Abstract

MEYER, DAVID CHARLES. Climate for Computer-Mediated Communication Technology Implementation and Implementation Success.

Electronic mail and the world-wide web may be particularly helpful to university faculty members as they implement these technologies into their teaching. However, effective implementation depends on a host of social, technical, and historical factors. This study creates and tests a "climate for computer-mediated communication technology implementation" survey. This quantitative climate measure correlates specific department-level policies and practices with implementation success.

The implementation climate at a large state university based on 420 faculty members representing 58 different academic departments suggests that a climate for computer-mediated communication (CMC) technology implementation does exist at the department level within the university. In addition, the climate for CMC technology implementation accounts for variance in implementation success over and above more traditional implementation correlates measured in prior MIS research (i.e., individual expectations, task urgency, technical expertise). The research results demonstrate the applicability of MIS research findings to educational settings and quantitatively confirm the existence of a department-level climate for implementation.

Climate for Computer-Mediated Communication

Technology Implementation and Implementation Success

by

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BIOGRAPHY

David Meyer studied history, English, and education at the University of Minnesota and received his bachelor's degree (cum laude) in Secondary Education. His career path has included teaching secondary school, facilitating teamwork within management teams, organizing community service programs for at-risk youth, and coaching collegiate alpine ski racing.

David's career activities are dedicated to the belief that the solutions to complex social and business problems require interpersonal communication skills and team-based problem solving approaches. This applied experience coupled with an academic background in organizational psychology, management of information science, and research methods provides the foundation of this dissertation.

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Watching someone write a dissertation may be more work than actually writing one. This dissertation is dedicated to my best friend, Jill Galanter. Thanks for being my biggest fan.

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APPENDICES

“Mokita” and Information Technology

The word “mokita” comes from a tribe in Papua, New Guinea and roughly translates to “the truth that we all know but agree not to talk about.” Within some organizations, the mokita surrounding computer technology reveals itself in resentment toward office automation, failure to use new computer technology as intended, and difficulty justifying ever-increasing information technology (IT) budgets. Indeed, financial records over the last twenty years reveal the paradoxical nature of information technology investments: despite huge expenditures for computer technology during this period, traditional productivity measures remain at about the same level (Brynjolfsson, 1993; Turnage, 1990). While various explanations of this “productivity paradox” exist (Brynjolfsson, 1993; Jurison, 1997; Pinsonneault & Rivard, 1998), few practitioners or researchers recommend computerization as a panacea for organizational problems. Instead, most IT researchers point out the difficulty of successful implementation (Bikson, 1987; Frederiksen, Riley, & Myers, 1985; Hiltz, 1988; Mirvis, Sales, & Hackett, 1992 are just a few examples). Despite the unprecedented growth in computers in organizations, (e.g., use of electronic mail, the Internet, and groupware applications), the unspoken truth about information technology is that computers do not necessarily improve organizational performance.

These “unspoken truths” raise fundamental questions about information technology in organizations: how are people responding to the profound changes in the nature of work caused by the new information technologies? More specifically, why do some people within the *same* organization using the *same* technology benefit from new technologies while other people waste resources on unwanted or under-utilized tools? When does e-mail really help employees and when does it simply waste time? The proposed research addresses these questions by focusing on one of the most common computer technologies in organizations, computer-mediated communication tools, and creating a climate for computer-mediated communication (CMC) technology implementation measure.

While many studies within the management information systems (MIS) literature recognize some relationship between the social environment within an organization and how successfully new CMC technologies are used, none of the current research provides a composite measure of the social climate for CMC technology implementation. Supported by over 50 years of theory and research on climate, this study applies the concept of *climate* to MIS research.

Climate, defined here as employees' perceptions of the events, behaviors, practices, and procedures active in the organization, is extended to a specific type of CMC technology used in university settings: web-based instructional technology. The quantitative measure of climate developed in this research correlates specific department-level policies and practices with implementation success. Within the context of the research setting, the *climate for computer-mediated communication technology implementation* is comprised of group-level perceptions of the events, behaviors, practices, and procedures active in the organization that affect the use of web-based instructional technology and the kinds of technology-enabled behaviors that are rewarded, supported, and expected.

Two key hypotheses are tested: (1) a climate for CMC technology implementation is hypothesized to exist at the department level within the university and; (2) the climate for CMC technology implementation is hypothesized to account for variance in implementation success over and above more traditional implementation correlates measured in MIS research (e.g., training, individual expectations, task urgency). These direct measures of implementation success will provide a benchmark for future change efforts.

This research helps uncover the "unspoken truths" that impact how CMC technology is used in organizations. The hypotheses tested measure the more traditional correlates of implementation success (as identified in prior MIS research) as well as the department-level climate for computer-mediated communication technology implementation. The strongest predictors of implementation success found in prior MIS implementation research are measured and entered first into a regression equation. After adding the climate for CMC technology implementation scores, any incremental increase in variance explained is used to evaluate the impact of the department's climate on implementation outcomes.

Overview

This study focuses on the implementation of a computer-mediated communication (CMC) technology in organizations. CMC technology is two or more electronically connected computers that distribute some combination of text files, database files, audio, or video messages between people. Common computer-mediated communication technologies include electronic mail, shared database systems, organization-wide intranets, and computerized decision support systems. These systems are increasingly common in both business and educational settings because of dramatically decreased computer prices and increased computing power.

One type of computer-mediated communication technology, web-based instructional technology, is increasingly used to support instruction in educational settings (Green, 1998). Typical applications of web-based instructional technology include electronic mail to support instructor-student correspondence, text-only electronic discussion groups, and hypertext web pages used to support instruction. Ideally, CMC technologies like web-based instructional technology help create a collaborative communication system in which computer users interact with each other in a shared electronic environment.

Despite the popularity of CMC technology, not all organizations successfully implement these technologies into employees' daily work routines. Implementation, defined here as the process of gaining targeted employees appropriate and committed use of an innovation (Klein & Sorra, 1996), typically occurs after the initial decision to adopt a technology—and after substantial organizational resources have been used purchasing and delivering a new CMC technology. Innovation and technology researchers suggest that the implementation activities within an organization are critical to the ultimate success of a new technology (Tornatzky & Fleischer, 1990). While upper-level mangers and technical experts typically make technology selection and adoption decisions, the implementation activities—appropriate and committed use of an innovation— are end-user behaviors. When end-users do not use CMC technologies or the technologies are implemented *differently* than the original adopters intended, the expected performance benefits to the individual, group, or organization are often not realized. Indeed, typical end-users are not often empowered to *choose* the CMC technology adopted, yet they are *responsible* for using it their work routines. Based on this incongruity between choice and responsibility, implementation problems often occur at the end-user level of the organization. Hence, the proposed research focuses on these end-users of CMC technology.

In order to identify the individual- and group-level variables that may account for implementation success, individual perceptions and group characteristics are quantified into a single *climate for implementation* score and associated with three different implementation outcomes. Groups that report high climate for implementation scores are predicted to utilize the new technology as intended and experience a greater frequency of positive outcomes. In contrast, groups that have a low climate for implementation are predicted to report a greater frequency of unintended consequences and negative outcomes. As reviewed later in this proposal, the definition of implementation success includes: technology-related outcomes (use of technology and degree of universal use), perceived impact on educational practices (an outcome relevant to the specific CMC technology studied here: web-based instructional technology), and satisfaction with technology (satisfaction with performance capabilities provided by new technology and satisfaction with technology's ease of use).

This literature review covers three broad topics and three distinct literatures: (1) MIS implementation research is used to define the outcome variable of interest; (2) the education and MIS literatures are reviewed to identify the key correlates of implementation success;

and (3) climate theory and research is used to help build the theoretical foundation for the proposed *climate* measure.

The fist section of this literature defines the technology studied (computer-mediated communication technology/web-based instructional technology) and the outcome variable (implementation success). This section also reviews some key issues involved in measuring implementation success. The second section includes a review of the education literature related to the use of CMC technology for instructional purposes in schools and universities. While much of this literature uses relatively weak research methodologies, some of these studies suggests that the number of class and educational institutions using web-based instructional technology is rapidly increasing. This section of the literature review then summarizes the prior correlates of implementation success found in the MIS literature, identifies some of the weaknesses of prior CMC implementation research that correlates a few implementation factors to various “implementation success” outcomes, and argues that a broad climate measure provides a way to address some of these deficiencies. Finally, this section summarizes Orlikowski’s (1992) “technological frames” model and suggests that this theory may provide the basis for a quantitative climate measure. The applied portion of the literature review ends with an integration of prior MIS research and Orlikowski’s frames model into a single climate for CMC technology implementation model.

The third section of the literature review covers the theoretical literature supporting climate. This section begins with an overview of the relationship between the social environment active in an organization and how new technologies are used. Next, a more specific review of the climate literature lays the foundation for the proposed CMC technology implementation climate measure. Based on the review of the climate literature and MIS implementation literature, I propose the specific hypotheses tested in this study.

This research makes two key contributions to the existing literature. First, the development of a climate measure for computer-mediated communication technology implementation integrates prior MIS research findings with an enduring social science concept. Informed by the vigorous academic debates within the climate literature, this study suggests that a quantitative climate for implementation measure may be used to represent group-level climate perceptions. The concept of *implementation climate* as well as the climate measure developed in this research may both apply to wide variety of organizational settings.

The second contribution that this research makes to the existing literature is the inclusion of both the individual- and group-level implementation correlates in a single study. Significant individual-level findings may help generalize prior research findings to a new setting. More importantly, significant group-level results—controlling for various accounted for by individual-level factors—provides new insight into how group-level expectations, training, implementation involvement, and interpersonal relationships may be managed to increase implementation success.

More important than these academic contributions may be the applied benefits gained by the cooperating university. This research focuses on the implementation of a rapidly growing application of computer-mediated communication technology used in educational settings: web-based instructional technology. The quantitative approach used, the extensive review of the MIS, educational, and climate literatures, and the survey instruments developed for this research all help delineate key individual- and group-level factors that are associated with implementation success. The research results help evaluate prior investments in web-based instructional technology and may help direct future change efforts in this university.

Literature Review

Defining Computer-Mediated Communication Technology

The definition of computer-mediated communication (CMC) technology is two or more electronically connected computers that distribute some combination of text files, database files, audio, or video messages between people. The specific CMC technology identified in the climate survey is frequently used in educational settings: web-based instructional technology. Typical applications of web-based instructional technology include electronic mail to support instructor-student correspondence, text-only electronic discussion groups, and hypertext web pages used to support instruction.

As summarized on Table 1, the key difference between CMC technology and web-based instructional technology is that the latter uses computer technology to *support instructional goals*. Another difference—one that is rapidly disappearing—is that computer-mediated communication technology can also include “stand-alone” systems that use proprietary standards and transmission protocols. Older versions of computer-mediated communication systems such as Lotus Notes or Valacich, Dennis and Nunamaker’s GroupSystems (1991) have used communication protocols and/or network systems that were independent of the Internet[1]. However, computer-mediated communication technologies are increasingly using Internet protocols and infrastructures to reduce development and administration costs as well as increase the number of potential users. In effect, computer-mediated communication technology is increasingly *web-based.*

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[1] The word "internet" literally means "network of networks" and is comprised of thousands of smaller regional networks scattered throughout the globe. The world-wide web (WWW), developed in 1990, was conceived as a seamless world in which all information, from any source, could be accessed in a consistent and simple way. Although these terms are often used interchangeably, the Internet and the world-wide web do not mean the same thing. The world-wide web refers to an abstract body of information while the Internet refers to the physical mass of cables and computers comprising this global network. More information may be found at the World Wide Web Consortium’s web page (http://www.w3.org/) and the European Laboratory for Particle Physics (http://www.cern.ch/Public/achievements/web/whatis.html)

The term "computer-mediated communication technology" may be modified to make it nearly synonymous with web-based instructional technology by adding the educational intent of web-based instructional technology. Hence, "computer-mediated communication technology used for instructional purposes" is the same as web-based instructional technology—excluding the few CMC applications that use communication protocols or network systems independent of the Internet.

Table 1

Definitions and Examples of CMC and Web-Based Instructional Technology

	DEFINITION	EXAMPLES
COMPUTER-MEDIATED COMMUNICATION TECHNOLOGY	Two or more electronically connected computers that distribute some combination of text files, database files, audio, or video messages between people.	Electronic mail, shared database systems, organization-wide intranets, computer-based audio/video conferencing systems, and computerized decision support systems using either proprietary or internet-based communication protocols.
WEB-BASED INSTRUCTIONAL TECHNOLOGY	Two or more electronically connected computers *used to support instructional goals that communicate with standard Internet transmission protocols*—TCP/IP (including HTTP, FTP, and SMTP) to distributed some combination of text files, database files, audio, or video messages between people	Electronic mail to support instructor-student correspondence, text-only electronic discussion groups (Listservs), and hypertext web pages used to support instruction, Internet-based conferencing technology.

Web-based instructional technology typically consists of electronic mail for instructor-student or student-student correspondence and hypertext pages posted on the world-wide web to support instruction. Electronic mail (e-mail) consists of messages, usually text, sent from one person to another via computer. An extension of e-mail is a mailing system (often referred to by the software used to run the system: "Listserv") that allows people to send e-mail to one address, whereupon their message is copied and sent to all of the other mail list subscribers. Hypertext web pages are blocks of text (or images) linked with multiple electronic paths. Selecting one of these electronic links provides the viewer with the content associated with that link, regardless of the physical location of either the computer on which the information is stored or the viewer.

Most of this literature review uses the term “computer-mediated communication technology” because it is derived from establish definitions within MIS research (Hiltz & Turoff, 1978). This more general term also helps link well-established MIS research findings to the educational literature on teaching and learning with technology. An additional reason for using a categorization scheme from the MIS literature is that a broader base focus may keep the research from being quickly outdated: the rapid pace of technological change can reduce the "shelf life" of highly focused research findings. For example, research focused on specific characteristics of a web-based instructional technology used five years ago (e.g., Gopher web servers and clients in university settings) would suffer from very time-limited research conclusions.

While the term “web-based instructional technology” is used in the survey to focus on education-specific uses of computer-mediated communication technology, most of this proposal uses “computer-mediated communication technology” to refer to the broader genre’ of technology studied in the proposed research model and survey.

Definition of Implementation

When managers spend as much as 70 to 80 percent of their day in communication-related activities (Mintzberg, 1973), tools that improve the communication process should render huge benefits to organizations. Potentially, CMC technologies can provide the means to communicate with people anywhere, anytime—across continents, time zones, and organizational hierarchies. These capabilities appear to be in demand: in 1996 groupware technologies grew at an annual rate of 42.5 percent to 11.9 million new users with an installed base of 38.7 million users (IDC, 1997). The large scale implementation of CMC technologies coupled with the profound impact that they can have on organizations lead Lucas and Baroudi (1994) to suggest that the "design of information technology and the design of organizations are largely becoming the same task" (p. 9). With high financial investments and high expectations of CMC technology, what does "successful implementation" actually *mean*?

Perhaps "implementation success" is best defined by understanding the antonym: "unsuccessful implementation." Poor implementation of new CMC technology may yield four negative outcomes within organizations: (1) failure of technology to deliver expected benefits (e.g., ability to contact co-workers, ability to share information, rapid access to time-sensitive data) because employees use the technology less frequently or less effectively than the adopters intended; (2) wasted financial and personnel resources used in adoption and implementation activities; (3) variable use of the CMC technology across sub-groups within an organization may create or reinforce intra-group rivalries and miscommunication; and (4) failure of technology to deliver expected benefits may reduce employees expectations and motivation to use future innovations. Unsuccessful implementation hurts organizations: not only do poor implementation efforts cost time and money, they may also damage employee relationships and expectations of other new technologies or practices.

This research defines "implementation success" as the *active use of the CMC technology by targeted individuals and groups within an organization in an organizationally relevant way*. The next sections review the literature supporting this definition.

Implementation Research Primer

The introduction of new technology into an organization may be conceptualized with a five stage model: (1) *need identification* in which a problem or need is identified that may be addressed by a new technology; (2) *selection* of appropriate technology based on the identified need; (3) *adoption decision*, the decisions surrounding the acquisition and early use of a technology; (4) *implementation*, the decisions and behaviors surrounding the active use of a new technology; and (5) *routinization*, the integration of the new technology into daily work routines (Rogers, 1983; Tornatzky et al., 1983; Tornatzky & Fleischer, 1990; Yin, 1979). These activities take place within the context of the organization's history, industrial area, and the technical parameters of the innovation itself.

Within this five-stage model, implementation merits special attention because it is the point at which the real transition between technology developers and technology users occurs: implementation is the point at which an innovation is actively used in a new setting. Adoption decisions within organizations are typically made by MIS personnel or upper-level managers—not by the end-users of a technology. A technology may be "officially" adopted—the technology may be purchased and provided to users —but never be actively used. The later stage, routinization, occurs when the technology is actively used (implemented) in the organization and, by definition, occurs after implementation. Implementation is the critical stage during which a technology is actively transferred and used in a new setting—or is adopted by upper-level managers and forgotten by users.

For purposes of understanding the "big picture" of how implementation fits into the larger innovation process, an additional caveat should be noted: technology is not "handed off" from developers to users. The chronology of technology development and implementation activities will vary—even within the same organization using a single innovation (Tornatzky et al., 1983). Innovation developer activities do not necessarily precede user activities nor do "good" innovations move lock step from adoption to routine use for all members within the organization. In the "real world" of technological change, common sense as well as empirical research suggest that the sequence of innovation user and producer activities are not linear (von Hippel, 1976; von Hippel, 1988).

Measuring Implementation Outcomes

Several researchers note the difficulty of defining and measuring implementation outcomes for complex technical and social innovations (Bikson, 1987; Eveland, 1981; Fleischer, Liker, & Arnsdorf, 1988; Grudin, 1988; Hiltz & Johnson, 1989; Ives & Olson, 1984; Tornatzky & Fleischer, 1990). In contrast to earlier implementation research which assumed that adoption decisions were the critical predictors of successful implementation (Fliegel & Kivlin, 1966, for example), most recent implementation researchers frame implementation as a *process* and have not defined a specific end point of adoption or implementation. Given this indistinct nature of “implementation success,” the operational definition depends on the purposes of the research. If the research is concerned only with whether or not a product has been purchased, “adoption” may be defined with this act—with the unsubstantiated assumption that adoption will lead to implementation. If the research is aimed at understanding the organizational, group, and individual behaviors necessary for a technology to be actively used, implementation researchers must create a specific, measurable definition what “implementation success” actually means.

Unfortunately, the operational definition of this construct varies across studies and different kinds of technologies (Tornatzky et al., 1983). Even within the narrow field of CMC implementation research “implementation success” has been defined in several different ways including: perceived increases in productivity (Bikson et al., 1987), increases in user performance (Bullen & Bennett, 1990), actual or reported frequency of use (Hiltz, 1988; Hiltz & Johnson, 1990; Orlikowski, 1992b; Robey, 1979), satisfaction with group and group process (Eveland & Bikson, 1989), and changes in the work design (Stasz et al., 1986). After users adopt an innovation (identify their needs, select, and acquire the technology) implementation—however it is operationally defined—does not necessarily follow (Bostrom & Heinen, 1977; Hall & Loucks, 1977; Liker, Fleischer, & Arnsdorf, 1992; Tornatzky et al., 1983; Tornatzky & Fleischer, 1990).

These multiple definitions of “implementation success” are symptomatic of a larger debate among implementation researchers. All implementation studies must define and measure what an “organizationally relevant ” use really means for the technology of interest. For example, does routine use of computers as telephone answering machines or photocopiers indicate high implementation rates? Indeed, users may adopt a new technology to meet the local demands of the organization and create uses for the technology not envisioned by the technology developer. Which implementation behaviors represent appropriate use of the new technology (and corresponding measures of “successful implementation”) and which behaviors are abhorrent applications of the technology is the topic of the adaptation/fidelity debate. This debate provides key guidelines for how “implementation success” is defined and measured in the proposed research.

The Adaptation/Fidelity Debate.

Generally, implementation research recognizes that knowledge, values, and purposes of the human user influence the function of a given technology. Even if a single “best” way to use a technology exists, there are almost always alternative ways to employ it (Tornatzky & Fleischer, 1990). For example, a ratchet wrench may have an optimal hand position, technique of changing sockets, and biomechanical position for maximum torque. However, the variability of social context—the way that the wrench is used by different mechanics at different repair shops—has a powerful impact on the end product: a successfully repaired car. Rather than conceptualizing technology as simply a material object, most research on the implementation of technology considers both material *and* social characteristics.

Should users strictly adhere to the original design of the technology or should the technology be changed to fit the users’ needs? Some innovation researchers suggest the latter: technology should be adapted to better meet the local needs, constraints, and goals (Datta, 1981). This pro-adaptation perspective focuses on site-specific changes in the technology and how well these changes meet the needs of the implementing organization.

In contrast, the fidelity perspective assumes that there is an identifiable configuration of the best technical and social practices for using a technology (Boruch & Gomez, 1979). This group of researchers suggests that the original invention went through rigorous evaluation prior to dissemination and variations on the original configuration may make the technology less effective.

Other researchers do not advocate an a priori supremacy of either the fidelity or adaptation perspective (Gutek, Bikson, & Mankin, 1984; Hall & Loucks, 1978; Rice & Rogers, 1980; Rogers, 1986). Practical considerations—the type of technology investigated and the goals of the researcher—better direct which perspective is used. A well-defined innovation with a proven effectiveness may produce better results if a fidelity model is followed. For example, Blakely et al. (1983) found seven out of eight criminal justice and educational innovations were implemented with “acceptable” fidelity *according to clear*, *developer-defined parameters*. In addition, Blakely et al. found a correlation between fidelity and effectiveness measures *that existed before the innovation was implemented* (i.e., reading test scores, school attendance, recidivism rates, and crime rates).

In contrast, a less well defined technology with a host of contingencies may achieve better results with an adaptation orientation. Berman and McLaughlin’s (1978) results suggest that adaptation rather than complete fidelity to the original model characterizes “successful” educational innovations. Berman and McLaughlin’s implementation outcome measure was teachers’ reports on the extent to which the innovation met *the teachers’ own goals*. Similarly, Fleischer, Liker, and Arnsdorf’s (1988) study of computer-aided design (CAD) technology used several measures of implementation behaviors, each reflecting a specific CAD feature and in the context of specific individual tasks and user requirements. Their study found that there was not a single “best use” standard to compare the diverse configurations of CAD technology. The studies outlined above are consistent with Pelz and

Munson's (1980) suggestion that user-initiated variations of a technology may not be regarded as "effective" according to the developers' criteria yet may yield highly desirable results in terms of the users' criteria. The present study emphasizes user-centered definitions of implementation success.

Despite a difference in research perspective, both "pro-fidelity" (Blakely et al., 1983; Fairweather & Tornatzky, 1977) and "pro-adaptation" (Berman & McLaughlin, 1978; Bikson et al., 1987; Frederiksen et al., 1985) researchers have used a core feature methodology to identify the use (or rejection) of a given technology at implementing sites. Tornatzky (1990) describes the core feature approach as a three-step process: (1) Identify the core aspects that define an innovation based upon an a priori, data-based judgment. These core attributes are the generic technical characteristics and social behaviors necessary to use the technology and are often defined by the innovation developers. (2) Determine whether these core attributes are implemented in the field via in-depth field assessments at implementing sites. (3) Distinguish empirically between those modifications that represent desirable adaptation and those that represent a negative distortion of the technology. The core feature approach is based on some identifiable, *generic* definition of the specific innovation, independent of the implementing organization. This core features approach provides a methodologically consistent way to identify the use of an innovation for across implementing organizations.

Defining Implementation Success: Use of Core Features by *Targeted Members*

In addition to defining a set of core features to operationalize "use" of the CMC technology, this study also includes the *targeted members of an organization* to measure "implementation success." Clearly, a communication technology requires at least two users. Similar to "universal" telephone service (de Sola Pool, 1983), the ability to reach anyone else in the world with the telephone, "universal service" of a CMC technology exists when any member of the organization may communicate with any other member via the CMC technology. Several researchers suggest that the more people within a community that actively use a given CMC technology, the more useful the system becomes for all users (Kraut, Rice, Cool, & Fish, 1994; Markus, 1990; Rice, Grant, Schmitz, & Torobin, 1990; Steinfield, 1986).

There are two key implications of universal access to a communication technology (Markus, 1990). First, only when *all* people in an organization or interest community use an interactive communication technology does *each* member have the ability to realize full benefits from using it; increases in communication efficiency and effectiveness occur only when all group members actively use the communication technology. Secondly, only when a new interactive medium has achieved universal access can organizations reduce the use of older universal access technologies. Without a universal communication medium, Markus warms that:

> [c]ommunities risk disintegrating into non-interacting subgroups. While a newer interactive medium may be more efficient than an older one, an older one that is universally accessible may be indispensable until almost everyone uses the new one. For example, in a certain organization, members of a central processing unit do not have telephones, communicating with people throughout the organization via electronic mail (Markus, 1988). Clearly, this firm is able to dispense with telephones for the central processors only because all the people who need to reach them also have access to electronic mail (p. 3).

Not only do technology-enabled benefits correlate with the proportion of people in the organization using the technology, but appropriate and committed use of a CMC technology by only a *few* individuals or sub-groups may be detrimental to the organization by reinforcing intergroup rivalry or miscommunication. If successful implementation is limited to a few individuals or sub-group—and these sub-groups replace older communication technology with the new CMC technology—intra-organizational communication may suffer. Interactive CMC technologies such as electronic mail, organization-wide intranets, video-conferencing, and shared databases require that a substantial portion of the organization (or at least key groups) actually use the technology; faithful use by a few technophiles does not constitute implementation success.

In the case of web-based instructional technology, large differences in usage rates between departments or faculty members may exacerbate inter-departmental conflicts and create conflicting demands of the university administration. Studies within the educational literature suggest that use of these teaching technologies creates a host of changes, including: different teaching norms and expectations (Driscoll, 1998), new demands for teacher training (Claeys, Lowyck, & Van der Perr, 1997), centralized IT planning and funding (Graves, 1999) with consummate evaluation procedures (McClure & Lopata, 1996; Mojkowski, 1999, April), and courses redesigned to reflect the demands of a less traditional population of students (Duderstadt, 1999).

In summary, the implementation process provides a key leverage point for managers to impact the success —or failure— of a new technology in an organization. The proposed research defines "implementation success" as the *active use of the CMC technology by targeted individuals and groups within an organization in an organizationally relevant way*. As developed in the methods section, a "core features" approach is used to define "active use" and a substantive judgment based on the cooperating organization defines "organizational relevance." Finally, this definition of implementation success assumes that technology-enabled benefits occur only when substantial portions of employees use these new communication tools.

With the outcome of interest, "implementation success" defined in the preceding section, the next section of this proposal focuses on the factors that impact implementation success. Specifically, the next section reviews the research that associates various independent variables with the active use of a CMC technology. The limitations identified in this section will drive the climate measure developed in the proposed research.

