positivist researchers work deductively to discover casual relationships, and as a result help to form a more generalized form of knowledge that can be utilized to predict patterns of behavior across multiple situations (generalizability). The second consequence is the necessary association between explaining, predicting, and controlling. Specifically, if a certain action can only be explained when certain premises or principles exist, then that action can be predicted based on the presence or absence of the premises and/or principles (Orlikowski and Baroudi 1991). In terms of information systems research then, the search for generalized connections between information technology and environmental conditions should be characterized through predictable, constant, relationships.

Researchers who follow the positivist paradigm utilize a number of research methodologies in support of their epistemological beliefs. An important consideration

associated with the choice of methodologies is that positivist researchers assume that data is identifiable and exists independent of the measurement method (Orlikowski and Baroudi 1991). Both survey research and controlled experiments are primary techniques used to collect data, and the use of inferential statistics is generally accepted as a method for establishing linkages among variables. Further, the reliability and validity of the research measures are crucial, as is the detachment of the researcher from the research process. Finally, the concepts presented in the language of the positivist research philosophy cannot reflect the everyday language usage of the participants as such language is considered too ambiguous (Orlikowski and Baroudi 1991).

Therefore, in the tradition of positivism, a research framework based on empirical evidence, and in the current case, in terms of established big-t theory, is essential to the proper development of an associated research model. The researchers involved in the study remain removed from the phenomena under investigation, and the research is value free. That is, while the research may uncover external social factors that may unduly affect the participants of the individual teams, no attempt will be made to affect these factors. The need for the research to remain value free differentiates the positivist paradigms from other paradigms of scientific inquiry (e.g., social critical theory [Fitzgerald and Howcroft 1998; Hirschheim and Klein. 1989]).

In the current study, big-t theory is provided by Social Cognitive Theory (SCT) and the reciprocal relationship of the person, the environment and the behavior. Theory is further provided by the mechanisms of collective efficacy that take place within the person component of SCT. Little-t theory is developed as part of this dissertation and is formed in terms of the interactive effects of virtual team efficacy and previously

established virtual team success factors on virtual team performance. The method of using the combination of big-t and small-t theory has been suggested as an appropriate method for conducting research in the area of information systems (Dennis and Valacich 2001).

Theory has been proposed as providing essential guidelines in terms of both data collection and the development of hypotheses that can be empirically tested (Wheeler 2002). A definition of theory is provided by Dubin (1969) below:

> *A theory is a model of some segment of the observable world. Such a model describes the face appearance of the phenomenon in such terms as structures, textures, forms, and operations. In order that such a model be considered dynamic, it also describes how the phenomenon works, how it functions. All scientific models, then, are the imaginative recreation of some segment of the observable world by a theorist interested in comprehending the forms and functions of selected segments of the world around him (Dubin 1969, p. 223).*

While formal definitions of theory such as the one provided by Dubin can be found in various literatures, more practical explanations of theory are harder to find. For example, within a special issue of *Administrative Science Quarterly* on theory, Sutton and Staw (1995) chose to address what theory is *not*, rather than what theory *is,* and by doing so, illustrate the difficulty of accurately explaining theory.

On the other hand, Dennis and Valacich (2001) do an excellent job of explaining the concept of theory without the use of a formal definition.

> *Theory is the **why** of the phenomenon, not the **what**. Theory explains the key actors in the phenomenon under study (the independent and dependent variables) how they interact (the plot), and why they interact as they do (their motivation).*

Further, they state:

> *Theory is any set of logical arguments that explain a relationship among a set of constructs. In most cases, the theory for a particular study will build on and substantiate a prior theory, modified as needed, or integrate a set of theories within the bounds of the study. In other cases, the study will build new theory based on prior empirical research and logical argument (Dennis and Valacich 2001, p. 11).*

Providing a clear example of the development of theory in information systems research as suggested by Dennis and Valacich (2001), Nicholson, Hardin and Nicholson (2003) developed a research model in which computer anxiety was proposed to have a negative influence on computer-based test performance (***the what***). While this relationship had been investigated in prior research (e.g., Johnson and Marakas 2000), little explanation for *why* computer anxiety may negatively influence performance had previously been offered. In their study, Nicholson, Hardin and Nicholson (2003) suggested that it was the additional load of computer anxiety on an individual's cognitive capacity (***the why***) that caused performance to be adversely affected during the completion of complex tasks.

In the current research, small-t theory is developed using the guidance of the big-t theory of SCT and collective efficacy. The small t-theory of virtual team efficacy is

developed by defining constructs, describing their relationships, and developing testable hypotheses. For example, the virtual team efficacy construct is defined and developed, its relationship with group outcomes and virtual team success factors is explained, and specific hypotheses are generated. Providing a noticeable example of the ***why*** in the VTE model is the positioning and explanation of the mediating processes in the efficacy—performance relationship rather than just the proposal of a direct relationship between virtual team efficacy and group outcomes (***the what***).

Having explained the ontological, epistemological, and methodological assumptions of the researchers, as well as providing a discussion of how theory was developed in this dissertation, the conceptual and research models are now respectfully developed. As part of the development of the conceptual model, we begin by explicating the theory associated with collective efficacy within the greater confines of Bandura's social cognitive theory.

3.1.1 Theoretical Model of Collective Efficacy

Bandura (1997) posits that as humans have become more interdependent in the course of their daily lives and work, the need to empirically investigate collective efficacy has become increasingly salient. Bandura (1986) further states that the overall findings in the literature support the suggestion that the socio-cognitive determinants of social cognitive theory operate much the same at the collective level as they do the individual. Therefore, when developing the theoretical framework for this study, it is logical to look to SCT and efficacy theory for guidance. As discussed in Chapter 2, Bandura (1997) posits four principle sources of information as antecedents to efficacy perceptions; enactive mastery (e.g., successful experience), vicarious experiences (e.g.,

behavioral modeling training), verbal persuasion (e.g., feedback), and physiological and affective states (e.g., anxiety). Mediators in the social cognitive theory framework include cognitive (e.g., cognitive constructions), motivational (e.g., causal attributions, outcome expectancies, cognized goals), affective (e.g., anxiety) and selective (e.g., choice of behaviors) mechanisms (Bandura 1997). Figure 3-1 graphically illustrates the theoretical relationships associated with the efficacy—performance relationship as proposed by Bandura (1997).

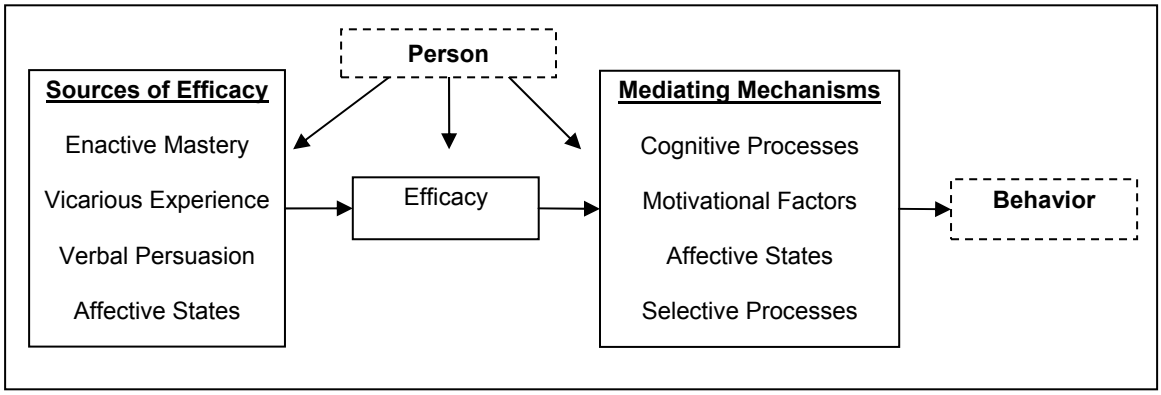

Figure 3-1 Model of Efficacy Development (Based on Bandura 1997)

It is important to acknowledge that even though this conceptual rendition of the efficacy development process depicts one-way directional paths, consistent with social cognitive theory the relationship between the person, behavior, and the environment is reciprocal. For example, successful performance (behavior) represents a source of enactive mastery information to be cognitively integrated by the individual or the group (person) and used to build future efficacy beliefs. In addition, (environmental) conditions play a significant role within the theoretical framework of SCT. The nature of the reciprocal relationships among these constructs presents an inherent complexity in the model specification and provides additional avenues for research in this area. Figure 3

further illustrates Bandura's (1986, 1997) conception of efficacy development based upon the reciprocal relationships of SCT.

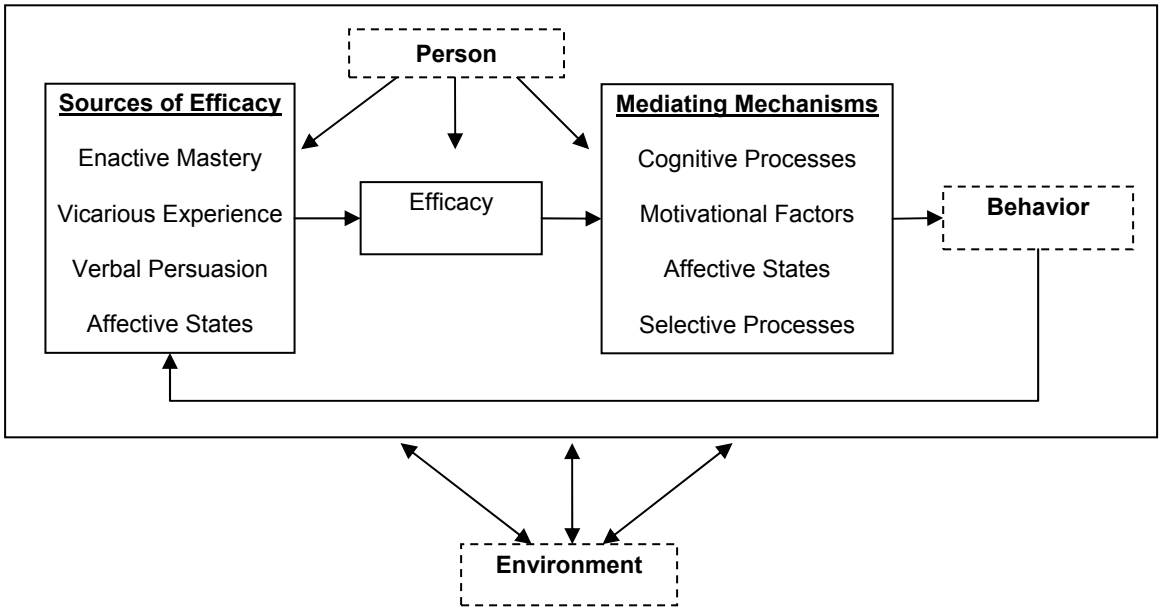

Figure 3-2 Model of Efficacy Development with Reciprocal Relationships

3.1.2 Virtual Team Efficacy

Consistent with our earlier discussion of the factors surrounding efficacy beliefs, we propose VTE as a context specific application of the more general concept of collective efficacy that accounts for both group-level influences and the media usage of virtual teams. We discuss both of these factors separately below.

3.1.2.1 Group-level Influences on VTE

VTE is differentiated from self-efficacy because of the involvement of "teams", and is thus consistent with previous group-level conceptions of efficacy. Teams, by their very nature, involve interpersonal relationships, and therefore efficacy formation and its effects in such teams may be influenced by various social influence processes. Because of this, both the development of the measure of VTE, and its placement within a larger

conceptual model, require consideration of group related social influences. For example, factors such as trust, communication, leadership, and conflict management, among others, may all affect, or be affected by, VTE. These factors are discussed in additional detail during the dilation of the conceptual model later in this chapter.

3.1.2.2 Media Influences on VTE

The second attribute that differentiates VTE from previous conceptions of efficacy is that virtual teams must communicate via technology, and thus media characteristics may alter any social influence processes (Maruping and Agarwal 2004) used during the development of efficacy beliefs. For example, media characteristics may influence how the sources of efficacy information will be integrated by the group. Specifically, enactive mastery information gained in a technology mediated environment may be interpreted differently by the individual team members and thus result in inconsistent effects on the virtual team's group level efficacy beliefs. Similarly, vicarious experience in the form of behavioral modeling training may also be interpreted inconsistently by team members. For example, consistent with our previous discussion of the influence of vicarious experience on efficacy beliefs, effects on beliefs can vary based upon the person's perceptions of the model. That is, if a person feels the model is similar and sees them successfully perform a task with little effort, efficacy should be raised. However, it may also be the case that one member of the team may perceive the model as similar while another may perceive the model as dissimilar, leading to inconsistent effects on perceptions of efficacy. Increasing the complexity of this situation is the lack of collocation of virtual team members, and their need to use technology to communicate. That is, in a collocated environment the team member who perceived the model as

similar, and thus whose efficacy was raised, could more easily be observed by the other team members during training performance, or if receiving the training separately, could easily relate their experience during the next face-to-face meeting. However, in a non-collocated environment, this would be made more difficult, especially if the training is delivered using a technology that does not allow the members to interact. Finally, even if the team member receiving the training shared the information, technology may influence how this information is interpreted (Daft, Lengel and Trevino 1987) by the other members of the virtual team.

3.1.3 Conceptual Model

We propose the following conceptual model (Figure 3-3), which illustrates both the antecedents and consequences of efficacy discussed earlier, and contextual variables such as group an environmental factors that may be influential in models of virtual team performance. The conceptual model depicts the basic relationships outlined in the efficacy theory section of this work, including the sources of efficacy information, other forms of efficacy, and the mediating processes identified by Bandura (1997) and Marakas et al. (1998).

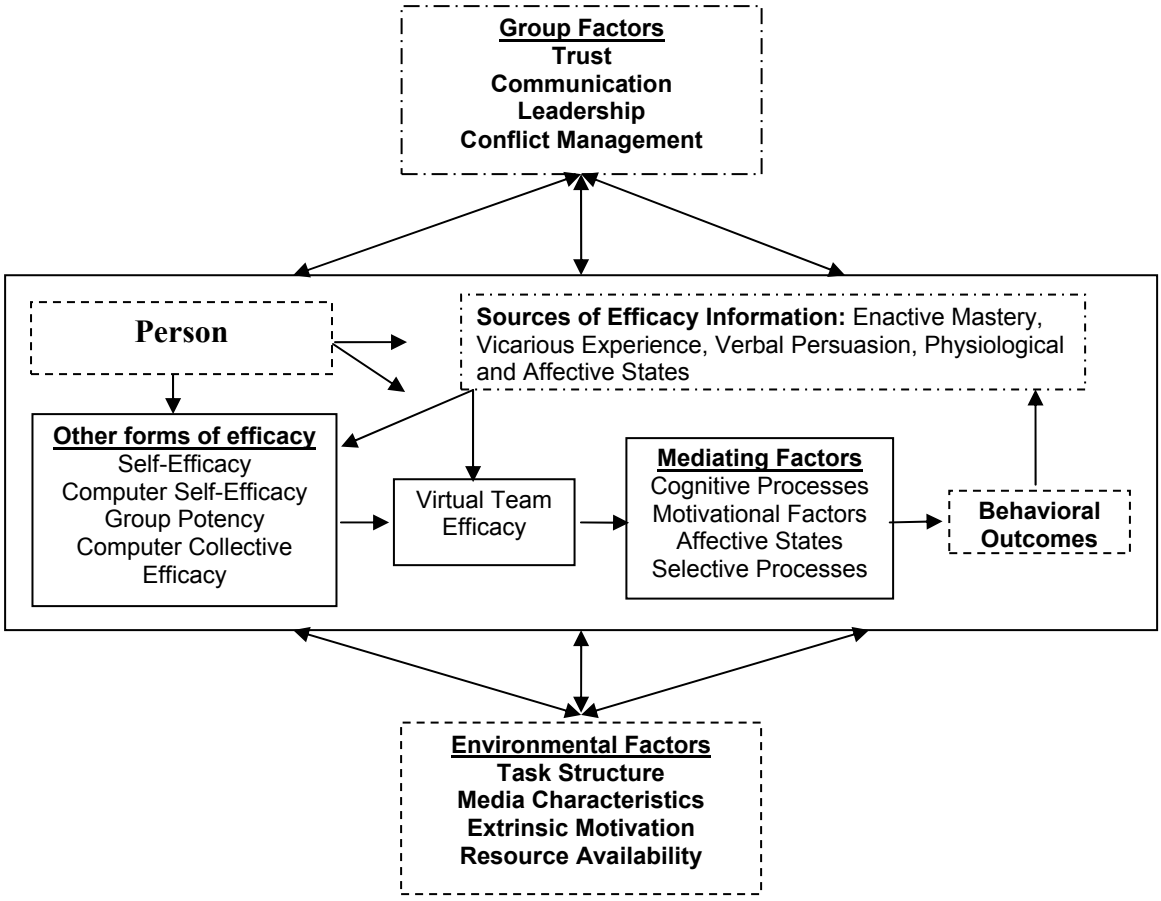

Figure 3-3 Conceptual Model of Virtual Team Efficacy

In addition, the conceptual model reflects group and environmental factors as playing a role in models of VTE. As outlined above, group level factors such as trust, communication, leadership, and conflict management may influence the VTE model in terms of the development of virtual team efficacy beliefs by the team, as well as potentially affecting, or being affected by, the VTE—performance relationship. For example—as will be hypothesized in the research model—VTE may directly influence both trust and communication among the respective teams.

Other factors, such as leadership and trustworthiness, may also influence VTE. For example, leaders with strong self-efficacy beliefs may be assigned to teams in an attempt to positively influence the efficacy of the other virtual team members (Bandura

1997). Trustworthiness perceptions may also influence the development of the collective efficacy beliefs of virtual teams. This may occur as perceptions of the ability, benevolence, and integrity of the team could influence perceptions of the team's collective abilities. Neither of these relationships has been sufficiently investigated, and future studies based on the efficacy of virtual teams should examine both of them in greater detail.

The influence of conflict management techniques may also affect the development of collective efficacy beliefs among the virtual team members. That is, the ability to incorporate effective conflict management initiatives may reduce conflict (Maruping and Agarwal 2004) increasing the team's belief in its ability to work together. Alternatively, beliefs in the virtual team's ability to work together (i.e., virtual team efficacy) may affect the team's ability to effectively incorporate conflict management strategies. As either of these relationships can be supported theoretically, such relationships should also be thoroughly investigated during future research conducted in this area.

Environmental factors such as how the task is structured, whether the team is extrinsically motivated (e.g., organizational reward systems), the availability of resources, and the type of media available, may all also influence the VTE—performance model. For example, it has previously been noted that for tasks that require the *independent* efforts of team members, self-efficacy rather than collective efficacy beliefs may be more predictive of group performance (Bandura 1997, Whiteoak et al. 2004). Factors such as organizational rewards may also influence models of virtual team efficacy. For example, to better develop group efficacy beliefs, team rewards rather than

individual rewards should be administered (Bandura 1997). Finally, the media available should also influence the development of group level efficacy beliefs among the virtual team members as discussed above in the section regarding the influence of media on VTE.