The Search for Independent Variables: Correlates of "Implementation Success" and Climate

Overview of Section

The proposed research measures the climate for CMC technology implementation. The hypotheses tested assert that (1) a group-level climate for CMC implementation exists and (2) the climate for CMC technology implementation is hypothesized to account for variance in implementation success over and above more traditional implementation correlates measured in MIS research. In contrast with much of the prior research on CMC implementation, the proposed research tests the group-level correlates of implementation success. These group-level climate perceptions are held by individuals as the result of employees' shared experiences, observations, and discussions regarding the organization's implementation norm, policies, and practices and the kinds of technology-enabled behaviors that are rewarded, supported, and expected in a setting.

The rationale for developing this climate measure is based on a review of prior implementation research within the education and management of information science (MIS) literatures. The following section will identify some of the key findings from these two literatures and suggests that current research fails to address group-level correlates of CMC implementation success. In addition, this review suggests that neither literature identifies any single factor that is necessary or sufficient to ensure successful implementation across all settings. This section also reviews the magnitude of effects found in prior research and suggests that even when significant statistical correlations are found between a given factor and implementation success, the variance accounted for is rather low. Finally, this review of the literature suggests that different social environments within and across organizations lead to different practices involving the same technology. These social environments—as measured by the proposed climate research—may help explain additional variance in implementation success.

The broader "CMC technology implementation climate" survey is proposed as a way to address some of these limitations. The CMC technology implementation climate provides a way to measure group-level CMC-related events, practices, and procedures that impact successful implementation. Ultimately, this measure may help assess implementation efforts across settings and depict the diverse nature of individual- and group-level interpretations of CMC applications. Even with non-significant findings, the proposed research may provide useful results: ruling out these individual- and group-level factors may help identify organizational barriers to successful implementation.

The cooperating organization in this research is a large state university using web-based instructional technology. Given this organizational environment, key insights into implementation success may be contained in research involving the "instructional" intend of CMC technology used to support teaching/learning activities. The next section of this literature review summarizes the recent research within the education literature on web-based instructional technology.

Given the limitations of the education literature identified (i.e., poorly defined constructs and limited quantitative research), the second section of this literature review summarizes the research from the management of information science (MIS) literature. The MIS literature supports the definitions and model tested in this research because this larger and older body of literature provides more sophisticated models, a greater number of research results, and, in most cases, a higher quality of research methods than the educational literature.

Summary of the Web-Based Instructional Technology Literature

Literature searches of PsychLit, CARL, and APA full-text databases provided lists of published articles on web-based instructional technology. In addition, searches of the world-wide web yielded several sites dedicated to teaching and learning with CMC technology. Finally, citation indexes of key published and web-based articles were consulted to find more current research related to the proposed implementation research. Because the participating research site is a large university, this search was focused on (but not limited to) research in post-secondary settings.

While literature review yielded articles ranging from theoretical position papers to second hand reports from the field, few studies provided methodologically sound empirical research results. Most of this literature did not provide the methodological rigor necessary to clearly define the technology of interest, identify the key correlates of effective use, or provide established measures of implementation outcomes. While the educational literature reviewed here does address important problems and promises to yield results in the future, the current state of this literature does not provide the same mature theoretical and applied research as the found in management of science literature.

Definitions Of Web-Based Instructional Technology

For purposes of the proposed research, web-based instructional technology means the use of hypertext world-wide web pages to support teaching activities and electronic mail correspondence with students. While this definition parallels a variety of terms and definitions found in the educational technology research, a review of the education literature provides little convergence on how, exactly, educational researchers define this relatively new form of CMC technology-supported teaching. Web-based instructional technology is referred to as: information and communication technology (Claeys et al., 1997; Gillani, 1998), teaching and learning with technology (Ehrmann, 1997a), on-line education (Berge, 1998), web-based learning (Bonk & Cummings, 1998; Corrent-Agostinho, Hedberg, & Lefoe, 1998), web-based training (Driscoll, 1998), and web-based instruction (Khan, 1998; Wiens & Gunter, 1998). Despite this diversity in identifying “web-based instructional technology," the focus of most of these articles is the use of e-mail and the hypertext-based world-wide web pages to achieve instructional goals.

The lack of specification is epitomized in Khan's (1998) definition of web-based instruction as "a hypermedia-based instructional program which utilizes the attributes and resources of the world-wide web to create a meaningful learning environment where learning is fostered and supported" (p. 63). Kahn's identification of "hypermedia-based" suggests a definition of web-based instruction that focuses on hyperlinked web pages. However, Kahn's proposed "framework for the delivery of Web-based instruction" and the ensuing discussion of this framework demonstrates that Kahn is using a much broader definition of "hypermedia"—a definition that includes other computer-mediated communication technologies such as e-mail, Listservs, newsgroups, databases, and web-based conferencing technology. While Kahn's model is quite valuable and his broader definition of "hypermedia" is certainly valid, the potential confusion caused by this broader definition underscores a continuing challenge in defining various web-based instructional technologies for many researchers working in this academic area.

The variety of terms and definitions found in the education literature may be indicative of the relatively young state of this literature. While most authors focus on similar CMC technologies, there is little agreement on web-related terms, definitions, and characteristics. A consistent categorization scheme for different web-based instructional technologies could both improve the generalizability and reduce the confusion across different studies of the same technology (two recent articles within the education literature by Bannan-Ritland, Harvey, & Milheim, 1998; as well as Khan, 1998 may form the basis for this work). For purposes of the current research, the MIS literature reviewed in part two of this literature review is used to define computer-mediated communication (CMC) technologies such as web-based instructional technology because it has a much larger literature base.

Major Themes in Educational Literature Related to Teaching With CMC

Two broad categories may be identified within the educational literature on CMC technology used to support instruction: *pedagogical*-related research and *implementation*-related research. The pedagogical research on web-based instructional technology is primarily devoted to identifying the most effective teaching methods to use in conjunction with this technology. Research results typically identify key instructor behaviors that impact student learning or student use of CMC technology. The implementation-related research focuses on key organizational attributes or broader management behaviors (e.g., dean or university administrative activities) that impact the use of web-based instructional technology in a department or institution.

Pedagogical-Related Research

Key topics from the pedagogical-related research include the changing roles of instructors in web-supported classrooms (Claeys et al., 1997; McGrath, 1998) recommendations for how to effectively use the computer-mediated communication technology to support instruction (Bonk & Cummings, 1998; Corrent-Agostinho et al., 1998; Gillani, 1998; Partee, 1996; Wiens & Gunter, 1998), and categorization schemas for understanding how web-based instructional technology are used in educational settings (Bannan-Ritland et al., 1998; Driscoll, 1997; Khan, 1998).

Recommendations from this literature include: instructors should have a clear understanding of what instructional mechanism the web can provide (Bannan-Ritland et al., 1998); instructors should have a unified plan for integrating web-based instructional technology with content, instructional objectives, student practices, and evaluation (Berge, 1998); and instructors should link established principles of effective teaching practices with new web-based instructional technology (Chickering & Ehrmann, 1996; Ehrmann, 1997a).

A critical review of this set of pedagogical research yields few firm, research-based conclusions. Most articles merely report local strategies and experiences in using CMC technology to support instruction. For example, Gillani (1998) recommends carefully defending the web-supported task, integrating an awareness of different students' learning styles into web-supported courses, and revising the web site based on formative evaluations. Unfortunately, Gillani's approach does not have any research model besides a narrative of his two year experience in designing and teaching a graduate course in learning theories and multimedia design. Gillani does not provide any review of the literature or methods for how to systematically understand web-based instructional technology. In addition, Gillani's outcome measure was the students' class evaluations (which he reports with: "the students really enjoyed the class…there are comments such as 'extra-ordinary', 'fantastic' class. Apparently, both groups of students considered the course and its design to be effective, innovative and original", p. 200). Finally, Gillani does not acknowledge likelihood of bias results due to the sample: graduate students interested in multi-media design are likely to have very different behaviors and learning outcomes using CMC technology relative to the general student population. While Gillani's recommendation makes sense, the weak research design does not provide conclusive evidence on what, if any, impact web-support had on educational outcomes.

Similarly, Partee (Partee, 1996) describes how he uses web-based instructional technology to improve his students' learning experience. Partee tells how e-mail creates a more "dynamic dialogue from a wider range of students" and suggests that custom newsgroups may emerge as a new mass communications medium as well as a mechanism to store previous semester's notes for a class. Partee also suggests that web-based instructional technology may increase student interaction with the course materials, other students, and the instructor. Like Gillani's article, Partee does not support these insights with an adequate research design, literature review, or even clear definition of the technologies discussed.

Finally, Berge (1998) typifies many of the subjective “reports from the field” with his list of guiding principles in web-based instructional design. Berge first states that the single most important element of successful “on-line education” is interaction among participants because group work “allows students to practice problem-solving and higher level thinking skills” (p. 72). However, Berg does not provide information on how these higher-level thinking skills may be measured or linked to web-based instructional technology. Berge continues with several guiding principles for designing effective web-supported instructional strategies. Berge’s list of principles may well help create highly effective web-supported instructions, but Berge does not support these principles with any primary data—and scant support from secondary sources.

In an attempt to address the subjective nature of much of this research, Russell’s (1999) annotated bibliography of 355 research reports on technology for distance education. His analysis suggests that there are no significant differences between different educational delivery systems. Unfortunately, it is not clear how many of the studies reviewed in the book were specifically designed to answer Russell’s research question. As reviewed by Neal (1998) many of the studies appear to have inappropriate research designs, weak or absent statistical analysis, and limited sample sizes. Given these research limitations, judgements regarding the effectiveness of computer-mediated communication technology for education are, currently, inconclusive.

Another approach to understanding CMC technology used for instructional purposes is Claeys, Lowyck, and Van der Perr's (Claeys et al., 1997) summary of 65 in-depth interviews of experts from nine different fields of education (ranging from university level to headmasters and teachers from primary and secondary schools). These interviews provide a systematically collected list of the issues related to teaching with web-based instructional technology. The strongest recommendation—one supported in the broader MIS research reviewed later—is the need for well-adapted, ongoing training in how to integrate web-based instructional technology in the learning process. As recommended by Claeys et al.: “the investments in profession development of teachers should equal the investment in new technology.” This integration would consist of both technical skills (e.g., how to put a page on the WWW) as well as how to use the CMC technology in a pedagogically sound way. Indeed, instructors using web-based instructional technology—like any new user of a technology—need to understand the possibilities and limitations of the new tool within the context in which it is used. Claeys et al. advocate that these “pedagogically sound” teaching techniques could be founded on teacher training, principal support, and a teacher network of “best practices.” The factors identified by Claeys et al.—training, leadership support, and a supportive network (in the form of group-level climate)—are all part of the proposed research model.

In summary, most of these pedagogical-related studies depend on informal case studies and subjective "recommendations" from the field. If an outcome measure is made, it typically consists of attitudinal outcomes (e.g., how the students felt about the experience) rather than a methodologically sound measure of learning outcomes. While these recommendations make intuitive sense and may certainly be critical to the longer term success or failure of web-based instructional technology in education, the lack of methodologically sound support for these recommendations makes quantitative research based on these suggestions more speculative than necessary. While this review of the pedagogical literature may provide interesting insights and research leads for further inquiry, the MIS research reviewed in later in this proposal provides the more rigorous definitions, models, and research results used to drive the implementation model tested in this study.

Implementation-Related Research in the Education Literature

The implementation-related research identifies some key organizational attributes or broader management behaviors (e.g., dean or university administrative activities) that impact the use of web-based instructional technology. While this branch of literature suffers from some of the same methodological limitations as the pedagogue-related literature reviewed above, some key recommendations correspond to recommendations made in the broader MIS literature. These factors include: administrative leadership, prior instructor experience teaching with CMC tools, general computer-related experience, availability of network computers to faculty and staff, and an organizational culture that rewards technical innovation/quality in teaching using web-based instructional technology. Additional MIS research with stronger research support for these factors is reviewed later in this paper and these factors are integrated into the research model.

Like the pedagogical research, the implementation-related research on web-based instructional technology uses narrative explanations (Dardig, 1997; Ehrmann, 1997b), and informal case studies designed to highlight a set of "best practices" (Collis & de Boer, 1998; Hexel, Marcellus, & Bernoulli, 1998; Riedl & Carroll, 1997). Exemplifying one of the better case study approaches, the Teaching, Learning, and Technology (TLT) Group of the American Association for Higher Education (information available on the AAHE’s web site) provides a mechanism for sharing local experiences and serves as a cleaning house to share experiences with educational institutions with the common goal of improving education through more effective use of technology. The fee-based questionnaires and focus groups offered by the TLT Group’s “Flashlight Project” focuses on faculty and student perceptions of the usefulness of web-based instructional technology. Although the “Flashlight Project” is still in its infancy, development of these projects across many universities may lead to a smaller set of “best implementation practices” appropriate for a variety of higher education settings.

More typical of the implementation-related literature is the case study approach used in Collis and de Boer’s (1998) summary of a web-based instructional project at a Dutch university. The “C@MPUS+” project integrates traditional first year resident students at the

University of Twente with two other cohorts: a group of other first year students at a satellite campus, and a group of mature students attending classes from their homes and workplaces. This case study describes their experiences and provides several useful recommendations for supporting web-based instructional technology in new settings including: administrative leadership, prior instructor experience teaching with CMC tools, general computer-related experience, availability of network computers to faculty and staff, and an organizational culture that rewards technical innovation/quality in teaching using web-based instructional technology. Notably, these recommendations are gleaned only from the faculty's experience in designing this new distance education program. Collis and de Boer do not provide operational definitions or measures of these factors that would facilitate generalization to a new setting or research effort. In addition, no formal outcome measures have been made (although the authors intend to use student evaluation). Nevertheless, many of these recommendations are supported in the broader MIS literature reviewed later and are integrated into the research model.

Similar to the case studies reviewed above, the narrative approaches provide interesting insights that may yield more substantive results in the future. Included in these reports are Ehrmann's (1997b) "letters" from an imaginary dean as she tries to understand the myriad of issue involved in implementing new information technology and Dardig's (1997) description of the design and implementation of a web site used to disseminate ideas originated by faculty and staff across the campus of a small liberal arts college. While these narratives have little methodological rigor, they do illustrate the complex weave of issues active in the implementation process.

Perhaps the most single most important insight from the educational literature is survey data suggesting that computer-mediated communication technology is, in fact, being used in university settings for instructional purposes. The strongest data on implementation rates of web-based instructional technology in universities comes from the annual Campus

Computing Survey, the largest continuing study of the role of information technology in US higher education. Over the last nine years, the Campus Computing Project has collected data from chief information officers (CIOs) or chief technology officers (CTOs) at over 600 two- and four-year colleges and universities across the United States. The 1998 survey (Green, 1998, N=571) reports that an increasing number of college courses are using CMC technology: the percentage of classes using e-mail jumped to 44 percent (compared to 8 percent in 1994); 33 percent of all classes are tapping into Internet resources as part of the syllabus (up from 15 percent in 1996); and almost one-fourth (22.5 percent) of all college courses are using “WWW pages for class materials and resources” (compared to 4 percent in 1994).

The 1998 Campus Computing Survey also suggests that an increasing number of faculty and students have access to web-based CMC technology. Respondents estimate that about half of the students and faculty use the Internet at least once a day (45 percent of the undergraduates and 51 percent of the faculty). Both student and faculty use is highest at research universities (over 50 percent for both groups) while at community colleges less than a third (29 percent) of the students and two-fifths (40 percent) of the faculty have daily contact with the Internet. Although this survey uses secondary sources to measure the web-based instructional technology implementation (CIOs and CTOs) the trend over the last nine years suggests that CMC technology is increasingly available and used to support instructional tasks. The current study may help explain which factors explain this large increase in implementation rates.

In summary, the educational literature on web-based instructional technology has several limitations: the definition of web-based instructional technology vary across studies, the literature is relatively new, and the recommendation tend to be based on observations of small samples and/or use methodologically weak research designs. In contrast, the existing MIS research reviewed in the next section provides clearer definitions, research models, and research results for studying the implementation of CMC technology used for instructional purposes.

Prior MIS Research: Organizational, Technical, And Implementation Variable Domains

Literature searches of PsychLit and CARL databases provided lists of published MIS research articles over the last 20 years. From this list, the articles related to CMC implementation were reviewed. Next, citation indexes of key articles were consulted to find more current research related to the proposed research. This strategy yielded a database of over 500 articles related to the implementation of computer-mediated communication technology. While a full review of all of these articles is beyond the scope of this paper, key articles representative of this literature are summarized on Table 2 along two features: level of analysis[1] and variable domain.

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[1] Level of analysis refers to the entities about which the research poses concepts and relationships: individuals, groups, organizations, or society. The level of analysis that researchers use is driven by the research question. For example, if individual's age is hypothesized to correlate with use of a new technology, using an individual level of analysis is the appropriate level of analysis—the data will provide information on individual-level differences. Group-level research is concerned with between group differences and some measure of implementation success. Organizational-level climate research identifies broad, organizational level characteristics that correlate with some outcome measure. As reviewed by Rousseau (1985), level of analysis issues impact the researchers choice of what to measure and what to analyze.

Table 2

Summary of MIS Implementation Field Research by Level of Analysis and Variable Domain

LEVEL OF ANALYSIS	Not Readily Manageable: Characteristics Active within Organization	Not Readily Manageable: Characteristics of CMC Technology	Manageable: Characteristics related to implementation management
Individual	• User task (Kraut et al., 1994) • Pre-existing user expectations of IT (Hiltz & Johnson, 1989; Meyer, 1995)	• System complexity (Hiltz & Johnson, 1989) • Perceived expressiveness of CMC system (Hiltz & Johnson, 1990). A.K.A., perceived "media richness:" technology's capacity to convey information cues (Daft, Lengel, & Klebe-Trevino, 1987)	• User involvement in implementation planning (Amoako-Gyampah & White, 1993; Guimaraes, Igbaria, & Lu, 1992; Legare, 1995) • Top management support (Guimaraes et al., 1992; Meyer, 1995) • Social support/positive group relationships (Fleischer & Morell, 1988; Hiltz, 1988; Orlikowski, 1992b; Papa, 1990) • User experience with IT (Guimaraes et al., 1992; Hiltz & Johnson, 1989) • Training (Fleischer & Morell, 1988; Gash & Kossek, 1989; Guimaraes et al., 1992; Meyer, 1995; Orlikowski, 1992b) • Formal pressure to use system (Beauclair, Golden, & Sussman, 1989; Kraut et al., 1994) • Surrounding social context (Markus, 1994) • Perceived benefits to users' task (Hiltz, 1988; Lee, 1989; Meyer, 1995; Orlikowski, 1992b; Robey, 1979)
Group	• Functional/task area (Bikson et al., 1987)	• User customizable/ modifiable software(Bikson et al., 1987) • Ratio of users per workstation (Bikson et al., 1987)	• User involvement in implementation planning (Bikson et al., 1987) • Training (Bikson et al., 1987; Stasz et al., 1986) • Perceived leadership support (Stasz et al., 1986) • "Change orientation" of organization or group (Bikson et al., 1987) • Shared expectation about communication procedures/shared "cognitive context" (Zack, 1994)
Organizational	• Diversity in production and marketing efforts (King & Sabherwal, 1992) • Decision centralization (+) (King & Sabherwal, 1992)	• System cost & complexity (-) (Cerullo, 1979)	• Top management knowledge/involvement in IS efforts (Cerullo, 1979; DeLone, 1988; Jarvenpaa & Ives, 1991; King & Sabherwal, 1992) • Management support (King & Teo, 1994; Neo, 1988) • Implementation climate (Klein & Sorra, 1996) • Customer Needs driven/Customer focused use of IT (Brynjolfsson & Hitt, 1996; Neo, 1988)

Note: outcome definitions and measures vary widely across studies.

Table 2 delineates between individual-, group-, and organizational-levels of analysis. The research reviewed here was assigned a given level of analysis depending on the level of analysis used by the authors. When the level of analysis was not overtly specified in the research article, the specific sampling technique and statistical approach used was used to assign the level of analysis used.

Two key levels of analysis issues are particularly relevant to the current research. First, a careful review of the variables on Table 2 suggests that many of the variables could be active at one or more levels of analysis. For example, “end user involvement in implementation activities” may occur at the individual level, group level, or organizational level. Similarly, perceptions of “top management support” of the new information technology may be collected and assigned to individuals, groups, or entire organizations. While these levels of analysis issues are found in all organizational research projects (Rousseau, 1985 provides a seminal review of the subject), few of CMC implementation studies reviewed for the proposed research addressed these levels of analysis issues.

The second—and related—level of analysis issue evident on Table 2 is the dearth of CMC implementation research focused on the group-level of analysis. Only two studies, both sponsored by the Rand Corporation (Bikson et al., 1987; and Stasz et al., 1986), have used the group level of analysis to identify group-level correlates of CMC implementation success. Assuming that various CMC technologies are positioned to become what Markus (1990) describes as “universal communication media” (e.g., e-mail or the Internet), further attention to group-level correlates of implementation success appears to be an essential research avenue; the current research helps address this need.

Table 2 also organizes prior research into two simple categories: “manageable” versus “not readily manageable”. “Not readily manageable” correlates are those judged to be relatively stable, enduring characteristics of the organization or the CMC technology[1]. These correlates include functional areas within the organization, pre-existing expectations employees have about information technology, or the organization's diversity in production and marketing activities.

In contrast, correlates judged to be relatively easy to control, changed, or modified by people in the adopting organization are identified as "manageable." For example, involvement in implementation planning, top management support, and training are all activities that people in organizations can manage as they adopt and use new CMC technology. This simple categorization scheme clearly identified correlates that may be managed by adopters, implementers, and end users and contrasts them with correlates that are difficult or impossible for technology users to change. In order to provide the most meaningful research results to typical CMC implementing organizations, the "manageable" correlates of implementation success are the primary focus of the climate measure developed for this research.

Organizational/Structural Attributes

The less manageable correlates may be further divided into organizational characteristics that influence implementation success and characteristics of the CMC technology itself. Prior CMC researchers have correlated several organizational/structural attributes with implementation success. These findings include: user task (Kraut et al., 1994) pre-existing user expectations of information technology (e.g., IT seen as helpful and easy to use versus unhelpful and complex), users' job tasks (Bikson et al., 1987), diversity in production and marking efforts (King & Sabherwal, 1992) and decision centralization (King & Sabherwal, 1992).

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[1] Some of these correlates could be changed via a larger organizational development intervention. For purposes of the proposed research, factors that require broad scope organizational development efforts (e.g., Burke, 1991) are categorized as "not readily manageable."

The individual's functional area (department) is the only structural characteristic from the literature reviewed that is included in the model tested. The other structural characteristics summarized on Table 2 are integrated into the individual expectation or climate measures discussed later in a following section. As discussed in last half of this study, the present research hypothesizes that group-level interpretations of CMC technology exist. In order to test this hypothesis, *functional area*—defined as the individual job task and function within the organization—is included in the model tested.

Technical Characteristics

Categorized under the "Not Readily Manageable" heading of Table 3 are several findings that correlate the technical characteristics of a CMC system with implementation success. Unfortunately, this set of factors is difficult to compare across studies. A computer-mediated communication technology is two or more electronically connected computers that distribute some combination of text files, database files, audio, or video messages between people. Beyond this generic description, however, there are few technical characteristics (i.e., specific hardware or software configurations) that apply across all examples of CMC technology. Instead of identifying hardware and software packages, researchers typically categorize CMC technology along four key functions: Group Information Support Systems, Group External Support Systems, Group Communication Support Systems, and Group Decision Support Systems. (See DeSanctis & Gallupe, 1987; McGrath & Hollingshead, 1994; Pinsonneault & Kraemer, 1990 for further discussion of computer mediated communication technology types.)

A comparison of the function and technical characteristic columns of Table 3 underscores the category-spanning nature of CMC technologies: the specific mix of functions and technical characteristics may be quite different between organizations using a given CMC technology. For example, one advertising company—or a group within the agency— may use electronic mail to communicate sensitive information to salespeople

(Group Communication Support System) while another company may use e-mail to link customers with a specific account representatives (Group External Support System). A third company may use archived records of electronic mail exchanges to help new employees understand the history of certain projects (Group Information Support System). Similarly, Internet, intranet, and other computer mediated communication technology may be used to address different functions across and within organizations. Consistent with Tushman and Rosenkopf's (1992) description of "open assembled systems," CMC technologies are highly influenced by the surrounding social context, political demands, and environmental conditions. Given the flexibility inherent in CMC technology, the choice of which CMC technology to use often depends on social rather than technical factors. Notably, researchers have found few specific, enduring technical features common to all CMC technologies that may be correlated with implementation success.

Table 3

Types of Computer-Mediated Communication Technologies

TECHNOLOGY TYPE	FUNCTION	TECHNICAL CHARACTERISTICS
GISS (Group Information Support System)	Information storage and retrieval—GISS aids in increasing the range and depth of information available to group.	Networked computers with shared database, on-line libraries, electronic mail archives of individual's or group's prior activities.
GXSS (Group External Support System)	Communication system supporting information transmission and reception with outside individuals, groups or agencies	Wide area networks (WANs) that support inter- and intra-organizational bulletin boards, discussion groups, electronic mail, or world wide web sites.
GCSS (Group Communication Support System)	Electronic communication transmission and receptions—GCSS aids in exchange of interpersonal and intra-group communication Goal of GCSS technology is to reduce communication barriers within groups and organizations.	Networked computers supporting audio or video teleconferencing, intranets, or electronic mail systems.
GDSS (Group Decision Support System)	Structures to group's information exchange and consensus activities. Electronic structure provides medium for minority opinions to be heard and more systematic assessment of decision alternatives. Goal of technology is to reduce uncertainty and process losses.	Computer automated Nominal and Delphi techniques, networked planning tools (PERT, Gantt), computerized decision tree and risk assessment models.

The impact of non-technical, social factors is evident even in the few research findings that do measure technical characteristics. Most of these studies operationalize technical characteristics with individual *user perceptions* of these features rather than enduring technical attributes. As illustrated on Table 3, the perceived complexity of the system and perceived expressiveness of system (Hiltz & Johnson, 1989, 1990) depend on *user perceived* technical characteristics. Even the customizability of software (Bikson et al., 1987) reported by individual users may depend more on the user's level of training and expertise than some generic technical characteristic. Only two studies on Table 2 refer to generic technical attributes: the ratio of users per workstation (Bikson et al., 1987) and, at the organizational level of analysis, system cost and complexity (Cerullo, 1979).

Despite the subjectivity of these “technical characteristics,” perceived system expressiveness and perceived interface complexity are included in the model tested. The “customizability of software” variable was integrated into other measures. Given the current ubiquity of desktop computers in typical organizations, the “ratio users per workstation” correlate was not included in the model.

Rather than conceptualizing CMC technologies as providing generic functions, most researchers focus on the surrounding organizational and social characteristics that impact if and how CMC capabilities are used. As illustrated in the next section, prior research has suggested that the variability of social context—the way interconnected computers are used by different individuals and organizations— provides many more correlates of implementation success.

Manageable Correlates: Characteristics Related to Implementation Management

Implementation variables refer to the organizational events, practices and procedures involved in implementing a new technology (recall the five-stage adoption/implementation model discussed earlier). Simply purchasing a leading edge technology or automating a “strategic” business function does not guarantee successful integration of the new technology into an organization. Instead, the implementation activities designed to support a new tool may be as important as the tool itself. As suggested by Eveland (1981) “[t]he manner in which a complex innovation is implemented may account for more of the variance in the net benefits realized than do its main technical features per se” (p.2).