It is important to note that the environmental and group factors listed above are only representative of the potential factors that may influence the model of VTE. Other variables may also be important and provide additional avenues for investigation in this important area. Following the discussion of our conceptual model, we now propose a research model designed to provide the framework for an initial test of the virtual team efficacy construct.

3.2 Research Model

As an initial test of the VTE model, selected variables from the conceptual model were empirically examined. The research model in Figure 3-4 depicts the various hypotheses among these constructs. The hypotheses are then each developed separately below.

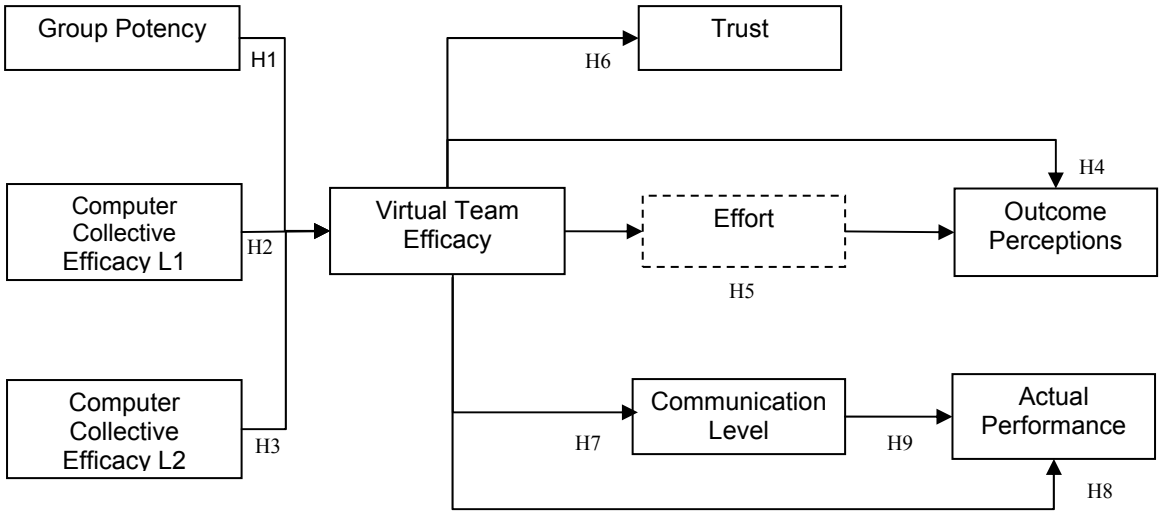

Figure 3-4 Research Model

3.2.1 The Antecedents of Virtual Team Efficacy

As discussed in previous chapters, more general forms of efficacy have been shown to be predictive of efficacy more specifically targeted at a particular task. While this relationship has generally been established during studies of self-efficacy, given that collective efficacy is known to operate through similar processes (Bandura 1997), a similar relationship should also exist at the group level. Therefore, we propose that group potency and computer collective efficacy—more general forms of group efficacy—will influence our more contextually specific, but related, concept of virtual team efficacy. These relationships are explored in greater detail below.

3.2.1.1 Group Potency

Group potency has frequently been examined by researchers interested in group performance (e.g., Gibson 1999) and is defined as a group's collective belief that it can be effective (Guzzo et al.1993). Consistent with the current context of technology-

mediated, virtual groups, group potency has previously been shown to predict outcomes in a group decision support systems environment (Sosik, Avolio and Kahai 1997). However, given that group potency is a more general measure of the group's efficacy, its prediction of outcomes within a specific context may have its limitation (Gibson et al. 2000).In turn this limited predictive power may reduce the amount of variance accounted for in models of virtual team performance. Therefore, rather than place group potency as a direct predictor of virtual team outcomes, we propose group potency—consistent with studies finding general self-efficacy beliefs to be predictive of more specific beliefs (e.g., Agarwal et al. 2000)—as a predictor of a team's belief in its ability to perform in the specific context of virtual teams (i.e., virtual team efficacy). Such a positioning is logical as first and foremost virtual teams must still function as groups. Because of this, perceptions of the team's ability to work together in general should be related to perceptions of the team's ability to work together in a technology-mediated, non-collocated, environment. The positioning of group potency as a predictor of virtual team efficacy, and virtual team efficacy as a predictor of ultimate performance is also consistent with prior findings establishing the greater predictability of efficacy beliefs specific to the domain being studied (Bandura 1997; Gibson et al. 2000; Gully et al. 2002). Consequently, the context specific measure of virtual team efficacy is positioned as an ultimate predictor of virtual team outcomes, while the general measure of group potency is positioned as a direct predictor of the domain specific measure of virtual team efficacy. Therefore we propose and test:

Hypothesis 1: Group potency will have a significant positive influence on virtual team efficacy.

3.2.1.2 Computer Collective Efficacy

Similar to Bandura's (1986) conception of collective efficacy as an extension of self-efficacy, we propose computer collective efficacy (CCE) as an extension of the more common computer self-efficacy construct. While computer self-efficacy has been defined as "a judgment of one's capability to use a computer" (Compeau and Higgins 1995, p. 192), we define computer collective efficacy as "the team's perception of its collective ability to use computers." Consistent with the Compeau and Higgins (1995) measure of general computer self efficacy, we propose computer collective efficacy as a general measure of the team's computer abilities. To measure the construct we adapted a general measure of computer self-efficacy developed by Murphy et al. (1989).

Specifically, the Murphy et al. (1989) measure of computer self-efficacy identified two separate levels of computer skills based on their level of difficulty, as well as a third that was focused on mainframe technology. Given the conceptual linkage between self and collective efficacy acknowledged by Bandura (1997), we propose that computer collective efficacy should also exist as a multilevel construct based on difficulty. Here we propose Level 1—computer collective efficacy as the group's ability to undertake more fundamental computer-related tasks, such as saving files or exiting from software programs. Level 2—computer collective efficacy on the other hand, is focused more on the group's ability to perform conceptual tasks, such as troubleshooting computer-related problems.

Consistent with our earlier placement of the general measure of group potency as a predictor of the domain specific measure of virtual team efficacy—and based on research establishing the relationship between more general forms of efficacy and more

context or task specific forms—we suggest that a belief in a team's ability to use computers in general will positively affect that same team's belief in its ability to use technology to work together as a virtual team. We propose this, as a general belief in the team's ability to use computers should have a positive influence on that same team's effectiveness when using the communication technology necessary for working in a virtual team. In turn, this should improve the communication among the respective virtual team members, positively affecting the team's perceptions of its ability to work together in a virtual capacity. Therefore we suggest that general computer collective efficacy will be positively related to virtual team efficacy, and further, that general computer collective efficacy will exist in terms of both fundamental and advanced levels of computer collective efficacy —Levels 1 and 2—and both should be positively related to virtual team efficacy.

Hypothesis 2: Level 1 computer collective efficacy will have a significant positive influence on virtual team efficacy.

Hypothesis 3: Level 2 computer collective efficacy will have a significant positive influence on virtual team efficacy.

3.2.2 The Consequences of Virtual Team Efficacy

As discussed previously, researchers have repeatedly shown collective efficacy to be a predictor of group outcomes, including both performance and satisfaction, leading to its frequent use by group researchers interested in the performance of teams (Whiteoak et al. 2004). For example, Gibson et al. (2000) found a significant positive relationship between collective efficacy and group outcomes, including measures of time to completion, intragroup agreement, process effectiveness, and perceived effectiveness of

the group's solution. Similarly, in a study of group performance and development, Pescosolido (2003) found collective efficacy beliefs to be positively correlated with outcome variables such as willingness to continue as a group, perceived learning, and overall group performance. These studies are representative of the predictive properties of collective efficacy and its ability to predict both objective and perceptual measures of performance. In the current research, we explore the influence of virtual team efficacy on perceived performance—measured in terms of team satisfaction, outcome satisfaction, and outcome quality perceptions.

Hypothesis 4: Virtual team efficacy will have a significant positive influence on perceived performance.

While the direct relationship between collective efficacy perceptions and group outcomes has previously been established, Bandura (1997) acknowledges that efficacy may also operate on outcomes through various mediating mechanisms. Additionally, Marakas, Yi and Johnson (1998) have also indicted the importance of the mediating processes in the efficacy–performance relationship and have called for their consideration in efficacy research. In the current study we chose to include effort—a motivational process (Bandura 1997)—as a mediator in the model because of its prior establishment as an influential variable within efficacy research (Bandura and Cervone 1983), its consistency with expectancy-value theory (Vroom 1964), and its identification by Marakas et al. (1998) as a potential mediating variable in models of computer self-efficacy and performance.

Hypothesis 5: Perceived effort will mediate the relationship of virtual team efficacy on perceived performance.

Trust has been studied often by information systems researchers interested in both the dynamics of virtual teams and how factors such as trust may differ in heterogeneous contexts (Jarvenpaa et al. 2004). In studies of trust, the distinction between trustworthiness and trust has been made. Trustworthiness, or trusting beliefs, must exist in the mind of the trustor before trust can form (McKnight et al. 2002), and is generally accepted to be based upon the trustor's perception of the ability, benevolence, and integrity of the trustee (Mayer et al. 1995). Trusting beliefs related to ability address perceptions of the trustee's competence to complete a desired task. Benevolence reflects the trustor's belief that the trustee will act in his or her best interests, while integrity is based upon the trustor's belief that the trustee will be honest and keep commitments (McKnight et al. 2002).

The distinction of trustworthiness and trust presents interesting possibilities in terms of the virtual team efficacy theoretical model. For example, trustworthiness, or a virtual team member's perception of the ability, benevolence, and integrity of the other members of the team, may influence that same team member's belief in the team's collective ability. That is given the knowledge of the other team members' ability, benevolence, and integrity a team member may be more likely to have a higher belief in the overall efficacy of the team. This may be especially true for perceptions of ability, as at some level, the trustworthiness factor of ability is conceptually similar to a belief in the virtual team's collective efficacy. Due to this conceptual similarity, we should expect that the ability factor of trustworthiness would at a minimum be positively related to collective efficacy. Therefore, future studies should be designed to investigate the causal structure between these two variables. However, while we may expect that perceptions of

integrity and benevolence would influence collective efficacy beliefs, we may not expect that collective efficacy will influence perceptions of integrity, and/or benevolence. That is, team members may feel that their team possess high ability, but still doubt the integrity and/or benevolence of the other team members. In the case of trustworthiness then, it may make greater sense conceptually to position trustworthiness as an antecedent to virtual team efficacy, rather than as a consequence, in models of VTE.

Trust, on the other hand, has been defined as the willingness of one party to be vulnerable to the actions of another (Mayer et al. 1995) and has been proposed as a behavioral intention rather than as a behavior (Mayer et al. 1995). That is, a team member may be willing to trust the other members of the team, however still not engage in what Mayer et al. (1995) has termed, risk-taking in relationships (RTRs). In the current study however, this does not affect the proposal of a relationship between VTE and trust as no action is required for perceptions of the team's ability to influence the willingness of virtual team members to be vulnerable to the actions of the other team members. Therefore, based on studies of trust establishing perceptions of ability to be precursors to trusting intentions, we propose that a team's belief in its collective ability, or VTE, will directly influence the team's willingness to be vulnerable to each others actions.

Hypothesis 6: Virtual team efficacy will have a significant positive influence on trust.

Communication has also been investigated within both collocated and virtual team models of performance (Jarvenpaa and Leidner 1999). Among the variations of communication that have been tested (e.g., quality, task specificity, level), communication level is one form of communication that has been specifically

demonstrated to influence virtual team performance (Jarvenpaa et al. 2004). In the current study, we expect that a virtual team's belief in its ability to work together using communication technology will influence its willingness to use the communication technology available during the completion of project deliverables. That is, teams who are confident in their ability to work together using technology will more frequently use the available technology. Thus, we expect that VTE will have a positive influence on the level of communication by the respective teams.

Hypothesis 7: Virtual team efficacy will have a significant positive influence on communication level.

The relationship between group efficacy and group outcomes is well established. Among the various group outcomes consistently predicted by group efficacy is actual group performance (e.g., Gibson et al. 2000). As outlined previously, this relationship has been found in numerous studies involving group efficacy, and is further evidenced by the finding of an overall effect size of .29 (n = 8,978) for the group efficacy—actual performance relationship by Gully et al. (2002) during their meta-analysis of the group efficacy construct. In the current study we propose that the context specific measure of VTE will have a direct affect on actual performance.

Hypothesis 8: Virtual team efficacy will have a significant positive influence on actual performance.

Finally, based on the previous literature establishing a relationship between communication and team performance, and the literature finding a relationship between communication level and virtual team performance (Jarvenpaa et al. 2004), we expect

that the level of communication among team members will also influence the team's actual performance.

Hypothesis 9: Communication level will have a significant positive influence on actual performance.

3.3 Summary

To test the theoretical framework proposed in conjunction with this dissertation it was necessary to formulate a research model based upon the more comprehensive conceptual model developed in terms of SCT and efficacy theory. The development of the research framework and the associated hypotheses for the research model was conducted in conformance with the perspectives of positivist scientific inquiry. The specific hypotheses associated with the current research are shown in Table 3-1 below.

Hypotheses #	Hypotheses
Hypothesis 1	Group potency will have a significant positive influence on virtual team efficacy.
Hypothesis 2	Level 1 computer collective efficacy will have a significant positive influence on virtual team efficacy.
Hypothesis 3	Level 2 computer collective efficacy will have a significant positive influence on virtual team efficacy.
Hypothesis 4	Virtual team efficacy will have a significant positive influence on perceived performance.
Hypothesis 5	Perceived effort will mediate the relationship of virtual team efficacy on perceived performance.
Hypothesis 6	Virtual team efficacy will have a significant positive influence on trust.
Hypothesis 7	Virtual team efficacy will have a significant positive influence on communication level.
Hypothesis 8	Virtual team efficacy will have a significant positive influence on actual performance.
Hypothesis 9	Communication level will have a significant positive influence on actual performance.

Table 3-1 Research Hypotheses

Having formulated a research model based upon the conceptual framework as presented, specific hypotheses were then developed. Following in Chapter 4, the research

methodology used for this dissertation is explained. In addition, the research measures are defined and discussed in detail.

Chapter 4 – Research Approach and Methodology

4.1 Introduction

This chapter provides a discussion of the research approach and methodology used in this study. This chapter is structured as follows. Following the introduction, the research methodology is discussed. Next the research measures are defined and discussed. Finally a summary is presented.

As discussed in Chapter 3, this study was designed based upon the principles of positivism. That is, an objective ontology was held by the researchers and an epistemological tool consistent with the positivist paradigm—surveys—was used for data collection. There was no manipulation of variables, or control group used in this study. Therefore, this study can best be described as a multi-wave, survey-based, field study. In making the decision to use such a methodology the researchers were cognizant that such an approach could lead to an increase in error variance in the data set. Specifically, the influence of variables known to influence team performance could not be accounted for. For example, group size was not controlled for, yet we know from the group support system literature that group size may influence group performance (Gallupe, Dennis, Cooper, Valacich, Bastianutti and Nunamaker 1992; Nunamaker et al. 1991). Neither was gender controlled for. However we know that gender may play a role in efficacy research (Hannah and Kahn 1989; Bandura 1997).

These two are only representative of the many external forces that may have an ultimate impact on both the formation of virtual team efficacy beliefs and the influence of those beliefs on team performance in such an environment. However, as we will

demonstrate through the findings discussed in Chapter 5, the model as specified, even in the face of increased error, is quite robust. A large amount of the variance was accounted for in many of the endogenous variables, and the relationships among several of the hypothesized relationships were quite strong. In addition, we argue that by establishing this model using a multi-wave survey methodology in a field setting, we are adding to the value of the research for several reasons. First, our purpose was to establish a baseline model describing both the mechanisms of virtual team efficacy, and its influence on team performance, that would be useful for predicting performance across varying projects, team sizes, compositions, and settings. Second, it was felt that by designing the investigation in this fashion, it would best replicate a situation in which the model could be later tested in an organizational environment. That is, we would not expect to be afforded the opportunity to apply the research model within an organizational setting and still have the capability to control extraneous variables such as team size, project type, and gender, among others. Finally, we felt that by designing and validating a robust general model in this fashion we would provide more value for research and practice alike, and the applicability of the model would range across a number of settings.

This chapter is structured as follows. Following the introduction, the research methodology is discussed. Next the research measures are defined and discussed. Finally a summary is presented.

4.2 Research Methodology

Data for this dissertation was collected during a series of virtual team projects conducted by researchers at universities in the United States and Hong Kong. Four separate projects involved teams composed of students attending schools in the United

States and Hong Kong. Teams were varied in terms of size and composition. A fifth project involved project teams composed of students from the United States, Hong Kong, and the United Kingdom. Again, team composition and size were varied. Finally, providing additional variance to the sample, an additional project was conducted using teams formed from students enrolled in the distance learning and on-campus versions of a senior-level information systems project management course at the United States University. Overall, over 400 students were involved in the various projects, of whom 318 (52 project teams) provided usable responses.

Projects were varied across the different semesters and courses; however, all projects required some type of team deliverable that had a substantial impact on each student's grade for the course. For example, the first project was designed so that US MBA students were charged with the responsibility of overseeing the development of a website that could be used by US expatriates preparing to relocate to Hong Kong as part of their job assignment. The websites were to be developed by the Hong Kong students who were enrolled in an e-commerce course. As part of this same project, a second set of Hong Kong students enrolled in a management skill development course were charged with finding material that could be included in the website under development such as housing, dining, and entertainment information.

While the subsequent projects were varied, all involved some form of collaborative project which required the team members to work interdependently. The Hong Kong, US and United Kingdom project, for example, required a deliverable evaluating the suitability of a knowledge management system within a global multi-national corporation. The project involving the on-campus and distance based US

students required the completion of a series of project management deliverables including a functioning celebrity website.

Data was collected by administering a series of electronic surveys during the course of the projects. Electronic surveys were created by the US researchers in an Active Server Pages (ASP) environment, using a combination of Hyper Text Markup Language (HTML), Visual Basic Script (VBScript), and JavaScript. The ASP environment was used to facilitate the process of automatically reading the survey responses to a Microsoft Access database. This was important as it allowed for the remote team member data (i.e., students not attending on-campus courses at the United States University) to be automatically recorded within an Access database located on the web server at the university located in the US. This had the affect of eliminating the need to rely on researchers at the remote locations to deliver the survey instrument instructions, and also reducing the potential for data entry error. HTML was used to develop the web forms viewed by the research participants. VBScript was then used to code the response pages to capture the data, open the database connection, and transfer the data to the Access database. JavaScript was then used to provide client side validation for the participant responses and was coded within the HTML web form pages. Client side validation was used to reduce the amount of traffic to and from the web server where the Access database resided. Validation was used to insure that the responses by the research participants were in the correct format, and also to reduce the number of missing values in the data set. For any questions deemed to be sensitive, such as age and gender, validation was not used so that respondents could choose not to answer those questions.