Table 2 illustrates the key implementation activities that have correlated with implementation success in prior MIS implementation research at the individual, group, and organizational level of analysis. Prior research done at the individual level of analysis has shown correlations between implementation success and several management or implementation-related activities including: individual user involvement in implementation planning (Amoako-Gyampah & White, 1993; Guimaraes et al., 1992; Legare, 1995), individual perceptions of top management support (Guimaraes et al., 1992; Meyer, 1995), individual perceptions of social support/positive group relationships (Fleischer & Morell, 1988; Hiltz, 1988; Orlikowski, 1992b; Papa, 1990), user experience with IT (Guimaraes et al., 1992; Hiltz & Johnson, 1989), training (Fleischer & Morell, 1988; Gash & Kossek, 1989; Guimaraes et al., 1992; Meyer, 1995; Orlikowski, 1992b), individual perceptions of pressure to use system (Beauclair et al., 1989), and perceived benefits to users' task (Hiltz, 1988; Lee, 1989; Meyer, 1995; Orlikowski, 1992b; Robey, 1979).

At the group-level of analysis, prior MIS research has correlated implementation success with: user involvement in implementation planning (Bikson et al., 1987), training (Bikson et al., 1987; Stasz et al., 1986), group-level perceptions of leadership support (Stasz et al., 1986) and the "change orientation" of organization or group (Bikson et al., 1987).

Finally, at the organizational level of analysis, top management knowledge/involvement in IS efforts (Cerullo, 1979; DeLone, 1988; Jarvenpaa & Ives, 1991; King & Sabherwal, 1992), management support (King & Teo, 1994; Neo, 1988) and the implementation climate (Klein & Sorra, 1996) have all correlated with one or more measures of implementation success. current research focuses on group- and individual-level predictors of implementation success because, as illustrated on Table 2, individual- and group-levels of analysis appear to provide more correlates of implementation success. While this may be a methodological artifact (statistically significant results may be easier to obtain using the large sample sizes available at the individual and group-level of analysis), a more likely explanation is that individual- and group-level attributes actually do have more impact on implementation success than organizational-level attributes. Bikson, Gutek, and Mankin (1987) offer empirical evidence for this conclusion in their study of computerized office technologies. The Bikson et al. sample included 530 individuals in 55 work groups from four different work group types (administrative, text-oriented profession, technical-oriented professional and clerical). Bikson et al. used three general outcome measures: proportion of users in each group, perceived incorporation into work design, perceived increases in productivity and satisfaction. Their statistical analyses suggested that organizational-level measures (e.g. industry type) do not account for variance in implementation success as well as group-level (categorized by intact work groups or by task type) variables.

An additional reason for focusing on individual- and group-level correlates is that the speed of technology-induced changes has made it difficult for researchers to identify specific organizational-level attributes of effective organizations—and effective technology users. Peter Drucker's prediction of information-based organizations (1988) may explain the dearth of organizational-level variables: the 1950's style "typical" manufacturing-based organization that can be succinctly identified by national economy, industry type, and worker tasks no longer exists. Even the traditionally "predicable" organizations—from floral shops to heavy industry—have moved from command and control organizations to flexible, information-based organizations that use teams of knowledge specialists to compete in a highly aggressive business environment. In order to identify the best set of implementation correlates, the current research is completed at the individual and group-level of analysis.

<u>Prior Observational and Correlation-Based Research</u>

Based on the parameters of this research, a field study done at the group- or individual-level of analysis, prior research was reviewed (as illustrated on Table 3) to identify a single set of the "best" correlates of implementation success. Specifically, studies completed at the individual or group-level of analysis that focused on group communication support systems (a specific genre' within CMC technology that provides electronic storage, distribution, or retrieval of information)[1] were selected. Based on these criteria, seven studies summarized on Table 4 typify much of current CMC technology implementation field research. Table 4 compares each study's statistically significant (or non-significant but notable) technical, social, and implementation correlates of implementation success. The variety of research contexts and definitions of implementation success are also presented.

[1]Research samples of ad hoc groups formed only for research purposes and research concerned with electronic group decision support systems were not included in this review.

Table 4

Summary of CMC Technology Implementation Field Research Using Natural Groups

(See next page for explanation of table abbreviations.)

	Research Context						Significant/Notable* Independent Variables			Dependent Variables	
	Size										
Author (year)	N of Individuals	N of Work Groups	Size of Each Work Group	Level of Analysis	Research Design	Subject Selection[1]	Individual /Group /Structural. Characteristics[2]	Technical Characteristics[3]	Implementation Characteristics[4]	Task Outcome	Group Outcomes
Bullen & Bennett* (90)	223	? (25 different organizations)	7 to 35	individual	exploratory observation & unstruc'ed survey	conv "referrals"- typical case	Exp, Perf	Cmpx	Lder, Tr	Perceived performance	Ind. perceived satisfaction
Orlikowski* (92)	91	?	?	individual	exploratory observation & unstruct'd survey	conv (?)	Func, Hier, Cohes,	controlled (one GCS system)	Part, Rw, Tr, WRed	Self reported use	Perceived ind. benefits
Stasz, Bikson & Shapiro* (86)		44 (across hierarchical levels of large national org)		group	unstruct'd survey	crit		Cus, local,	Lder, Tr	Changes in work design, performance	Changes in staffing, satisfaction
Bikson, Gutek & Mankin (87)	530	55	4 to 40 mean=10	group	survey	?	Chg, Func	Cus, Ind,	Part, Tr, Sup	% of Users in Group, Perceived Incorp'tion, Productivity	Individual. satisfaction
Hiltz & Johnson (88, 90)	505	? (4 different organizations)	?	individual	survey	quot	Age(-), Expt, Frus, Cohes, Impt, Int, Sat,	Ind, Cmpx, (4 different GCS system designs)	Lder,	Frequency of Media use;	Ind. satisfaction; Perceived Ind. benefits
Lee, Kim & Lee (1995)	236	2 organizations		Individual	survey	random	end user acceptance		Training	Use	Job Satisfaction
Robey (79)	66	? (one organization)	?		survey	conv	Impt, Goal, Perf	controlled (one GCS system)	Lder	actual use of system	Perceived ind. & group benefits; Ind satisfaction
Papa (90)	301	One organization (1 treatment, & 1 control group)		individual	correlational	conv	Diverst.(+) Cohes, Size of Group(+)	controlled		Use	

Table 4 (cont.)

Explanation of Table 4 Abbreviations

*: hypothesis testing not indication for research design (first three studies listed in table)
Blank: not applicable
?: not directly addressed in research description

[1] subject selection abbreviations
Based on Henry (1990) non-probability sample designs.

conv:	convenience sample
crit:	critical cases
quot:	quota sample
typ:	typical cases

[2] individual/group/structural characteristics

Chg:	change orientation of organization or group
Diverst.	Network diversity; the number of hierarchical levels included in group
Goal:	perception that media supports users goals
Expc:	user expectations of media
Frus:	individual's frustration with media
Func:	individual's functional or task area
Hier:	level of individual in organizational hierarchy
Cohes:	perception of group cohesiveness (pos. feelings, trust, non comp.)
Impt:	user's/group's perceived importance of task using media
Int:	user interest in media
Perf:	perception that media supports users performance
Sat:	individual's satisfaction with media

[3] technical characteristics abbreviations

Cmpx:	technical complexity of system
Cus:	user-customizable/modifiable software
Ind:	individual workstations for users
local:	local (within workgroup) storage of database information

[4] implementation characteristics

Lder:	individual perception of implementation leadership/support
Part:	participation in implementation decision/process
Rw:	reward
Tr:	training
WRed:	work redesign
Sup:	user support

[5] DEPENDENT VARIABLE: Task
Perceived Incorp'tion:
perceived incorporation of technology into work routines

Key Findings of Prior Research

The literature review found 10 recurring characteristics and practices that support implementation of CMC technology. Table 5 presents a simplified review of these implementation correlates

Table 5

Key Structural, Technical and Implementation Dimensions at Individual- and Group-Level of Analysis

STRUCTURAL CHARACTERISTICS	TECHNICAL CHARACTERISTICS	IMPLEMENTATION CHARACTERISTICS
Functional Area/Task[3]: Functional area or task of employee	**Perceived CMC system expressiveness[1]:** Capacity to convey relevant information	**Expectations[1]:** Individual expectation of technology before adoption/implementation activities began.
	Perceived Complexity[1]: Perceived complexity of software interface (significant findings at individual-level of analysis)	**Leader Support[3]:** Individual perceptions of top leadership/supervisor support for implementation activities or leader support for technology-enable capabilities
		User Participation in Adoption/Implementation Activities[3]: End-user participation in adopting new technology (e.g., need identification, choosing technology) and implementation planning (e.g., how users are trained, planning how new technology will be used in work routines)
		Rewards[1]: Perception that employee is rewarded by organization for using technology. (Significant findings at both individual- and group-level of analysis.)
		Training[3]: Availability and quality of training program available to new users
		Social Relations[3]: Perceived group cohesiveness (e.g., frequency and depth of communication). Pressure to use CMC system.
		Task Importance[1]: Perceived importance of technology-related task

[1]=Significant findings at individual-level of analysis.
[2]=Significant findings at group-level of analysis.
[3]=Significant findings at both individual- and group-level of analysis.

Difficulty of Applying Existing Research

Despite the existence of significant individual- and group-level correlates of implementation success, the literature reviewed does not, unfortunately, provide a reliable "checklist for implementation success" that predicts implementation outcome based on a few factors. Instead, the factors identified above provide only general guidelines to researchers and practitioners. No single factor is necessary or sufficient to ensure successful implementation.

Even when significant statistical correlations are found between a given factor and implementation success, the variance accounted for is rather low. While the total amount of variance accounted for is not reported in many of these studies, most researchers report modest correlations between the predictor and outcome variables. For example, Lee, Kim and Lee's (1995) correlations ranged between .47 and .02 with the majority of the variables hovering around .25. Bikson, Gutek and Mankin (1987) found no statistically significant relationships between any of their 10 independent variables and computer system use. Papa's (1990) multiple regression model accounted for 30 percent (R^2=.30) of the total variance in productivity; the strongest single correlate (network diversity) comprised 23 percent of this explained variance.

Exemplifying these studies, Hiltz and Johnson's (1989) study of over 500 people explained 18% (r=.43 p<.01) of the variance in the outcome labeled as "satisfaction with the technology" with a independent variable "perceived importance of communication with people on the system." The second strongest correlate, "perceived task urgency", dropped to 11% (r=.34, p<.01). However, even these modest correlations may over estimate the strength of the relationship. Meyer's (1995) multiple regression analysis controlled for user expectations and found that implementation-related variables (participation in implementation activities, formal training, perceived leadership support of CMC system, and changes in work design) explained only an additional 5% of the variance in use (R^2 change=.05, $p<.01$).

Despite the host of statistically significant research findings, the current literature does not provide researchers or practitioners a few reliable correlates of implementation success. Instead the current research provides modest correlates that may not be applicable across settings. Why don't these research findings provide more specific predictors of implementation success?

Climate for Implementation: Contributions to the Literature

The seven empirical studies summarized on Table 4 illustrate three problems that challenge practitioners and researchers when applying much of the existing research to novel settings: different social environments within and across organizations that lead to different practices involving the same technology, the need to collect information on site-specific implementation practices, and the changeable nature of CMC technology. The climate measure developed in the current research addresses the first two of these difficulties.

Much of the prior MIS research does not adequately measure the impacts of the surrounding social environments. As illustrated on Tables 1 and 3, many studies show simple correlations between implementation success and technical, financial, structural or other characteristics (typical examples include Guimaraes et al., 1992; Lucas, Walton, & Ginzberg, 1988; Sanders & Courtney, 1985). Unmeasured in many of these studies are perceptions of the *climate* active in the group or organization. Climate perceptions—based on employees' shared experiences, observations, and discussions regarding the implementation norm, policies, and practices and the kinds of technology-enabled behaviors that are rewarded supported and expected in a setting—impact if and how a new technology will be used within a given social context. Indeed, fundamental to organizational psychology literature is the idea that organizations are not "rational systems" in which behaviors are based on a linear evaluation of objective inputs and outputs. Instead, organizations are *social systems* in which people act according to individual experiences, informational cues provided by both work-group peers as well as broader organizational politics (Katz & Kahn, 1978; Savage, Nix, Whitehead, & Blair, 1991).

As tested in this study's climate model, different social environments active in organizations (i.e., different departments within in the organization) will create different implementation behaviors, different interpretations of how the technology "should" be used, and different implementation outcomes (Levine & Rossmoore, 1993; Weick, 1990). Implementation success may be a product of what Katz and Kahn (1978) describe as "equifinality:" the same outcome may by achieved by a variety of actions. This "equifinality" within the implementation process prevents researchers from predicting implementation success based on a few key factors. Indeed, one indicator of Katz and Kahn's "equifinality" may be indicated by the large number of moderate correlates found in Table 4; no single factor dominates this table, yet all receive empirical support. As Klein (1992) suggests, even if an organization fails to address several factors (e.g., training and rewards), it may successfully implement a new technology through flawless execution of other practices (e.g., leader support and user participation). As noted in Levine and Rossmoore's (1993) case study of IT implementation in a large financial services company:

> Much of the theory and practice of organizational IT implementation assumes that organizational decisions—whether technical or social—are consequences of individuals and organizational units objectively collecting, evaluating, and applying information in a rational manner to make choices on behalf of the organization. However, recent data from case studies of IT implementation suggest that rationality may be the exception rather than the rule (p. 55).

Correlating a single factor (or small set of factors) with implementation success may not yield consistent results because some unmeasured variable in the organizational or group environment may impact implementation success or may moderate the correlation in a way not tested in the research design. As described later in this literature review, the climate measure used in this research defines and measures a group-level climate for CMC implementation. In addition, many of the correlates of implementation success identified in prior research are integrated into the step-wise regression model tested thereby reducing the chance that an important predictor variable will be missed. This analysis strategy also provides a demanding test of the climate for CMC implementation measure.

The second problem in prior research that the climate measure may address is the need to collect information on site-specific implementation practices. The variety of CMC configurations possible as well as the number of alternative uses of this technology requires researchers to carefully document these variables. In response to this “equifinality” (Katz & Kahn, 1978) problem outlined above, much of the CMC field research uses qualitative and case-based research methods to preserve valuable contextual information (Levine & Rossmoore, 1993; Orlikowski, 1992b; Papa, 1990 are a typical examples). Without multiple replications of the research, however, qualitative and single-site case methods prevent generalizing these findings to other settings (Cook & Campbell, 1979). While the current research focuses on a few sites and will have the same need for replication, the climate measure developed *facilitates* this replication: future researchers will have a quantitative tool available to them that requires far less time than qualitative research.

As discussed in further detail later in this paper, the climate for implementation measure helps integrate the implementation practices and procedures active in an organization into a *set* of activities as perceived by CMC technology users. In this way, the measure adds parsimony to the current state of the research in which a host of factors may—or may not—support implementation. In Klein and Sorra’s (1996) words:

> The climate for implementation construct thus pushes researchers away from *the* search for the critical determinates of implementation effectiveness—training *or* rewards *or* user friendliness—to the documentation of the cumulative influence of all these on innovation use (p. 1073, italic in original).

The climate for CMC implementation developed here is an inexpensive, quick, quantitative measure that integrates some of the site-specific implementation correlates identified in previous research. With additional research and testing, the CMC technology implementation climate measure provides a tool that may be helpful for generalizing research findings across settings.

The third problem with applying much of the existing correlation-based research is that a single factor (or small set of factors) may not consistently correlate with implementation success because of the nature of computer-mediated communication technology itself. Weick (1990) describes CMC technologies as “equivoque”: (p.2) because, as illustrated on Table 2, CMC technologies have a broad range of possible uses and context-specific functions. While all the studies presented on Table 4 focus on CMC technology, the specific system and functions may be quite different. For example, Hiltz and Johnson (1988; 1990) compare three different electronic conferencing systems and one electronic mail system on subjective satisfaction and use outcomes. In contrast, Bullen and Bennett (1990) identify different groupware applications with group calendar functions, project planning and coordination tools, as well as electronic mail. Not surprisingly, research that focus on different computer-mediated communication capabilities often find different correlates of implementation success.

The primary strategy used to control for the variety of possible CMC configurations is to select a single function (e.g., electronic mail) or application (e.g., Lotus Notes® groupware application). In addition, several researchers have proposed categorizations schemes for CMC technology in terms of their level of sophistication (Dennis, George, Jessup, Jay F. Nunamaker, & Vogel, 1988; DeSanctis & Gallupe, 1987; McGrath & Hollingshead, 1994; Pinsonneault & Kraemer, 1990) or restrictiveness (Silver, 1991). These strategies narrow the research focus and provide some consistency within the "equivocal" nature of CMC technology. However, even an e-mail application may be used in different ways: organizations may use e-mail lists for general announcements (e.g., announcement of where employees may purchase discount movie tickets) or encrypted e-mail messages reserved for time critical and highly confidential communications. The current research carefully describes the core features of the CMC technology investigated and how it is used within the cooperating organization.

Summary of Prior Research

Prior CMC implementation research provides both qualitative/case-based observations and quantitative correlational surveys. The qualitative research provides valuable insight into site-specific factors, however, the methods are time consuming, expensive, and the research results may not be generalizable to other settings. The quantitative research reviewed suggests a host of significant correlates of implementation, yet no single set of factors appears to consistently predict implementation success. In addition, three challenges face researchers when applying much of the existing research to new settings: (1) different social environments within and across organizations that lead to different practices involving the same technology, (2) the need to collect information on site-specific implementation practices, and (3) the changeable nature of CMC technology. The current study facilitates measuring the different social environments within organizations and suggests that the flexible nature of a single CMC technology and characteristics of the surrounding organizational environment impact how CMC technology is used.

In light of these findings, this study uses prior research in two ways: (1) prior correlates of implementation success at the individual level of analysis are tested in the proposed model and (2) prior research findings help build a broad group-level climate for implementation measure. The next sections of this paper review a model that integrates many of the findings reviewed above into a group-level climate for implementation survey.

The first section reviews the theoretical background of the proposed climate measure: Orlikowski's (1992a) "technological frames" model. Next, the quantitative results introduced in the previous section are integrated into the frames model to create a climate for CMC implementation measure. This composite, quantitative measure provides a simple and efficient way to measure implementation efforts in organizations.

"Technological Frames" as Climate—Extending an Existing Model

Overview of Section

The previous sections reviewed recent MIS literature reviewed that helps identify the specific factors that comprise a group's climate for CMC implementation. The final sections of this paper review the climate literature and provide the theoretical basis for the definition of climate, the identification of a "climate for CMC technology implementation," and the methods for identifying the appropriate level of measurement and analysis. Hence, the MIS literature reviewed in the previous sections provides the *content* of the climate for CMC implementation measure while the climate literature reviewed in the next sections provides the *form* of this research.

The following section summarizes Orlikowski's research on technological frames and outlines how the current research extends her work with a quantitative climate for CMC technology implementation measure. Next, following Zohar (1980) and Klein's (1992) strategy for developing a focused climate *for something*, the current research uses existing research results to identify the organizational events, practices, and procedures that differentiate organizations on the dependent variable of interest: implementation success. While much of the literature reviewed earlier identify only individual-level correlates of implementation success, these findings may inform variable selection at the group (climate) level of analysis. The section ends with an integration of some of Orlikowski's "technological frames" elements with the research results summarized in Table 5 to identify the key climate domains measured.

"Technological Frames" Model

The definition of climate used in this research (employees' shared experiences, observations, and discussions regarding the organization's implementation norm, policies, and practices and the kinds of technology-enabled behaviors that are rewarded, supported, and expected in a setting) parallels the descriptions of Orlikowski's (1992a) "technological frames" model. "Technological frames" refer to the cognitions and values of users including the underlying assumptions, expectations, and knowledge that people have about technology. Orlikowski's sociotechnical "frames" model outlines a dynamic interrelationship between people, technology, and the surrounding group and organizational environment.

Orlikowski (1992b) used an observational field research methodology in her five-month study of an organization implementing a specific CMC technology (Lotus Notes®). Her sources were: 91 one-hour long unstructured interviews of users across hierarchical levels, reviews of office documents, and observations of work and training sessions. Orlikowski's outcomes were worker perceptions of the technology's effectiveness in helping them do their jobs and an informal, self-reported "use" measure. Orlikowski found several organizational elements that may affect individual user's perceptions and early use of one type of CMC technology: reward systems, training, policies, and organizational norms.

A second analysis of this case study helped Orlikowski and Gash (1994) build the "technological frames" concept. This model, in turn, informs the climate measure developed in the proposed research. Orlikowski's model posits a dynamic relationship between the surrounding group- and organizational environment and the use of new CMC technology. Technological frames refer to local (organizational or group) interpretations of how new technology is used "including the specific conditions, applications, and consequences of that technology in *a particular context*" and contains "*local understanding of specific uses in a given setting*" (p.178, italics added[1]).

Three of Orlikowski and Gash's (1992) seven technological frames dimensions are used to organize the climate measure: (1) *Philosophy towards technology* represented by beliefs about the specific CMC technology implemented as well as information technology in general. Specifically, these beliefs include both the users' perceptions of the group- and organization's expectations regarding technology-enabled capabilities as well as the users' perceptions of the groups' and organization's history with computer technology (e.g., technology is seen in this group/organization as enabling as empowering versus deskilling and useless). (2) *Implementation issues*:[2] represented by shared, group-level knowledge and experiences in the implementation process of a specific technology, including involvement, barriers/facilitators, training, managerial support. (3) *Relations with others in computing social world* is defined as expectations and experiences about the frequency and extent of interaction with other people using information technology, perception of the group's attitudes towards and understanding of technology.

Three of Orlikowski's dimensions are treated as outcomes rather than independent variables. (1) *Use Issues* : knowledge and experiences in using the specific technology in routine tasks, experiences of the technologies centrality, usefulness, and reliability. (2) *Success criteria* : beliefs about how successful the technology is/should be assessed.

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[1] As discussed in the "Levels of Analysis in Climate Research" section later in this proposal, the items used to measure climate ask individuals about their perceptions of group- and organizational-level characteristics . If statistically indicated, these individual-level climate perceptions will be aggregated to the group level of analysis.
[2] In order to simplify the proposed climate model, the "implementation" dimension was combined with the seventh of Orlikowski's dimensions, *initiation issues*. Orlikowski defines initiation issues as user knowledge and experiences in the "choosing" stage of technology implementation including participants feasibility assessment and perceptions of technology's objectives. These initiation issues are reflected in user perceptions of the technology's rationale/history, cost/benefit analysis, and managerial support.

(3) *Impact* : beliefs about the impact of the technology on the strategy, structure, way of doing business and norms of the group and organization. “Impact” includes how much/well a technology has changed jobs, tasks, job related knowledge, skills, abilities, social relations, status, and workload. These three variables are highly similar to one of the most frequently used satisfaction measures in the MIS literature (Adams, Nelson, & Todd, 1992; Davis, 1989).

Problems with the Technological Frames Model

While Orlikowski and Gash’s (1994) seven technological frames dimensions provide a broad model of user perceptions and a way to organize users technology-related “interpretations of the world...[and] implicit guidelines that serve to organize and shape their interpretations of events” (p 176), the model has several limitations.

Despite the conceptual strength of this model, Orlikowski and Gash’s case study does not provide quantitative measures for identifying technological frames in other organizations. Orlikowski’s qualitative measures (interviews and observations) of inter-group and intra-group technological frames makes replication of this research at other sites time consuming and expensive. The technological frames model developed by Orlikowski and Gash needs testing in other organizations; the climate measure developed for this research facilitates this replication.

A second problem with Orlikowski’s approach is that it does not quantitatively measure implementation outcomes (e.g., use of the new technology, user satisfaction with the technology, satisfaction with technology’s impact on user performance, or fidelity of implementation). Without incorporating implementation outcomes into a testable model, there is no way to evaluate organization’s implementation effort or the impact of various implementation predictors. In contrast, Lewis and Seibold (1993) identify two possible outcomes measures in their case study of a large manufacturing corporation. Like

Orlikowski's model, Lewis and Seibold use a structurational[1] model to propose a set of dynamic relationships between characteristics of the organization, the individual, and the new technology. However, Lewis and Seibold suggest that the social policies and practices active in the model (policies and practices that may be modified depending on the implementation efforts active in the organization) influence two key implementation outcomes: fidelity (match between design/intended use and actual use) and uniformity (similarity across users). Measuring implementation outcomes such as use, satisfaction, fidelity, or satisfaction with group processes enables researchers and managers to link implementation plans, user perceptions, and technology-related outcome measures.

Finally, Orlikowski's technological frame model does not include contextual characteristics. Additional environmental/contextual factors may also influence the implementation of new CMC technologies. As summarized on Table 2, some key factors identified in prior research include: individual and group task (Kraut et al., 1994), perceived expressiveness of CMC system (Daft et al., 1987; Hiltz & Johnson, 1990), system complexity (Hiltz & Johnson, 1989), user customizable software (Bikson et al., 1987; Stasz et al., 1986), and number of hierarchical levels included in group (Papa, 1990).

In light of these considerations, the present research modifies Orlikowski's model in three ways. First, a quantitative measure of technological frames is proposed: the climate

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[1] Anthony Gidden's theory of structuration is used by several implementation researchers to explain the relationship between individuals, organizations and new technologies (Barley, 1990; Orlikowski & Robey, 1991; Poole & DeSanctis, 1990). Structuration theory suggests that new technologies have no *inherent* meaning apart from their use. Instead, the meaning of a technology stems from the way it is employed by people in a particular setting. The structuration model posits that social processes involve reciprocal and dynamic relationships between human actors and structural features of organizations. Social structures are first formed by human actions. The structures then serve to shape future human actions. Structuration—the creation of institutional norms, practices, roles in a particular setting—is a process; structures are formed by human interaction and then they constrain future human action. Hence, structures have a dynamic and interactive nature: they are both a *product* of human activities and an *input* which shape future human action. Implementation researchers have used this dynamic model to interpret how new technology is integrated into social systems.

for CMC technology implementation. This measure provides a quick, inexpensive, quantitative way to measure how group- and organizational-level behaviors, experiences and expectations impact implementation outcomes. Second, the model tested in the current research includes technology-related outcome measures—some of those proposed by Lewis and Seibold (1993) as well as other MIS researchers reviewed earlier. Finally, as reviewed in the next section of this paper, this research integrates prior implementation research on individual and group factors that support implementation success.

Empirical Support for Climate Model

Based on four of Orlikowski's "technological frames" dimensions, the climate model tested provides a broad "fabric" of the climate for CMC implementation measure. This theoretical model is useful because it helps organize the wide variety of implementation activities and user perceptions into a single model. More importantly, each of these dimensions is supported by prior qualitative and quantitative field research. While much of the literature reviewed earlier analyzes survey data at the individual-level (e.g., individual expertise with technology, individual expectations, individual training experience), these findings provide guidance for variable selection at higher (group) levels of analysis.

This section integrates Orlikowski's "technological frames" model with the research results summarized in Table 5 to identify the key climate domains measured in the current research. In order to control for the individual-level correlates of implementation success, the final model tested includes both individual- and group-level measures.

The specific climate model was created with a three-step procedure. First, the quantitative research reviewed earlier (summarized on Tables 1, 2 and 3) was used to identify the key implementation support factors (Klein, 1989; Kozlowski & Hults, 1987; Schneider, 1990; Zohar, 1980 also use this approach of reviewing the literature to identify components of a climate for measure). Next, factors from these empirical research results were then categorized along four of Orlikowski's frame dimensions. Those factors that could be meaningfully measured at the group level of analysis were included in the climate measure. Finally, factors that did not fit into Orlikowski's frame model but had solid empirical support were added to the climate model. These factors include perceptions that: the CMC technology will support job goals, the CMC-related task is urgent, and the complexity/novelty of the CMC system. In addition, *perceived task importance* was added to the final climate model. Table 6 lists the factors and operational definitions in the climate model.

Table 6

Climate for CMC Implementation Measure

Philosophy towards technology: beliefs about the specific CMC technology implemented and information technology in general

- Perception of group- and organizational-level expectations regarding technology-enabled capabilities
- Individual perceptions of the group's history and expertise with computer technology innovations

Implementation Behaviors: knowledge and experiences in the implementation process of specific technology, including involvement, training, managerial support

- Individual perceptions of the group's participation in implementation decisions
- Perceive support for training opportunities and training-related attitudes within group
- Perceptions of management support (both supervisors and top level)

Social Relations: extent of interaction with other people using information technology, perception of attitudes towards and understanding of technology

- Perceived level of group cohesion (i.e., the frequency and depth of intra-and inter-group relationships)
- Perception that group members expect individual to use CMC technology

Perceived Task Importance

- Perception that technology-supported tasks are important to group's goals

The first climate factor, *philosophy towards technology* finds support in two of the studies reviewed (Bikson et al., 1987; Hiltz, 1988; Hiltz & Johnson, 1990). Most notably, Hiltz and Johnson's study of CMC technology in four different organizations (N = 505) found correlates with two of four different outcome measures of implementation (subject satisfaction with computer interface, system performance, system expressiveness, and overhaul satisfaction with computer as a mode of communication). Most relevant to the *philosophy* factor identified in the climate model are three factors representing user expectations of technology: expectations that the CMC technology will support user productivity, expectation that CMC technology will save time, and expectations that the CMC technology will not be frustrating.

Hiltz and Johnson found significant correlations between these user expectation variables and two outcome variables: satisfaction with the computer interface and satisfaction with the computer as a mode of communication. The first outcome, satisfaction with interface, correlated with expectations that the CMC technology will support user productivity (r=.24, p<.01) and expectation that CMC technology will save time (r=.29, p<.01). The second outcome, satisfaction with the computer as a mode of communication, correlated to two other factors that fall under the rubric of “philosophy:” expectations that the CMC technology will not be frustrating (r=.24, p<.01), expectation that the CMC technology will save time (r=.22, p<.01). Two sets of questions measuring “philosophy” perceptions were used in the present research: one set asked individual-level perceptions and the other set measured group-level perceptions.

The second factor identified in the climate model, *implementation issues*, may be defined as user knowledge and experiences during the active use of a specific technology. This factor receives strong support in both qualitative and quantitative empirical research. Specifically, research demonstrates notable correlations between implementation success and: user perceptions of leadership support (Bullen & Bennett, 1990; Hiltz, 1988; Hiltz & Johnson, 1990; Robey, 1979; Stasz et al., 1986), user participation in implementation activities (Hiltz & Johnson, 1990; Robey, 1979), and training (Bikson et al., 1987; Bullen & Bennett, 1990; Lee et al., 1995; Stasz et al., 1986). Again, both individual- and group-level implementation measures are included in the proposed research.

Relations with others in computing social world was a notable implementation correlate in several of the studies reviewed (Bikson et al., 1987; Hiltz, 1988; Hiltz &

Johnson, 1990; Papa, 1990). Hiltz and Johnson found significant correlates with one measure of implementation success (user perceptions that the system is productivity-enhancing, time saving, and stimulating) and several group oriented factors including: existence of group before system adoption ($r = .19$, $p < .01$), number of group members known personally ($r = .19$, $p < .01$), importance of communication with people using the CMC technology ($r = .43$ $p < .01$), and feeling that there is no one of interest on the CMC technology ($r=-.33$, $p <.01$). Another factor that fits into the social relations factor is formal group pressure to use CMC system. Beauclair, Golden and Sussman's (1989) survey of 600 CMC at an urban Midwestern university correlated self-reported use of the system and formal social pressure ($X^2 = 35.862$, $p < .001$).

The final factor included in the model is how important the CMC technology-related task is perceived to be. Hiltz and Johnson's (Hiltz, 1988; Hiltz & Johnson, 1990) study of CMC technology in four different organizations ($N = 505$) found that satisfaction with interface correlated with CMC technology-related task urgency ($r = .15$, $p < .01$).

Summary of Proposed Model

Figure 1 illustrates the complete model tested including the key contextual and individual-level variables identified in the MIS literature reviewed earlier, the group-level CMC climate for implementation measure based on Orlikowski's frames model, and three factors measuring "implementation success" (use of technology, impact on group processes, and satisfaction with technology).

The prior MIS literature reviewed earlier identifies several structural, technical, and individual-level factors that correlate with CMC technology implementation success. At the individual level, perceptions of CMC system expressiveness, interface complexity, expectations of goal support, task urgency, perceived novelty/complexity at time of implementation, implementation involvement, training, and functional area/job task were included in the model tested. These structural and individual-level perceptions and characteristics were entered first into a step-wise multiple regression model.

The second step of the regression equation included climate factors measured at the individual level but aggregated (if statistically indicted—this point is discussed in detail later in this literature review) to the group level; this measurement and analytic strategy provided a strict test of the climate measure. The climate measure provides the means to measure complex implementation perceptions and behaviors within an organization (e.g., social expectations, interpretations of events, and perceptions of work-related routines) and relate them to other variables of interest. The climate model organizes the empirical quantitative findings along four theoretical "technological frames" dimensions proposed by Orlikowski and Gash (1992). Again, technological frames are defined as the cognitions and values of users including the underlying assumptions, expectations, and knowledge that people have about technology. The current research integrates four of these dimensions into a climate for CMC implementation measure: philosophy, implementation behaviors, and social relations (see Table 6) . Based on a review of the empirical literature, a fifth dimension was added to the climate model: perceived task importance.

Figure 1

Proposed Climate Model and Outcome Variables

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The MIS literature reviewed in the previous sections, including Orlikowski's technological frames model, provides the specific factors—the content—of the climate for CMC implementation. The following sections of this review focus on the fundamental *form* of this research: climate research. The climate literature provides the theoretical basis for defining climate, the identification of a "climate *for* CMC technology implementation," the methods for effectively measuring climate, and general analytic strategies. The theoretical background of climate research begins with a summary of general social theories concerning people and technology including the relevant organizational development and socio-technical theories. The review then narrows to review some key implications of previous climate research.

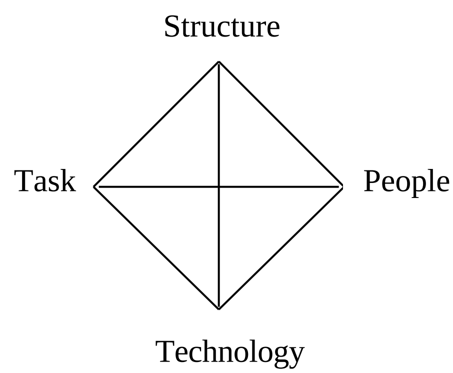
People and Technology: A Climate Primer

Much of the theory behind MIS planning and implementation stems from the organizational development literature because this research area provides insight into the values, processes, and traditions that influence behavior in organizations. Within the organizational development literature, an open systems approach posits that organizational structures, people, tasks, and technology all influence organizational performance (Katz & Kahn, 1978). Lucas and Baroudi's (1994) assertion that the "design of information technology and the design of organizations are largely becoming the same task" (p. 9) reflects a continuing open systems approach to the design and implementation of information technology. As illustrated in Leavitt's (1965) early open systems model (see Figure 2), a change in one organizational component will result in changes in the others. The implementation of a new information technology will influence—and be influenced by—the existing organizational culture, tasks, and structures. Hence, implementation research models must integrate the recursive nature of the organizational environment.

More recent theories also reflect this integration of people, task and technology. These theoretical explanations include *sociotechnical system theory* (Pasmore, Francis, Haldeman, & Shani, 1982; Trist, 1981) which emphasizes the "the joint optimization of the technical and social aspects" (Cherns, 1976, p. 784), and *adaptive structuration theory,* which identifies how norms and expectations assigned to a technology are contingent on the social context in which it is used (Barley, 1986; Orlikowski & Gash, 1992; Poole & DeSanctis, 1990). Finally, various *technology transfer models of implementation* (Bikson & Eveland, 1992; Bikson et al., 1987; Blackler & Brown, 1986; Stasz et al., 1986) also describe how the active use of a new technology is shaped by a process of mutual adaptation of task and technological demands. Advocates of all of these theories propose dynamic relationships between the social characteristics within the organization and the technical demands of the innovation.

Figure 2

Leavitt's Open Systems Model



Moving these socio-technical theories one step closer to application, the theory and methods supporting the current research suggest that individuals and groups interpret the surrounding social environment. These interpretations, in turn, influence individual behavior and, ultimately, organizational outcomes. Like the open systems and socio-technical theories outlined above, climate theory recognizes the relationship between the person and the environment. In fact, Lewin's (1951) famous formula (B = f(P,E)) stems from the first mention of "climate" in the psychology literature (Lewin, Lippitt, & White, 1939). The concept of *climate* helps apply the socio-technical concept of "social aspects" by operationalizing and measuring individual perceptions of their environment; climate researchers assume that people organize specific perceptions of the environment into a cognitive map that guides future behavior (Ittelson, Proshansky, Rivlin, & Winkel, 1974). While MIS researchers have paid little attention to climate research, fifty years of climate theory and methods provide powerful tools for understanding contemporary challenges. The current research uses climate theory and methods to measure how individuals and groups interpret new CMC technologies.

Climate for CMC Technology Implementation

Informed by prior climate research, the following section argues that a *quantitative climate for implementation* measure may be used to represent the *employees' perceptions of the events, practices, and procedures that influence the implementation of CMC technology and the technology-enabled behaviors that are rewarded, supported and expected in a setting.* The following review of the climate literature supports this definition. Based on prior climate research, the concept of climate is defined and the notion of climate *for* a particular construct is presented. Next, a review of three theoretical approaches to measuring climate and a summary of level of analysis issues helped guide the research design and survey development. Finally, this review returns to the socio-technical literature summarized above to build a model illustrating the relationship between context, climate (i.e., individual perceptions of technology), and implementation success. The climate literature reviewed in the next sections provides the fundamental *methods* used in the current research; the MIS literature review earlier provides the specific *content* of the climate measure developed.

Over the last 40 years researchers have debated over the theory, methods, and even existence of climate in organizations. Key controversies within the organizational climate literature include: defining "climate" (Denison, 1996; Poole, 1985; Reichers & Schneider, 1990), the appropriate level of analysis (Dansereau & Alutto, 1990; Glick, 1985; James, 1982; Rousseau, 1985), theoretical (Moran & Volkwein, 1992; Poole & McPhee, 1983; Schneider & Reichers, 1983), and methodological issues (Hellriegel & Slocum, 1974; Rousseau, 1990). While a full review of these debates is beyond the scope of this review, depth and vigor of these debates helps focus this research.

Defining Climate

As reviewed earlier, this research assumes that features of the organizational context (e.g., Leavitt's 1965 model presented earlier) provide stimuli and information that people use to interpret their work environment. These interpretations or "sensemaking" activities comprise *climate.* The most common theme across climate definitions is a link between people's perceptions of themselves, their work, and their environment. For example, Ashforth defines climate as a perceptually based measure which reflects what is psychologically meaningful to the individuals concerned (1985). Similarly, Poole and McPhee (1983) define climate as the collective attitudes continually produced and reproduced by members' interactions. Other definitions of climate include: perceptually based sets of descriptions that incorporate people interpretations of the organizational context (Kozlowski & Hults, 1987); and employees' perceptions of the events, practices, and procedures and the kinds of behaviors that are rewarded, supported and expected in a setting (Schneider, 1990). Despite the range of climate definitions in the literature, most definitions of climate include a perception-based characterization of a system's practices and procedures.

Defining a Climate *For Something*

A climate *for something* consists of perceptually based sets of descriptions that incorporate people's interpretations of *specific features* of the organizational context (Schneider, 1985; Schneider & Reichers, 1983). Clearly, organizations have different practices and procedures to support various organizational goals. Each set of these practices and procedures may influence people's perceptions of the organization and, in turn, individual behavior. Hence, many *different* climates may be active within a single organization. Schneider's (1991) narrower definition of climate assumes that people make sense of their workplace by interpreting countless events, routines, and procedures into *related sets*. For example, bank employee may perceive a strong climate for service when the bank rewards them for retaining customers, recognizes them when they develop new ways to serve customs, and has established routines for providing excellent customer service (Schneider, Parkington, & Buxton, 1980).

Some specific climates identified in prior research include: climate for service (Schneider, 1990), climate for safety (Zohar, 1980), climate for achievement (Litwin & Stringer, 1968), climate for technical updating (Kozlowski & Hults, 1987), and climate for implementation (Klein, 1992). Each of these targeted climate definitions facilitates the measurement of a specific dependent variable(s) of interests.

Careful definition of the particular climate of interest addresses a key criticism of prior climate research: multi-dimensional measures of climate become merely measures of job satisfaction (Guion, 1973; Johannesson, 1973). In contrast to a general "organizational climate," careful specification of a specific climate of interest improves the construct validity of the research. Indeed, a climate *for something* focuses on a limited set of perceptions (e.g., climate for implementation) and reduces the danger of a tautological relationship with job satisfaction.

Theoretical Approaches to Climate Research

While few researchers argue with the merits of a focused climate *for something*, major controversy surrounds the locus of climate: does climate primarily reside within the individual or within the organization? Most climate researchers use survey methodology with individuals as the source of measure. If climate resides outside of the individual (e.g., climate stems from characteristics of the group or organization), how can individual perceptions be used to measure these higher level characteristic? These issues are topics of some key theoretical and methodological debates within the climate literature.

A major difficulty within the climate literature is this: how does an organizational-level phenomena, organizational climate, develop from individual perceptions? Three theoretical approaches to organizational climate answer this question differently and have implications for how “climate” is defined and how the research is designed. Moran and Volkwein (1992) define these three theoretical approaches as: structural, perceptual, and interactive. As illustrated in Figure 2, the three approaches assume different relationships between the organizational conditions, individual perceptions, and climate.

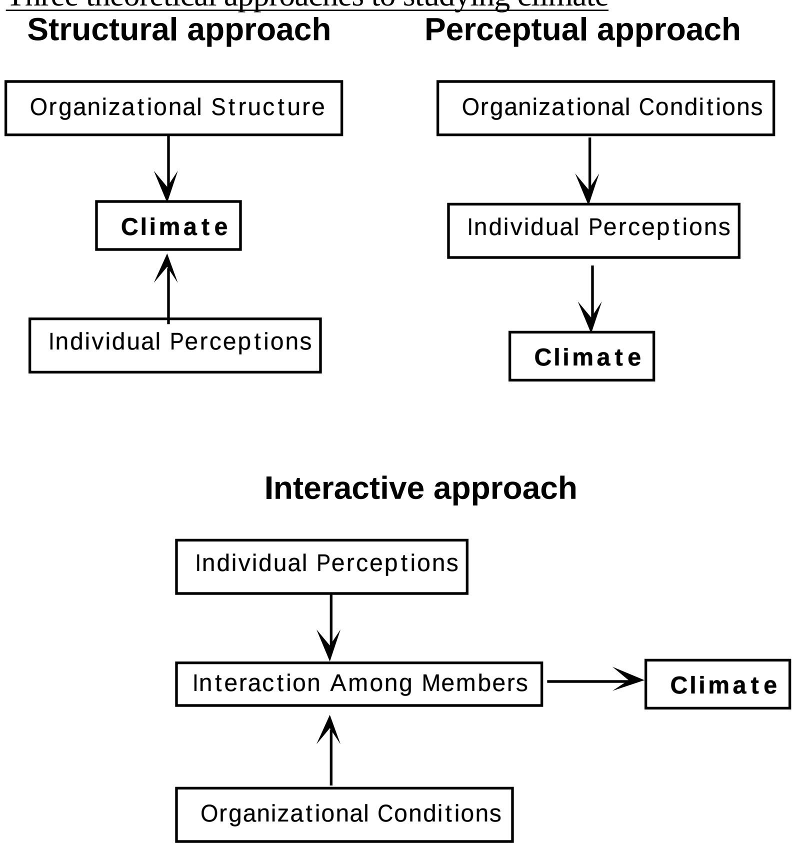
The first approach, a *structural approach*, posits that the actual conditions in the organizational setting are the key determinates of members’ attitudes, values, and perceptions of organizational events. James and Jones (1974) called this the “multiple measurement-organizational attribute approach.”

A structural approach assumes that organizational climate arises from objective aspects of the organizational structure. This approach defines organizational structures in terms of formal, objective organizational attributes (e.g., size, hierarchical arrangement of command structure, industry type). These attributes remain *independent* of individual member’s perceptions or attributions (Falcione, Sussman, & Herden, 1987). Indik (1965), for example, found a negative correlation between organizational size and broad measure of participation in organizational life. Glick (1985), in fact, proposed that the term “organizational climate” be reserved for only this type of structural approach. A structural approach argues that climate exists *outside* of the individual thus, collecting data at the individual-level is merely a way to indirectly measure an organizational attribute.

The key difficulty of this approach arises when group-level climates within the same organization are identified (Howe, 1977; Powell & Butterfield, 1978 for example). The structural approach to climate does not explain why such within-organization variance exists; according to a structural model, the factors that create climate (e.g., size, management structure, etc.) should be active *throughout* the organization. An additional difficulty with this approach is that studies that compare structural attributes and climate relationships do not find consistent relationships (Berger & Cummings, 1979). If climate is derived from structure, organizations with similar structures should have similar climates. Nevertheless, a structural approach may be highly useful for between-organization comparisons where broad, industry-level attributes are of interest.

Figure 3

Three theoretical approaches to studying climate



In contrast to the structural approach, the *perceptual approach* places the origin of climate mainly in the individual. James and Jones (1974) refer to this as the “perceptual measurement-individual attribute approach." This approach posits that the individual perceives organizational conditions and responds to them based on *internal* and *subjective* interpretations of the situation. Because individuals are exposed to common conditions, these individual interpretations are expected to be shared within groups or organizations. Thus, aggregated measures of individual interpretations are used to represent organizational climate (Drory, 1993 exemplifies this approach). Notably, Moran and Volkwein (1992) use the term "conditions" rather than "structure" to expand the locus of climate from objective structural properties to include process characteristics of the organization (e.g., communication, leadership style, expectations, and communication patterns). Recognizing the broader processes active within the organization, researchers using a perceptual approach to climate integrate subjective perceptions into the definition and measurement of organizational climate. Researchers using a structural approach, in contrast, would have difficulty defining these constructs as objective organizational attributes.

Structural approaches and perceptual approaches to climate have also been differentiated as "organizational" and "psychological" climate (James & Jones, 1974). "Psychological climate" refers to individual-level psychological processes in which the individual translates perceived organizational attributes and characteristics into a set of expectancies, attitudes, and behaviors (James & Jones, 1974). As suggested by Schneider (1975), psychological climate perceptions are "psychologically meaningful molar descriptions" that people can agree characterize a system's practices and procedures. In other words, climate is comprised of cognitively-based perceptions that help people make sense of their environment.

This strength of the perceptual approach is also its weakness. According to Moran and Volkwein (1992), the key problem with this perceptual approach is that the source of climate resides primarily within individuals: meaning is imposed on organizational processes and events. As a result, researchers using this approach may underestimate the impact of broader organizational characteristics.

The third perspective of climate, the *interactive* approach, combines the two approaches reviewed above: climate is the result of interpersonal processes in which individuals forge a shared interpretation of the organization (Schneider & Reichers, 1983). James and Jones (1974) call this the "perceptual measurement-organizational attribute approach." Interpersonal *engagement* is key to this approach because the meaning of organizational events and conditions is socially constructed. This approach avoids the theoretical and methodological shortcomings of purely structural or perceptual approaches: climate is not derived purely from external characteristics (as in a structural approach) nor is climate a product of subjective individual perceptions (as in a perceptual approach). Instead, climate is formed through social interactions that are impacted by both the surrounding organizational characteristics *and* individual-level cognitive processing. Interactive approaches assume that organizations have relatively enduring characteristics that impact attitudes. At the same time, climate is seen as a perceptual measure dependent on individual experiences.

Within the context of the current research, the key advantage of this interactive approach to climate formation is that it explains how several group climates may exist within a single organization: regular social interaction with members of the same group would give rise to a common perceptions of the organization's climate. If climate is a function of social interaction, then perceptions of the climate may vary within organizations depending on the local group context.

In addition, an interactive approach to climate is consistent with the socio-technical theories reviewed earlier; the interactive model of climate formation parallels the adaptive structuration theory of technology use. According to an interactive model, climate forms through a dynamic interplay between the person and social context (Schneider & Reichers, 1983). Similarly, adaptive structuration theory posits that the use of technology is contingent on the social context (local norms and expectations) in which it is used (Barley, 1986; Orlikowski & Gash, 1992; Poole & DeSanctis, 1990). The climate for CMC implementation is consistent with both of these theories: CMC implementation climate arises from social interaction and it reflects the local norms/expectations regarding the use of CMC technology.

Level of Analysis Issues in Climate Research

The differences between structural, perceptual, and interactive approaches to defining and measuring climate create a contentious level of analysis debate. Researchers that focus exclusively on perceptual approaches (i.e., psychological climate) assume that individual actors' perceptions are important in and of themselves. Hence, an individual level of analysis will provide information on individual-level differences in climate perceptions. In contrast, structural approaches to climate identify broad, organizational-level characteristics that correlate with some measure of organizational performance. For researchers interested in higher (group- or organizational-) levels of analysis, the debate revolves around translating data gathered at the individual-level into to group- or organizational-level attributes.

The structural approach suggests that organizational climate is a property *of* the organization. As such, both the theories and measures of organizational climate must reflect the broad characteristics of the organization itself. Glick (1985) states that climate should not be "reduced" (p. 604) to its constituent elements of measures taken at the individual level. In addition, Glick (1988) suggests that many studies of organizational climate are, in fact, measuring *aggregated psychological climate* rather than organizational climate.

In response to Glick's argument for organizational level theory and measures, James, Joyce and Slocum (1988) suggest that "attributing meaning to environmental stimuli is a product of cognitive information processing, and that *it is individuals, and not* *organizations, that cognize*."(p. 130). In addition, they argue that the use of aggregated psychological climate scores provides a way to describe external environments in psychological terms. James (1982) maintains that describing an environment in psychological terms (rather than static situational descriptors such as the organization's size or salary structure) helps demonstrate how individuals imbue meaning to environments and how individuals will respond to environments. In counterpoint to Glick's macro-organizational focus, James et al. (1988) argue that that the fundamental unit of analysis in climate research *must* remain at the individual level: organizations do not cognize.

The current research gains focus from this lively debate. Consistent with James, Joyce and Slocum, this research uses the individual as the fundamental unit of *measurement* and aggregates individual measures to the group-level of analysis in order to represent the social environment active within the group. However, Glick's concern over conceptual issues of defining climate (arguing for organizational climate measures indicated by appropriate organizational-level questions) raises important issues about defining if and when aggregated individual perceptions accurately represent group or organizational characteristics. These concerns are addressed by composition theory.

Composition Theory

"Composition theory" for climate refers to how a construct operationalized at one level of analysis (e.g., psychological climate measured at the individual level) is related to another form of climate construct at a different level of analysis (e.g., group climate) (Joyce & Slocum, 1984). Careful consideration of composition theories in prior research provides a way to identify a group-level climate for CMC implementation based on measures taken at the individual level.

Jones and James (James, 1982; 1979) outline four criteria to justify aggregation of individual-level climate measures to higher (group) levels of analysis: (a) significant differences in aggregated or mean perceptions across different subunits (between group differences); (b) inter-perceiver reliability or agreement (within group correlations)[1]; (c) homogeneous situational characteristics (e.g., similarity of context, structure, job type, etc.); and; (d) meaningful relationships between the aggregated score and various organizational, subunit or individual criteria.

Clearly, reliance on a single criterion to justify aggregating individual-level measures is not adequate. Significant group mean differences, for example, may not necessarily indicate that all individuals within each group differ; a few outlying scores in either group may significantly raise or lower the group mean. Similarly, homogeneous situational characteristics does not necessary lead to homogeneous perceptions of the environment; individual differences or unmeasured variables may create differences within well-defined groups. Methodological limitations inherent in each of these procedures requires more than one of these criteria to be met before climate perceptions measured at the individual level may be aggregated to the group level. By extension, the more of these criteria are met, the stronger the case for aggregation.

The current research is consistent with the James, Joyce, and Slocum (1988) argument for the individual level of *measurement* . The individual is the appropriate unit of measurement because individuals, alone in front of computer screens or together with peers, struggle with the daily implementation issues (e.g., reliability issues, perceived centrality to their work, perceived leadership support, user friendliness of the software, ability to communicate with coworkers). Consistent with Jones and James first two aggregation criteria outlined above, this research uses these individual-level measures to evaluate mean perceptions within and across groups.

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[1]These differences may be statistically tested by calculating within- and between-eta correlations which will provide an indication of the degree to which scores agree or do not agree within and between groups (Dansereau, 1990).

This research also meets Jones and James' third aggregation criteria, homogenous situational characteristics, by using Schneider and Reichers (Schneider & Reichers, 1983) definition of "group:" a collection of individuals who "selectively interact with one another on a wide variety of issues, frequently, and over a substantial period of time" (p.35). Based on Schneider's work, the proposed research assumes that people develop sets of perceptions and expectation regarding implementation within a specific social context (i.e., individuals who "interact with one another on a wide variety of issues, frequently, and over a substantial period of time"). If these expectations are shared within the group, the level of analysis will be moved to the group.

Review of Analytic Approaches to Climate

With the aggregation of individual-level perceptions to the group level, the next key analytic issue is testing the statistical relationship between group-level climate and the outcome variable(s) of interest. A database search of recent empirical climate research was conducted to identify the key analytic issues and most promising statistical approaches to identify a climate—outcome relationship. From this search, nine key articles were reviewed and compared according to the approach to climate (i.e., the structural, perceptual, and interactive approaches discussed earlier), research methods, level of analysis, sample size, statistical tests, independent variables, dependent variables, and results.

Several themes emerge when comparing the articles on the criteria presented on Table 7. While not all articles explicitly identify the approach to climate used, a close reading of these articles suggests that over half of the articles use an interactive approach to studying climate (see Agrell & Gustafson, 1994; Burningham & West, 1995; Drory, 1993; Schneider et al., 1998; Zammuto & O'Connor, 1992). Each of these articles measure climate as individual perceptions about the surrounding organizational or group environment then, if statistically indicated, aggregate these perceptions to higher levels of analysis.