Survey 1 was designed to collect both demographic and individual level efficacy information, as well as other information not included in the current work. This survey was administered very early in the project, and in fact, was administered prior to any interactions among the respective team members. This was done to insure that responses to the individual level items were not influenced by perceptions of a respondent's group. While the individual level data has not yet been utilized, the demographic information was collected to provide overall statistics regarding the make-up of each of the samples. Survey 2 was administered after the teams' introductory deliverables were graded and returned. This was done to insure that the team members had sufficient information from which they could develop perceptions of their team's ability (Jung and Sosik 2003). This is an important consideration in studies of group efficacy as interrater reliability calculations are generally recognized to be a necessary preliminary step in such situations (Whiteoak et al. 2004). Survey 2 was designed to collect individual member perceptions of the team's group potency, computer collective efficacy, and virtual team efficacy, as well as other information not included in the current work. The final survey, administered after project completion but prior to any feedback on the team's final deliverables was given, was designed to collect perceptions of team effort, trust, and performance, and also included additional measures not included in the current work. Table 4-1 describes the various processes of the research methodology.

Methodology Step #	Methodology Description
Step 1	Administer Survey 1
Step 2	Assign Teams
Step 3	Grade and Return Introductory Deliverables
Step 4	Administer Survey 2
Step 5	Final Deliverable Submission
Step 6	Administer Survey 3
Step 7	Grade and Return Final Deliverable
Step 8	Conduct Analyses

Table 4-1 Research Procedures

4.2.1 Research Measures

This section discusses the measures specifically used to test the hypotheses developed in Chapter 3.

4.2.1.1 Exogenous Measures

To test the research model and hypotheses proposed in Chapter 3, data were collected for two exogenous variables, group potency and computer collective efficacy.

4.2.1.1.1 Group Potency

The group potency (GP) measure developed by Guzzo et al. (1993) was used to measure perceptions of the team's general effectiveness. The GP measure has often been used by collective efficacy researchers interested in the performance of groups (Gibson et al. 2000; Lester 2002), and has consistently been shown to predict general group

outcomes (Gibson 1999; Gully et al. 2002). The measure contains items that are used to elicit the individual members' perceptions of the team's general abilities. Eliciting the individual perceptions of the team members' allows for the use of the measure in studies designed to predict individual level outcomes, and also for the eventual aggregation of the member responses for use in studies designed to predict group level outcomes. Our intention to place the group potency construct as an antecedent to the more domain specific measure of virtual team efficacy, dictated the use of the GP measure. That is, GP has consistently been used by group efficacy researchers as a general measure of the group's effectiveness (Gibson et al. 2000; Gully 2002), rather than as a more context specific form of collective efficacy used to predict domain specific outcomes.

4.2.1.1.2 Computer Collective Efficacy

Computer collective efficacy was measured by adapting a previously validated measure of general computer self-efficacy (Murphy, Owen and Coover 1989) to reflect member perceptions of the *team's* collective computer abilities. While consideration was given to adaptation of the Compeau and Higgins's (1995) measure of computer self-efficacy for this same purpose—a well established measure of computer self-efficacy—the authors believed that the Murphy et al. (1989) measure would better suit the needs of the current research for two reasons. First, the Compeau and Higgins (1995) measure relies on individuals assessing their competency relative to the software of their choice. For example, an opening vignette is presented to research participants asking them to imagine a software package of their choosing. Consider the following introduction to the Compeau and Higgins (1995) computer self-efficacy measure:

Often we are told about software packages that are available to make work easier. For the following questions in this section, imagine that you were given a new software package for some aspect of your work. It doesn't matter specifically what this software package does, only that it is intended to make your work easier and that you have never used it before.

The Compeau and Higgins (1995) measure's vignette is worded in an individual based context. That is, each respondent is asked to imagine a software package of their choice. When used for assessing the computer self-efficacy of individuals, this method exhibits face validity. Having individuals imagine a software package of their choice does not affect the overall results as the individual is cognitively assessing their own efficacy, not the efficacy of others.

However, the current research involves individuals assessing their team's collective abilities. This means, as mentioned earlier, that the generally accepted process of establishing the interrater reliability of the respective teams must be followed. This process will be discussed in detail in the next chapter, but for now suffice it to say that agreement among the members must be sufficient to properly establish that a true group level effect is being observed. Because of this, having team members base their perceptions on differently imagined software packages could lead to exaggerated differences among the team members. For example, where team members may all agree that as a team they have the ability to perform a specific task using computers, having one member imagine using Microsoft Word and another imagine using Microsoft Project may result in very different responses to the survey questions. These different responses could then adversely affect calculations of interrater reliability for that team, negating the

finding of a group level affect. Therefore, to remedy this concern, we believed having the participant's rate their teams' efficacy based on more objectively consistent skills—consistent with the Murphy et al. [39] measure—would better serve the purposes of the current research.

Second, the Compeau and Higgins (1995) measure is focused on software efficacy. While it could be argued that any interaction with technology by the project teams would be through the use of some form of software package, it may alternatively be expected that a team's willingness to engage in the use of communication technology may also in part be based upon the collective perception of the team's ability to understand and utilize computer hardware.

The original Murphy et al. (1989) computer self-efficacy measure was designed to measure three separate levels of general computer self-efficacy. The first two levels are focused on the general usage of hardware and software and only differed in the difficulty of the skills required to complete the tasks referred to by the measurement items. The third level—which was not considered for use during this research—focused on computer self-efficacy related to mainframe technology. Therefore, the current study adapts the two separate levels of computer self-efficacy to the group level. Computer collective efficacy level one (CCEL1) and computer collective efficacy level two (CCEL2). Both were measured in terms of the individual virtual team members' perceptions of their team's computer capabilities.

4.2.1.2 Endogenous Measures

The current study specifies six endogenous measures: virtual team efficacy, effort, trust, communication level, perceived performance, and actual performance.

4.2.1.2.1 Virtual Team Efficacy

The virtual team efficacy (VTE) measure was developed by the authors. Measurement items were developed based upon a review of the social cognitive theory, collective efficacy, and virtual team literatures. General instrument development procedures recommended by psychometric theorists were followed. Specific to the SEM analyses used for instrument development, the procedures recommended by Chin, Gopal and Salisbury (1997), and Salisbury, Chin, Gopal and Newstead, (2002) were used to guide the analyses. These procedures are outlined in some detail in Chapter 5.

4.2.1.2.2 Effort

During the development of the effort measure, consideration was given to the measure used by Lester, Meglino and Korsgaard (2002) in a study involving collective efficacy and group performance. The measure used by Lester et al. (2002), however, was designed to simultaneously measure both effort and persistence. These two constructs are posited by Bandura (1997) to be distinct within the social cognitive theory framework, and therefore, the decision was made to represent effort as an independent construct and avoided the use of any items anchored by persistence.

4.2.1.2.2.2 Communication Level

During the analysis of the research data at the group level, actual performance was used. While, effort perceptions could certainly be aggregated (and in fact were), a more objective measure was desired for testing the model when using object performance. In this case, the number of postings in each group's discussion area were counted and used to measure communication level as a surrogate measure of actual effort. This method of measurement is consistent with previous measures of communication

level (Jarvenpaa 2004). A further discussion of this measure and its role in the examination of the group level research model will be discussed in the next chapter.

4.2.1.2.3 Trust

Many measures of trust have been proposed in the literature (Mayer et al. 1995; McKnight et al. 2002). While differences in models of trust exist, it is generally accepted that trusting beliefs such as ability, benevolence, and integrity, influence trust, or a person's willingness to be vulnerable to others. In the current research, we are interested in the latter. Specifically, as explained during the research model development, we are interested in how an individual team member's perception of his or her team's ability will influence that same member's willingness to trust the other team members. Remaining consistent with our research context, we chose to use the previously validated trust items as adapted by Jarvenpaa and Leidner (1999) during their investigation of trust in virtual teams.

4.2.1.2.4 Perceived Performance

Perceived performance was measured by the three separate first order constructs of group satisfaction, outcome satisfaction, and outcome quality. Group satisfaction was measured by three items consistent with previous measures of satisfaction in project groups. The outcome satisfaction construct was measured by three items as was outcome quality, again both consistent with previous measures of these constructs. These three measures were then used to form a second order construct of perceived performance. This was done for several reasons. First, the constructs were highly correlated during an initial model test. Second, model fit was improved when the three constructs were included in a second order factor structure. Finally, the use of the second order perceived performance

construct allowed for the evaluation of effort as a mediator in the model in a single process, rather than in three separate processes. This was an important consideration as the Baron and Kinney (1986) process for evaluating mediation consists of three steps. Without the use of the second order construct, 9 separate steps (3 variables * 3 steps) would otherwise have been necessary.

4.2.1.2.5 Actual Performance

Actual performance was measured in terms of the teams' overall grades for each project.

4.3 Conclusion

This chapter has provided a discussion of the research methodology associated with the dissertation. In addition, the measures used to evaluate the hypotheses as developed in Chapter 3 were explained. The next chapter, Chapter 5, discusses the instrument development process associated with the virtual team efficacy measure developed by the authors. In addition, the analysis and results associated with the dissertation research model are discussed.

Chapter 5 – Analyses and Results

5.1 Introduction

This chapter presents a discussion of the analyses and results associated with this dissertation. First, the instrument development procedures used to develop and validate the virtual team efficacy measure are related. Next the results from the evaluation of the research model hypotheses are discussed. Finally, a summary is presented.

Before beginning the dilation of the procedures associated with the virtual team efficacy instrument development, it is important to be clear on the relationship of the instrument development procedures to the research model and hypotheses. An important consideration in the development of the virtual team efficacy measure was establishing its predictive validity within a nomological network. In this case, the nomological network was provided by a model similar to that depicted by the research model. However, instrument development procedures were conducted at the individual level of analysis. This was justified, as the items were designed to measure the individual level perceptions of the members regarding the teams' collective abilities. Following the validation of the virtual team efficacy construct at the individual level of analysis—which allowed for the utilization of the covariance based SEM tool, AMOS 4.0—the measure was then reevaluated for its convergent, discriminant, and predictive validity within the research model at the group level of analysis. This was made possible through the use of the aggregated team member responses following the establishment of interrater reliability among the respective teams.

It is also important to explain the use of the SEM tools used in the analyses, and further, to explicate why each tool was used for a particular analysis. As mentioned above, AMOS 4.0, a covariance based SEM tool, was used during instrument development for the confirmatory tests involving both the confirmatory factor analysis and nomological model test. For the evaluation of the hypotheses at the group level of analysis, PLS-Graph 3.0, a principle components based SEM tool was utilized. The use of each of these tools is explained separately below.

5.1.1 The Use of AMOS 4.0

AMOS 4.0 was used during the instrument development portion of the dissertation. AMOS 4.0 is a SEM tool used by researchers to evaluate the fit of a hypothesized model to the sample data variance-covariance matrix. In addition, factor loadings and/or regression paths are estimated during model fit procedures. This second capability is particularly important as it allows researchers the ability to estimate path coefficients while simultaneously accounting for measurement error. The ability to account for measurement error during path estimation differentiates SEM techniques from traditional regression analysis in that regression analysis requires researchers to first create an indicator value through some form of aggregation of the respective construct measurement items. In this manner researchers are essentially assuming away any measurement error that may exist. Because of this, SEM techniques have been recognized to provide more conservative estimates of path coefficients (Gefen et al. 2000).

In the current study—using AMOS 4.0—maximum likelihood estimation (MLE) was used to evaluate the null hypothesis that the specification of the nomological model was valid. Using MLE, our purpose was to maximize the probability that the observed

data would be reproduced if another sample was drawn from the same population. Further, the chi-square statistic (X^2) was generated and used to evaluate the model's ability to replicate the variance-covariance matrix associated with the sample data. In doing so, the X^2 was compared to a critical value, where a finding of non-significance was the desired result. That is X^2 is a likelihood ratio statistic used to test the hypothesized model against the alternative that the covariance matrix is unconstrained (Bagozzi and Yi 1988). The calculation of X^2 is sensitive to sample size however, and because of this, larger samples are more likely to result in a significant X^2 indicating that the null hypothesis should be rejected. This may occur even though the hypothesized model may fit the data well (Byrne 2000), or alternatively, when the model fit is poor (Bagozzi and Yi 1988). Because of this limitation, a host of alternative model fit indices have been proposed by SEM researchers.

During the evaluation of the CFA and nomological models during instrument development, several model fit indices were evaluated. Among these were GFI, AGFI, NFI, CFI, and RMSEA. GFI (goodness of fit index) is representative of the proportion of variance and covariance accounted for by the model, with AGFI (adjusted goodness of fit index) only differing from GFI in its ability to account for the number of the degrees of freedom in the specified model. More specifically, AGFI imposes a penalty for the inclusion of additional parameters (Byrne 2000). Both GFI and AGFI are considered to be absolute fit indices because they basically compare the hypothesized model with no model at all (Byrne 2000). In general the recommendation for acceptable model fit is for GFI to be .9 or larger, and AGFI to be .8 or larger (Bagozzi and Yi 1988). NFI (normed fit index) and CFI (comparative fit index) were also reported in the current research.

These two fit indices are based on the comparison of the hypothesized model with a baseline model, with CFI purportedly better suited to account for sample size (Loehlin 1998). To indicate acceptable model fit, values for both NFI and CFI are generally recommended to be greater than or equal to .9 (Bagozzi and Yi 1988). Finally, RMSEA (root mean square error of approximation) was also reported in the current study. RMSEA is indicative of how well the model, with unknown but optimal parameter values, would fit the population covariance matrix (Byrne 2000). The RMSEA has been recognized by some SEM researchers to be the most informative of the fit statistics (Loehlin 1998). While many have proposed that a RMSEA of equal or less than .05 is necessary for good model fit, others have proposed that below .1 is indicative of good fit, and at or below .05 is excellent (Loehlin 1998).

Given the large number of fit statistics generated by SEM programs such as AMOS 4.0, it is often difficult to determine with certainty how well a given model fits the sample data variance-covariance matrix. Because of this, several fit statistics should be evaluated and reported. Further, the fit statistics should be evaluated along with criteria accounting for the statistical and practical aspects of the model (Byrne 2000). Finally, the use of MLE within AMOS 4.0 is generally recognized to be a confirmatory tool and therefore strong theory should guide model specification (Gefen et al. 2000). In the case of the current research this recommendation was met through the development of the research model based upon established theory, the reporting of several complimentary fit indices, and the model's parsimonious nature.

While the use of MLE within AMOS 4.0 allows for the comparison of the hypothesized model to the sample variance-covariance matrix, factor loadings and

regression paths are also calculated. Factor loadings are interpreted much the same as in exploratory factor analyses—such as principle components—and path coefficients are interpreted in manner similar to the interpretation of regression coefficients generated during traditional linear regression analysis. Also similar to linear regression is the interpretation of R^2 or the variance accounted for (VAF) in the endogenous variables of interest.

Finally, convergent and discriminant validity are determined through the loadings of the items on their respective latent constructs. Specifically, convergent validity can be determined by examining the factor loadings of the respective constructs (Chin et al. 1997), while discriminant validity can be determined through the use of the chi-square differences test (Chin et al. 1997). Both of these procedures are outlined in the instrument development section later in this chapter.

5.1.1 The Use of PLS-Graph 3.0

PLS-Graph 3.0 was used for testing the research model hypotheses at the group level of analyses. While AMOS 4.0 and the use of MLE would be acceptable for testing these hypotheses, it is generally recommended that at an absolute minimum, a sample size of 100 is needed to produce accurate results when using MLE (Gefen et al. 2000). In the current study, 52 teams were available for analysis 1, and 31 were available for analysis 2, both obviously well below the 100 minimum.

For PLS it has been suggested that to calculate the minimum sample size required the endogenous construct with the most paths leading into it should first be identified (Jarvenpaa et al. 2004). Following this identification, the minimum sample is then determined by multiplying the number of paths leading into the construct by 10 (Chin

1998). In the current case, this means the VTE construct which has three paths leading into it. Therefore the minimum sample size was calculated to be 30 of which both samples exceeded. Based on this information, a decision was made to utilize PLS-Graph 3.0.

PLS-Graph 3.0 is a principle components based SEM tool which combines both factor and regression analysis in a manner similar to AMOS 4.0. However, unlike AMOS 4.0, PLS-Graph 3.0 provides no evaluation of the fit of the hypothesized model to the variance-covariance matrix. Because of this, no fit statistics are generated. Rather, fit is evaluated through the examination of the regression paths and variance accounted for in the model (Chin 1998). While R^2 is generated automatically by the PLS-Graph program, the significance of the regression paths must be determined by examining the t-values returned during bootstrap or jackknife procedures. Based on the t-values generated during either of these respective procedures, statistical tables can then be consulted to determine the significance of the respective paths (Chin 1998).

Convergent and discriminant validity can also be determined using PLS-Graph. Convergent validity is evaluated by insuring that the measurement items load higher on their respective constructs than on any other variable in the model. Discriminant validity is evaluated by insuring that the square-root of the average variance extracted (AVE) is larger than the correlation with any other construct (Chin 1998).

PLS-Graph 3.0 and its use of ordinary least squares has been proposed to be especially well suited for small sample sizes (Gefen et al. 2000). Because PLS performs an iterative set of factor analyses combined with path analyses, it is also less susceptible to violations of multivariate non-normality (Thompson, Barclay and Higgins 1995). For

this reason, PLS has also been purported to be especially well-suited for exploratory studies, yet suitable for confirmatory tests as well.

Having explained the use of the respective SEM tools in this dissertation, we now present a discussion of the instrument development procedures that were followed.

5.2 Development of the Virtual team Efficacy Instrument

To begin investigating the theoretical tenets of the virtual team efficacy model, it was necessary to first develop an instrument suitable for measuring individual members' perceptions of their virtual team's efficacy. As a first step in this process, virtual team efficacy items were generated based upon a review of the published research from the areas of social cognitive theory, collective efficacy, and virtual teams. Once items were generated, researchers familiar with both virtual team research and social cognitive theory were called upon to review the items for content validity. Next the construct was examined in an exploratory factor analysis using SPSS 11.1. Finally, the construct was tested in a confirmatory manner using AMOS 4.0. Confirmatory analyses consisted of two separate processes. The first process was a test of the VTE factor structure along with other similar measures using confirmatory factor analysis (CFA). The second process involved testing the VTE measure within a nomological model to establish predictive validity.