Not surprisingly, all but one of the articles listed on Table 6 used a group or organizational level of analysis (the one exception— Deshpande, 1996 —provides little information on the theoretical or methodological issues regarding climate and instead focuses on a review of the organizational ethics literature). When the climate measure involved sub-scales, a factor analysis was used to identify the most important elements of the climate measure (e.g., Agrell & Gustafson, 1994; Burningham & West, 1995; Schneider et al., 1998).

In order to identify the existence and magnitude of the relationship between climate and the outcome variable(s) of interest, most research reviewed on Table 6 used a multiple regression approach (e.g. Burningham & West, 1995; Deshpande, 1996; Drory, 1993; Gunter & Furnham, 1996). When sample sizes were too small to calculate effect size using a multiple regression approach, studies resorted to ANOVA techniques (see Burningham & West, 1995; Dunn & Birley, 1994).

Burningham and West's (1995) study is particularly noteworthy because it illustrates the challenge of demonstrating magnitude of effects using relatively small samples with small effect sizes. Their analyses used both ANOVA and multiple regression approaches.

Table 7

Analytic Approaches to Climate

Author, Date	Climate Construct	Approach to climate*	Methods	Level of Analysis	N	Statistical tests	Independent Vars.	Dependent Vars.	Findings	Comments
Agrell & Gustafson, 1994	Team Climate: (four dimensions)	Interactive	Survey (separate IV and DV samples)	Grp	124 people from 16 teams	Factor analysis of team climate. Simple correlations of climate factors to DV	Team Climate participation, support, group goals, task orientation.	Innovativeness, quantity and quality of production	Group level r significant for 2 of 4 factors on innovativeness measure. (r=.51 and .49). Not sign. relationship with quantity or quality of production.	Teams came from different orgs. No test of between-group differences.
Burningham & West, 1995	Team Climate: team vision, participative safety, task orientation, support for innovation	Interactive	Survey(separate IV and DV samples)	Grp & Ind.	59 individuals from 13 teams	Factor analysis of team climate. Coefficient of concordance and ANOVA (to id groups). Stepwise multiple regression (ind level).	Structural variables: gender, age, group size, work site. Climate variables: Vision, participative safety, task orientation, support for innovation (16 sub-scales)	External rating of team innovativeness	High level of agreement within groups(Kendall's W), significant differences between high and low innovative groups on all 4 climate IVs (ANOVA). Multiple regression (ind. level) demonstrates significant relationships with group innovativeness on 2 of 4 climate variables. (task orientation, R^2.13, vision, R^2=.21).	Group-level hypotheses not tested directly in regressions due to small sample size.
Deshpande, 1996	Ethical Climate: shared perceptions of how ethical issues should be addressed	Perceptual	Survey	Ind.	252 managers	Multiple regression (IVs as dummy variables?)	Ethical Climate (4 types; professional, caring, rules, instrumental)	Ethical Behavior and Managerial Success measure	Managers that perceive "caring" climate demonstrate positive relationship with DV while "Instrumental" has negative relationship.	Possible discriminate validity problem: significant intercorrelations between climate types. Mono-method bias likely.
Drory, 1993	Political Climate: perceptions of decision making process in org.	Interactive	Survey	Org, Ind	200 individuals from 5 orgs	ANOVA to identify org. and group differences, Stepwise multiple regression (Ind)	Job attitudes (satisfaction with superior, satisfaction with co-workers, commitment). Status in Organization (moderator)	Political Climate	Job status moderates relationship between job attitudes and political climate perceptions. Significant betas range from .15 to .19.	Very small significant relationship between climate and job status and position magnitudes (R^2 range from .02 to .05). Groups identified as supervisory or non-supervisory positions.
Dunn & Birley, 1994	"Actual Culture" and "Desired Climate"	Structural	Survey	Grp	3 groups (168 managers)	Cluster analysis to identify groups 33(n=168) and MANOVA (n=3)	Org. Values, Goal Orientation, Climate	Marketing Effectiveness	Differences between management groups shown in Values, Goal Orientation, Climate and Marketing Effectiveness.	No regression model tested. IV's seem highly related. Definition of org. culture and climate inconsistent with broader culture/ climate lit.
Gunter & Furnham, 1996	Organizational Climate	Structural	Survey	Ind.	4 public service orgs	Multiple regression	Climate and biographical data (analyzed at individual level then compared across four organizations)	Job satisfaction and pride	Climate factors and job satisfaction correlations range between -.12 and .51 at individual level. Finds overall climate factors more significant than biographical factors as predictors of satisfaction and pride in multiple regression. Climate has R^2 with satisfaction ranging from .17 to .43 between four organizations.	Climate measure appears to be alternate measure of job satisfaction—satisfaction—climate controversy not addressed in lit. review. Single item outcome measures. No analysis of between organizational differences.
Schneider et al., 1998	Service Climate	Interactive	Survey (Separate IV & DV samples)	Branch	134 bank branches	Factor analysis of climate measure (prior research) SEM for branch-level relationships	Work Facilitation and Interdepartmental Service mediated by Service Climate. Service climate measured as global climate measure + perceptions of customer orientation, managerial practices and customer feedback	Customer perceptions of service quality	Simple correlations between outcome and two dimensions of service climate significant (global climate .26; customer feedback=.31). SEM shows marginal relationship between global service climate and outcome (p=.06)	SEM requirements restricted model to 3 of 11 factors in original model. Hypothesized one-way influence between employee climate—>customer experience shown to be reciprocal.
Schuster et al., 1997	15 factor Human Resources Index (HRI)	Perceptual	quasi-experiment	Org	1 org. ; 3,000 employees	Time-Series Analysis (multiple regression of 5 annual surveys)	Employee-centered management intervention (measured with 15 dimension HRI scale)	Operating Income of single organization	Correlation between annual HRI scores and financial performance has R^2 of .75	Limited review of climate/culture literature.
Zammuto & O'Connor, 1992	Organizational Culture (six subscales)	Interactive	quasi-experiment	Org	1 org. (76 interviews, 190 surveys)	chi-square comparison of Pre-test—post-tests	Communication intervention program.	Org. Culture (teamwork, morale, supervision, involvement, information flow)	Organization have higher scores after communication intervention on 4 of 6 culture subscales.	Also used interviews and observations of organization to triangulate results.

*As reviewed in proposal, these approaches are defined as structural, perceptual, or interactive.

At the group-level of analysis, Burningham and West (1995) demonstrated statistically significant relationships between high-, medium-, and low-innovation groups (an externally rated outcome variable) on four team climate variables. For purposes of the analysis of variance, the climate measures were used as the dependent variable and group characteristics (innovativeness) were the independent variable. In contrast to these interpretable and significant ANOVA results, a stepwise multiple regression at individual level of analysis suggests that only two of 16 subscales from Burningham and West's team climate scale were significant predictors of work group innovation. Work group vision accounted for 13% of the variance in group innovativeness ($p = .004$) followed by "negotiated vision" ($R^2 = .07$, $p = .002$). Among the four major independent variables suggested that only one variable, support for innovation, accounted for variance in group innovation ($R^2 = .13$, $p < .008$). These individual-level results may be less disappointing than they first appear: calculating these statistics at the individual-level of analysis negates the effect that group membership has on team climate perceptions. If more than 13 teams were available and climate perceptions were aggregated to the group level, Burningham and West's multiple regression results would likely have more statistical power. The research by Drory (1993) used a similar analytic approach (ANOVA at the group level and multiple regression at the individual level) yielded similar results.

Finally, Schneider, White, and Paul's (1998) climate for service study is noteworthy because of the statistical approach taken as well as the depth of prior research supporting their hypothesized relationships. Specifically, Schneider et al. used structural equation modeling to test a mediated relationship between context, climate for service, and a criterion variable (customer perceptions of a bank's service). In contrast with most other climate research reviewed, Schneider supports his climate for service measure and mediated model with nearly 20 years of research (Schneider, 1990; Schneider et al., 1980; Schneider et al., 1998) including a well-established climate measure (Schneider et al.,

1980) and prior research on the causal relationships between these variables (Schneider, Ashworth, Higgs, & Carr, 1996).

Despite these strengths, Schneider et al. were forced to test an abbreviated climate model between two “foundation issues” (work facilitation/resource issues and interdepartmental service quality), a general climate for service measure, and customer perceptions of service quality. Sample size restrictions reduced the four-dimension climate measure to a general climate for service measure. Notably, the 134 bank branches surveyed by Schneider et al. (1998) is the largest sample size of any of the articles reviewed; the second highest number of groups surveyed is Agrell and Gustafson’s (1994) survey of 16 teams. Despite the large sample size and simplified climate measure, Schneider’s (1998) structural analysis yielded marginal results; the relationship between global service climate and outcome yielded an unstandardized beta of .26 with a significance level of.06.

Schneider et al. (1998) illustrate the attraction as well as the challenges of using structural equations to test mediating independent variable—climate—dependent variable relationships. Mediating SEM relationships are attractive because mediators may explain how external physical events (e.g., surrounding organizational environment) take on internal psychological significance (Baron & Kenny, 1986). Given this definition of mediation, climate may provide a potent mediator variable (particularly within research using a perceptual approach to climate). A mediated role between the organizational context, climate perceptions, and behavior is consistent with James and Jones’ “translation” of organizational attributes: “(climate is) individual-level psychological processes in which the individual translates perceived organizational attributes and individual characteristics into a set of expectancies, attitudes and behaviors” (James & Jones, 1974).

Despite the substantive value of testing the mediating effect of climate, Schneider et al. illustrate the disadvantages of testing mediators with SEM. While structural modeling methods are useful for testing measures with unknown error terms—SEM still requires both large sample sizes and multiple measures of the same construct. Testing a structural equation model with the number of groups typically available for research purposes limits number of factors that may be included. Moreover, additional measures of climate are usually not available.

Analytic Approaches to Climate—Summary and Implications

Several themes emerge from this review of the recent climate research. First, most climate researchers use an interactive approach to climate at the group or organizational level of analysis. Second, mediated models help explain the theoretical relationship between context, climate, and outcome variables. These mediated relationships, however, are typically beyond the methodological constraints of climate research. Most climate research—including the current study—test models with unknown mediation effect size using novel climate measures on small samples of groups or organizations. Demonstrating significant mediation effects with these limitations requires well-defined constructs with little measurement error. Finally, sample size restrictions (more common in research at the group- or organizational level of analysis) force researchers to compromise between testing a large number of variables with less powerful statistics (ANOVA techniques) or testing a few of the most promising variables with statistics that provide information on both the existence and magnitude of relationships (multiple regression or SEM).

Summary

The current study uses an interactive approach to climate: climate forms through a dynamic relationship between people and their work environment. This dynamism creates a climate that is highly influenced by social interactions and reflects local norms and expectations. As Schneider, Parkington, and Buxton describe, “[t]he climates of organizations emerge out of the naturally occurring interactions of people” (1980 p. 254).

Because regular social interaction occurs between members of the same group, groups may forge common climate perceptions—and several *different* climates may exist within a single organization. The current research assumes that the climate for CMC implementation held by individuals is the result of employees' shared experiences, observations and discussions regarding the organization's implementation policies and practices. As reviewed earlier, these "shared experiences"—and the resulting perceptions and implementation climates— are hypothesized to differ between groups (department cohorts) within a single organization.

This research identifies a climate *for something* by assuming that for each set of procedures active in an organization, people hold an implicit or explicit set of beliefs (Schneider & Reichers, 1983). These beliefs, in turn, influence employee behaviors and organizational outcomes. This study builds from Schneider's (1990) definition of climate: *employees' perceptions of the events, practices, and procedures and the kinds of behaviors that are rewarded, supported and expected in a setting.* This definition emphasizes employees' perceptions—not evaluations— of their work environment. As applied to computer-mediated communication technology, CMC implementation climate is *employees' perceptions of the events, practices, and procedures that affect the use of CMC technology and the technology-enabled behaviors that are rewarded, supported and expected in a setting.* This definition is parallel to Klein's (1992) discussion of climate for manufacturing technology implementation. A strong, positive climate for CMC implementation exists when employees perceive: 1) successful implementation of the new technology is critical for organizational effectiveness; and 2) employee efforts to implement the new system are both supported and rewarded.

Finally, this research *measures* climate perceptions at the individual level but *analyzes* climate at the group level. Aggregation of individual-level measure to the group-level of analysis will follow Jones and James (James, 1982; 1979) recommendation for identifying group climate: between group differences, within-group agreement, homogeneous situational characteristics, and substantive theoretical relationships between the measure and the unit of analysis.

Climate Hypotheses

In summary, this research tests the hypotheses that (1) individual-level characteristics identified in prior MIS research will correlate with implementation success, (2) a climate for CMC technology implementation exists at the group level within a single organization and (3) climate factors will have a positive correlation with implementation outcomes (use, group process perceptions, and satisfaction), and (4) a group-level climate for CMC implementation will correlate with implementation outcomes over and above implementation correlates found in prior MIS research measured at the individual level. Unlike traditional correlational studies of technology characteristics and implementation outcomes, this study tests a research model (see Figure 1) that integrates contextual factors, climate, and implementation outcomes.

Like Klein and Sorra's (1996) climate for implementation model, this research assumes that the climate for implementation held by individuals is the result of employees' shared experiences, observations and discussions regarding the organization's policies and practices and the kinds of behaviors that are rewarded, supported and expected in a setting. In addition, this design tests the possibility that employees in *different* groups have different interpretations of their work situation (Newman, 1975). The interpretations that comprise the shared climate for CMC technology implementation, then, are also likely to be different within each group. As reviewed earlier, "groups" is identified with Schneider and Reichers (1983) criteria of people who "selectively interact with one another on a wide variety of issues, frequently, and over a substantial period of time" (p.35).

The present study organizes the climate for computer-mediated communication technology implementation broadly based on Orlikowski's "technological frame" factors. Specifically, individual-level frames of reference are correlated within- and between-groups. Higher within-group correlations than between-group correlations of the climate factors will indicate group-level climate for electronic computer-mediated communication technology implementation.

Based on the theoretical relationships discussed, the specific hypotheses tested are:

H_1: Individual-level characteristics identified in prior MIS research correlate with implementation success.

H_2: Different CMC technology implementation climates exist within a single organization as indicated by greater between group than within group climate scores.

H_3: Climate factors have a positive correlation with implementation outcomes (use, satisfaction, and group outcomes).

H_4: Climate factors have a positive correlation with implementation outcomes controlling for the effects of contextual and individual-level variables.

Method

The cooperating university (henceforth "State University") was involved in a large scale IT implementation project. While this site provides a rare opportunity to study CMC implementation, the depth and scope of the university's project requires that this study address some of the priorities identified by the university's administrators. Hence, the research focuses on faculty members and their use of computer-mediated communication technology—web pages and electronic mail—to support their teaching responsibilities.

Description of CMC Technology Studied

Hypertext pages posted on the world-wide web and electronic mail are two of the most common types of CMC technologies currently used. Hypertext is composed of blocks of text or images electronically linked by multiple paths. A hypertext document is non-linear and non-hierarchical and provides both authors and viewers open-ended opportunities to explore the interrelationships between linked documents (see Landow, 1992).

Electronic mail (e-mail) consists of messages, usually text, sent from one person to another via computer. An extension of e-mail is a mailing list, an automated system that allows people to send e-mail to one address, whereupon their message is copied and sent to all of the other subscribers to the mail list.

Both hypertext web pages and electronic mail are widely adopted in public and private institutions due to their low cost and open standards. The open standards and protocols of hypertext world-wide web pages (i.e., Hypertext Transfer Protocol or HTTP) can be used to seamlessly link different organizational resources (i.e., databases, files, and other existing information systems) and integrate them into a common, unified, internal information structure that is accessible across all computing platforms. This Internet technology may also be used exclusively within the university as an organization-wide *Intranet* that is open only to university employees and/or students. Like hypertext web pages, electronic mail provides a low cost, widely accessible computer-mediated communication technology that uses a platform-independent protocol (i.e., Simple Mail Transfer Protocol or SMTP). The low cost and wide spread adoption of web pages and e-mail has made these two technologies the primary CMC technology used at State University.

Based on my own evaluation of faculty web sites as well as interviews of a random selection of ten faculty members at State University, the core features of using the world-wide web for instructional purposes are: (1) personal use of the world-wide web for planning and preparing courses, (2) recommendations of course-related web sites to students, (3) an instructor home page—these pages typically contain contact information, a list of courses taught, office location, etc., (4) a course home page, (5) lecture notes and/or a course syllabus posted on a course home page, (6) student-produced web pages posted on the home page, and (7) other student learning activities that are available only on the class home page.

Typical core features of electronic mail used by faculty for instructional purposes are: (1) reading messages in an e-mail “in” box (including messages from students, teaching-related memos from the department, or messages containing subject-relevant information), (2) correspondence with professional peers via e-mail (that may have a direct or indirect impact on teaching activities), (3) collecting e-mail addresses of the students in the instructor’s class and distributing the list back to the class members, (4) responding to e-mail messages sent by students, (5) writing e-mail messages to students (individually), (6) sending messages to class via a class e-mail list, (7) creation of student learning activities that are available only via e-mail.

As discussed in the survey development section, the survey items measuring the “use” dependent variable employ these core features of hypertext web pages and electronic mail behaviors.

Participants

The participants were selected from a population list of all university faculty members working at State University. A stratified sample of faculty members within 58 academic departments each containing six or more members was drawn. In order to insure that a minimum of five survey responses were returned from each department, all faculty members in departments with ten or fewer faculty members received surveys. Ten faculty members were randomly selected from larger departments with replacement of faculty members who did not respond within 20 days.

Faculty respondents were required to have access to all necessary hardware and software necessary to operate the targeted CMC technology; the department must have *adopted* the technology—this survey evaluates the *implementation* of this technology. Respondents were asked in the survey's letter of introduction if they met this basic adoption criterion. Any faculty member who did not meet this adoption criteria or who was unwilling to participate in the survey was instructed to complete and return a "non respondent" postcard (see Appendix A). All necessary documentation was filed with the North Carolina State University Institutional Review Board (IRB) for the use of human subjects in research and the IRB approved this survey.

Data Collection

The first of three survey waves began on September 27, 1999. Each wave consisted of an initial survey packet followed by two reminder letters to non-respondents (see Appendices B and C) sent ten and twenty days after the initial survey mailing. Surveys were send via inter-campus mail. Enclosed with each survey was a personalized letter of introduction (see Appendix D), a letter of support from the University's Provost (see Appendix E), and a "non- respondent" postcard.

The three survey waves totaled 754 surveys mailed to faculty members and instructors. This sample provided 496 returned surveys or postcards yielding a total response rate of 66%. The surveys comprised 420 of this total (a 56% response rate) and represented 58 academic departments within State University with a mean of 7.25 faculty members responding per department (range = 4 to 14).

Only 83 of the 496 responses were postcard respondents. Notably, none of these respondents reported that they did not have access to a personal computer. Thirty-five postcard respondents reported that they did not have teaching responsibilities. The 48 postcard respondents who checked “Other” reasons for not completing the usually fell into one of three categories: faculty members nearing retirement, faculty members who felt that they were inappropriate due to their work situation, and faculty members who simply refused to participate.

Scale Development

Like all survey research, this research strikes a balance between reliability, validity, and efficiency. In an effort to keep the surveys short enough to insure that survey respondents complete and return the survey—yet rigorous enough to provide meaningful data— prior research was used to find reliable and valid survey items. For each construct identified in Figure 1 (see page 61), the CMC and implementation literatures were reviewed for relevant survey items. Two criteria drove item selection: 1) experimenter-judged construct validity and 2) empirical reliability demonstrated in prior research. While this literature review provided many relevant measures of some constructs (e.g., use of new technology or satisfaction with technology) other constructs appear only in qualitative research or were original items developed for this survey.

Telephone interviews of ten randomly selected faculty members at State University and a pilot survey of 23 faculty members at an unrelated state university helped reduce a preliminary 83 item survey by approximately 33%. Based on the results of this pilot test, several factor scales were reduced to two or three item scales. The final 55 item survey (see Appendix F) utilizes two to five item scales to measure the nine rationally constructed factors listed in Figure 1.

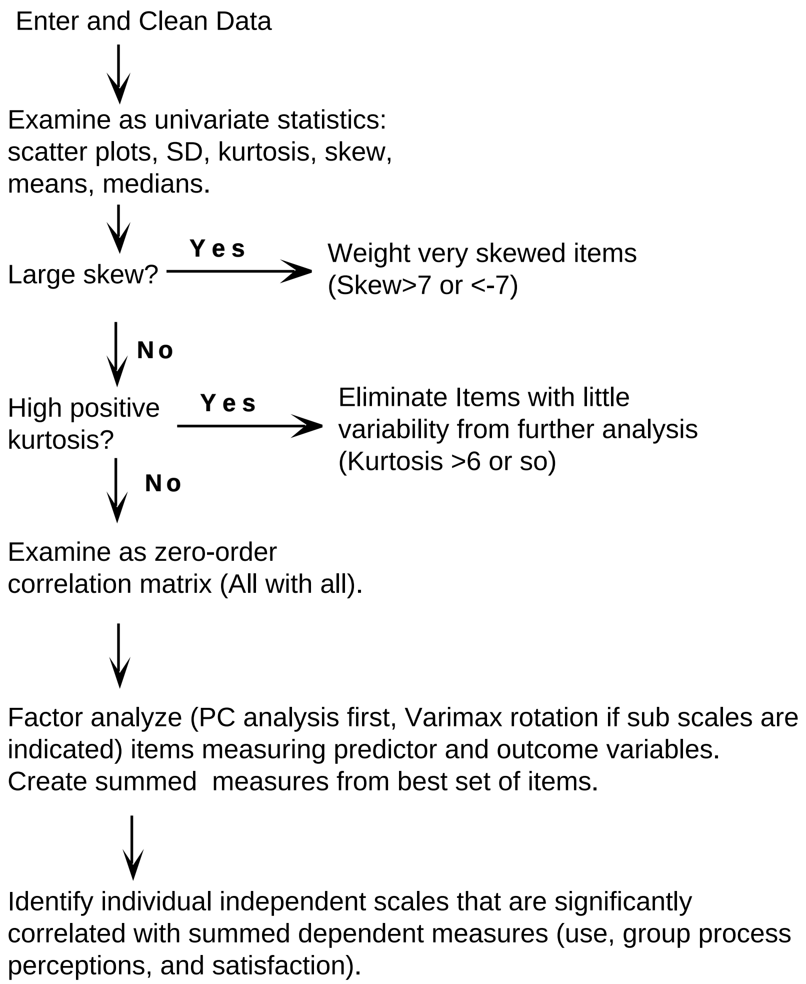
Perceptions and behaviors regarding computer-mediated communication technology may vary widely from very positive and very negative. In order to reflect a wider range of user experiences, bipolar response stems were used on all Likert-format items. Unless otherwise noted, all multiple choice items used a 5-point scale ranging from “strongly disagree” to “strongly agree.”

Scale Development Procedure

As summarized in Figure 4, the scale development procedure began with an examination of the univariate statistics for items measuring the independent and dependent variables. Besides a validity check response on one question (a bogus computer-related abbreviation with a skew of 7 indicted that not a single respondent misrepresented their computer knowledge), all items were retained because they provided adequate variability and distributions patterns.

Figure 4

Data Cleaning and Summed Scale Development Analysis Plan



Summed Scale Construction: Analysis Procedure

Each of the three main construct classes summarized in Figure 1 (see page 61 summarizing the dependent variables, climate measures, contextual and individual-level variables) are represented by rationally constructed homogeneous item clusters. While a detailed analysis of each scale follows section, the identification of all scales used the same factor analysis and reliability assessment outlined below.

The minimum number of factors comprising each construct class was statistically confirmed with principle component analyses containing all the items within the respective class (i.e., all dependent variable[1] items, all climate items, and all individual-level items). Within each construct class, a minimum eigen value of 1 was used as a criteria for extraction (Kim & Mueller, 1978). In addition, a scree plot of each eigen value plotted against factors was used to substantiate the minimum number of factors that best accounted for variance in the model (Cattell, 1966). Next, the orthogonally rotated (varimax) factor loading matrixes were examined to identify items that loaded primarily on single factors within the construct class. This statistical examination was supplemented by a visual examination of a graphical plot of the items as they loaded on the two highest rotated factors. Item clusters that that were both statistically (via orthogonal rotation) related as well as contained within the same rationally constructed scale were then removed and analyzed as a potential item cluster.

Next, following Spector (1992), each of these item clusters was run in a separate reliability analysis to identify the items that best accounted for variance in their respective scale based on how each individual item affected the scale's coefficient alpha (the variance of the total scale score compared to the variance of the individual items). The survey items that best accounted for variance in their respective factors were then summed into a scale. For all measures, only items that were *both* substantively and statistically relevant were summed into the respective scale. Items that reduced the factor's coefficient alpha were removed and "returned" to the pool of remaining items for the class construct. This procedure of factor rotation, factor score examination, visual plotting of all items on the two highest remaining factors, and reliability analysis was repeated within each construct class until the remaining items would not form a reliable score or only a single factor remained.

In summary, construction of the summed scales was first driven by the substantive relationship between each item and the underlying factor. These relationships were then affirmed by an exploratory factor analysis and reliability analysis. Because the final survey

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[1] The dependent measures were first standardized in order to compare items on different scales.

items were gleaned from pilot test results, most items comprising the rationally constructed factors were statistically related to their respective scale. However, as detailed in the discussion of each scale score, the factor analysis/reliability assessment procedure determined that some items did not form a reliable scale. Nunnally's (1994) recommended coefficient alpha of .70 was used as a benchmark of scale reliability.

Figure 5 summarizes the modified model based on the factor analysis and scale development procedure. The following section reviews the details of these analyses, including the specific items comprising the scales, factor loadings, scale coefficient alphas, and summary statistics.

Figure 5

Web-based Instructional Technology Implementation: Model Tested

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Dependent Measures

“Implementation success” is defined as the active use of computer-mediated communication technology by targeted individuals and groups within an organization in an organizationally-relevant way. This definition is operationalized with three separate scales: Use of the technology, Satisfaction with web-based instructional technology, and Perceived Impact on Educational Processes. A principle component analysis of all 18 original dependent items yielded 5 factors with eigenvalues greater than one with 57% of the variance accounted for by these three factors. An orthogonal rotation (varimax) of this five factor solution is summarized in Appendix G.

Additional factor analysis and reliability analyses (earlier section “Summed Scale Construction: Analysis Procedure” describes this process) reduced this 5 factor solution containing 18 items into the three factor solution containing the 11 items summarized in Table 8. These items accounted for 60.5% of the variance in three dependent variables: Use, Satisfaction, and Perceived Impacts on educational processes. The following sections reviews the specific items measuring each of these three dependent variables.