5.2.1 Step 1—Item Development

Following established psychometric procedures (e.g., Nunnally and Bernstein 1994) the Virtual Team Efficacy (VTE) measurement items were generated based on an extensive review of the social cognitive theory, collective efficacy, and virtual team

literature. The unit of analysis was also given consideration. That is, items were generated at the individual level of analysis however consideration was given to the need for the eventual aggregation of the response data to facilitate testing the model at the group level (Bandura 1997). Such an approach has been used during the development of other measures of group efficacy. For example, the group potency measure (Guzzo et al. 1993), while being developed for the purposes of measuring a group's perceptions of its general abilities across multiple domains, was developed using items designed to elicit individual team members' perceptions of their group's abilities. By designing the measure in this fashion, the items could then be used in studies at either the individual or group level of analysis (Zellars et al. 2001). Based on these criteria, eight items were developed by the authors that would reflect a respondent's belief in his or her team's ability to work in a virtual team context. To reflect the focus of the analysis, items were worded as "I believe my group has the ability…" For example, item 1 is worded: "I believe my group has the ability to use communications software to collaborate with remote group members."

Necessary to the development of any measure of efficacy is the consideration of generality, strength, and level (Bandura 1997). Generality refers to the specific predictive ability of the efficacy measure being developed. For example—as outlined in Chapter 3—domain specific measures have been found to be more predictive than general efficacy measures within a given domain. However, Bandura (1997) also argues that the appropriate level of generality may vary between domains and that many domain specific, yet general measures of efficacy exhibit substantial predictive validity. Further, efficacy researchers have noted that designing efficacy measures too narrowly may result

in a loss of both external validity and practical relevance (Lent and Hackey 1987). As an example, while a measure designed to garner efficacy beliefs regarding students' abilities to perform a specific mathematical equation may have exceptional predictability in terms of the students' ability to complete that same equation, it would be of limited use for predicting other areas of mathematical performance. Alternatively, while a general measure of mathematical efficacy may have somewhat less predictive power for specific equations, it would be more useful in predicting mathematical ability across various equations and/or situations.

In terms of the current research, it was virtually impossible to identify every dimension relevant to the performance of the project teams, as the project team deliverables were varied across the various studies. Further—as stated earlier—it was decided that developing a narrowly defined measure would be of limited value to either the academic or practitioner communities. That is, a measure designed to evaluate the efficacy of a virtual team performing a specific task in a specific situation, would only be useful in those situations were those same conditions were present. However, a more general, yet domain specific measure which took into account the need to use technology to overcome a lack of collocation, would be of value to both communities across a wide range of situations. Therefore, the virtual team efficacy measure was developed as a domain-specific, general-task measure, in line with the recommendations of Bandura (1997).

Bandura also speaks to the issue of efficacy strength. For example, individuals possessing weak efficacy beliefs will often falter in the face of difficulties, whereas those possessing a strong belief in their abilities often persevere (Bandura 2001). Strength of

efficacy belief has also been associated with choice of behaviors. That is, individuals with strong efficacy beliefs are more likely to undertake a given behavior than individuals with weak efficacy beliefs in that same area. Efficacy strength is most often captured by the structure of the efficacy scale (Bandura 2001). That is, scales are generally developed in terms of a yes-no response indicating whether an individual believes s/he (or in the case of the current research, whether his or her team) can perform a given behavior. A no response indicates that the individual does not believe that they (or their team) can perform the behavior in question. If the respondent chooses yes, they are then instructed to indicate their strength in that belief on a scale from 1 to 10 or 10 to 100. In the case of the current study, the VTE measure was designed using this structure and therefore meets Bandura's (2001) requirements for assessing efficacy strength.

Bandura's (2001) third prescription—level of efficacy belief—concerns the number of activities in a given domain that an individual is willing to undertake given a specific level of efficacy belief. That is, a continuous measure of efficacy is converted to a dichotomous variable and then used to predict the number of activities an individual will engage in based on a predetermined efficacy cut-off value. However, Bandura (2001) acknowledges that converting a continuous measure to a dichotomous one results in a loss of predictive power. In this study, level was not considered. Rather, level of efficacy belief was captured by the continuous measure of efficacy strength (Bandura 2001). Items generated for the virtual team efficacy measure are shown in Table 5-1.

Item #	Item Text
1	I believe my group has the ability to use communications software to collaborate with remote group members
2	I believe my group has the ability to use technology to collaborate with others across time and space
3	I believe my group has the ability to use technology to work in groups that are not collocated
4	I believe my group has the ability to do teamwork in a distributed environment if we have access to the appropriate technology
5	I believe my group has the ability to share information using technology with remote group members
6	I believe my group has the ability to work with remote team members using technology
7	I believe my group has the ability to use computers to work with group members who cannot meet face to face
8	I believe my group has the ability to use communications technology to do work with people who can't physically get together to meet

Table 5-1 Virtual Team Efficacy Items

5.2.2 Factor Structure and Validity Testing

The VTE latent construct was specified as a reflective variable and therefore the measurement items are considered to be "effect indicators" (Nunnally and Bernstein 1998). Two forms of factor analyses can be conducted using effect indicators, exploratory

and confirmatory. Exploratory and confirmatory factor analyses are generally considered to differ in terms of the specificity associated with the measure or measures. For example, a researcher may believe that the items under consideration measure some form of team satisfaction, yet s/he is not exactly sure of the type(s) of satisfaction that may be represented by the items. On the other hand, a researcher may specifically propose two types of team satisfaction, satisfaction with the team, and satisfaction with the team deliverables. In the first case, the question is open-ended. That is, the researcher is not sure of the constructs represented by the items, and therefore is unable to specify a specific factor structure. This situation is an example where exploratory factor analysis should be used to determine the factor structure. In the second case, the researcher is able to specify two factors for the factor structure, and to assign items to the factors accordingly. This situation is as an example of confirmatory factor analysis.

The two analyses also differ in that an EFA represents the mathematical representation of the factor structure, whereas a CFA is used to determine the likelihood that the factor structure specified by the researcher fits the data (Nunnally and Bernstein 1994). More specifically, exploratory factor analysis is used in cases where researchers are unwilling to specify hypotheses associated with the potential factor structure of their research variables (Nunnally and Bernstein 1994), and thus allow them to be mathematically determined, and confirmatory factor analysis is used when researchers are willing to formulate hypotheses associated with the factor structure of their data, and assign items to a specific construct.

5.2.2.1 Exploratory Factor Analysis

In this study, the authors were careful to develop the virtual team items based upon the literature associated with efficacy theory and what they felt were items representing a single VTE factor. However, to further substantiate the item structure, the VTE items were tested in an EFA using SPSS 11.1.

The EFA consisted of evaluating the eight VTE items using a principal components analysis (PCA) within SPSS v.11. While a varimax rotation—designed to maximize the variance explained by the factor structure—was specified, a single-factor solution was observed and therefore rotation was unnecessary. The single factor explained approximately 76% of the variance. Reliability was also established at this stage and was found to be acceptable (alpha = .96). Table 5-2 depicts the results of the PCA.

Component Matrix								
Item	VTE8	VTE4	VTE5	VTE3	VTE1	VTE2	VTE7	VTE6
Loading	.915	.898	.886	.878	.877	.874	.842	.827

Table 5-2 VTE Exploratory Factor Analysis Item Loadings

5.2.2.2 Confirmatory Factor Analysis

The VTE, CCEL1, CCEL2, and GP efficacy related constructs described in Chapter 4 were then tested in a factor structure specified by the authors using AMOS 4.0. The responses to survey 2, from a sample of 127 US and Hong Kong students, were used for the confirmatory factor analysis. Each factor was specified within AMOS 4.0 as a latent construct reflecting its respective measurement items. Specifically, CCEL1 was

specified with 5 items, CCEL2—5 items, GP—8 items, and VTE—8 items. Covariance paths were specified between the respective constructs. Using maximum likelihood estimation, the model was then tested in a four factor structure. While the items loaded on their respective latent constructs, initial model test results revealed unacceptable fit measures. Based on these results the modification indices were examined. Upon examination, it was evident that highly correlated error terms existed among the items within the respective latent constructs, adversely affecting model fit. This is an indication of the error—or what is unique about each measurement item—being the same, indicating that the items may be interchangeable (Gefen et al. 2000). Therefore we chose to follow the strategy of current IS research and parse the items for each construct to improve the fit of the model to the variance-covariance matrix (Chin et al. 1997; Salisbury et al. 2002). This method also has the added benefit of reducing the complexity of the model. That is, during a process of elimination, items with highly correlated errors were removed from the model, reducing the number of items measuring the respective latent constructs.

Each time an item and its respective error term were eliminated, the model was re-run and the modification indices reexamined. This was done to insure that any changes in the modification indices from the prior run were accounted for. This process involved copying the modification indices into Microsoft Excel, performing a sort procedure and determining the total value of the modification indices for each item. This procedure was conducted each time a new model was run.

The process of eliminating the correlated error terms and their associated items resulted in a more parsimonious model (i.e., three items for CCEL1, three items for

CCEL2, three for GP, and four for VTE) that provided an excellent fit to the data. While some researchers have suggested that the deletion of items based on the modification indices generated by a SEM program during a CFA moves the researcher into a realm of exploratory analysis (e.g., Byrne 2001), support is provided in the information systems literature for the deletion of items at this stage of the factor analysis (Chatterjee, Grewal and Sambamurthy 2002; Chin et al. 1997; Venkatesh, Morris, Davis and Davis 2003). Fit measures for the final CFA model were GFI .91; AGFI .88; NFI .92; CFI .98; and RMSEA .036. Reliability (alpha) for the respective constructs after item deletion was found to be (CCEL1 .85; CCEL2 .75; GP .83; and VTE .93).The list of the final instrument items is presented in appendix E.

As shown in Table 5-3, all factors loaded above the .6 level for each of the respective latent constructs providing evidence of their convergent validity (Salisbury, Chin, Gopal, Newsted 2002). Additionally, none of the latent constructs were correlated above .85, a preliminary indication of discriminant validity (Chin, Gopal and Salisbury 1997).

Construct Name	Item #	Factor Loadings			
CCEL1	2	0.81			
	3	0.83			
	4	0.78			
CCEL2	6		0.87		
	8		0.61		
	9		0.68		
GP	1			0.78	
	3			0.85	
	6			0.76	
VTE	1				0.83
	4				0.90
	5				0.87
	8				0.89

Table 5-3 CFA Final Factor Loadings

To further establish the discriminant validity of the VTE construct, a chi-square differences test was conducted following the procedures described by Chin, Gopal and Salisbury (1997). Using this procedure, the correlation between VTE and each of the constructs was set to 1 and then tested in separate structural regression models. By setting the correlation between VTE and the other constructs to 1 the researcher is essentially specifying that the constructs are the same. The chi-square statistics generated from running each of the models where the correlations were set to 1 was then subtracted from the chi-square statistic generated from running the original model in which the correlation between VTE and each of the other factors was freely estimated. If a significant difference exists between the original model chi-square statistic and the other chi-square statistics associated with the models in which the correlation is set to 1, the constructs can be said to be truly different from each other (i.e., discriminant validity). As Table 5-4

below shows, the difference in the chi-square exceeds the critical value for all three models where the correlation was artificially set to 1. This result indicates that VTE is in fact an independent construct and exhibits discriminant validity.

	Final Model	VTE-CCEL1	VTE-CCEL2	VTE-GP	Critical Value
Chi-Square	74.524	120.141	133.166	141.154	
Difference		45.617	58.642	66.63	3.84($p < .05$)
Significance		yes	yes	yes	

Table 5-4 Chi-Square Differences Test Results

To complete the development of the VTE measure the construct was next placed within a nomological model to establish its predictive validity. The nomological model was used to test paths similar to hypotheses 1 through 5 specified in the research model developed in Chapter 3. Therefore, the nomological model was specified in accordance with established efficacy theory and provided a plausible nomological net for testing the predictive validity of the VTE construct. Specifically, the paths between CCEL1and VTE, CCEL2 and VTE, and GP and VTE were evaluated. Two additional paths were also evaluated, VTE to effort and effort to perceived performance. Finally, the direct path between VTE and Perceived Performance was evaluated both with and without effort included in the model during subsequent tests used to evaluate the mediating effects of effort. Unlike the test of the research model, the instrument development analyses were conducted at the individual level, and the model paths were used only for providing a nomological net in which the predictive validity of the VTE construct could be established (Chin et al. 1997). The nomological model is shown by Figure 5-1 below.

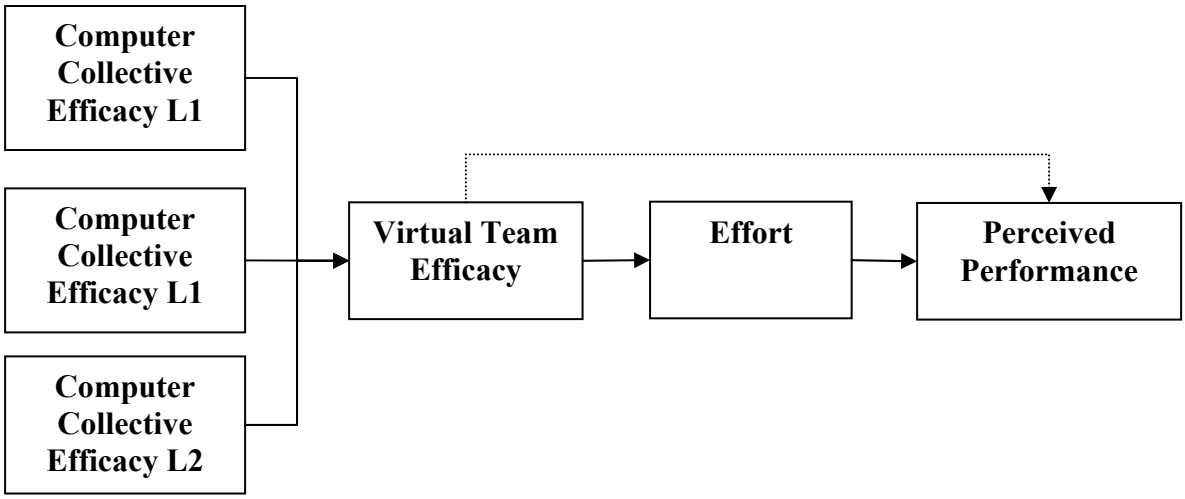

Figure 5-1 Nomological Model[1]

5.2.2.2 Confirmatory Model Test

Three separate tests were conducted during confirmatory model testing. The initial test examined the nomological model as specified. To support the findings associated with the initial test a replication study was then conducted using a separate sample. Finally, a confirmation data set, consisting of the data from the initial and replication studies, was used to provide a final test of the construct.

5.2.2.2.1 Initial Test

The sample used for the CFA (n = 127) was utilized for the initial test of the VTE construct within the nomological model. Although the model exhibited acceptable fit (GFI .84; AGFI .80 NFI .88; CFI .97; and RMSEA .049), the path from CCEL1 to VTE was found to be non-significant (p = .104). The finding of non-significance in the case of the path from CCEL1 to VTE may have been a result of limited statistical power. This

[1] The dotted arrow connector represents the direct path from VTE to Perceived Performance that was estimated during procedures used to evaluate the mediating effects of effort. This path was not estimated during the initial, replication, and confirmatory tests of the nomological model.

concern is specifically addressed by the replication and confirmatory tests discussed in the following sections. However, because of the finding of non-significance associated with the path from CCEL1 to VTE, the model was retested with the path removed. Fit was observed to be improved (GFI .86; AGFI .83; NFI .90; CFI .98; and RMSEA .047), and all structural paths were found to be significant at the $\underline{p} < .05$ level.

5.2.2.2.2 Replication Test

Because of concerns with the statistical power of the initial test, a replication test was conducted using a new sample (n = 191) collected during a separate set of virtual team projects. The nomological model as originally specified was reexamined first. Results revealed that although the model exhibited acceptable fit (GFI .83; NFI .90; CFI .95; and RMSEA .070) the path from CCEL1 to VTE was once again non-significant ($\underline{p} = .356$), confirming the results of the initial test. All other structural paths in the model were found to be significant at the $\underline{p} < .05$ level. Because of findings consistent with those of the initial test, the model was retested without the path from CCEL1 to VTE. The model fit was observed to improve (GFI .86; AGFI .82; NFI .92; CFI .96; and RMSEA .066) and all structural paths in the model were found to be significant at the $\underline{p} < .001$ level.

5.2.2.2.3 Confirmatory Test

A confirmation test was conducted using the combined sample from the initial and replication model tests (n = 318). Once again, the research model as originally specified was tested. Although the model exhibited excellent fit (GFI .91; NFI .94; CFI .98; and RMSEA .044), the path from CCEL1 to VTE was once again found to be non-significant ($\underline{p} = .103$). Because of the non-significant finding, the model was retested with

the path removed. The model fit was observed to be excellent (GFI .92; AGFI .90; NFI .95; CFI .98; and RMSEA .043). Further, all structural paths in the model were found to be significant at the $p < .001$ level. Table 5-5 provides the fit statistics for the CFA, initial, replication, and model tests.

Model	Fit Statistics				
	GFI	AGFI	NFI	CFI	RMSEA
CFA	.91	.88	.93	.99	.046
Initial Model	.86	.82	.90	.98	.044
Replication Model	.85	.82	.92	.96	.066
Confirmation Model	.92	.90	.95	.98	.043

Table 5-5 Instrument Development Model Fit Statistics

5.2.3 Additional Analysis

Three additional analyses were conducted in support of the findings associated with the SEM analyses used to evaluate the nomological model. First, a bootstrap analysis was conducted to alleviate concerns of any multivariate non-normality in the data. Second, a mediation analysis was conducted to test for the mediation effects of effort in the model. Third, a power analysis was conducted to ensure that sufficient power was available for detecting potential effects where non-significant effects were observed.

5.2.3.1 Bootstrap Analysis

Due to some concern with the multivariate non-normality of the data (Mardia 1970), a bootstrap analysis was conducted. The use of a bootstrap analysis has been recommended in cases involving multivariate non-normality to further evaluate the significance of regression paths in structural models (Byrne 2001). Using AMOS 4.0, 1000 random samples of the same size as the nomological model sample (n = 318) were

generated from the original data set, with replacement. Bias-corrected confidence intervals were then generated as they are generally considered to be the most accurate (Byrne 2001).

Bootstrap analysis results indicated that none of the bias-corrected confidence intervals included zero, providing additional evidence for the rejection of the hypothesis that the population regression weights were equal to zero. An associated p value for each confidence interval reflects how small the confidence interval must be before the lower bound will equal zero. As a specific example in the current study, results indicate that the confidence interval associated with the path from CE to VTE would need to be 99.8% before the lower bound would be zero.