Table 8

Summary of Items and Factor Loadings for Varimax Orthogonal Three-Factor Solution for the Dependent Variables

Item	Factor loading 1	2	3	Communality
52/ EDPR_DV2. Student Class Preparedness	**.80**	.19	.12	.69
53/ EDPR_DV3. Student Ability to Pose Class-Related Questions	**.79**	.10	.11	.65
54/ EDPR_DV4. Student Ability to Keep Up with Class Work	**.75**	.09	.24	.64
51/ EDPR_DV1. Student Performance	**.68**	.32	.18	.61
37/USE_DV2. How frequently do you use WWW as research tool to support teaching (1=nonexistent…5=daily)	-.03	**.71**	.18	.54
38/EMAILFUN . Number of e-mail functions used (Choose all core features that apply, e.g., correspond with student, use class e-mail list)	.15	**.68**	-.05	.49
36/WEBFUN . Number of different web functions used to support teaching (Choose all core features that apply, e.g., provide course home page, recommend course-related URL's…)	.34	**.62**	.04	.51
41/ USE_DV6 . (R) When possible I try to avoid using CMC to support my teaching	.28	**.52**	.36	.48
42/USE_DV7 . (R) Even when I can use CMC to support teaching, I still use the old way of doing things.	.27	**.46**	.42	.47
49/ USEFL_D1. CMC is effective in supporting my department's instructional goals	.13	.07	**.86**	.76
50/ USEFL_D2. (R) CMC provides capabilities that are of only minor importance to this department's teaching performance	.23	.11	**.83**	.77
Eigenvalues	4.78	1.21	1.17	
% variance	38.9	11	10.6	

Note. Boldface indicates highest factor loadings.

Dependent Variable: Use

Use of web-based instructional technology is operationalized as use of hypertext world-wide web pages posted on the Internet to support teaching activities and use of electronic mail to correspond with students for instructional purposes. Seven rationally constructed items originally targeted this construct. The factor analysis and scale reliability procedure reduced this set to the five items under “Factor 2” on Table 8.

The two eliminated items were respondents’ estimates of the number of individual students contacted each week using electronic mail (coded “numbstud” in Appendices G and H) and the number of e-mail correspondences sent during the typical work week (coded “numbmess” in Appendices G and H). Additional rescaling, transformations, and factor analyses of these items did not improve their factor loadings or identify separate factor scales.

Two multiple response items containing seven distinct web and e-mail behaviors asked respondents to check the core features of using e-mail and the world-wide web (The identification of these core features was based on previous qualitative interviews of faculty members). In order to compare across survey items, these two core feature scores were standardized to use a five-point scale.

In order to increase the construct validity, three of the “Use” questions pertained specifically to e-mail (i.e., number of messages sent, number people contacted, and core features used) and one question targeted only web pages (core features used). All four of these items were developed especially for this survey. Despite the media-specific in question wording (web versus e-mail), the rotated factor analysis did not identify factors based on media type.

The scale reliability of the “Use” measure was increased by including two reverse-coded items adapted from Klein’s (1992) seven-item “avoidance of use” scale (coefficient alpha = .74): “When possible, I try to avoid using computer-mediated communication technology to support my teaching” and “ Even when I can support my teaching using computer-mediated communication technology, I still use the old way of doing things instead.” The total amount of scale variance explained by these five use items is 46% and the coefficient alpha is .71.

Dependent Variable: Universal Use

Degree of universal use was intended to be a second component of the Use factor. Universal use was operationalized as the proportion of faculty members in the respondents' department that currently use CMC technology to support their teaching and the proportion of students that instructors perceive have access to web-based instructional technologies. Universal use was measured with three items: one multiple choice item ("Computer-mediated communication technology —e.g., e-mail or world-wide web— is a viable way to share information with any student attending one of my courses") and two completion items ("What percentage of faculty members in your department actively use computer-mediated communication technology —e.g., e-mail or world-wide web ?" and "What percentage of students taking your courses actively use computer-mediated communication technology like e-mail or world-wide web?").

As illustrated in the factor loadings in Appendix G, these items did not correspond to a rationally constructed Universal Use scale. Attempts to create a reliable scale by adding the two eliminated items from the Use scale (number of students e-mailed and number of messages sent) did not yield scale alpha reliabilities above .6. Rescaling and transforming the two completion items did not improve the scale's reliability.

The completion item asking faculty perceptions of universal student use (i.e., proportion of students that instructors perceive have access to web-based instructional technologies) was tested as a moderator variable in the post hoc analysis. An additional post hoc test modifies the Use outcome measure by adding the "universal use" multiple choice item ("Computer-mediated communication technology —e.g., e-mail or world-wide web— is a viable way to share information with any student attending one of my courses").

Dependent Variable: User Satisfaction

The second factor operationalizing "implementation success" is user satisfaction with CMC technology. Consistent with prior MIS research (Davis, 1989), user satisfaction is measured with perceived ease of use of the software/interface design and perceived usefulness of the CMC technology vis a' vis the user's job responsibilities. Four rationally constructed items originally targeted these two related constructs. The factor analysis and scale reliability procedure reduced this set to two items, both items targeted perceived usefulness of the CMC technology vis a' vis the user's job responsibilities.

The two eliminated "ease of use" of the software/interface items were adapted from Adams (1992) "ease of use" scale (Adam's original measure had four items with a coefficient alpha of .88). These items did not form a single factor nor did they increase the coefficient alphas in other outcome variables. (See Appendix H for correlations with other dependent variables).

Perceived usefulness of the CMC technology—perceptions that the CMC technology supports the productivity, saves time, and helps achieve job-related goals—were focused on department-level perceptions of web-based instructional technology implementation. Respondents were asked to evaluate department-related satisfaction with two items: "How effective is computer-mediated communication technology like e-mail and the world-wide web for supporting my department's instructional goals" and a reverse coded "The capabilities that computer-mediated communication technology —e.g., e-mail and the world-wide web— provides capabilities that are of only minor importance to this department's teaching performance."

Based on the reliability analysis of these items, a department-level satisfaction scale was created with a coefficient alpha of .77 accounting for 82% of the variance within these two items.

Dependent Variable: Perceived Impact on Educational Outcomes

The third dependent variable scale, impact of CMC technology on educational process perceptions, is operationalized as faculty perceptions of the impact that web-based instructional technology has on students' learning behaviors. These impacts were measured with four rationally constructed items asking instructors about student performance, preparedness, ability to pose class-related questions, and ability to keep up with class work. As illustrated in Appendix G and Table 8, all four items loaded on a Perceived Impact scale. A reliability analysis confirmed that each item added to the scale's coefficient alpha of .82. These four items account for 66% of the scale variance.

Respondents were asked to complete these items *only* if they use web-based instructional technology to support their teaching. Hence, the sample size is reduced from 400 responses to the Satisfaction scale items to 323 respondents answering the Education Process scale questions.

Predictor Variables

The four individual-level predictor variables summarized on Figure 5 are structural characteristics, technical perceptions, individual expectations, and expertise. A principle component analysis of all 14 individual-level independent items[1] yielded five factors with eigenvalues greater than one with 68% of the variance accounted for by these five factors. Rotating these factors (varimax) yielded the five-factor solution illustrated on Table 9.

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[1] Items measuring structural characteristics were not entered into the principle components or factor analysis because they were not intended as scale items.

Table 9

Summary of Items and Factor Loadings for Varimax Orthogonal Five-Factor Solution for the Individual-Level Predictor Variables

Item	Factor loading 1	2	3	4	5	Communality
14/ URGENT1. I felt that is was important to communicate with students using these technologies	**.85**	-.03	.04	.22	.14	.79
15/ URGENT2. I felt that is was important to use these technologies to support my teaching	**.84**	-.02	.05	.22	.18	.80
11/ GOAL2. (R) I had low expectations regarding how much these technologies would help students learn	***.74***	*.11*	*.19*	*.12*	*.11*	.62
10/ GOAL1. (R) I expected that these technologies would give me less control over my teaching	***.51***	*.22*	*.37*	*.15*	*-.27*	.54
8/ COMPX2. (R) Distracted by the mechanics of using e-mail	.08	**.85**	.03	.03	-.01	.74
7/ COMPX1. (R) Distracted by the mechanics of using the world-wide web	.11	**.79**	.13	.08	-.05	.66
9/ RICH1. How frequently have you felt frustrated in you ability to express your views using e-mail…	-.09	**.73**	.07	.05	.05	.54
13/ NOVEL2. (R) Using these technologies in my teaching would be a major change	.08	.08	**.88**	.05	-.08	.79
12/ NOVEL1. (R) Using these technologies would require major adjustments…communicate w/ students	.16	.12	**.87**	-.01	.09	.81
1/ TRN_IND1. From a technical perspective, I have sufficient knowledge to utilize CMC for teaching (e.g., how to create html pages, how to put courses on the web…)	.21	.12	.16	**.79**	.13	.73
2/ EXPERT1. How many of the following computer-related abbreviations can you define: RAM SQL, ROM, DRE, HTML, VPN, CGI, PBX	.22	.02	-.09	**.74**	-.03	.61
3/ TRN_IND2. How much formal computer training did you have during the last year	*.08*	*.04*	*.00*	*.10*	***.85***	.73
4/ TRN_IND3. How much self instruction and one-on-one support have you had during last year	*.16*	*.06*	*.05*	*.49*	***.56***	.58
5/ TRN_IND4. If more training related to teaching with CMC were available, I would participate	*.41*	*-.15*	*-.12*	*-.32*	***.54***	.59

Note. Items in italics eliminated during reliability analysis. Boldface indicates highest factor loadings.

The factor analysis and reliability assessment reduced this 14 item set to nine items that accounted for 61% of the variance in a four factor[1] solution presented on Table 10. The following section reviews the specific items measuring each of these individual-level predictor variables.

Table 10

Eigenvalues, Percentages of Variance and Cumulative Percentages for Five Factor Predictor Variables

Factor	Eigenvalue	% of variance	Cumulative %
1. Urgency	3.7	26	26
2. Complexity	2.2	16	42
3. Novelty	1.5	11	53
4. Expertise	1.2	8	61
5. Training	*1.0*	*7*	*68*

Note. Factors in italics eliminated during reliability analysis.

Structural Measures

Not noted in the review of the individual-level predictors are the structural characteristic illustrated on Figure 1 (see page 61). These characteristics were measured by matching an employee database with a unique survey number on each questionnaire and included: departmental membership, tenure status, race, and years of service. Departmental membership and years of service were included in some of the multiple regression analyses. Tenure status and race were used to evaluate the demographic characteristics of the sample.

[1] For purposes of testing the proposed predictors, this four factor solution was transformed into a five factor model. A single “media richness” item was used as a separate factor.

Technical and Individual-Level Measures

Technical Characteristics

A principle component analysis of all individual-level independent variables yielded five factors with eigenvalues greater than one with 68% of the variance accounted for by these five factors. Three items measuring technical characteristics (operationalized as perceived system expressiveness and perceived interface complexity) were adapted from Hiltz and Johnson's (1990) technical satisfaction measure. The analysis procedure indicated that these three items (listed under "Factor 2" in Table 9) did not correspond to a single factor and were used as two separate factors in the regression analyses: Perceived System Expressiveness (one item) and Complexity (two items).

The single, reverse coded item measuring Perceived System Expressiveness (M = 4.0, SD = 1.0) is: "How frequently have you felt frustrated in you ability to express your views using e-mail (provides text-only communication)."

Perceived Interface Complexity was measured with two items adapted from Klein's (1992) climate for implementation research. This couplet accounts for 78% of the scale variance (coefficient alpha = .72).

Individual-Level Predictors: Individual Expectations

As discussed in the review of the MIS literature, individual-level expectations of new CMC technology are important correlates of implementation success. As illustrated in Figure 1, this research originally operationalized individual-level expectations with three factors found in the MIS and implementation literatures: expectations of goal support, perceived task urgency, and perceptions of the technology's novelty. However, the rotated factor solutions containing these items did not converge on a broad "Individual Expectations Factor."

Instead, items comprising two of these factors—Perceived Task Urgency and individual-level expectations of goal support—converged on their respective factors (listed under "Factor 1" in Table 9). The reliability analysis indicated that the items targeting expectations of goal support did not improve the scale's reliability. These two items were adapted from Meyer's (1995) three item measure of this construct (alpha coefficient of .85 in prior research). However, these items failed to produce an acceptable coefficient alpha as an independent scale, nor did they load on other factors. These two "expectations of goal support" items were dropped from further analysis.

Perceived Task Urgency

The Task Urgency factor was measured with two items that asked respondents to anchor their responses to the time that they first considered using e-mail and the world-wide web to support their teaching (see "Factor 1, Table 9). Both of these items added to the scale's coefficient alpha and were summed into a Perceived Task Urgency scale that accounted for 90% of the scale variance with a coefficient alpha of .89.

Novelty Perceptions

Faculty members' perceptions of the technology's novelty were measured with two items (see "Factor 3, Table 9). Similar to the task urgency questions, these items were anchored to initial exposure to web-based instructional technology. These two items accounted for 81% of the scale variance with a coefficient alpha of .77.

Individual-Level Predictor: Individual-Level Implementation Involvement

While the broader MIS literature reviewed earlier suggests that involvement in implementation decisions is an important correlate of implementation success, the technology studied here has been in place for over ten years. Questions concerning individual-level implementation involvement (e.g., "How much influence did you have in implementing CMC technology in your organization?) were not relevant to the participating university. However, general knowledge and training regarding how to use computer-mediated communication technology and how to use these tools to support teaching tasks may vary widely across users and provide a more appropriate measure of individual-level implementation involvement.

Given the importance of user knowledge, individual-level implementation involvement was operationalized as the quality and quantity of training available to the respondent, the amount of training received, and individual expertise.

Preliminary interviews of faculty members at State University indicated that teacher training related to web-based instructional technology was relatively new; items specific to this type of training may not have provided adequate variance. Hence, two of the four training items targeted general computer training and skills rather than teaching-specific CMC training. Despite these efforts, the four items relating to training failed to converge on a single factor. Three of the four training items were eliminated from further analysis because rotated factor solutions did not indicate that they accounted for additional variance in other factors. Appendix I provides the zero-order correlations between these individual-level items and the three dependent variables.

One training item did combine with a user expertise measure to form an individual-level expertise factor. Specifically, the question “From a technical perspective, I have sufficient knowledge to utilize computer-mediated communication technology for teaching (e.g., how to create html pages, how to put my course pages on the web and how to set up an e-mail discussion list)” had a substantial correlation with a multiple response item asking how many computer-related abbreviations respondents could define (response choices range from common to esoteric abbreviations). Although the coefficient alpha falls below .7, this expertise item (coefficient alpha = .64) was entered into the regression analysis. The scale variance accounted for by this couplet is 75%.

Climate Measure

As reviewed earlier, a key criticism of prior climate research is that multi-dimensional measures of climate become merely measures of job satisfaction (Guion, 1973; Johannesson, 1973). In response, climate researchers use carefully worded items that are descriptive rather than affective or evaluative in nature. While perceptual/cognitive perceptions are certainly linked to evaluative/affective reactions, Schneider and Synder

(1975) demonstrate relative independence of the two constructs[1]. Hence, an effort was made to keep the wording of climate measures used in the survey focused on descriptions of the organizational environment rather than on subjective attitudes.

The climate items asked individuals to report their observations about the behaviors and attitudes active in their department. As discussed in the theoretical portion of this study, climate is posited to stem from both individual-level cognitive process as well as characteristics of the surrounding organizational context (in this case, the department). Many of the survey items drawn from prior research used an individual-level of analysis, hence, the wording of these items was changed in order to anchor each question to a department-level of analysis.

Identifying Climate

The original research design used a total of 19 items to measure four departmental-level factors: philosophy, implementation behaviors, social relations, and perceived task importance. Consistent with the factor analysis/reliability assessment strategy used for the outcome and dependent variables, all 19 climate items were included in an initial factor analysis and a rotated factor solution (varimax) identified 4 factors with eigen values greater than 1 that accounted for a total of 58% of the total matrix variance. Table 11 summarizes the factor loading and eigen values for this four factor solution.

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[1]When instructed, survey respondents were able to separate their work environment *descriptions* from their work environment *evaluations*. Schneider and Snyder (1975) found a correlation between the climate measure and the JDI (a job satisfaction measure) was .19 while the average scale intercorrelations for the JDI was .27 and a .33 intercorrelation between their climate measure items (perceptual/cognitive based descriptions).

Table 11

Summary of Items and Factor Loadings for Varimax Orthogonal Four-Factor Solution for the Climate Variables

Item	Factor loading 1	2	3	4	Communality
23/HIST_CL3. Our dept. has procedures in place that help us learn…	**.75**	.09	.01	.02	.57
22/HIST_CL2. This dept. shows that it values new comm. Capabilities by creating supportive policies related to CMC	**.74**	.20	.16	.17	.64
26/TRN_CL5. This department provides the resources necessary to insure that faculty member learn how to use CMC technology to support teaching	**.72**	.13	.15	-.07	.57
19/TRN_CL2. If I ever have problems using CMC, I have someone in my department that can help me	**.72**	.06	.00	.04	.52
21/HIST_CL1. Our dept's current efforts in implementing CMC continues this dept's history of using computer technology effectively	**.62**	.31	.14	.19	.54
28/LEAD_CL3. (R) When it comes to teaching with CMC technology, my department head does not take an active interest in our problems and successes	**.62**	.15	.48	-.04	.64
27/LEAD_CL2. The use of CMC tools to support instruction is important to my department head	**.59**	.22	.39	-.03	.55
18/TRN_CL1. In this department, faculty members support each other's efforts in adopting and using unfamiliar new computer-mediated communication technologies	**.48**	.34	.06	.33	.45
29/LEAD_CL4. (R) Judging from the practices and procedures active in this department, faculty members are not expected to utilize the capabilities that CMC technology provides to achieve the department's instructional goals	**.47**	.31	.31	.21	.46
24/LEAD_CL1. This university's top management—the chancellor and most deans—is strongly committed to the use of CMC technology to support teaching	**.40**	-.04	.29	.19	.28
32/GREX_CL2. For me and my fellow faculty members in this department, CMC is part of teaching	.20	**.82**	.12	.05	.73
33/GOAL_CL1. Using CMC is important to the smooth operation of this department because this technology supports critical teaching tasks	.15	**.81**	.18	-.02	.72
34/GOAL_CL2. The tasks addressed by CMC help people in this department provide better instruction	.01	**.75**	.26	.06	.63
31/GREX_CL1. Members of my department expect me to use CMC to support my teaching activities	.37	**.70**	-.13	.11	.65

(Table 11 continues)

(Table 11 continued)

Item	Factor loading 1	2	3	4	Communality
35/GOAL_CL3. Compared with other tasks that compete for our time, the teaching tasks for which faculty members in this department use CMC tech. are trivial.	.07	.22	**.75**	.00	.61
25/TRN_CL4. (R) Judging from the training opportunities provided, this department sees training related to web- or e-mail supported teaching as a waste of time	.43	.05	**.53**	.16	.50
16/EXPT_CL1. (R) Faculty members in this department have low expectations of the instructional capabilities provided by computer-mediated communication technology	.25	.24	.21	**.72**	.68
TRN_CL3.(R) I'm sometimes concerned about "looking dumb" when I ask someone else in my department for help with a CMC-related problem.	.06	.17	.16	**-.67**	.50
17/ EXPT_CL2. Faculty members in this department feel that computer-mediated communication technology (e.g. use of e-mail or the world-wide web) is a helpful teaching tool.	.11	.35	.42	**.63**	.71
Eigenvalues	6.7	1.89	1.4	1.0	
% variance	35.1	9.8	7.3	5.5	

Note. Items in italics eliminated during reliability analysis. Boldface indicates highest factor loadings.

Following Cattell's (1966) scree test, an examination of the eigen values plotted against factors shows a distinct break between the slope between the fourth and fifth eigenvalues. As recommended by Tabachnick and Fidell (1996), several factor analyses were run, each analysis specified a different number of factors and each time the scree plot and residual correlation matrix were examined. Two large (greater than .10) and several moderate (.05 to .1) residual correlations[1] were evident when three factors were used—these residual correlations suggest another factor is present in the model. All of these tests suggest that the climate data are best represented by four factors.

[1] These residual correlations are identified by subtracting the observed correlation coefficient and the correlation coefficients identified in the factor model. The numbers in the residual matrix are partial correlations between pairs of variables with effects of the factors removed.

Climate Scales

Based on a rational examination of the item content and the rotated factor analyses, the four factors identified are:

(1) *Task Importance and Peer Pressure Climate*: perception that CMC-supported tasks are important to department and the perception that departmental peers expect respondent to use computer-mediated communication technology. This factor accounts for 10% of the variance in the initial 19 item scale (listed under "Factor 2" of Table 12).

(2) *Management Climate*: perceptions of department-level training opportunities and management support (accounts for 35% of the variance in the initial 19 item scale). This factor accounts for 35% of the variance in the initial 19 item scale (listed under "Factor 1" of Table 11).

(3) *Perceived Peer Expectations*: perceived peer expectations of the instructional capabilities provided. This factor accounts for 6% of the variance in the initial 19 item scale (listed under "Factor 4" of Table 11).

(4) *Triviality*: perceptions that web-based instructional technology is trivial. This factor accounts for 7% of the variance in the initial 19 item scale (listed under "Factor 3" of Table 11).

A total of 17 items were used to construct measures of these factors with 2 items being excluded because they did not increase any scale's coefficient alpha. The following section reviews the specific items measuring each of these climate variables.

Task Importance and Peer Pressure Climate

The first climate factor combined items asking about peer expectations regarding the use of computer-mediated communication technology (under the "social relationships" factor in Figure 1) and perceptions about how important the technology-supported tasks are for departmental performance ("perceived task importance" in Figure 1). One item ("Compared with other tasks that compete for our time, the teaching tasks for which faculty members in this department use computer-mediated communication technology are trivial“) originally designed to measure this latter construct did not improve this scale’s reliability. However, this item did load on a “Triviality” scale and is discussed later in this section. The final “Task Importance and Peer Pressure Climate” measure summarized on Table 12 accounts for 67% of the variance in the four item scale score and the coefficient alpha for this scale is .83.

Table 12

Climate Items Measuring Task Importance/Peer Pressure Climate

Question Number/ label	**Item Description**	**Factor loading**	**M**	**SD**	**Scale Alpha**
	SCALE SCORE		12.7	3.8	.83 (N = 392)
33/ GOAL_CL1	Using CMC is important to the smooth operation of this department because this technology supports critical teaching tasks	0.85	3.10	1.2	
34/ GOAL_CL2	The tasks addressed by CMC help people in this department provide better instruction	0.78	3.43	1.14	
31/ GREX_CL1	Members of my department expect me to use CMC to support my teaching activities	0.77	2.98	1.2	
32/ GREX_CL2	For me and my fellow faculty members in this department, CMC is part of teachings	0.86	3.23	1.13	

Management Climate

The second climate factor, perceptions of department-level training opportunities and management support (henceforth called “Management Climate”) is comprised of eight items accounting for 45% of the scale variance (coefficient alpha = .82). An initial factor analysis included items referring to the department’s history implementing and using computer technology. However, these four items were judged to be substantively less related to the training and leadership items; removing the three history-related items helps create a single scale focused on activities under the control of department heads and other university leaders. In addition, the exclusion of these items only slightly reduces the scale's reliability (from a coefficient alpha of .87 to .82). One training item ("I'm sometimes concerned about 'looking dumb' when I ask someone else in my department for help with a problem related to computer-mediated communication technology") did not improve the scale's coefficient alpha and was not used in further analyses. Table 13 provides detailed summary statistics for this scale.

Table 13

Items Measuring Implementation Management Climate (Training and Leadership)

Question Number/ label	Item Description	Factor loading	M	SD	Scale Alpha
	SCALE SCORE		26.4	6.2	.82 (N = 360)
18/ TRN_CL1	In this department, faculty members support each other's efforts in adopting and using unfamiliar new computer-mediated communication technologies	0.59	3.25	1.20	
19/ TRN_CL2	If I ever have problems using CMC, I have someone in my department that can help me	0.62	3.21	1.44	
25/ TRN_CL4	(R) Judging from the training opportunities provided, this department sees training related to web- or e-mail supported teaching as a waste of time	0.63	3.57	1.13	
26/ TRN_CL5	This department provides the resources necessary to insure that faculty member learn how to use CMC technology to support teaching	0.70	2.62	1.10	
24/ LEAD_CL1	This university's top management—the chancellor and most deans—is strongly committed to the use of CMC technology to support teaching	0.51	3.71	1.02	
27/ LEAD_CL2	The use of CMC tools to support instruction is important to my department head	0.77	3.48	1.10	
28/ LEAD_CL3	(R) When it comes to teaching with CMC technology, my department head does not take an active interest in our problems and successes	0.79	3.53	1.20	
29/ LEAD_CL4	(R) Judging from the practices and procedures active in this department, faculty members are not expected to utilize the capabilities that CMC technology provides to achieve the department's instructional goals	0.70	3.15	1.18	

Perceived Peer Expectations

The third factor identified in the rotated factor analysis, Perceived Peer Expectations of the instructional capabilities provided, consisted of two items with a coefficient alpha of .75 that accounted for 81% of the variance in this couplet (see Table 14).

Table 14

Climate Items Measuring Departmental-Level Expectations

Question Number/ label	Item Description	Factor loading	M	SD	Scale Alpha
	SCALE SCORE		7.0	1.9	.83 (N = 400)
16/ EXPT_CL1	(R) Faculty members in this department have low expectations of the instructional capabilities provided by computer-mediated communication technology	0.90	3.56	1.14	
17/ EXPT_CL2	Faculty members in this department feel that computer-mediated communication technology (e.g. use of e-mail or the world-wide web) is a helpful teaching tool.	0.90	3.67	.98	

Finally, perceptions that web-based instructional technology is trivial, was represented by another couplet with an unacceptably low reliability (coefficient alpha = .44). One of these reverse coded items ("Compared with other tasks that compete for our time, the teaching tasks for which faculty members in this department use computer-mediated communication technologies are trivial") did not increase the coefficient alpha of other climate factors when included in reliability estimates and was not used in further analyses. The other item ("Judging from the training opportunities provided, this department sees training related to web- or e-mail supported teaching as a waste of time.") was included in the Management Climate measure because it increased the scale's coefficient alpha. A summary of all measures is presented on Table 15.

Table 15

Summary of Measures

Factor Set	Measure	Number of Items	Mean	Coefficient Alpha
Dependent Variables	Use of Technology	5	16.4	.71
	Perceived Impact on Educational Processes	4	13.3	.82
	Satisfaction with Technological Capabilities	2	6.9	.77
Individual-Level Variables	Years of Service	1	15	—
	Media Richness	1	4	—
	Complexity of Interface	2	7.5	.72
	Task Urgency	2	7.0	.89
	Novelty of Technology (at time of implementation)	2	5.6	.77
	Expertise	2	5.3	.64
Climate Variables	Task Importance/Peer Expectations	4	12.7	.83
	Management Climate (training and leadership)	8	26.4	.82
	Expectations of CMC Capabilities	2	3.6	.83

Results

Sample Demographics

The average faculty respondent has worked at State University for 15 years (SD = 9.4). Most respondents were white (86%), male (75%), tenured (65%) faculty members who worked at State University full-time (92%). Sixty-seven percent of respondents were Full or Associate Professors and 20% were Assistant Professors. Eighty-three percent of the respondents were tenured or on a tenure track.

Nearly all (98%) of the faculty respondents currently use e-mail. Ninety five percent of respondents reported that they respond to e-mail sent to them by students. Ninety percent of respondents read general e-mail announcements and corresponded with professional peers via e-mail. However, the number of faculty respondents using e-mail to directly support interactions with students is lower. While a quarter (26%) of the respondents report that they collect and distribute the e-mail addresses of students in their classes and more than half (52%) report that they create and use a class e-mail list, only ten percent state that they create student learning activities that are available only via e-mail. The median number of students e-mailed each week is five with a median of five messages sent.