5.2.3.2 Mediating Analyses

The procedures recommended by Baron and Kinney (1986) complemented by those recommended by Shrout and Bolger (2002) were used to provide additional support for effort as a mediating variable in the research model.

Baron and Kinney (1986) recommend that the direct path between the independent and dependent variables should be established prior to including the mediating variable in the model[2]. In the current study, this means that the direct path from virtual team efficacy to perceived performance should be estimated. Using the final combined sample of n = 318, this path was specified within AMOS 4.0 and then estimated. The weight associated with the path was calculated to be .46 and was found to

[2] Some authors have proposed that this step should be eliminated during the evaluation of mediating effects (e.g., MacKinnon et al. 2002). However, other authors (e.g., Shrout and Bolger 2002) have stated that this step should be retained in studies where a proximal mediation relationship is expected and suppression is unlikely to occur. Both of these conditions were present in the current study.

be significant at the $p < .001$ level. The second step involves estimating the path from the independent variable to the mediating variable. In the current study this means that the path from virtual team efficacy to effort should be estimated. Again using the final sample of n = 318, the path was specified in AMOS 4.0 and then estimated. The weight was calculated to be .48 and was significant at the $p < .001$ level. The third step involves estimating the path from the mediating variable to the dependent variable. In the current study, this means estimating the path from effort to perceived performance. Using the final sample of n = 318, this path was specified in AMOS 4.0 and then estimated. The weight was calculated to be .87 and was significant at the .001 level. The final step recommended by Baron and Kinney (1986) is to estimate the path from the independent variable to the dependent variable with the mediating variable in the model. In the case of the current study, this means estimating the path from virtual team efficacy to perceived performance while also estimating the paths from virtual team efficacy to effort and effort to perceived performance. These paths were specified within AMOS 4.0 and then estimated. The path from virtual team efficacy to group outcome perceptions was calculated to be .05 and was found to be nonsignificant ($p = .247$).

In addition, Shrout and Bolger (2001) recommend estimating the effect proportion mediated as a measure of the strength of mediation in the model. This is done by calculating the indirect effect (the regression weight from the IV to the mediating variable multiplied by the regression weight from the mediating variable to the DV when the direct path is included in the model) and then dividing by the regression weight from the IV to the DV (step 1 as recommended by Baron and Kinney 1986). In the current study this means the weight associated with the path from virtual team efficacy to effort

(.48) multiplied by the regression weight associated with the path from effort to perceived performance (.85) equaling an indirect effect of .41. This is then divided by the weight associated with the direct path from virtual team efficacy to perceived performance (.46) as estimated in step 1 of the procedure recommended by Baron and Kinney (1986). The result is an effect proportion mediated value of .89 with 1.0 representing complete mediation. These results provide additional support for the findings using the Baron and Kinney (1986) approach, and for the role of effort as a mediator within the nomological model.

5.2.3.3 Power

Statistical power should be considered in any empirical study. Sufficient statistical power is used to guard against the possibility of making a Type II error, or the failure to reject the null hypothesis when it is false (Cohen and Cohen 1983). In this study, the issue of power is especially salient given the sample size associated with the CFA (n = 127), and the findings of non-significance for the path from CCEL1 to VTE, during the initial, replication and confirmation tests of the model. These concerns are addressed below. Post-hoc power analyses procedures in this study follow the recommendations of Chin, Gopal and Salisbury (1997).

5.2.3.3.1 CFA

To test the power of the specified CFA model (n = 127), it was important to test for the ability to detect cross-loading items (Chin, Gopal and Salisbury 1997). To test for this ability, the original model was re-specified with an additional path from the GP latent construct to VTE item 1 essentially specifying that VTE item 1 was common to both the VTE and GP constructs. This path was added as both VTE and GP are measures of group

efficacy differing only in their level of specificity, and the likelihood of a cross-loading item should be of particular concern. The regression weight for this path was set artificially to .5 and the new model was rerun. Based on this model a new covariance matrix was generated. The new covariance matrix was then used as input data for a subsequent re-test of the model as originally specified. The resultant chi-square was found to be 12.1. Using the 12.1 chi-square statistic and a single degree of freedom as information, a power table was then consulted where statistical power was found to be above .9, with .8 being generally accepted as a metric for sufficient power (Cohen and Cohen 1983).

5.2.3.3.2 Model Test

Next it was necessary to determine the power of the structural model to detect a miss-specified path. To do this, three separate power analyses were conducted. The first analysis was conducted using the initial study sample of 127. To determine the power of the analysis, an additional path from GP to perceived performance was specified with the regression coefficient artificially set to .25. This path was chosen as it would be logical to assume that GP may influence performance perceptions directly as GP has been previously established as a predictor of general outcomes. As outlined above, the covariance matrix from this new model was used as input data for a subsequent retest of the original model, resulting in a chi-square of 6.7. With this information a power table was once again consulted and power was determined to be above .7, but below the .8 level generally accepted. This confirmed our suspicions of low power during the initial model test and validated our need to re-test the model in the replication study.

The second power analysis was conducted using the replication sample of 191. A model was specified with a path from GP to group outcome perceptions set at .25 and once again a new covariance matrix was generated. The covariance matrix was then used as input data for testing the research model resulting in a chi-square of 13.8. This statistic, along with 1 degree of freedom, was used to consult a power table, where it was found power was above .9, in excess of the accepted level of .8.

The final power analysis was conducted using the confirmation sample of 318. A new model was specified with a path from GP to group outcome perceptions set at .25. The chi-square statistic generated when using the new covariance matrix as input data was 15.1. This statistic, along with an associated degree of freedom of 1, was used to consult a power table, where it was found that power was well above .9, in excess of the accepted level of .8. Table 5.6 depicts these results.

Model	Chi-Square	Power	Acceptable
CFA	12.1	>.9	yes
Initial Model	6.7	>.7	no
Replication Model	13.8	>.9	yes
Confirmation Model	15.1	>.9	yes

Table 5-6 Power Analyses Results

5.2.4.4 Summary of Additional Analyses

The bootstrap analysis results provided support for the structural paths as specified in the model, reducing concerns over any violations of multivariate non-normality assumptions. The mediation analyses provided support for effort as a mediator

of the VTE–perceived performance relationship, further establishing the VTE measure's predictive behavior to be consistent with efficacy theory. Finally, power analyses revealed that sufficient power was utilized during both the CFA and subsequent model testing. Although the initial model test (n = 127) exhibited power below the recommended level of .8, the subsequent tests conducted to confirm the initial findings exhibited sufficient power.

5.3 Research Model—Group Level Analyses

The virtual team efficacy measure was validated using individual level data. Further, predictive validity was established by testing the measure within the boundaries of a nomological model. Following the development of the VTE measure, hypotheses 1 through 9 were then tested at the group level of analysis using the aggregated perceptions of the respective team members. All hypotheses were tested using PLS-Graph 3.0 a principle components based SEM tool. Hypotheses 1 through 5 were tested first using the full sample of 52 teams in analysis 1. Hypotheses 6 though 9 were then tested using a subset of the full sample (n = 31) in analysis 2.

5.3.1 Level of Analyses

The data collected from students participating in the research studies was aggregated and used to create a data set representing 52 interacting information systems project teams. Because of the limited sample size, it was no longer suitable to use AMOS 4.0 as an SEM tool. Instead, PLS-Graph 3.0, a principle comments based SEM tool less susceptible to sample size (Gefen et al. 2000) was utilized.

Prior to testing the model with PLS-Graph 3.0, it was necessary to establish the interrater reliability of the respective groups to insure the presence of a group level effect (Jung and Sosik 2003; Sosik, Avolio and Kahai 1997). Two approaches have generally been used by collective efficacy researchers, within and between analyses (WABA) and the rwg (j) coefficient developed by James, Demaree and Wolf (1984). Both techniques are purported to have their respective advantages and disadvantages (Jung and Sosik 2003). While WABA is designed to assess between and within variance simultaneously, the rwg (j) coefficient is designed to assess the interrater reliability of multiple judges or group members, for multi-item criteria, or latent constructs.

Due to its consistent use by collective efficacy researchers, and the weakness of WABA for studying teams composed of unequal member numbers (Lester 2002), the rwg(j) coefficient was used in the current study. The rwg (j) coefficient is shown below.

$$rWG\,(J) = \frac{J\,[1 - (Sxj^2/\varphi EU^2)]}{J\,[1 - (Sxj^2/\varphi EU^2)] + (Sxj^2/\varphi EU^2)}$$

rWG (j) represents the within-group interrater reliability for judges' mean scores on J essentially parallel items, Sxj^2 is the mean observed variances, and φEU^2 is determined by the following equation.

$$\varphi EU^2 = (A^2 - 1)/12$$

Where EU refers to an expected error, and A is the number of alternatives available in the measure response scale.

The rwg (j) coefficient was developed by James et al. (1984) specifically for multiple-item latent constructs. That is, the equation accounts for essentially parallel items measuring a common construct. Commonly used methods to estimate IRR, on the other hand, "treat agreement as an all-or-nothing proposition" (James et al. 1984, p. 88), and are not appropriate for evaluating the IRR of judges or groups across multiple item measures. As the constructs used in this study are all multiple item latent constructs, the rwg (j) coefficient was used to establish the IRR across the respective groups. To accomplish this, an rwg (j) coefficient was computed for each team, for each construct, and then an average across teams was calculated. Computing the rwg(j) coefficient consists of calculating the mean variance among the team members for each item, for each latent construct, and then entering the computed average variance into the rwg(j) formula which takes in to account both the number of items (j) and the number of alternatives (A) to the response scale. In this study, the rwg(j) coefficient was applied to the GP, CCEL1, CCEL2, VTE, Effort, Trust, Group Satisfaction, and Outcome Perceptions measures. Because communication level and actual outcomes (team grades) were measured in terms of a single item, and/or based on objective measures, it was unnecessary to evaluate agreement. Results reveal that the average rwg(j) coefficient across the constructs was .83, ranging from a low of .74 to a high of .96, well above the .7 value suggested as sufficient for establishing interrater agreement (Sosik, Avolio and Kahai 1997). Based on these findings, data were aggregated to the group level. Table 5-7 depicts these results.

CCEL1	CCEL2	GP	VTE	Effort	GrpSat	OutSat	OutQual	Trust
.96	.77	.84	.81	.90	.79	.74	.86	.76

Table 5-7 Interrater Agreement (rwg(j) coefficient)

While the rwg(j) coefficient has been accepted as a method for establishing group level effects in studies of group efficacy, as mentioned earlier other alternative methods have been proposed for measuring group efficacy. One such method is the group discussion method (Gibson et al. 2000) which avoids the need to test for interrater reliability (Jung and Sosik 2003). While the difficulty of using such a method in a virtual context has been acknowledged in the literature (Gibson et al. 2000), it is nonetheless, possible to allow the virtual team members to reach a consensus through the use of some form of communication technology. When considering the use of such a method however, researchers must be aware of the social influence processes that may occur, as well as the potential influence of the technology being utilized. To investigate the viability of using such a method, a separate study was conducted by the authors. Through the results of this study, the use of the aggregation method in the dissertation was further supported. Details of the study are discussed at length in Appendix A.

5.3.2 Analysis Procedures

Following the establishment of a sufficient level of inter-group reliability, hypotheses 1 through 9 were then tested at the group level of analysis using the aggregated perceptions of the respective team members. All hypotheses were tested using PLS-Graph 3.0, a component based SEM technique which combines a principle components analysis for determining factor structure, and a linear regression analysis for

evaluating structural paths (Chin 1998). The move from the covariance based tool—AMOS 4.0—to a principal components based analysis in PLS-Graph 3.0, was dictated mainly by the smaller sample associated with the group level data (Chin 1998). During analysis 1, hypotheses 1 through 5 were tested using the full sample of 52 teams. During analysis 2, hypotheses 6 though 9 were tested using a subset of the full sample (n = 31).

5.3.2.1 Measurement Model Results—Analysis 1

Analysis 1 was designed to test hypotheses 1 through 5 using the full sample of 52 teams (318 individuals). All items loaded on their respective factors above the .707 level (Gefen et al. 2000), an initial indication of convergent validity (Chin 1998). Table 5-8 reflects the correlations and variance extracted for the various constructs. As shown, the square root of the variance extracted for each construct is larger than its correlation with any of the other variables, providing evidence of each constructs respective discriminant validity. Table 5-9 reflects the factor loadings.

Construct #	Construct Name	1	2	3	4	5	6
1	CCEL1	**.870**					
2	CCEL2	.702	**.877**				
3	VTE	.668	.670	**.928**			
4	PerPerf	.296	.321	.603	**.880**		
5	Effort	.366	.402	.648	.849	**.897**	
6	GP	.601	.708	.745	.483	.580	**.898**
Bold Diagonal = Square root of the average variance extracted							

Table 5-8 Measurement Model Results—Analysis 1

Construct	Item #	Loadings					
GP	GP1	.896					
	GP3	.895					
	GP6	.905					
CCEL1	CCE2		.945				
	CCE3		.813				
	CCE4		.847				
CCEL2	CCE6			.870			
	CCE8			.812			
	CCE9			.881			
VTE	VTE1				.895		
	VTE4				.939		
	VTE5				.938		
	VTE8				.943		
Effort	EFF1					.885	
	EFF2					.895	
	EFF3					.910	
PerPerf	GPST1						.899
	GPST2						.903
	GPST3						.803
	OTQL1						.891
	OTQL2						.907
	OTQL3						.890
	OTST1						.897
	OTST2						.910
	OTST3						.896

Table 5-9 Factor Loadings Measurement Model—Analysis 1

5.3.2.2 Measurement Model Results (Analysis 2)

Analysis 2 was designed to test hypotheses 6 through 9. Measurement model results show that the factor loadings were all above the .707 level (Gefen et al. 2000) save two of the trust items. The composite reliabilities were all above the .7 level with the lowest being .790 for the trust measure. Because of the trust measure's acceptable reliability, and its inclusion in prior research, the decision was made to retain the two

factor items. Table 5-10 reflects the correlations among the respective constructs and the respective variance extracted. As shown, the square root of the variance extracted for each construct is larger than its correlation with any of the other variables, providing evidence of their discriminant validity. Table 5-11 shows the factor loadings.

Construct #	Construct Name	1	2	3	4
1	VTE	**.922**			
2	Comlvl	.395	**n/a**		
3	Grades	.569	.569	**n/a**	
4	Trust	.526	.180	.245	**.669**
Bold Diagonal = Square root of the average variance extracted					

Table 5-10 Measurement Model Results—Analysis 2

Construct	Item #	Factor Loadings			
VTE	VTE1	.885			
	VTE4	.931			
	VTE5	.926			
	VTE8	.944			
Comlvl	n/a		1.0		
Grades	n/a			1.0	
Trust	Trust1				.542
	Trust2				.729
	Trust3				.556
	Trust4				.904

Table 5-11 Factor Loadings Measurement Model—Analysis 2

5.3.2.3 Structural Model Results (Analysis 1)

The structural model for analysis 1 was tested in a three step process to test for the mediating effect of effort predicted by efficacy theory (Bandura 1997, Marakas et al. 1998). Hypotheses 1 through 4 were tested in the first step in which GP, CCEL1, and CCEL2, were evaluated in terms of their influence on VTE, and VTE was evaluated in

terms of its influence on perceived performance. All hypotheses except H3 were supported as expected.

Hypothesis 5 was then tested by evaluating VTE's influence on perceived performance with effort in the model. As expected, H5 was supported through results showing that the path between VTE and perceived performance was no longer significant when effort was included in the model (Baron and Kinney 1986). The structural model results are depicted in Table 5-12.

Hypothesis	Path	Beta	T-Stat	Supported
H1	GP-VTE	.488	3.75	Yes
H2	CCEL1-VTE	.274	2.21	Yes
H3	CCEL2-VTE	.145	1.22	No
H4	VTE-PerPerf	.621	8.82	Yes
H5	VTE-PerPerf (w/effort)	.093	.974	Yes

Table 5-12 Structural Model Result—Analysis 1

5.3.2.4 Structural Model Results (Analysis 2)

Analysis 2 was designed to test hypotheses 6 through 9. As expected, VTE was found to have a direct positive influence on trust perceptions explaining 28% of the trust measures variance. Also as expected, VTE was found to have a direct positive affect on actual outcomes as did communication level. Combined, the VTE and communication level constructs accounted for just over 46% of the variance in actual outcomes. VTE was also found to have a direct positive affect on communication level explaining 16% of the variance. Therefore, hypotheses 6 though 9 are supported. The structural model results are depicted in Table 5-13.

Hypothesis	Path	Beta	T-Stat	Supported
H6	VTE-Trust	.526	5.21	Yes
H7	VTE-Grades	.408	3.01	Yes
H8	VTE-Comlvl	.395	3.27	Yes
H9	Comlvl-Grades	.407	2.67	Yes

Table 5-13 Structural Model Result—Analysis 1

5.4 Conclusion

This chapter provided a discussion of the instrument development processes followed for the VTE measure. As a component of that development, the VTE measure was tested within the confines of a nomological model to establish the measure's predictive validity. Next, a research model was examined at the group level of analysis, examining the influence of VTE on both perceptual and actual measures of group performance. In addition, the relationship between VTE and the existing virtual team success factors of trust and communication level was explored. The next chapter provides a discussion of the results, limitations, and implications associated with the dissertation. A conclusion to the dissertation is also presented.

Chapter 6 – Discussion and Conclusion

6.1 Introduction

This chapter brings to a close the major sections of the thesis. Chapter 1 provided an introduction to the dissertation. During the introduction, important definitions were presented and the general research questions associated with the study were discussed. In addition the structure of the dissertation was outlined. Chapter 2 provided a review of the relevant prior literature where both the virtual team and social cognitive theory literature were explicated. As part of the social cognitive theory literature dilation, both self-efficacy and collective efficacy were considered. Chapter 3 proposed a conceptual model relating the known virtual team success factors within the virtual team efficacy model, and a research model and its associated hypotheses was also presented. Chapter 4 presented the research methodology and defined each of the constructs individually. Chapter 5 discussed the instrument development process and the results associated with the test of the hypotheses proposed in the dissertation research model.

This chapter has several purposes. The first is to provide a review of the instrument development results. Next, a discussion of the results associated with the research model analyses is presented. Limitations and future research are then discussed. Finally each research question is discussed individually in terms of the findings, and a conclusion is presented.