Use of the world-wide web for teaching is less frequent but more intense for those faculty members using this technology. A majority of faculty respondents recommend course-related web sites to students (59%) and look at course-related sites for planning and preparing courses (62%). In addition, 38% of instructors provide an instructor home page, 42% provide a course home page, and 41% post class lecture notes and/or a course syllabus. Relative to e-mail usage, almost twice as many respondents (19%) reported that they create student learning activities that are available only on the class web page. An additional 20% reported that they use the web in other, less traditional ways, including on-line tutorials, course-related research activities, labs, and web-based discussion pages.

Test Results

The survey data yielded information about faculty members at State University and tested four hypotheses concerning: (1) replication of prior MIS research correlating individual-level characteristics with implementation success, (2) the existence of a departmental-level climate for web-based instructional technology implementation as indicated by higher within- than between-department climate means, (3) positive correlations between implementation climate and implementation outcomes, and (4) positive relationships between implementation climate and implementation outcomes controlling for the effects of "traditional" individual-level factors identified in prior MIS research.

Hypothesis One: Correlations with Prior MIS Variables

The first hypothesis that individual-level characteristics identified in prior MIS research will correlate with implementation success was supported. Table 16 illustrates the correlation matrix between all three outcome variables, all the individual-level predictors identified in prior MIS research, as well as the aggregated climate measures (justification for aggregation is discussed in the next section).

Despite the focus on web-based teaching technology and its applications in higher education, almost all of the individual-level variables identified in the broader MIS literature (this literature drove the selection and measurement of scales numbered five through nine on Table 16) had significant correlations with one or more outcome scales. As illustrated on Table 16, only the single-item Perceived Media Richness measure failed to correlate with any outcome measure. Interestingly, perceived Complexity and perceived Novelty of the CMC technology also had a significant correlations with Use (respectively, $r = .15$, $p < .01$ and $r = .13$, $p < .05$), but in the *opposite* direction as found in prior MIS research: both of these predictors had *positive* correlations.

The strongest individual-level predictors, Perceived Task Urgency and Technical Expertise, had notable positive correlations across all three outcome variables ($ps < .01$).

Both Perceived Task Urgency and Technical Expertise had correlations above .5 with Use. Task Urgency had an equally strong correlations with Satisfaction (r = .53) and Perceived Impact on educational processes (r = .5). Despite its relatively low coefficient alpha (.64), Technical Expertise also had notable correlations with both Satisfaction (r = .22) and Perceived Impact on educational processes (r = .32).

Table 16

Intercorrelations of Predictor and Outcome Variables

Measure	1	2	3	4	5	6	7	8	9	10	11	12
1. Use scale	--											
2. Satisfaction scale	.381**	--										
3. Impact on educational processes scale	.537**	.419**	--									
4. Years of service at State University	-.143**	-.109*	-.118*	--								
5. Perceived Media Richness	.073	-.044	.032	-.026	--							
6. Perceived Complexity scale	.148**	.082	.064	-.082	.438**	--						
7. Task Urgency scale	.539**	.526**	.503**	-.178**	-.034	.071	--					
8. Perceived Novelty scale	.128*	.188**	.061	.061	.146**	.213**	.203**	--				
9. Technical Expertise scale	.543**	.223**	.323**	-.117**	.073	.197**	.385**	.131**	--			
10. Management Climate scale	.146**	.249**	.146**	-.039	.022	.100*	.201**	.098*	.138**	--		
11. Task Import./ Peer Pressure Climate Scale	.274**	.331**	.251**	-.05	.028	.156**	.304**	.198**	.328**	.545**	--	
12. CMC Expectations Climate scale	.262**	.509**	.194**	-.038	.032	.120**	.384**	.168**	.180**	.295**	.476**	--

Note. *p < .05, **p < .01 (1-tailed).

Hypothesis Two: Existence of Departmental-Level Climates

The second hypothesis proposed, different CMC technology implementation climates exist within a single organization as indicated by greater between-group than within-group climate scores, was tested by comparing the between- and within-group mean squares using the intraclass correlation(1) and the intraclass correlation(2) for each of the three climate scales identified in the factor analysis.

As discussed in earlier in the literature review, measuring within-group agreement and reliability has been one of the most controversial issues in organizational multilevel research (Bliese, 2000; Dansereau & Alutto, 1990; Glick, 1988; Glick, 1985; James, 1982; James et al., 1988; Lindell & Brandt, 2000). The present research follows statistical models provided by Shrout and Fleiss (1979) and uses the intraclass correlation(1) and intraclass correlation(2) because they are one of the most common statistics to evaluate climate constructs and justify aggregation (Bliese, 2000; James, 1982; Joyce & Slocum, 1984; Klein et al., 2000; Schneider et al., 1998). Unlike r_{wg} values (a measure of within group agreement), intraclass correlation coefficients do not rely on estimates of expected random variance[1].

Both forms of the intraclass correlation coefficient (ICC) are calculated from a one-way ANOVA where the variable of interest, climate, is the dependent variable and group membership is the independent variable (Bliese, 2000). The resulting ICC(1) can be interpreted as the extent to which one rater in the group may represent all the other raters in the group. This interpretation is most germane to sub-organizational climate research and the reason why James' (1982) recommends using it as a criteria for aggregating. A somewhat different interpretation is Bryk and Raudenbush's (1992) explanation that ICC(1) is the proportion of the total variance that can be explained by group membership.

The ICC(1) and ICC(2) are related to each other as a function of group size. ICC(2) uses the Spearman-Brown formula to provide a reliability estimate of the group means

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[1] R_{wg} calculations compare an observed group variance to an expected random variance. In its simplest form, expected random variance is estimated with equal numbers of each response category. Unfortunately, most survey responses are from a restricted range (fewer responses at the extremes, tendency for more positive scores). The r_{wg} values calculated with this simple expected variance model over estimates membership agreement (Bliese, 2000). While James Demaree, and Wolf (1984) proposed several alternative methods for calculating expected variance, each relies on the researcher to choose from a variety of statistical parameters to calculate expected variance.

(Bartko, 1976). If ICC(1) is interpreted as the reliability of a single assessment of a group-level property and we know the group size, the calculated ICC(2) value provides the reliability of the group mean (Bliese, 2000). The ICC(2) adjusts the ICC(1) for the number of respondents within each group and, all things equal, the larger the group size, the higher the ICC(2) will be (Klein & Kozlowski, 2000).

Applying a one-way ANOVA model and intraclass correlation calculations to the three departmental-level climates measured here suggests that two of the three climates differ according to departmental membership. Specifically, departmental membership accounts for 17% of the variance in Task Importance/Peer Pressure Climate (ICC(1) = .17) and the reliability of this group mean, as indicated by the ICC(2) was .60, with a one-way ANOVA model F (57, 340) = 2.48, $p < .001$). Similarly, departments differed according to their perceptions of the Management Climate (leadership and training) with an ICC(1) of .22 and an ICC(2) of .67 with an one-way ANOVA F (57, 302) = 3.01, $p < .001$. In contrast, variance in the Expectation Climate did not significantly differ by departmental membership, F (57, 342) = 1.23. The variance accounted for by departmental membership was merely 3% with an ICC(2) of .18.

While there are no established levels of acceptability for either ICC(1) or ICC(2) in the climate research, the ICC(1) values reported for the Task Importance/Peer Pressure (.17) and Management Climate (.22) scores both exceed the median value of the organizational climate literature of .12 reported by Joyce and Slocum (1984). In addition, the ICC(2) values of the Task Importance/Peer Pressure (.60) and Management Climates (.67) meet Glick’s (1985) recommendation of .60, although they are somewhat below Klein and Kozlowski’s recommendation of .70 (2000). Both values for both climate measures far exceed the values used to justify aggregation used by Schneider, White, and Paul (1998) who found ICC(1) values of .09 and ICC(2) of .47 in their study of service climate in banks.

Based on these ANOVA models and intraclass correlations, the second hypothesis was supported for two of the three climate measures: intra-departmental climates for implementation do exist. Again, the Task Importance/Peer Pressure Climate scale is comprised of items relating to faculty perceptions about how important the technology-supported tasks are for departmental performance as well as perceptions of peer expectations to use CMC technology to support teaching activities. The Management Climate is comprised of items relating to perceptions of leadership support of CMC technology and CMC-related training resources available to departmental members.

These results also justify aggregation of individual-level climate perceptions to the department level consistent with Jones and James (James, 1982; 1979) recommendation that climates must have (1) significant between group differences (as indicated by the intraclass correlations), (2) homogeneous situational characteristics (respondents were grouped according to departmental membership) and (3) substantive theoretical relationships between the measure and the unit of analysis (item wording referred to departmental-level phenomena). The climate measure that did not differ by departmental membership, the expectation climate, was used as an individual-level predictor variable in post hoc analyses.

Hypothesis Three: Correlations Between Climate and Implementation Success

Following Klein et al. (2000), the departmental mean of the Management and Task Importance/Peer Pressure Climate was assigned to department cohorts. These aggregated climate scores formed the basis of the third hypothesis: department-level climate factors will have a positive correlation with implementation outcomes (Use, Perceived Impact on Educational Processes, and Satisfaction).

As summarized on Table 17, both of the climate variables had significant correlations with all three outcome variables at a $p < .01$ level. Most notably, the Task Importance/Peer Pressure Climate score had the highest correlation across all three outcomes: Use (r = .27), Satisfaction (r = .33), and Perceived Impact on Educational Processes (r = .25). These results provide clear support for hypothesis number three.

Table 17
Correlations of Departmental-Level Climate and Dependent Variables

Item	1	2	3	4	5
1. USE SCALE	--				
2. SATISFACTION SCALE	.381**	--			
3. ED. PROCSS SCALE	.537**	.419**	--		
4. MANAGEMENT CLIMATE	.146**	.249**	.146**	--	
5. TASK IMPORT/PEER PRESSURE CLIMATE	.274**	.331**	.251**	.545**	--

Note. *p < .05, **p < .01 (1-tailed).

Hypothesis Four: Climate Effects Controlling for Prior MIS Variables

The fourth hypothesis, climate factors will have a positive correlation with implementation outcomes controlling for the effects of contextual and individual-level variables was tested with cross-level operator analysis (Klein et al., 2000). Cross-level operator analysis (CLOP) is a statistical technique designed to test the effect of higher-level variables or "operators" (in this research, departmental climates) on lower-level outcome data individual-level (Use, Perceived Impact on Educational Outcome, and Satisfaction) using stepwise multiple regression techniques. While there are a growing number of statistical techniques able to evaluate factors operating at different levels of analysis, CLOP was chosen for its ability to test the direct effect of multiple cross operators. Moreover, CLOP and hierarchical linear modeling (or "HLM," an alternative to CLOP) have been demonstrated to yield very similar parameter estimates (Klein et al., 2000). While CLOP and HLM differ in interpretation of how variance in predictor variables is assigned to outcome variables[1], the two techniques will provide the same substantive conclusions.

[1] CLOP explains total variance in the outcome while HML parses variance into between unit variance in the outcome.

Each step of these regression equations adds an entire construct class (i.e., contextual/structural characteristics, individual-level variables, and group-level climate variables). Only variables within each construct class with significant zero-order correlations with the outcome variable are included. Hence, significant beta coefficients within each step indicate the relative contribution that the variable makes in explaining implementation outcomes within that factor set. Comparisons between the factor sets are indicated by significant F statistics, the change in the squared multiple correlations (R^2), and estimates of the variance explained by that factor set controlling for the effects of factor sets entered earlier (R^2 change).

Consistent with Klein et al. (2000), the first step of this CLOP analysis was to assign the departmental[1] mean to the individuals within the department for each of the climate variables. Again, only climate variables with ANOVA and intraclass correlation statistics justifying aggregation were included in these models: the Task Importance/Peer Pressure and Management Climates.

CLOP Analysis: Use

Table 18 suggests that approximately two percent of the variance in Use can be accounted by years of service, $F_{1, 290} = 7.2$, $p < .01$. The negative beta ß = -16, $p < .01$ may be a proxy for age; older faculty members may be less willing to use new tools and/or an indication that newer faculty members are more likely to embrace these new teaching technologies. However, the marginal significance of years of service disappears with the addition of other independent variables across all three outcome variables.

The set of variables entered in step two, individual-level characteristics, accounted for most of the variance in Use (R2 change = .42, $p < .01$, $F_{4, 286} = 46.5$, $p < .01$).

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[1] Departmental membership was originally designed to be a independent variable. However, the large number of dummy variables required for this procedure 57 reduced the degrees of freedom available for factors entered later in the equation. This reduction in degrees of freedom coupled with the reduction in variability for the two climate variables due to aggregation by department created an untenable regression equation. For all analysis, the departmental dummy variables were dropped and departmental differences were accounted for by assigning the group mean for each department to departmental cohorts.

Of these individual-level factors, individual Expertise was the strongest predictor (ß = .41, p < .01), followed by perceived Task Urgency (ß = .38, p < .01). Neither perceived Complexity nor Novelty were significant predictors of Use in this regression equation. Finally, the department-level Task Importance/Peer Pressure Climate and Management climates measure failed to accounted additional variance in Use (respectively, ß = .03, p =ns, ß = .02, p = ns).

Table 18

Regression Analysis Individual and Climate Variables Relationship With Use of Technology

	Step and predictor variable	Step 1 ß	Step 2 ß	Step 3 ß
Step 1				
	Years of Service	-.16***	-.04	-.04
Step 2				
	Complexity		.02	.02
	Task Urgency		.38***	.38***
	Novelty		.00	.00
	Expertise		.41***	.40***
Step 3				
	Task Importance/Peer Pressure Climate			.03
	Management Climate			.02
	R2	.02	.45	.45
	Adj R2	.02	.44	.44
	R2 change	.02***	.42***	.002
	Model F	7.2***	46.5***	33.2***

Note. All ß coefficients are standardized. Step 1 degrees of freedom = 290. *p < .01 **p < .05, ***p < .01.

CLOP Analysis: Satisfaction

Table 19 illustrates the results of the three-step regression equation evaluating the contextual, individual, and climate variables that best account for variance in Satisfaction with web-based instructional technology. Years of service, entered on the first step, explained 2% of the variance in Satisfaction F1, 357 = 5.51, p < .05. The individual-level variables entered on step two accounted for an additional 27% of the variance in satisfaction, $F_{3, 354} = 34.7$, $p < .01$.

Table 19

Regression Analysis of Contextual, Individual and Climate Variables Relationship With Satisfaction With Technology

	Step and predictor variable	Step 1 β	Step 2 β	Step 3 β
Step 1				
	Years of Service	-.12**	-.04	-.04
Step 2				
	Task Urgency		.50***	.45***
	Novelty		.09**	.05
	Expertise		-.01	-.06
Step 3				
	Task Importance/Peer Pressure Climate			.21***
	Management Climate			.07
	R2	.02	.28	.34
	Adj R2	.02	.27	.33
	R2 change	.02**	.27***	.06***
	Model F	5.51**	34.7***	28.9***

Note. All β coefficients are standardized. Step 1 degrees of freedom = 357. *$p < .1$ **$p < .05$, ***$p < .01$.

Within this factor set, perceived task urgency was a strong significant predictor β = .5, $p < .01$. Perceived Novelty of the CMC technology had a more modest *positive* relationship with Satisfaction β = .09, $p < .05$. Individual Expertise was not a significant predictor of Satisfaction. Finally, the two climate variables entered at the last step accounted for an additional 6% of the variance in Satisfaction, controlling for the effects of all other variables entered in the equation $F_{2, 352} = 28.9$, $p < .01$. Similar to the analysis of prior outcomes, only the Task Importance/Peer Pressure Climate significantly predicted Satisfaction β = .21, $p < .01$.

CLOP Analysis: Perceived Impacts on Educational Processes

The variance in how faculty members perceive the impacts of web-based instructional technology on student learning processes is illustrated in Table 20. Again, years of service accounted for approximately two percent of the variance in this outcome, $F_{1, 290} = 4.79$, $p < .01$.

Table 20

Regression Analysis of Contextual, Individual and Climate Variables Relationship With Perceived Impact on Educational Processes

	Step and predictor variable	Step 1 β	Step 2 β	Step 3 β
Step 1				
	Years of Service	-.13**	-.02	-.02
Step 2				
	Task Urgency		.45***	.42***
	Expertise		.15***	.12**
Step 3				
	Task Importance/Peer Pressure Climate			.13***
	Management Climate			-.01
	R2	.13	.27	.28
	Adj R2	.02	.26	.27
	R2 change	.02*	.25**	.01*
	Model F	4.79**	35.3***	22.4***

Note. All β coefficients are standardized. Step 1 degrees of freedom = 290. *$p < .1$ **$p < .05$, ***$p < .01$.

The individual-level characteristics entered in step two accounted for most of the variance in Perceived Impacts on Educational Processes (R^2 change = .25, $p < .01$, $F_{2, 288} = 35.3$, $p < .01$). Contrary to its predictive value in the Use dependent variable, individual Expertise was not as strong a predictor (β = .15, $p < .01$) as perceived Task Urgency (β = .45, $p < .01$). Controlling for the contextual and individual-level variables on the third step of the regression, the department-level Task Importance/Peer Pressure and Management Climates accounted for an additional 1% of the variance in Perceived Impacts at the $p < .1$ level. (R^2 change = .01, $p < .1$, $F_{2, 286} = 35.3$, $p < .01$). Between the two climate factors, only Task Importance/Peer Pressure was a significant predictor (β = .13, $p < .01$).

Open-Ended Comments

In addition to the 51 closed-ended questions asked in the implementation survey, one open-ended question appeared at the end of each major section of the survey for a total of four questions. These open-ended questions provided an opportunity for respondents to relate additional information that may not have been directly addressed in the closed-ended questions.

Open-ended comments from each of the 58 departments surveyed were randomly selected and transcribed. Additional respondents were drawn from within that department until comments for all four questions were found or until the department's surveys were exhausted. Although this quota sampling strategy yielded a large number of comments (over 220), it may over represent respondents that felt particularly intense about CMC-related issues. Comments from each question were transcribed and then organized along key themes. Table 21 summarized the results of this informal content analysis. The last column of Table 21 provides some quotes that encapsulate each major theme (several of these quotes came from respondents that were not randomly selected, rather, they were gleaned from particularly well-articulated statements that summarized a major theme).

Table 21

Major Themes Identified in Open-Ended Responses

Question	Top 3 Themes Identified	Faculty Quotes
What training topics or resources would be most helpful to you in using computer-mediated communication technology like the world-wide web or e-mail to support your teaching?	• Web page design & related technical information (71%) • Other –money for software, accessibility, etc. (12%) • Availability of training personnel (10%)	*" People who know how to do it and are available."*
Specifically, what could your department do to help you use information technology to support your teaching (e.g., provide rewards or recognition for integrating new communication technology into teaching, providing training time to learn new technology, etc.)?	• Provide training time, money, technical support personnel (57%) • Recognize the time and effort required (19%) • Provide department-based, more convenient, or one on one training (12%)	*"(My department) would purchase computer equipment for me instead of making me beg other, well-funded, faculty members to buy it, or, as it did in the 80s--make me buy my own."*
What prevents you from using computer-mediated communication tools in your instructional activities more than you already do?	• Time-to learn and use (53%) • Concerns about appropriateness of technology for teaching (21%) • Technical challenges (12%)	*"An adequate web-based courses is a lot of work to do properly & usually isn't 'cost' effective. Student can easily be deluded that the web (or a book) is an adequate teaching device. Even some administrators believe this."* *"At times, I fear a loss of personal contacts (face to face or voice to voice) with students."* *"Using it more might be overkill. I integrate CMC tools where they provide a distinct benefit to the learner…Other forms of learning still have their value."*
What else is important to know about faculty use of computer-mediated communication technology to support teaching?	• Media limitations and inappropriateness (48%) • Time, training and support issues (37%) • Positive benefits of teaching with technology (9%)	*"Educators should beware of removing the human bond from the teaching/learning process."* *"Using CMC technology does require much more time than preparing "traditional' classes. It would be nice if the institution were to acknowledge this, e.g., in the form of release time to make up for the investment of extra time by the faculty member who is learning and using CMC technology. "*

Most of the themes identified in these open-ended comments were consistent with the closed ended survey questions posed (e.g., need for more training, comments about the quality of leadership support, and technical challenges). However, an entire genre of comments relating to the limitations and appropriateness of the CMC technology for teaching were not included in the closed ended questions.

Specifically, a large percentage of the quota sample made comments concerning the large time commitment required for preparing/maintaining CMC-based teaching tools, concerns that web-based instructional technology limits face to face contact with students and other concerns about the inappropriateness of CMC technology in the teaching/learning process. The two the open-ended questions ("What prevents you from using..." and "What else is important to know…") on bottom two rows of Table 21 provides several examples of these concerns. The responses may provide insight into some underlying attitudes about web-based instructional technology at State University.

Post Hoc Analysis

Modified Use Measure

The initial analysis of the effect of the two climate scales on Use, controlling for individual-level variables was not significant (see Table 18). These regression results may be influenced by the lack of variance explained by the five item Use measure: 46%. A modified Use measure accounting for 53% of the scale variance was constructed by adding three items that loaded on the Use factor and improved the measure's coefficient alpha. Two items from the Computer Expertise scale ("I have sufficient knowledge to utilize computer-mediated communication technology for teaching" and "Which of the following computer-related abbreviations can you define?") were added because respondents with high levels of computer expertise are likely to have gained that expertise through computer use. The third item, a universal use completion item ("Computer-mediated communication technology —e.g., e-mail or world-wide web— is a viable way to share information with any student attending one of my courses") was added because perceptions that all students have access to the technology correlated with use[1]. Clearly, these three items are not analogous to "use" and they were originally designed to other

[1] An additional post hoc analysis tests a related universal use item as a moderator variable.

variable domains. However, creating a more reliable Use measure within a post hoc analysis provides additional insight into the climate model tested. This modified eight-item Use measure had a coefficient alpha of .79 (M = 25.9, SD = 5.7). The original five-item Use scale summarized on Table 8 yielded a coefficient alpha of .71 (M = 16.4, SD = 3.7).

Table 22 illustrates how the structural, individual-level, and climate factors influence the modified Use measure. Most notably, of the Task Importance/Peer Pressure Climate is significantly related to Use, holding the effects of all structural and individual-level variables constant (ß = .18, $p < .05$; R^2 change = .02, $p < .01$). In contrast, the Task/Peer Pressure scale had a nonsignificant relationship (ß = .03, *ns*) with the original five-item Use measure.

Table 22

Regression Analysis of Contextual, Individual, and Climate Variables Relationship With Modified Use Measure

	Step and Predictor Variable	Step 1 ß	Step 2 ß	Step 3 ß
Step 1				
	Years of Service	-.16**	-.07	-.07
Step 2				
	Complexity		.15**	.15**
	Task Urgency		.52**	.47**
	Novelty		.05	.03
Step 3				
	Task Importance/Peer Pressure Climate			.21**
	Management Climate			-.03
	R2	.03	.33	.37
	Adj R2	.02	.32	.35
	R2 change	.03**	.31**	.04**
	Model F	7.39**	35.24**	27.25**

Note. All ß coefficients are standardized. Step 1 degrees of freedom 1, 290. *$p < .05$, **$p < .01$.

Sophistication of Use Measure

In contrast to the significant relationship between climate and a modified Use factor, a post hoc logistic regression analysis failed to identify any relationship between climate and sophistication of use. A logistic regression analysis was used to test the same independent variables as in the multiple regression analysis evaluating the Use factor (see Table 23), however, group membership (high and low "Sophistication") was used as the dependent variable. Logistic regressions are interpreted by comparing two models on the difference in their natural log[1]-likelihoods and using the chi square statistic. The smaller model contains only the constant while the larger model contains the constant plus the predictor variables(s). The difference between log-likelihoods creates a statistic that is distributed as a chi-square (Tabachnick & Fidell, 1996). Reliable differences in the chi-square statistic indicate that the larger model contains predictors of group membership.

Sophistication levels were identified based on a factor analysis of the number of web functions used[2]. The initial factor analysis of the web functions used indicated three use levels. However, the most current version of SPSS (10.0) does not allow testing of more than two levels of group membership (Tabachnick & Fidell, 1996). Given these limitations[3], "Low Sophistication" instructors were identified as those who did not use the web combined with instructors who only looked at web sites in planning and/or recommending web sites to students. "High Sophistication" instructors had some combination of a professionally-oriented web page, a course home page, and/or teaching activities that are available only on the web.

A forced forward regression model containing all the individual-level predictors as well as both climate measures significantly predicted membership in the High Sophistication group χ^2 (6, $\underline{N}$ = 312) = 91.27, $\underline{p} < .0001$. A step-wise logistic regression

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[1] The logarithm of a number is an exponent of the base number indicating the power to which that number must be raised to produce another number. For example, common logarithms use base 10 so the log of 100 is 2: 10^2 (10 X 10)= 100. The natural log of a number uses the "universal constant" (2.718281…) as the base number.
[2] This factor analysis used the nominal data from a multiple response "core feature" item concerning teaching with the world-wide web: (1) personal use of the world-wide web for planning and preparing courses, (2) recommendations of course-related web sites to students, (3) an instructor home page—these pages typically contain contact information, a list of courses taught, office location, etc., (4) a course home page, (5) lecture notes and/or a course syllabus posted on a course home page, (6) student-produced web pages posted on the home page, and (7) other student learning activities that are available only on the class home page.
[3] Given the non-significant findings for the two-level model presented here, a three-level model is unlikely to yield a substantively interpretable result.

model (see Table 23) first containing individual-level predictors with significant zero-order correlations followed by the two significant climate measures, Task Importance/Peer Pressure and Management Climates, suggests that only the individual-level variables are associated with the log likelihood of membership in High Sophistication groups, χ^2 (4, N = 312) = 89.18, p < .0001. Like the multiple regression equations, Task Urgency (expB = 1.16, p < .05) and, User Expertise (expB = 1.79, p < .01) were significantly related to the odds[1] of being a High Sophistication instructor. Neither of the climate variables entered on the second step significantly predicted membership in the High Sophistication group, χ^2 (2, N = 312) = 2.08, p = *ns*.

Table 23

Logistic Regression Analysis: Predicting Sophistication of Use With Individual-Level and Climate Predictors

	Beta	p	Exp(B)
Complex	-.013	.867	.987
Urgent	.153	.024	1.166
Novel	.092	.183	1.097
Expert	.586	.000	1.797
BLOCK	χ^2		
	89.18	.000	
Task /Peer Climate	-.030	.727	.970
Management Climate	.062	.166	1.064
BLOCK	χ^2		
	2.083	.35	

[1] The logistic coefficient (B) in these regressions can be interpreted as the change in the log odds associated with a one-unit change in the independent variable. The odds, a more interpretable measure, are reported in the expB statistic. For example, when the Task Urgency score changes from 0 to 1, the odds of being a high user increase by 1.16.