6.2 Instrument Development Results

An important component of this research was the development of an instrument to measure the efficacy of virtual team members. While a number of items were generated during the item development process, only four items remained that provided a unique representation of the underlying VTE latent construct. The instrument items were developed in accordance with the recommendations of Bandura (2001) for efficacy measures, and were validated using the procedures outlined by Chin, Gopal and Salisbury (1997), and Salisbury, Chin, Gopal and Newstead (2002) for SEM based instrument development. The virtual team efficacy (VTE) measure was found to exhibit convergent, discriminant, and nomological validity. An additional form of validity implicitly established during the instrument development process was predictive validity. In the current case this meant the establishment of the VTE construct's ability to predict group outcomes at both the individual and group level of analysis. Specifically, at the individual level, VTE was found to explain over 70% of the variance in perceived performance when mediated by effort. At the group level of analysis VTE explained over 32% of the variance in actual performance, and over 46% when communication level was included in the model. In addition, VTE was found to significantly predict both team trust and communication level. As this research was conducted using a field study where controls were not possible, the ability of the VTE measure to predict group outcomes in the face of substantially increased error has significant importance. In fact, the instrument development portion of the dissertation—which includes an initial test of the construct at the individual level of analysis—alone provides a significant contribution to both the academic and practitioner communities.

6.3 Research Model Results

The research model was developed in accordance with established efficacy theory. While social cognitive theory provided the molar framework, theory associated with collective efficacy assisted in the development of the little-t theory of virtual team efficacy used to guide the specific hypotheses. In addition, the findings of previous virtual team researchers were considered during the development of the theoretical model. The combination of the guidance from the big-t framework of SCT, along with our development of the relationships among collective efficacy and the established virtual team success factors, led to the development of a little-t theory of virtual team efficacy. We now discuss the results from the evaluation of the specific hypotheses.

Group potency was found to predict VTE providing support for hypothesis 1. This result was not unexpected as previous research findings support the proposition that a belief in the general effectiveness of a group would be predictive of a belief in that same group's ability to perform in a more specific context. Clearly, if a team had doubts about its general effectiveness, it would most likely have those same doubts in a more specific situation. This finding is enlightening however, as the relationship between general and specific types of efficacy—and their relationship with outcomes—is not entirely clear. For example, Agarwal et al. (2000) proposed and sustained a model which placed general computer self-efficacy as a predictor of application specific computer efficacy. However, during the development of their conceptual model of computer self-efficacy and performance, Marakas et al. (1998) proposed that over time, application specific efficacies will lead to an overall perception of general computer self-efficacy. This is the classic "chicken before the egg" question, and the findings of the current dissertation help

shed some light on this issue. In the current study, it made sense conceptually to order the constructs as proposed, as the teams had no prior history, and thus no chance to develop a series of efficacies in specific domains that could be used to develop an overall general belief in the group's effectiveness. Had these teams remained intact, and worked together on successive projects in different contexts, eventually their virtual team efficacy may have become partially predictive of a more general belief in their ability to perform across various situations.

Hypothesis 2 was also supported. This finding is particularly interesting as at the individual level of analysis (during the nomological test) this relationship was not supported. Making the overall relationship of CCE to VTE more problematic was that the reverse was found for CCEL2. That is, the path associated with hypothesis 3 was found to be significant at the individual level, but not at the group level. Based on the findings at the individual level alone, we had surmised that the level 1 CCE items were not representative of a sufficient level of difficulty to influence perceptions of the team's ability to use the technology needed to work together as a team in a virtual context. That is, it was felt that no significant relationship was found between CCEL1 and VTE because too low a level of computer skill was being assessed by the CCEL1 items. However, given the reverse findings at the group level, (i.e., CCEL1 being significantly related to VTE while CCEL2 was not), it is now evident that a problem exists with the CCE construct in general. To further investigate these results, two additional models were specified and run within PLS-Graph 3.0. The first model specified only the GP and CCEL2 constructs as predictors of VTE. Results revealed that CCEL2 was significantly related to VTE ($b = .309$, $\underline{p} < .001$), supporting the findings of the nomological test using

the non-aggregated data. However, when the model was re-run with CCEL1 included in the model, the path from CCEL2 to VTE dropped to .188, and was non-significant at the $p < .05$ level. These results indicate that the CCEL2 to VTE relationship is partially mediated by CCEL1 at the group level. However, no theoretical reason for this relationship could be justified. That is, we were unable to theorize why higher level CCE beliefs would influence VTE beliefs mainly through their influence on lower level CCE beliefs.

While disappointing in terms of the current research—due to the feeling that the CCE paths were consistent with efficacy theory—these findings present additional opportunities for research in this area. As a beginning, researchers should strive to develop a more robust measure of computer collective efficacy rather than relying on the adaptation of a computer self-efficacy measure developed during a period of time in which individual levels of computer experience were much different than today. This opportunity will be discussed in greater detail in the future research section.

Supporting hypothesis 4, virtual team efficacy (VTE) was found to significantly predict perceived performance. This relationship was found at both the individual and group level of analysis providing robust support for the relationship between VTE and performance perceptions. This finding is also consistent with previous studies of group efficacy (e.g., Gibson et al. 2000). In the current case, the significant findings at both levels provide particularly strong evidence towards the robust nature of the model—and the predictive power of the VTE measure—as the nomological model in the current study is consistent with research models of group efficacy generally conducted at the individual level of analysis (Zellars et al. 2001). In other words, perceptual outcome measures are

most often used in studies conducted at the individual level prior to any aggregation of group member responses, and the ability to predict perceptual outcomes using group level data provides further support for the predictive properties of the VTE measure.

Hypothesis 5 proposed that effort would mediate the VTE–perceived performance relationship. Using the combined procedures from Baron and Kinney (1986) and Shrout and Bolger (2001), support for this mediating relationship was established during the evaluation of both the nomological and research models. In terms of the evaluation of hypotheses 5 at the group level of analysis, the path from VTE to perceived performance was .651 ($\underline{p} < .001$) without effort in the model. Once effort was included, the regression weight associated with this path dropped to .093 and was no longer significant ($t = .974$).

In addition, the effect proportion mediated ratio was found to be .87 with 1 representing complete mediation (Shrout and Bolger 2001). As discussed in Chapter 5, this finding is consistent with the findings at the individual level, where the effect proportion mediated was calculated to be .89. These finding are important as they represents an important test of the mediating processes that Bandura (1997) proposes as central to efficacy theory. Further, it highlights the importance of the consideration of the mediating processes suggested by Bandura (1997) during investigations of efficacy on performance. One obvious benefit of such a consideration is the ability to explain additional variance in efficacy models. For example, in the current study, the direct effect of VTE on perceived performance accounted for 21% of the variance at the individual level, and 39% at the group level. However, when the models were mediated by effort the variance accounted for was 77% for the individual level model and 73% for the group level model.

Hypothesis 6 proposed that VTE would positively affect trust. This hypothesis was supported as expected. This finding is especially interesting as the importance of trust to virtual team success has previously been reported (e.g., Jarvenpaa 2004). However the mechanisms of trust in such an environment are not well understood (Paul and McDaniel 2004). Because VTE was found to explain over 27% of the variance in team trust, the VTE construct should be included in subsequent models investigating the mechanisms of trust in virtual teams. In addition—as will be discussed in the limitations and future research section—the interactive relationship of VTE and trust should be investigated within process models of trust and efficacy development.

Hypothesis 7 was designed to investigate the relationship between VTE and communication level. Here it was proposed that a team's belief in its ability to work together in a virtual environment using communication technology would influence that same team's willingness to use the communication technology available. Because of this, the frequency of communication, or communication level among team members, should be increased. This relationship was supported as expected, through the finding of a significant relationship ($p < .001$), and the explanation of 16% of the variance in communication level.

Hypothesis 8 proposed that VTE would positively affect actual performance. In the current study, actual performance was measured in terms of the teams' project grades, calculated as their average score across the project deliverables. Consistent with prior findings and efficacy theory (Bandura 1997), this relationship was found to be significantly positive. When entered into a restricted model where only VTE was specified as a predictor of team grades, VTE alone accounted for over 32% of the

variance in actual performance. When specified in a model along with communication level, the two constructs accounted for over 46% of the variance in actual performance. These findings have particular significance to both academia and practice as the establishment of the VTE measure as a predictor of both communication level and actual performance provides support for VTE as useful tool for diagnosing and improving the performance of virtual teams.

Finally, hypothesis 9 tested for the influence of communication level on actual performance. Again, as expected, the relationship was supported as proposed. This finding is consistent with the findings of other virtual team researchers (Jarvenpaa et al. 2004), and as such, provides additional credibility to the other findings associated with the research model developed during this dissertation.

6.4 Limitations and Future Research

Some researchers have voiced their concern with using students as research subjects (Gordon et al. 1985). However, as is true for research in other areas, virtual team research has often been conducted using student teams (e.g., Jarvenpaa and Leidner 1999; Sarker and Sahay 2003). To minimize this potential limitation in the current research, student teams were assigned projects that had a substantial impact on their grades. In addition, student teams were assigned realistic project management tasks which often included the development of viable e-commerce web sites. Further, many of the projects involved MBA students who were currently employed within organizations in management positions.

Future research in this area should be conducted within organizational settings to increase the generalizability of the dissertation findings. While we are confident—given

the robust findings associated with our field study methodology—that our model will be supported within organizational virtual teams, this confidence must be supported empirically. It should also be noted that our intentions for this research were not to generalize our results from student teams to organizational teams, but rather, to generalize at the theoretical level (Lee and Baskerville 2003). That is, we intended to develop a baseline theoretical model that could later be tested in an organizational setting. Future studies should be designed to investigate the VTE theoretical model within various organizations, utilizing various team structures and compositions, and where possible across varying tasks to verify our findings in other settings.

The goal of this research was to develop and test a theoretically based model of virtual team efficacy in as natural environment as possible. This involved the use of different team compositions, sizes, project deliverables, and project durations. Having purposefully designed the study in this manner, we are cognizant of the fact that our chosen methodology does little to control for the influence of extraneous variables. While we realize that this may be seen as a limitation, we feel that this methodology gave us the greatest chance of developing a model that would be useful for both the academic and practitioner communities. While using an experimental setting for testing the model would have been extremely beneficial, such a methodology would also of have had its own respective limitations. That is, establishing the model relationships within a controlled environment, while allowing for the control of potential extraneous variables, would have had limits in terms of its generalizability to field settings. More specifically, replicating an experimentally validated model within an organizational setting would require constraints on team size, composition, task structure, or any variable that was

controlled using the experimental methodology. While the use of experimental methodologies is unarguably beneficial for theory development, we felt that given the strength of the SCT big-t theory used as a framework for developing our little-t theory of VTE, such a first step, while admittedly valuable, was less necessary. In addition, conducting a true lab experiment using virtual teams would be difficult, if not impossible, given our definition of virtual teams in this research. This means that in reality, a field experiment methodology would have been our most likely alternative. While such a methodology has been used in previous studies of virtual teams (e.g., Massey et al. 2003), it is not without its own limitations. Further, when conducting research that involves teams made up of students from various universities, attending various classes, proctored by different instructors, the ability to control team size and composition is often limited.

Conducting the study in the manner described in this dissertation allowed for the development of a broad theoretical framework for understanding the influence of efficacy on virtual team performance that can be applied in a variety of contexts. Future studies can now be designed in experimental settings to further refine the relationships among the constructs proposed, as well as to introduce and test new constructs within the model. We also believe that the strength of the theoretically based relationships among the variables, coupled with the large amount of variance that was accounted for, provide testament to the strength of the model as specified.

Another important aspect of this research was to examine computer collective efficacy as a potential antecedent to VTE. The hypotheses in this respect were developed in the belief that perceptions of the teams' general computer abilities would be related to the perceptions of the virtual team's ability to use communication technology to work

together, increasing the use of the communication technology available. In turn, it was felt that this increased communication would ultimately influence downstream performance. CCE was described as a multilevel construct focused on both more general level and advanced computer skills. The multilevel nature of CCE has been previously established (Murphy et al. 1989) and is also logically reasonable, as a particular team may have high efficacy for simple computer related tasks but a lower level of efficacy for tasks that are more complex. The assessment of this construct is difficult however, because what constitutes "simple" versus "complex" computer skills has and will continue to change over time. As an example, while the ability to navigate and use the Internet may have been an advanced task in the early 1990's, this is something that many children now experience on a routine basis.

This study was focused on the development of a virtual team efficacy model in which a measure of virtual team efficacy was central. Given that a measure of virtual team efficacy did not exist, it was necessary to focus on the development of the VTE measure rather than on the development of a measure of computer collective efficacy. Because of this, we chose to adapt a previously established measure of general computer self-efficacy that best fit the needs of our study. While this older scale did exhibit convergent and discriminant validity, we are aware of the limitations associated with the adaptation of a measure of computer self-efficacy that was developed in the somewhat distant past. That is, while some measures are designed to stand the test of time, such a measure involving the technological abilities of individuals or groups is more sensitive to the constantly changing skills of computer users. Future research should reexamine the computer collective efficacy construct and develop new instrumentation with sensitivity

toward more recent technology characteristics. Further, if possible, researchers should strive to develop more robust scales that are more resistant to evolutionary changes in technology.

The current research investigated VTE using a series of cross-sectional surveys. While the administration of surveys using a multiple wave methodology has advantages over the use of a single survey—specifically in terms of the ability to indicate temporal precedence—the methodology is limited in terms of understanding the process of efficacy development. Future research should be conducted using a process rather than a variance approach to gain a further understanding of how VTE may develop.

This research did not investigate the influence of the sources of efficacy information on VTE and could also be considered a limitation of this research. However, the purpose of this research was to establish the influence of VTE on performance, and to investigate its relationship with existing virtual team success factors. Future research should be conducted to investigate the influence of the sources of efficacy information suggested by Bandura (1986) on the VTE model. For example, the influence of enactive mastery on VTE in a virtual team context provides an interesting area of study. While Bandura (1997) has demonstrated that enactive mastery experience is important to the development of efficacy beliefs in individuals, and has proposed the same for collectives, how technology may influence this process has generally not been investigated. For example, based on teams such as those used in the current research, studies should be designed to investigate how enactive mastery information gained through experience is interpreted by the members of the virtual teams. In such studies the question should be asked as to whether or not enactive mastery information is interpreted differently by the

remotely located team members. Exasperating this process—and providing an additional area of study—could be the effects of cultural differences among team members. Here it may be found that an interactive affect may be observed between cultural differences and the communication media used by the team.

Further, communication media should be varied across or within studies, to determine which characteristics are best for the delivery of the sources of efficacy information, as the influence of communication technology on social influence processes is well documented (Maruping and Agarwal 2004). In addition, the capabilities of certain types of communication technology to convey information have previously been acknowledged (e.g., Dennis and Valacich 1999). This area may provide the most fruitful stream of information systems research based on this work. While group efficacy has been studied often within traditional teams, there has been little work using computer-mediated teams, and virtually no attempt to our knowledge to study collective efficacy within distance-based, technology-mediated teams. Both forms of teams should be investigated by researchers as it cannot be assumed that efficacy beliefs will develop in such teams in the same manner as traditional teams.

Finally, while the current research model was designed to test the relationship between efficacy beliefs and a select set of group outcomes, other types of outcomes are also of interest. For example, VTE may influence other factors such as learning, and may be further mediated by factors such as anxiety, goal setting, and persistence (Bandura 1997).

6.5 Implications

The implications of this research are many. To more clearly present these implications, this section is separated into implications for research and implications for practice.

6.5.1 Research Implications

The virtual team efficacy theoretical framework provides a robust, theoretically developed tool for researchers interested in studying virtual teams. Because collective efficacy beliefs are know to have a large influence on group outcomes (on average .35 for team efficacy based on a meta-analysis of 10793 subjects [Gully et al. 2002]), existing models of virtual team performance may be missing an integral component. Therefore, given that the virtual team efficacy framework as developed accounts for existing virtual team success factors such as trust and communication level, the framework can be immediately applied by virtual team researchers. Further, this application can be made in multiple situations with confidence given that the model was consistently supported across a variety of team sizes and compositions, as well as across multiple project tasks.

The validated virtual team efficacy measure also has significant research implications for IS scholars. The VTE measure was developed in accordance with psychometric theory and the recommendations for SEM based instrument development described by Chin, Gopal and Salisbury (1997), and Salisbury, Chin, Gopal and Newstead (2002). Discriminant, convergent, and nomological validity were established during measurement and structural model tests. During the test of the VTE construct within the nomological net, predictive validity was also established. Because efficacy has consistently been shown to influence performance, the establishment of predictive

validity provides a robust test of the VTE measure (Bandura 1997). The measure is parsimonious, has high reliability, and can easily be administered in either traditional or electronic survey form. In addition, the VTE measure was re-validated at the group level using PLS-Graph 3.0, where once again, the instrument was found to be highly reliable, and exhibit convergent, discriminant, and predictive validity.

6.5.2 Implications for Practice

The implications for practice also represent a promising application of the current research. While, virtual teams are commonly used in many organizations (Majchrzak et al. 2004), and much research has been conducted in this area (Jarvenpaa et al. 2004), questions still remain regarding how best to improve the performance of virtual teams (Sarker and Sahay 2003). Commonly studied virtual team success factors such as trust have been shown to have an equivocal influence on actual virtual team performance (Jarvenpaa et al. 2004), while the influence of group efficacy on group performance is well established. The virtual team efficacy theoretical model as developed during this dissertation gives researchers a robust and parsimonious tool for improving their understanding of the performance, and the performance mechanisms, of virtual teams. Based on this increased understanding, researchers can begin to develop viable interventions that can be used by organizational managers to improve team efficacy beliefs, which should in turn influence downstream performance.

The sources of efficacy information articulated by Bandura (1986, 1997) can be used to build the efficacy of virtual teams. Based on the research model as developed, both group potency and virtual team efficacy could be measured, evaluated, and then targeted by specific interventions designed to increase efficacy beliefs if needed. For

example, team based exercises could be used to provide vicarious experience through behavioral modeling training.

Group potency, or the belief in the general effectiveness of the team, could be directly targeted if needed. Enactive mastery could be used in this situation. For instance, virtual teams could be assigned a series of lesser tasks in diverse settings to build on their belief in their collective ability to be effective across multiple situations. Alternatively, group training initiatives could be implemented to help decrease the negative impact of affective states such as team anxiety.

Virtual team efficacy beliefs could also be directly targeted. Any of the four sources of efficacy information, enactive mastery, vicarious experience, verbal persuasion, and affective states, could be targeted by managerial interventions. Here, interventions could be designed such that the team as a whole would be involved. In individual studies of efficacy, the sources of efficacy information can be used to influence a person's internal belief in their ability to successful undertake or perform a task. However, groups add an additional complexity. Here, not only do interventions need to be designed to raise the efficacy beliefs of individual team members, but they also need to be designed in such a way that allows other team members to be cognizant of any individual change in efficacy belief. That is, if team members' efficacy beliefs are individually changed, some mechanism must be in place to allow other team members to be aware this has happened. It has been suggested that an individual team member's increased belief in his or her individual ability to perform some task should have an impact on the overall efficacy of the team (Bandura 1997). However, this can only take place *if* the other team members are aware of that team member's change in efficacy

belief. One way to facilitate this would be to have the team collectively undertake the intervention and require individual reports of the experience to be distributed among the team members. Virtual teams then add a second complexity. Here, technology based interventions must be designed to allow dispersed team members to receive the intervention as a collective. In this case, researchers will need to evaluate existing technology for its effectiveness in delivering interventions in this manner.

6.6 Research Questions Evaluation

Before providing a conclusion to this thesis, a discussion of the research questions in terms of the results is presented below. Each research question is discussed separately.

RQ1: What is Virtual Team Efficacy?

This question was answered during the development of the conceptual model. Specifically, virtual team efficacy (VTE) was proposed as a domain specific, yet general, concept of collective efficacy. Such a concept—and its associated measure—was proposed as the greater predictability of domain specific measures is well known (Bandura 1997), and the limited utility of task specific measures has also been acknowledged (Lent and Hackett 1987). To support our proposal of the virtual team efficacy concept, a measure of VTE was developed. The VTE measure was developed based upon accepted methods of instrument development, and was found to exhibit, convergent, discriminant, and predictive validity. The reliability of the measure was also established. Both the concept of virtual team efficacy and the VTE measure can be immediately applied by researchers interested in virtual team performance, or the efficacy of distributed teams.

RQ2: What are the antecedents of Virtual Team Efficacy?

Two antecedent variables were directly evaluated during this research, group potency (GP) and computer collective efficacy (CCE). This placement was based upon previous studies finding a relationship between general and specific forms of computer self-efficacy (Agarwal et al. 2000; Johnson and Marakas 2000). While a significant positive relationship between GP and VTE was found, the relationship between CCE and VTE was not clearly established. Specifically, CCEL1 was found to be predictive at the group level of analysis but not the individual level. The reverse was found for CCEL2. While these findings are disappointing in terms of the current work, they do provide additional opportunities for research in this important area. For example, a measure of CCE does not presently exist. In this study, an existing measure of general computer self-efficacy was adapted to the group level of analysis. This decision was made as the focus of the current work was on the development of the VTE measure, rather than the development of a measure of computer collective efficacy. Future studies should focus on the development of a more viable measure of CCE.

A discussion was also presented regarding the influence of the previously established virtual team success factors as antecedents in the VTE model. While not empirical verified in the current work, it was proposed that variables such as trustworthiness and leadership may play an important role in the development of a virtual team's belief in its collective abilities. These relationships should also be investigated.

RQ3: What is the influence of Virtual Team Efficacy on performance?

Research question 3 represents the key question addressed during the dissertation. Separate models were specified in order to evaluate the influence of VTE on both

perceived and actual performance. In both cases the relationship was supported empirically. This represents an important contribution to both the virtual team and collective efficacy research streams. Based on the findings of this dissertation, virtual team researchers now have an additional tool for diagnosing virtual team performance. In addition, collective efficacy researchers can now begin to apply measures of collective efficacy within distributed teams with confidence. Finally, as this investigation matures, interventions can be designed for use by practitioners in the enhancement of the performance of virtual teams.

RQ4: What variables mediate the Virtual Team Efficacy – performance relationship?

The results associated with research question 4 are particularly intriguing. While models of efficacy have generally been used to investigate the direct influence of efficacy beliefs on performance, Bandura (1997) has acknowledged the importance of investigating the influence of various mediating processes. Specifically, Bandura states that while most studies of efficacy acknowledge that efficacy acts on performance through various mediating mechanisms, few studies have directly measured them. This, he states, represents a weak test of the associated theory, whereas a strong test of the theory involves directly accounting for these mediating processes. In addition, this portion of the investigation clearly addresses the ***why*** of theory development.

In the current study effort was specified as a mediating process in the virtual team efficacy model. That is, in accordance with efficacy theory, it was proposed that teams with a higher belief in their collective ability would put in greater effort towards the completion of project deliverables, resulting in a downstream, positive influence on

virtual team performance. This relationship was empirically established at both the individual and group level of analysis for the perceived performance endogenous construct.

While not hypothesized in the current dissertation, the influence of communication level was also investigated as a potential mediator of the VTE—performance relationship. Here, an objective measure of communication level was used as a surrogate measure of effort, and was tested as a mediator of the VTE—actual performance relationship. The investigation of this relationship revealed a partial mediating effect. Specifically, when tested alone the VTE—actual performance path was estimated as .569 and accounted for just over 32% of the variance in team grades. Once communication level was entered into the model, the path for the VTE—actual performance relationship dropped to .408. Based on the procedures recommended by Shrout and Bolger (2002) this represents a partial mediating effect of .28, with 1 representing total mediation. Such a finding is quite reasonable given that full mediation in behavioral research is considered unlikely to occur in light of the many other possible effects that may influence such relationships (Shrout and Bolger 2002).

While the identification of a specific meditation effect is interesting, the ability to explain additional variance in models of efficacy and performance may provide the greatest value in terms of academic research. For example, in the research model investigating the influence of VTE on perceived performance, VTE directly accounted for 39% of the variance, while the model mediated by effort accounted for 73%. In the research model investigating the influence of VTE on actual performance, VTE directly accounted for 32% of the variance, while the model including communication level

accounted for 46%. These findings are encouraging and should be investigated further in future research.

RQ5: What influence will the previously established virtual team success factors have within a theoretical model of virtual team efficacy?

Research question 5 was answered in several ways. During the development of the conceptual model, the influence of several of the established virtual team success factors were discussed in terms of their potential influence on the virtual team efficacy model. While their placement within the conceptual model was not specified in all cases, the importance of their influence was described.

One variable that was specifically considered in the research model was trust. This variable was selected for initial investigation due to its previously recognized importance in models of virtual team performance (e.g., Ives and Piccoli 2003; Jarvenpaa et al. 1999, 2004). In the case of the current research, team trust—or a willingness to be vulnerable to the other members of the team—was found to be predicted by VTE. This was expected as perceptions of ability have been found to be a precursor of trusting intentions (Mayer et al. 1995). This finding has additional interest in that trust has been repeatedly shown to be an influential variable within models of virtual team performance however previous studies have not investigated the potential relationship between collective efficacy beliefs and trust. This relationship should also be investigated further in future studies.

As discussed above the role of communication level in the virtual team efficacy model was investigated. The construct was found to be predicted by VTE, and also to exert influence directly on actual performance. In addition, communication level was

used as a surrogate for effort and examined in terms of its potential mediating influence on the VTE—performance relationship, where a partial mediating effect was found. This relationship is important as the influence of communication level in models of virtual team performance has also been previously established (Jarvenpaa et al. 2004).

6.6.1 Summary of the Research Questions Evaluation

Each of the research questions was discussed individually in terms of how they were answered during the dissertation. Important results, implications, and future research were presented for each. Following, a conclusion of the dissertation is now presented.

6.7 Conclusion

During this research, a robust measure for assessing virtual team efficacy was developed and then tested within a comprehensive nomological model. The measure was found to exhibit convergent, discriminant, and predictive validity. Model tests at the individual level of analysis—the nomological model—established the VTE measure's ability to predict group outcomes. Following instrument development, the data were aggregated to the group level and then used to test the hypotheses associated with the theoretical model of virtual team efficacy. Here, model tests revealed that once again the VTE measure was predictive of group outcomes, including a measure of actual performance. Further, model tests revealed significant relationships between VTE and two of the previously established virtual team success measures. Specifically, trust and communication level were found to be predicted by VTE. These findings are important in that they provide virtual team researchers with additional information for diagnosing

virtual team performance. Given the economic advantages in using virtual teams, such as the significant reduction in travel costs experienced by Microsoft (Lohr 2004), and the continued development of more and more sophisticated technology to support distributed teamwork, the trend of organizations to rely on virtual teamwork seems assured. This research establishes an empirical foundation for future studies designed to further explore the influence of the collective efficacy of virtual teams on performance outcomes.

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Appendix A: Support of Group Level Aggregation

A.1 Introduction[3]

Group researchers continue to debate the merits of the various methods that have been proposed for measuring group efficacy (Whiteoak et al. 2004). Such methods include the non-aggregated perceptions of the group's ability (e.g., Zellars et al.2001), the aggregated perceptions of the individual team member's self-efficacy (e.g., Whiteoak et al. 2004), the aggregated perceptions of the group's ability (e.g., Jung and Sosik 2003), and group efficacy consensus formed during group discussion (e.g., Gibson et al. 2000). Each of these methods has been reported to have its respective advantages and disadvantages, and have sometimes been compared within studies. Table A-1 below lists the respective measurement methods and their respective strengths and weaknesses.

[3] Appendix A is based upon a manuscript that is currently under review at Small Group Research. The research was authored by Hardin, A., Fuller, M., and Valacich, J. under the title "Measuring Group Efficacy in Virtual Teams: New Questions in an Old Debate"

Measurement Method	Advantages	Disadvantages	Important Findings
Assessment of individual level group efficacy beliefs	Predictive of individual level outcome variables such as satisfaction with the group. Eliminates the need for inter-rater reliability.	Potential cross-level analysis when predicting group level actual outcome variables such as performance.	Found to predict individual level variables such as job satisfaction (Zellars et al. 2001).
Aggregation of individual self-efficacy beliefs for use in studies at group level	Predictive of group performance for tasks with low interdependence.	Generally recognized to be less predictive of group performance for tasks with high interdependence.	Found to not differ from other methods in terms of task difficulty or the magnitude of the relationship with goal setting. However study task had low interdependence (Whiteoak et al. 2004).
Aggregation of group efficacy beliefs to the group level	Is predictive of group level outcome variables such as group performance.	Requires the use of some form of interrater reliability test.	Was found to be superior to group discussion method for predicting group performance. Group means were found to be higher for responses using discussion method than aggregation method (Jung and Sosik 2003).
Group level consensus of group efficacy beliefs reached through discussion	Eliminates need for inter-rater reliability.	Potential for efficacy inflation due to social persuasion factors (Bandura 1997).	Found superior to aggregation method when predicting group performance. Found task specific measures were predictive of tasks, while general measures were predictive of the general ability of the group (Gibson et al. 2000)

Table A-1 Group Efficacy Measurement Methods

As shown in Table A-1, findings reported in the literature are varied. For example, while Gibson et al. (2000) found efficacy beliefs reached through group discussion were more predictive than the aggregated perceptions of the group's ability. Jung and Sosik (2003) report the opposite. That is, Jung and Sosik (2003) found that the aggregated individual perceptions of the group's ability were more predictive than

efficacy beliefs reached through discussion. Further, in a separate study, Whiteoak et al. (2004) reported no difference between the aggregation of self-efficacy beliefs, the aggregation of group efficacy beliefs, and group discussion, when predicting group goal setting an important precursor to team performance (Locke and Latham 1990).

So what are Bandura's suggestions for measuring the efficacy of groups? Bandura (1997) suggests that group efficacy should be measured through either the aggregation of self-efficacy beliefs, or the aggregation of team members' perceptions of the group's ability. In fact, Bandura states that measures of self and group efficacy should be correlated as an individual will naturally take into account his or her own efficacy when making assumptions about the group's collective efficacy. However, Bandura also suggests that the aggregation of self-efficacy beliefs should only be used in situations where team member interdependence is low. Therefore, when tasks with high interdependence are being studied, perceptions of the group's abilities should be aggregated. So what then of the group discussion method that has been proposed in the literature? Bandura speaks to this as well:

> *Forming a consensual judgment of a group's efficacy by group discussion is subject to the vagaries of social persuasion and pressures for conformity. A few influential individuals, especially the ones with more prestige or those in the positions of authority, can sway the group to a judgment that does not accurately represent the views of many of its members. A single judgment forged by group discussion masks the variability in members' beliefs about their group's capabilities. A forced consensus therefore, can be highly misleading. Moreover, assessment of*

collective efficacy by group deliberation can raise or lower the very belief being measured, depending on the direction the discussion takes to achieve the consensual judgment (Bandura 1997, p. 479).

Further Bandura states:

…a deliberative method of assessment can introduce serious confoundments in comparative studies of collective efficacy. Even if a group judgment provided a sound index of collective efficacy, this assessment procedure would be unimaginable with large groups (Bandura 1997, p. 479).

Given that Bandura's (1997) directions on measuring group efficacy have not always been adhered to by group efficacy researchers, the most appropriate method for measuring group efficacy remains unclear. To remain consistent with our use of SCT, in the current study we chose to follow the recommendations of Bandura (1997) and use the aggregation of group efficacy beliefs. However, given that our context has not previously been used in studies of group efficacy, we chose to conduct an additional study to investigate the measurement of group efficacy within virtual teams. The methodology and results associated with this investigation are detailed below.

A.2 Methodology

Seventeen teams comprised of forty-six senior level management information systems students enrolled in a US university participated in the study. Virtual teams were formed through the combination of on-campus and distance learning students participating in an information technology project management course. The on-campus and distance learning students were unable to meet face-to-face at any time during the

course of the project. Fourteen of the teams completed both measures and were thus included in the analysis.

A.2.1 Measures

Group potency was measured in a manner consistent with its use in the dissertation. Cronbach's alpha for the group potency measure was found to be acceptable at .94.

Virtual team efficacy was measured using the instrument developed by the authors during the course of the dissertation. Cronbach's alpha was found to be .94 for the virtual team efficacy measure in the current study.

Perceived performance was measured by aggregating the responses to measures of satisfaction with the group, satisfaction with the team deliverables, and perceptions of quality regarding the teams' deliverables. Cronbach's alpha for the perceived performance measure was found to be .97.

Team performance was measured by the project grades based on the average of the project deliverable scores.

A.2.2 Procedures

WebCT—a web based learning environment—was utilized during the facilitation of the course. Each student team was provided with a private group discussion area, however, there was no mandatory requirement to use the group discussion area, and many teams used other forms of media to communicate throughout the semester. Deliverables for the course were based on the management of information systems

projects and were due in various forms throughout the semester. Team grades were based on the average of the deliverable scores.

A.2.2.1 Survey 1 (Aggregation of Team Member Efficacy Beliefs)

Individual perceptions of the virtual teams' abilities were collected after the first project deliverable had been completed and feedback was given. In this survey, each student filled out an electronic survey individually and the responses of the individual team members were then aggregated. Survey 1 included both the group potency and virtual team efficacy measures.

A.2.2.2 Survey 2 (Group Level Consensus)

To examine the effectiveness of measuring group efficacy by a group level consensus within virtual teams, team members were asked to fill out an electronic survey containing measures of group potency and virtual team efficacy *as a group*. Survey 2 was administered three days after the first survey. No deliverables were graded or returned between surveys. Survey 2 included the group potency and virtual team efficacy measures and an additional measure not included in the study to reduce the potential for testing effects (Shadish, Cook and Campbell 2002). Team members were asked to complete the second survey as a group. No instructions were given other than to request that the students submit documentation as to how they arrived at a group level consensus. It was stressed to the students that this component of the assignment was as important as filling out the survey itself, and further, that the documentation of the process the group followed was necessary for receiving the research participation points.

A.2.2.3 Survey 3 (Individual Performance Responses)

A final survey was administered near the end of the semester to measure perceived performance. Perceived performance was measured in terms of outcome quality, outcome satisfaction, and group satisfaction.

A.3 Results

The members of the teams completed the individually administered group efficacy survey first. These individual responses were then aggregated and compared statistically with the group efficacy beliefs reached through consensus. The rwg(j) coefficient was calculated for each measure to insure a group level effect. Results revealed that the rwg(j) coefficient was .93 and .94 respectively for the group potency and virtual team efficacy measures, and therefore the data were aggregated to the group level with confidence.

Teams then filled out the second survey based on a consensus of the group's efficacy reached through discussion. In reaching this consensus, eight of the fourteen teams used the asynchronous group discussion area within WebCT while the other six used a synchronous chat technology. For the eight teams choosing to use the discussion area, a log of their discussion was automatically recorded. The six teams using the chat technology were required to submit a text file of their group's discussion to complete the assignment. No significant difference was discovered between teams using chat and teams using the discussion board to reach a group level consensus for either group potency $\underline{F}$ (1,12) = .822, $\underline{p}$ = .382 or, virtual team efficacy $\underline{F}$ (1,12) = .012, $\underline{p}$ = .915.

Upon the examination of the discussion board postings and the chat logs, it was revealed that all eight teams using the asynchronous discussion board averaged the

individual team member responses. In this case, members individually posted their perceptions of the team's efficacy, and a designated member then averaged those responses. Following this process a single team member then used the calculated average for the responses to complete the electronic survey.

Two teams using a synchronous chat platform reached consensus through a combination of discussion and averaging. In the case of these two teams, discussion was used to reach agreement for most questions, however when disagreement occurred, an average was then calculated. The final four teams discussed the survey questions using chat technology in order to reach agreement. One student generally undertook the task of recording the group consensus and completing the electronic survey as the discussion was taking place, or once the discussion was completed.

A.3.1 Analysis 1

Analysis 1 was designed to test for differences between the aggregation of group efficacy beliefs (survey 1), and group level consensus (survey 2). To test for these potential differences, a paired sample t-test was conducted for each of the measures. Results from these tests indicate that the group level consensus associated with the virtual team efficacy measure ($\underline{M}$ = 96.88, $\underline{SD}$ = 5.94) was significantly greater than group level aggregation of virtual team efficacy beliefs ($\underline{M}$ = 86.69, $\underline{SD}$ = 8.92, $\underline{t}$ (13) = 5.87 $\underline{p}$ = .000). The results for the group potency measure were similar. Group level consensus ($\underline{M}$ = 89.20, $\underline{SD}$ = 10.2) was found to be significantly greater than the aggregation of group efficacy beliefs for the group potency measure ($\underline{M}$ = 81.42, $\underline{SD}$ = 9.73, $\underline{t}$ (13) = 3.95 $\underline{p}$ = .002).

A.3.2 Analyses 2

Analysis 2 was designed to investigate whether the group potency and virtual team efficacy measures were significantly related to performance perceptions. Using linear regression, the aggregation of virtual team efficacy beliefs was found to be significantly related to perceived performance, ($\underline{b}$ = .538, $\underline{p}$ = .047, R^2 = .29), however the group level aggregation of virtual team efficacy beliefs relationship to *actual* performance was found to be non-significant ($\underline{b}$ = .096, $\underline{p}$ = .74). The group consensus regarding the team's virtual team efficacy's relationship to group outcome perceptions was found to be non-significant ($\underline{b}$ = .452, $\underline{p}$ = .105) as was its relationship with actual performance ($\underline{b}$ = -.101, $\underline{p}$ = .73).

For the group potency measure, neither the aggregation of group efficacy beliefs ($\underline{b}$ = .416, $\underline{p}$ = .139) nor the consensus regarding group efficacy beliefs ($\underline{b}$ = .434, $\underline{p}$ = .121), was found to significantly predict perceptions of performance. Finally, neither the aggregated group potency responses ($\underline{b}$ = .027, $\underline{p}$ = .93), nor the group consensus group potency responses ($\underline{b}$ = .241, $\underline{p}$ = .41), was significantly related to actual team performance.

A.3.3 Additional Analysis - Group Outcome Perceptions to Team Performance

A final regression analysis was conducted to test for a potential relationship between performance perceptions and team grades. Results show that perceptions of performance were significantly related to team grades ($\underline{b}$ = .583, $\underline{p}$ = .028, R^2 = .34).

A.4 Discussion

This study was designed to investigate the measurement of group efficacy within virtual teams and to provide further support for the use of the aggregation method in the dissertation. T-tests results revealed that the group level consensus means were significantly greater than the group level aggregation means for both the group potency and virtual team efficacy measures. In addition, only the aggregated virtual team efficacy beliefs were found to significantly predict performance perceptions. Neither, measure was predictive of actual team performance, regardless of measurement method. Finally, performance perceptions were found to be significantly related to team grades.

Teams who used the synchronous chat format for reaching consensus inflated their scores in comparison to their aggregated individual responses. This finding provides evidence of the social persuasion that Bandura (1997) suggests, and interestingly in this case, within a technology mediated environment. Additional evidence of social persuasion was evident on a further review of the chat logs, where comments such as "we are good aren't we?" were exchanged between group members.

Teams were free to use either asynchronous discussion boards or synchronous chats for reaching consensus. Perhaps most interestingly, the inflation of the efficacy scores took place in groups regardless of technology choice, even though social persuasion should be made more difficult in an asynchronous environment due to factors such as the ability of the team to communicate in parallel (Nunamaker et al. 1991). This result may have occurred because postings in either form of technology were not anonymous, and groups had a shared history (Benbasat & Lim 1993). These results indicate that researchers should pay special attention to the potential for inflated group

efficacy consensus reached by discussion in computer-mediated environments, regardless of whether a synchronous or asynchronous environment is used.

Eight of the fourteen teams chose to calculate an average of their team members' perceptions and then use that average to record a group level consensus for both the group potency and virtual team efficacy measures. In addition, two teams used averaging after disagreement developed during a synchronous chat session. This result is interesting, and illustrates that even if virtual team members are asked to reach a group consensus within a technology mediated environment, they may not always follow the process expected—i.e., to come to a consensual decision based on group discussion. The tendency to average group efficacy beliefs may, however, be unique to situations such as the current context where group members were unable to physically meet at anytime during the course of the project. That is, face to face groups may more easily engage in verbal discussions to reach efficacy consensus. Using the technology afforded such teams, one virtual team even created a spreadsheet of the individual responses and resultant averages.

The finding of significance during the regression analysis provides support for the predictive ability of the aggregation of virtual team efficacy beliefs and further supports the use of this method in the dissertation. Further, this finding is in agreement with the recommendations of Bandura (1997) for measuring group efficacy, and is supportive of Jung and Sosik's (2003) findings of inflated group discussion responses as discussed previously. This finding also supports the positioning of the efficacy constructs in the dissertation research model, as the greater predictability of the more domain specific virtual team efficacy measure over the general group potency measure was consistent

with efficacy theory (Bandura 1997), and the findings of previous group efficacy researchers (Gibson et al. 2000).

Limitations associated with this study clearly exist. First, our sample size was limited. Because of the sample size limitations, more sophisticated statistical analyses such as SEM could not be used. Because of this, error was assumed away during regression analyses, prohibiting the ability to account for measurement error. In addition, statistical power is low and may account for some of the non-significant effects observed during the regression analyses. Future studies with larger samples should be conducted to corroborate these findings.

An additional limitation similar to the limitation acknowledged during the dissertation is a lack of control. Student teams were observed in a natural environment without manipulation making issues of causality difficult to address. The lack of a proper counterbalance procedure during survey administration is also problematic. This procedure has been previously used for comparing group efficacy measures (Jung and Sosik 2003) however, and the finding of inflated group consensus efficacy beliefs is not inconsistent with prior research.

As stated in Chapter 6 of the dissertation, future research should investigate the issue of how group efficacy beliefs develop among virtual team members. For example, it cannot be assumed by researchers that efficacy beliefs will develop in a technology mediated environment the same way they would in a collocated environment. In addition, the type of technology used by virtual teams should also be investigated to determine its influence on the development of group efficacy beliefs. For example, while the response delay associated with asynchronous technologies such as email may have one effect,

synchronous technologies such as videoconferencing may have another, as the varying impacts of communication cues on social influence processes are well established in the literature (Daft, Lengel and Travino 1987; Markus 1994; Maruping and Agarwal 2004; Lee 1994). Finally, field experiments more aptly designed for addressing causality should also be conducted.

Both the measurement of group efficacy and its relationship with team performance have been discussed extensively within the literature. However, even in the face of this attention, group efficacy beliefs are still not being consistently measured by researchers. This modest study helps build on the discussion regarding the measurement of group efficacy by extending the discussion to the context of virtual teams. Finally, this study provides additional empirical evidence which support the use of aggregated efficacy perceptions during the course of the dissertation analyses.

Appendix B: Survey Instrument 1[4]

Please answer the following questions as accurately as you can. The questions are focused on your personal feelings about your personal abilities. As such, there is no right or wrong answer to any particular question. The first part of each question asks you about whether or not you feel you have the ability to perform a particular function. If you answer YES to the first part of any question, the second asks you to indicate how confident you are with your ability to perform that particular function. Try not to second-guess yourself. Just answer each question based on your personal ability assessment rather than some comparison to another person. Also, try not to skip any questions or leave the answer blank.

For Example:

I believe I have the ability to use computers. (Yes) No

	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	(60)	70	80	90	100

Survey Questions

I believe I have the ability to enter and save data (numbers or words) into a file. Yes No

	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe I have the ability to use computers. Yes No

	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe I have the ability to escape/exit from a program or software. Yes No

	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe I have the ability to use the computer to write a letter or essay Yes No

	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe I have the ability to work on a personal computer. Yes No

	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

[4] The survey represented here is a word document replication of the electronic version of survey 1 administered to the CFA sample.

I believe I have the ability to understand terms/words relating to computer software.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to understand terms/words relating to computer hardware.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to describe the function of computer hardware (keyboard, monitor, disk drives, computer processing unit).	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to troubleshoot computer problems.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to explain why a program (software) will or will not run on a given computer.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to work in groups.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to work with others.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to do group work.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to work collaboratively with others.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe I have the ability to work in partnership with others.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to function in a team.	No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to do teamwork.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
in groups.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to use communications software to collaborate with remote team members.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to use technology to collaborate with others across time and space.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to use technology to work in groups that are not co-located.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to do teamwork in a distributed environment if I have access to appropriate technology.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to share information using technology with remote team mates.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe I have the ability to work with remote team mates using technology.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to use computers to work with team members who cannot meet face to face.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe I have the ability to use communication technology to do work with people who can't physically get together to meet.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

Demographic Information

Please complete the following information.

21. What is your name: _____

22. What is your student identification number: _____

23. What is your team number_____

24. In what year were you born? _____

25. What is your nationality? _____

26. What was your nationality at birth if different? _____

27. Are you male or female? ☐ Male ☐ Female

28. How many years of formal school education (or their equivalent) did you complete (starting with primary school): (Please circle the correct answer)

10 years or less	11 years	12 years	13 years	14 years	15 years	16 years	17 years	18 years or over

28. How many years of experience do you have using computers in general? _____(Number of years)

29. How many times have you worked in a project with more than two members? _____(Number of times)

	Very infrequently				Very frequently
How often do you find you work in teams	1	2	3	4	5

31. How many times have you used technology to work with team members who can't meet face to face? _____ (Number of times)

Thank you once again for taking the time to complete this survey!

Appendix C: Survey Instrument 2[5]

Please answer the following questions as accurately as you can. The questions are focused on your personal feelings about your group's ***aggregate*** abilities. (**In other words your responses should reflect the group as a whole rather than individual members as separate units**) As such, there is no right or wrong answer to any particular question. The first part of each question asks you about whether or not you feel your group has the ***aggregate*** ability to perform a particular function. If you answer YES to the first part of any question, the second asks you to indicate how confident you are with your group's ***aggregate*** ability to perform that particular function. Just answer each question based on your group's ***aggregate*** ability assessment rather than some comparison to another group. Also, try not to skip any questions or leave the answer blank. For Example:

I believe my group has the ability to use computers. (Yes) / No

	Not at all Confident				Moderately Confident					Totally Confident
If yes, how confident are you?	10	20	30	40	50	(60)	70	80	90	100

Survey Questions

I believe my group has the ability to enter and save data (numbers or words) into a file. Yes / No

	Not at all Confident				Moderately Confident					Totally Confident
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe my group has the ability to use computers. Yes / No

	Not at all Confident				Moderately Confident					Totally Confident
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe my group has the ability to escape/exit from a program or software. Yes / No

	Not at all Confident				Moderately Confident					Totally Confident
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe my group has the ability to use the computer to write a report Yes / No

	Not at all Confident				Moderately Confident					Totally Confident
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe my group has the ability to work with personal computers. Yes / No

	Not at all Confident				Moderately Confident					Totally Confident
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

[5] The survey represented here is a word document replication of the electronic version of survey 2 administered to the CFA sample.

I believe my group has the ability to understand terms/words relating to computer software.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to understand terms/words relating to computer hardware.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to describe the function of computer hardware (keyboard, monitor, disk drives, computer processing unit).	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to troubleshoot computer problems.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to explain why a program (software) will or will not run on a given computer.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
My group has confidence in itself.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
My group believes it can become unusually good at producing high quality work.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
My group expects to be known as a high-performing team.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

My group feels it can solve any problem it encounters.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
My group believes it can be very productive.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
My group can get a lot done when it works hard.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
No task is too tough for my group.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
My group expects to have a lot of influence around here.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to use communications software to collaborate with remote group members.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to use technology to collaborate with others across time and space.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to use technology to work in groups that are not co-located.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe my group has the ability to do teamwork in a distributed environment if we have access to appropriate technology.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to share information using technology with remote group members.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to work with remote team members using technology.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to use computers to work with group members who cannot meet face to face.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to use communication technology to do work with people who can't physically get together to meet.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

29. What is your name: _____

30. What is your student identification number: _____

Thank you once again for taking the time to complete this survey!!

Appendix D: Survey Instrument 3[6]

Please answer the following questions as accurately as you can. The first section's questions are focused on your personal feelings about your group's ***aggregate*** abilities. (**In other words your responses should reflect the group as a whole rather than individual members as separate units**) As such, there is no right or wrong answer to any particular question. The first part of each question asks you about whether or not you feel your group has the ***aggregate*** ability to perform a particular function. If you answer YES to the first part of any question, the second asks you to indicate how confident you are with your group's ***aggregate*** ability to perform that particular function. Just answer each question based on your group's ***aggregate*** ability assessment rather than some comparison to another group. Also, try not to skip any questions or leave the answer blank. For Example:

I believe my group has the ability to use computers. (Yes) No

	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	(60)	70	80	90	100

Survey Questions

I believe my group has the ability to enter and save data (numbers or words) into a file. Yes No

	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe my group has the ability to use computers. Yes No

	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe my group has the ability to escape/exit from a program or software. Yes No

	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe my group has the ability to use the computer to write a report Yes No

	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe my group has the ability to work with personal computers. Yes No

	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

[6]The survey represented here is a word document replication of the electronic version of survey 3 administered to the CFA sample.

I believe my group has the ability to understand terms/words relating to computer software.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to understand terms/words relating to computer hardware.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to describe the function of computer hardware (keyboard, monitor, disk drives, computer processing unit).	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to troubleshoot computer problems.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to explain why a program (software) will or will not run on a given computer.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
My group has confidence in itself.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
My group believes it can become unusually good at producing high quality work.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
My group expects to be known as a high-performing team.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

My group feels it can solve any problem it encounters.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
My group believes it can be very productive.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
My group can get a lot done when it works hard.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
No task is too tough for my group.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
My group expects to have a lot of influence around here.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to use communications software to collaborate with remote group members.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to use technology to collaborate with others across time and space.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to use technology to work in groups that are not co-located.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

I believe my group has the ability to do teamwork in a distributed environment if we have access to appropriate technology.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to share information using technology with remote group members.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to work with remote team members using technology.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to use computers to work with group members who cannot meet face to face.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100
I believe my group has the ability to use communication technology to do work with people who can't physically get together to meet.	Yes No									
	Not at all Confident			Moderately Confident					Totally Confident	
If yes, how confident are you?	10	20	30	40	50	60	70	80	90	100

Team Outcomes and Performance Assessment

Please answer the following questions as accurately as you can. The questions are focused on your personal feelings about your group outcomes and performance. As such, there is no right or wrong answer to any particular question. Please answer all questions ***honestly***. These answers ***will not*** be used in determining your final grade for the course.

For each of the behaviors listed below, use a number (1-7) to indicate how much you agree or disagree with each of these statements by writing the appropriate number in the space to the left of each statement:

Disagree Strongly	Disagree	Neither Agree nor Disagree	Agree	Agree Strongly
1	2	3	4	5

___ 1. Despite barriers, my group was determined to meet the goals of the project

___ 2. My group was persistent in trying to achieve its goals

___

___ 3. My group continued to work on the project even when obstacles appeared

___ 4. My team endured despite encountering problems

___ 5. My group refused to quit despite difficulties

___ 6. Using technology to work with remote team members made my team nervous

___ 7. My team did not feel threatened when using technology to work with others who were at a distance

___ 8. It did not bother my team to use technology in order to work with others across time and space

___ 9. My team was reluctant to use computers when working with others who were not collocated

___ 10. My team felt comfortable using technology to work with remote team members

___ 11. Using computers to work with others who were not physically present made my team feel uneasy

___ 12. My group worked hard on the project

___ 13. My team didn't really exert much energy on our project

___ 14. My team exerted substantial effort on the project

___ 15. My group did a significant amount of work on the project

___ 16. My team didn't work very hard on this project

___ 17. My group established goals for managing our group processes

___ 18. My group established goals related to the quality of project deliverables

___ 19. My group established goals on how to use time efficiently

___ 20. My group established goals on how to get the most out of our efforts

___ 21. My group established goals related to the deadlines for project deliverables

___ 22. My group tried hard to achieve its goals

___ 23. My team was committed to the goals set by the group

___

___ 24. My group was determined to reach its performance goals

___ 25. My team was enthusiastic about attempting to achieve its goals

Disagree Strongly	Disagree	Neither Agree nor Disagree	Agree	Agree Strongly
1	2	3	4	5

___ 26. My team set difficult goals

___ 27. My team set goals at a high level

___ 28. My teams goals were easily reached

___ 29. My team set goals that were not difficult

___ 30. I am satisfied with the project outcome produced by my team

___ 31. I am pleased with the quality of work we did in my team

___ 32. I am satisfied with the final project deliverable submitted by my team

___ 33. I was unhappy with the outcome produced by my team

___ 34. The work produced by my team was high quality

___ 35. The project outcome produced by my team was excellent

___ 36. My team's project was not very good

___ 37. The deliverables of my team were outstanding

___ 38. I was satisfied with my group members

___ 39. I was pleased with the way my teammates and I worked together

___ 40. I was very satisfied working with this team

___ 41. I leaned a lot from this project

___ 42. This project was useful in furthering my education

___

___ 43. I didn't learn much from this project

___ 44. This project helped me build new skills

___ 45. I gained knowledge doing this project.

___ 46. I learned a lot about virtual teams from this project

___ 47. This project was useful in furthering my education about virtual teams

___ 48. I didn't learn much about virtual teams from this project

___ 49. This project helped me build new virtual team skills

___ 50. I gained knowledge about virtual teams doing this project

___ 51. I learned a lot about working with other cultures from this project

___ 52. This project was useful in furthering my education about working with other cultures

___ 53. I didn't learn much about working with other cultures from this project

___ 54. The project helped me build new skills for working with other cultures

___ 55. I gained knowledge about working with other cultures doing this project

Disagree Strongly	Disagree	Neither Agree nor Disagree	Agree	Agree Strongly
1	2	3	4	5

By participating in this virtual team project…

____ 56. The members of my team will be able to find better employment.

____ 57. The members of my team will be able to gain high-level employment

____ 58. The members of my team will have many opportunities for employment

____ 59. The members of my team will be perceived as ready for promotion

____ 60. The members of my team will gain the admiration of other people

____ 61. The members of my team will be perceived as team players

____

____ 62. The members of my team will be proud of their abilities

____ 63. The members of my team will increase their sense of accomplishment

____ 64. The members of my team will feel good about themselves

65. What is your name: _____

66. What is your student identification number: _____

Thank you once again for taking the time to complete this survey!!

Appendix E—Final Instrument Items

Computer Collective Efficacy Level 1	
CCE2	I believe my group has the ability to use computers.
CCE3	I believe my group has the ability to escape/exit from a program or software.
CCE4	I believe my group has the ability to use the computer to write a report
Computer Collective Efficacy Level 2	
CCE6	I believe my group has the ability to understand terms/words relating to computer software.
CCE8	I believe my group has the ability to describe the function of computer hardware (keyboard, monitor, disk drives, computer processing unit)
CCE9	I believe my group has the ability to troubleshoot computer problems
Group Potency	
GP1	My group has confidence in itself.
GP3	My group expects to be known as a high-performing team.
GP6	My group can get a lot done when it works hard.
Virtual Team Efficacy	
VTE1	I believe my group has the ability to use communications software to collaborate with remote group members.
VTE4	I believe my group has the ability to do teamwork in a distributed environment if we have access to appropriate technology.
VTE5	I believe my group has the ability to share information using technology with remote group members.
VTE8	I believe my group has the ability to use communication technology to do work with people who can't physically get together to meet.

Table E-1 Final Instrument Items

Effort	
Effort 1	My group worked hard on the project
Effort 2	My team exerted substantial effort on the project
Effort 3	My group did a significant amount of work on the project
Trust	
Trust 1	If I had my way, I wouldn't let the other team members have any influence over issues that are important to the project
Trust 2	I would be comfortable giving other team members responsibility for the completion of a project
Trust 3	I really wish I had a good way to oversee the work of other team members on the project
Trust 4	I would be comfortable giving the other team members a task or problem which was critical to the project
Perceived Performance	
Outsat1	I am satisfied with the project outcome produced by my team
Outsat2	I am pleased with the quality of work we did in my team
Outsat3	I am satisfied with the final project deliverable submitted by my team
Grpsat1	I was satisfied with my group members
Grpsat2	I was pleased with the way my teammates and I worked together
Grpsat3	I was very satisfied working with this team
Outqual1	The work produced by my team was high quality
Outqual2	The project outcome produced by my team was excellent
Outqual3	The deliverables of my team were outstanding

Table E-1 Final Instrument Items (cont'd)