Inclusion of Expectation Climate in Multiple Regression Analysis

Because the Expectation Climate items did not differ by departmental membership (as indicted by ICC (2) correlations of .18, well below the benchmark of .60), an additional multiple regression equation containing this variable as an individual-level factor was constructed. A correlational analysis of the disaggregated Expectation Climate indicated that this factor had non-significant zero-order correlations with both Use and Perceived Impact on Educational Processes. However, the significant zero-order correlation with Satisfaction ($r = .36$, $p < .01$) indicated that this variable may improve the predictive validity of the model. Indeed, as illustrated on Table 24, individual-level Expectation Climate did increase the total amount of variance accounted for in Satisfaction with a Model R^2 of .37, $p < .01$) and $F(7, 344) = 29.3$, $p < .01$. In contrast, the regression model without Expectation Climate (see Table 19) accounted for 34% of the variance in Satisfaction with a Model R^2 of .34, $p < .01$ and $F(6, 352) = 29.9$, $p < .01$. The shared variance between the department-level Task Importance/Peer Pressure Climate and the individual-level Expectation Climate is notable: the standardized beta of the Task Importance/Peer Pressure Climate is reduced by almost half when the Expectation Climate is included (from $\beta = .21$ $p < .01$ to $\beta = .12$, $p < .05$).

Table 24

Regression Analysis Including Expectation Climate as Individual-Level Variable: Prediction of Satisfaction With Technology

		Step 1 β	Step 2 β	Step 3 β
Step 1				
	Years of Service	-.12*	-.03	-.03
Step 2				
	Task Urgency		.43**	.41**
	Novelty		.07	.05
	Expertise		.07	.03
	Dept. Expectations (Ind. Level)		.29**	.23**
Step 3				
	Task Importance/Peer Pressure Climate			.12*
	Management Climate			.06
	R2	.01	.35	.37
	Adj R2	.01	.34	.36
	R2 change	.01*	.34**	.02**
	Model F	5.03*	37.8**	29.3**

Note. All β coefficients are standardized. Step 1 degrees of freedom = 350. *$p < .05$, **$p < .01$.

Zero-order correlations between leadership support and implementation outcomes

A stable finding within the wider MIS literature is the relationship between leadership support and implementation outcomes (Bullen & Bennett, 1990; Hiltz, 1988; Hiltz & Johnson, 1990; Robey, 1979; Stasz et al., 1986). None of this research, however, compares the level of leadership support with implementation outcomes.

In order to identify which leadership level most influences implementation success, the zero-order correlations between three leadership items targeting top leadership, departmental leadership, and peer pressure were compared. The three items all used five point, strongly disagree to strongly agree scales. Results of these correlations are shown in Table 25.

Table 25

Correlations Between Leadership Support at Three Levels and Implementation Outcomes

	USE	SAT	EDPROC	Top Leaders	Dept. Head	Dept. Peers
USE	--					
SATISFY	.381**	--				
EDPROCESS	.537**	.419**	--			
Top Leaders	.042	.153**	.047	--		
Dept. Head	.127*	.344**	.039	.193**	--	
Dept. Peers	.174**	.400**	.143**	.173**	.270**	--

Note. *$p < .05$, **$p < .01$ * (2-tailed).

Notably, the top-level item, "This university's top management—the chancellor and most deans— is strongly committed to the use of computer-mediated communication technology to support teaching" had only one significant correlation with the outcomes of interest (satisfaction $r = .15$, $p < .01$). In contrast, the department head item, "The use of computer-mediated communication tools to support instruction is important to my department head," had significant correlations with both Use ($r = .11$, $p < .05$) and Satisfaction ($r = .34$, $p < .01$). The strongest correlate of all three implementation outcomes was the peer pressure item: "Members of my department expect me to use computer-mediated communication technology to support my teaching activities (e.g., use of e-mail and the world-wide web)." This item had significant correlations with Use ($r = .17$, $p < .01$), Perceived Impacts on Educational Processes ($r = .14$, $p < .01$), and Satisfaction ($r = .40$, $p < .01$).

These results provide additional justification for the sub-organizational (departmental) level of analysis used in the present research. These zero-order correlations support the idea that local, departmental-level actors provide more frequent and powerful stimulus that may influence individual-level climate perceptions.

Universal Use as Moderator Variable

In order to evaluate the possiblity that universal use perceptions moderate the influence of other predictor variables, a product term moderator variable was constructed by multiplying the esimated percentage[1] of students who actively use computer-mediated communication technology ("What percentage of students taking your couses actively use computer-mediated communication technology (e-mail or the world-wide web") by each of the eight independent variable that had a significant zero-order correlation with one or more of the dependent scale items (As illustrated on Table 16, Media Richness is the only measure that did not have a significant corrleation with any outcome). A total of 21 regression equations were tested.

Table 26 summarizes results of this post hoc testing of 18 different regression equations. As with all of the regression analyses, only variables significant zero-order correlations with the outcome were entered. The moderator term was entered at the last step and, as reported in Table 26, significant beta coefficient represent the incremental increase of varince explained in the dependent variable. Blank squares were untested because zero-order correlations did not exist between the independent varialbe and the outcome variable.

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[1] This percentage data was first standardized into Z-scores.

Table 26

Universal Use as Moderator Variable: Incremental Increase in Variance Explained based on Regression Results

Product Term Moderator[1]	Use Scale ß	Satisfaction Scale ß	Educational Process Scale ß
Years of service at State University	*ns*	*ns*	*ns*
Perceived media richness	--	--	--
Perceived complexity scale	*ns*	--	--
Task urgency scale	*ns*	*ns*	*ns*
Perceived novelty scale	.25*	*ns*	--
Technical expertise scale	*ns*	*ns*	*ns*
Management climate scale	*ns*	*ns*	*ns*
Task Import./ Peer Pressure Climate	*ns*	.23***	*ns*
	r	r	r
Universal use item zero-order correlation	.18[t]	.21[t]	.21[t]

Note. * Significance of F change = .1. **Significance of F change = .05. *** Significance of F change = .01. [t]Significant at $p < .05$ (2-tailed).

Two significant interaction terms with universal use were identified: Novelty and Task Importance/Peer Pressure Climate. The marginal statistical significant for the Novelty by Universal use interaction suggests that at any given Novelty perception, higher Universal Use values will raise the use of web-based instructional technology. Similarly, at any given Task Importance/Peer Pressure Climate score, higher Universal Use values will raise the Satisfaction with web-based instructional technology.

[1] Z-Score of Estimated Percent of Student Using Web and E-mail multiplied by each of the independent variables listed.

Discussion

The purpose of this study was to gain insight into the factors that support successful implementation of computer-mediated communication technology in educational settings. To this end, a survey measuring both the individual-level correlates of implementation success identified in prior research as well as items measuring a departmental-level climate for computer-mediated communication technology implementation was given to faculty members in 58 different academic departments within a large state university. All four of the hypotheses relating to this research were either supported or partially supported. Understanding the nature of this support provides several important contributions to the academic literature as well as applied lessons for universities struggling to effectively use new computer-mediated teaching technology. Finally, these results help us understand the unsaid and unspoken "mokita" of information technology.

Academic Contributions

Hypothesis One

The first hypothesis supported, individual-level characteristics identified in prior management of information science (MIS) research will correlate with implementation success, effectively replicates prior MIS findings in a new research setting. The strength and statistical significance of the correlations that these variables (i.e., Perceived Interface Complexity, Task Urgency, Novelty of Technology, and User Expertise) have with implementation outcomes supports the inclusion of these variables in future research on web-based instructional technology. Support for this hypothesis demonstrates that traditional MIS correlates heretofore studied only in business contexts may be equally relevant in educational settings.

This applicability of prior MIS results to educational settings may provide educational researchers a rich foundation for designing future studies—not only by identifying relevant predictor variables but also in the broader research tools used. If the individual-level variables identified in prior research are applicable in educational setting, so too may other MIS-derived theories and research approaches.

As discussed earlier, the current educational literature provides relatively few methodologically sound empirical studies of information technology in educational settings. Transferring well-researched MIS-based findings to educational research settings may provide a host of theories, methodologies, and measures to this area inquiry. Educational researchers interested in increasing the quality and quantity of empirical studies in this area have a rich MIS research base to consult (likely starting points would include Attewell & Rule, 1984; Bair, 1978; Baroudi, Olson, & Ives, 1986; Benbasat & Lim, 1993; Bullen & Bennett, 1990; DeSanctis & Poole, 1994; Hiltz & Johnson, 1990; Ives & Olson, 1984; Kling, 1987; Markus, 1994; Orlikowski, Yates, Okamura, & Fujimoto, 1995; Whelan, 2000; Zaheer & Venkatraman, 1994).

A key exception to the parallel findings in business and academic settings found in the first hypothesis are the *positive* relationships between Use and the Perceived Novelty and Perceived Complexity of the CMC technology found in the present study. Prior MIS research suggests a negative relationship between both of these variables and implementation outcomes (Bullen & Bennett, 1990; Klein, 1992; Nord & Tucker, 1987; Tait & Vessey, 1988). A possible explanation of this finding is the nature of the sample: the willingness to learn demanded by an academic career may make faculty members at State University attracted and compelled by novel and complex new tools like web-based instructional technology.

Hypothesis Two

The partial support for the second hypothesis, different CMC technology implementation climates exist within a single organization, empirically supports a new theoretical construct: the climate for computer-mediated communication technology implementation. This construct, as measured by two underling factors, the Task Importance/Peer Pressure Climate and a Management Climate, demonstrates that departmental-level processes and procedures *do* influence departmental members' perceptions and behaviors regarding CMC technology in a consistent way. This finding is consistent with the perspective that people assign "technological frames" to new technology complete with a set of assumptions, meanings, knowledge and expectations used to understand the nature and role of technology in organizations (Pinch & Bijker, 1987). The data collected at State University suggests that the technological frames held by each respondent are influenced by their departmental peers.

Indeed, hypothesis two provides the first quantitative confirmation of two of the three "technological frames" dimensions (Orlikowski & Gash, 1992) that guided the development of the climate measures. Orlikowski and Gash's *relations with others in computing social world* (i.e., expectations and experiences about the frequency and extent of interaction with other people using information technology and perception of the group's attitudes towards/understanding of technology) was operationalized in the Task Importance/Peer Pressure Climate. Similarly, Orlikowski and Gash's *implementation issues*: (shared, group-level knowledge and experiences in the implementation process of a specific technology, including involvement, barriers/facilitators, training, managerial support), guided the development of the Management Climate measure. The high intra-class correlations (an ICC(2) of .60 for the Task Importance/Peer Pressure Climate and .67 for Management Climate) supporting this hypothesis demonstrates that Orlikowski and Gash's theoretical model based on qualitative observations can be quantitatively measured. These quantitative measures, in turn, have predictive value in assessing implementation outcomes.

The dimension that did not have sufficiently high intra-class correlations, Expectation Climate, was based on Orlikowski and Gash's *philosophy towards technology* (individuals' perceptions of the group- and organizational-level expectations regarding technology-enabled capabilities as well as the individuals' perceptions of the groups' and organization's history with computer technology in general). As discussed earlier, the intra-class correlation formula is calculated with comparisons of within- and between-group mean squares. The restricted variance provided by the two-item "couplet" is the likely reason for the non-significant findings for this climate measure. Adding more items to the Expectation Climate measure may increase the within- and between-group variance and provide higher intra-class correlations.

Despite the non-significant results for one of the climate factors, two of the three climate factors provide quantitative, empirical evidence supporting a rich "technological frames" perspective on how and why new tools are used in new settings (see Orlikowski & Gash, 1994). The climate construct definitions, item reliabilities, and survey results may provide future implementation researchers with a foundation of psychometric integrity from which to build more powerful climate models.

Support for Sub-Organizational Climate

In addition to empirical support for a "technological frames" perspective of technology in organizations, the test of hypothesis two also furthers the concept of a sub-organizational climate. While much of the existing climate research focuses on the organizational level of analysis, this and other sub-organizational level climate investigations (Agrell & Gustafson, 1994; Burningham & West, 1995; Howe, 1977; Powell & Butterfield, 1978; Zohar, 2000) suggests that the sub-organizational level may be an important source of climate perceptions. Indeed, investigations targeting a sub-organizational level of analysis assume (or test the idea that) the broader "policies and procedures" that individuals interpret into their climate perceptions are executed at lower hierarchical levels. Differences in how broader organizational directives are managed within local groups creates differences in sub-organizational climate and differences in sub-organizational performance.

The high intraclass correlations supporting the second hypothesis provides strong statistical support for a sub-organizational climate. The present analysis yielded ICC(1) and ICC(2) values of .17 and .60, respectively, for the Task Importance/Peer Pressure

Climate and ICC(1) and ICC(2) values of .22 and .67, respectively, for the Management Climate.

These research results are consistent with other investigations of sub-organizational climate. Most related to the current research is Zohar's (2000) study of 53 work groups within a single organization that created and tested a new two-factor group-level safety climate. The two factors , "Supervisor Action" and "Supervisory Expectation," yielded ICC(1) values of .17 and .22 and ICC(2) values of .77 and .69. While Zohar had slightly higher ICC2 values and his climate measures accounted for a significant amount of variance in accidents, (R2 change = .16, $p < .05$), his multiple regression equations did not include individual-level correlates of the dependent variable.

The present results compares even more favorably to other sub-organizational climate research. Both ICC values observed here exceed the values found in Schneider, White, and Paul's (1998) study of 134 different bank branches in which the "climate for service" measure yielded an ICC(1) value of .09 and ICC(2) value of .47. Similarly, Burningham and West's (1995) analysis of 16 team climate scales did not justify aggregation and the investigators were forced to use used individual-level data in regression analyses.

The results supporting the second hypothesis builds empirical support for Orlikowski and Gash's (Orlikowski & Gash, 1992; Orlikowski & Gash, 1994; Orlikowski et al., 1995) "technological frames" perspective as well as empirical support for the existence of sub-organizational climates.

Hypothesis Three

The third hypothesis, department-level climate factors will have a positive correlation with implementation outcomes, demonstrates the predictive qualities of the climate for implementation measures. Both the Task Importance/Peer Pressure Climate and the Management Climate measures had significant positive correlations with all three outcome variables. Of these two climate measures, the Task Importance/Peer Pressure Climate score had the highest correlation across all three outcomes: Use ($r = .27$, $p < .01$), Satisfaction ($r = .33$, $p < .01$) and Perceived Impact on Educational Processes ($r = .25$, $p < .01$). Not only do faculty members' climate perceptions differ depending on their departmental membership, but also these departmental-level climates have positive correlations with implementation success.

Hypothesis Four

Despite the positive correlations found between climate and implementation outcomes observed in the test of hypothesis three, a more statistically conservative test of these climate variables lies in the fourth hypothesis tested: climate factors will have a positive correlation with implementation outcomes controlling for the effects of individual-level variables. The cross-level operator analysis (CLOP) and stepwise multiple regressions demonstrated partial support for this hypothesis. The department-level Task Importance/Peer Pressure Climate accounted for an additional 6% of the variance in Satisfaction while controlling for the effects of the individual-level variables (i.e., perceived Task Urgency, Novelty, and User Expertise). Besides the task Importance/Peer Pressure variable, only Task Urgency was a significant predictor of Satisfaction (see Table 19).

Unfortunately, even the positive model assessing Satisfaction should be interpreted with caution: the Satisfaction measure consisted of two items, both anchored to perceptions of department-level satisfaction. Given the parallel level of analysis for both the climate scores and the satisfaction items, these results are better interpreted as department-level climate perceptions predicting a closely related construct: department-level satisfaction.

More telling are the non-significant regression models predicting Use and Perceived Impact on Educational Processes. Neither outcome was predicted by the climate measures while controlling for the significant zero-order correlatives at the individual-level (i.e., Perceived Task Urgency, Novelty, and User Expertise). As discussed in the next section, these results may be due to the definition and strength of the outcomes measured.

Discussion of Non-Significant Results: Outcome Measurement

The outcome measures themselves may explain the non-significant regression results observed in the test of the fourth hypothesis. The department-level Task Importance/Peer Pressure Climate and Management Climates may have been more predictive if the outcome variables were more reflective of faculty priorities; "use" of a web-based instructional technology, as measured in this study, may have missed the critical factors that delineate intensive versus moderate users of CMC technology for instructional purposes. Similarly, faculty perceptions of the impact that CMC technology has on student educational processes may not be critically important for faculty members. This technology may be considered far more important as a peer communication tool rather than strictly and student-oriented teaching tool. Faculty interviews and qualitative observations would improve the sensitivity of the outcome measures.

Additionally, more items may strengthen all three of the outcome measures. The effectiveness of this latter recommendation is illustrated by the significant relationship Task Importance/Peer Pressure Climate had with the modified 8-item Use measure in the Post Hoc section compared to the non-significant relationship with the original 5-item use measure.

A more fundamental outcome measurement issues concern broader organizational- and society-level priorities. Some critics of web-based instructional technology argue that this technology represents a fundamental revolution in higher education. David Noble (1998) suggests that universities are increasingly selling distribution rights to electronic courses, including copyright, to private, for-profit corporations. Such arrangements, argues Noble, may reduce faculty to replaceable content providers. Indeed, even distance learning advocates cite the fundamental change these technologies offer with the promise of a more cost-effective education; more students are taught with fewer faculty members (Duderstadt, 1999).

If Noble's fears ring true for a significant minority faculty members at State University, several factors measured within the climate scales (e.g., department-level leadership support or department-level task urgency) would have unpredictable relationships with the "implementation success" outcomes. The relatively high percentage of open-ended responses noting the limitations or inappropriateness of CMC technology in the teaching/learning process may signal that, in fact, these broader themes may be a major concern for faculty members.

Practical Implications

In the "real world" of managing CMC technology in organizations, the high correlations of Task Urgency and User Expertise across all three implementation outcomes reinforces the idea that the highest implementation levels are found when highly computer-literate employees use computers to solve important, job-relevant tasks. The current research illustrates that these variables, derived from the MIS literature, are equally effective in predicting implementation success based on the Use, Satisfaction, and Perceived Impact on Educational Processes outcomes.

In addition, university administrators and IT managers may find utility in the two climate measures developed in this research. Both climate factors have reliable coefficient alpha's above Nunnally's benchmark of .70. More importantly, the Management and Task Importance/Peer Pressure Climate scales have construct validity: faculty members working in the same department do share demonstrably similar perceptions of the events, practices, and procedures that influence the implementation of web-based instructional technology and the technology-enabled behaviors that are rewarded, supported and expected in the department (both measures have intra-class correlations above .60).

Based on the Management and Task Importance/Peer Pressure Climate scales, a climate for CMC technology implementation is a measurable construct that may offer some of the most powerful and "manageable" leverage points for the implementation of new web-based instructional technology. For example, changing the leadership priorities of department heads or deans (as measured in Management Climate factor) may be far more feasible than changing the Use Expertise level of every faculty member. Similarly, identifying key departmental-level tasks to be addressed by new web-based instructional technology (as found in the Task Importance/Peer Pressure factor) may be more manageable than identifying how these new teaching tools can be used to address the idiosyncratic teaching needs of individual faculty members.

Unfortunately, the climate measures tested did not have predictive validity for two key outcomes: Use and Perceived Impacts on Educational Processes. Managers interested in using climate measures for predicting implementation outcomes will be forced to reevaluate the definition and measurement of "Implementation Success."

Recommendations

The biggest single improvement to the current study would be to improve the definition and measurement of the dependent variables. As illustrated in the post hoc analysis, simply adding more items to the original 5-item use measure increased the incremental variance explained by the Task Importance/Peer Pressure climate from non-significance to a statistically significant 4% of the variance in Use, holding all other predictors constant.

More important than improving the psychometric properties of the survey, however, may be understanding the different definitions of "implementation success" for web-based instructional technology. Understanding the use of these teaching tools may require much more than clear articulation of a single set of "core features" applicable across settings. Instead, "implementation" success may require a much broader understanding of how and why these teaching tools are used.

Just as a "productivity paradox" has existed over the last two decades revolving around the inability of traditional productivity measures to demonstrate value from investments in information technology (Brynjolfsson, 1993; Jurison, 1997; Pinsonneault & Rivard, 1998; Turnage, 1990), relatively recent financial commitments to teaching and learning with web-based instructional technology may now suffer from a " pedagogy paradox:" improvements in pedagogy driven by web-based instructional technology may not be evident because researchers and administrators have not yet found the methods to measure the effectiveness of these tools. One way to improve outcome measurement of web-based instructional technology would be to define a set of financial indicators to provide longer-term implementation benchmarks.

Just as a generation of IT researchers struggled with the evaluation of more general computer technologies, current research into the impact of web-based instructional technology may need to hone financial—or other— outcome measures to represent the impacts of these new teaching tools. A starting point for these efforts may be accounting based outcomes such as cost per student figures, return on investment calculations, or Strassmann' s (1988) Return-on-Management ratio.

In addition, future research could measure the time-dependent implementation *process*. The current research provides results based on a single survey of "implementation success" at one point in time. However, the activities involved in adopting, implementing, and routinizing web-based instructional technology in daily teaching activities occurs over the course of several years. Moreover, different individuals and departments will be at different stages of the implementation process at any given time. Longitudinal research methodologies may more accurately measure the dynamic nature of the implementation process.

Finally, outcome measures could focus on the ability of web-based teaching tools to teach more effectively. As faculty members and students become more adept at using computer-mediated communication technologies they may find ways to use these technologies in innovative new ways. According to a forthcoming report by Eric Brynjolfsson and Lorin Hitt, "Computing Productivity: Evidence from a Firm-Level

Survey," information technology's contribution to productivity increases continues to improve over time because, as companies gain experience utilizing the technology and workers become comfortable using the new tools, companies discover other ways to apply those technologies to improve productivity (McGee, 2000). Similarly, innovative new uses of web-based instructional technology may take some time to discover—but they may have impacts far beyond their current form.

Closing Thoughts

Perhaps the most valuable contribution empirical research can make is the *unintended questions* raised rather than the targeted hypotheses tested. The present research certainly provides this value. Testing the hypothesis that group-level climates for implementation exist within a single organization was intended to be the largest research contribution made in this investigation. However, a more critical issue to universities implementing and managing new web-based instructional technologies may be the definition and measurement of implementation outcomes. With nearly every university wrestling with how—and why—to implement new web-based technology, careful definition and measurement of implementation outcomes will be fundamental to the management of these tools.

What is the unsaid and unspoken "mokita" of computer-mediated communication technology in educational settings? First, a "truth we all know" appears to exist: shared climate perceptions can be quantitatively measured. Second, the existence of these shared truths—talked about or not—do not obviate limitations of the technology (real or perceived) or the honest differences between constituencies within an organization. Definitions of "implementation success" become less of a methodological issue and more of a political issue as stakeholders within an organization (and some outside of the organization) advocate their own priorities, perspectives, and values. How an organization defines and measures implementation outcomes may provide more fundamental and far reaching insight than what factors correlate with “success.” These questions are raised—but not answered by the present research.

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Appendices

Appendix A

Postcard for Non-Respondents

Survey Number: ___ ___ ___ __

Mail this card only if you do NOT intend to complete the survey

Dear Instructional Technology Research Team:

I do **not** intend to complete the Instructional Technology Survey for the following reason (please check one):

- ❍ I do not have access to a personal computer
- ❍ My responsibilities do not include teaching
- ❍ Other (please describe):_______________________

____

You do not need to send me reminder letters.

Appendix B

First Reminder Letter

October 5, 1999

Dear Dr. «LastName»,

In cooperation with Provost XXXX, we sent you a copy of the Technology and Instruction Survey Project on xxDATExx. This survey is part of a continuing effort to involve faculty members in shaping how information technology is used at this University.

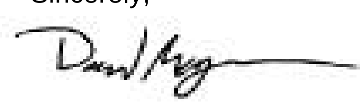
In order to keep survey cost low, we have selected a relatively small sample of respondents. However, the accuracy of our findings depends on the cooperation of the few people that we have contacted. Please take a few minutes now to complete and return the survey. If you feel that you are not an appropriate person to take this survey, please return the postcard and check the box that best describes your situation.

If you have already completed the survey or sent in the postcard, thank you for your response! Please disregard this letter—we will take you off our reminder mailing list.

If you have any questions or would like another copy of the survey or postcard, feel free to e-mail me at: david_meyer@stateuni.edu.

Thank you for your prompt attention to this matter.

Sincerely,



David Meyer
Technology and Instruction Survey
Project Director

Appendix C

Second Reminder Letter

October 18, 1999

Dear Dr. «LastName»,

On xxDATExx we sent you a copy of the Instructional Technology survey. Approximately ten days later we sent you a reminder letter. We've been persistent in our efforts to hear from you because you are a part of small sample of potential respondents: the accuracy of our findings depends on the cooperation of people like you.

We realize that faculty members have extremely busy schedules. However, the Technology and Instruction Survey Project offers you an opportunity to shape how information technology is used at this University. Several large investments in information technology are currently underway, including President XXX XXXX Information Technology Strategy Project.

Please take a few minutes now to complete and return the survey. If you feel that you are not an appropriate person to take this survey, please return the postcard and check the box that best describes your situation. If you have already completed the survey or sent in the postcard, thank you for your response! Please disregard this letter—we will take you off our reminder mailing list.

If you would like another copy of the survey or postcard, feel free to e-mail me at: david_meyer@stateuni.edu or call me at 222-2222.

Thank you for your prompt attention to this matter.

Sincerely,

David Meyer
Technology and Instruction Survey
Project Director

Appendix D

Letter of Survey Introduction

September 27, 1999

Dear Dr. «LastName»

Is the Internet changing higher education? Maybe. Ideally, web-based communication tools like electronic mail and web pages posted on the Internet will improve instructor effectiveness and have a positive impact on students' learning outcomes. However, the implementation of web-based instructional technology depends on a host of factors: from student access to web technology to the perceived usefulness of web-based technology for teaching tasks. This survey is designed to assess the importance of these factors.

You are one of a small group of people that we have sampled to find out about how instructors use—or don't use—web-based instructional technology. Please help insure the accuracy of our findings by completing and returning this questionnaire.

If you don't have access to a personal computer, your job responsibilities don't include teaching, or you are unwilling to complete the survey, just check the appropriate box on the enclosed postcard and discard the survey. We will then remove your name from follow-up mailings. If you have any questions or would like a summary of the research results, feel free to e-mail me at: david_meyer@stateuni.edu.

Thank you for your assistance in this effort!

Sincerely,

David Meyer
Technology and Instruction Survey
Project Director

Appendix E

Letter of Support from University Provost

TO: Faculty and Instructors

FROM: (Provost and Vice Chancellor for Academic Affairs, State University)

SUBJECT: Technology and Instruction Survey

Information technology will play a critical role in higher education during the next century. We now have a unique opportunity to identify new ways of using information technology to achieve this University's mission and goals. Future instructional applications of information technology may foster new approaches to teaching, support learning that is independent of time and place, and provide new mechanisms for faculty-student communication. As a key constituency within the university community, university faculty members and instructors will play a pivotal role in shaping how new information technology is used to support education.

The attached survey is part of a continuing effort to involve faculty members in planning information technology implementation (please see attached letter introducing the survey). The results of this survey identify how web-based instructional technology is currently used to support teaching activities and what factors encourage its use. Understanding the present usage patterns of this technology is an important first step in planning future information technology investments.

Part of this University's future success and competitiveness will hinge on our ability to effectively utilize teaching and learning technology. Please complete the attached survey and help this University understand how web-based instructional technology can improve our teaching and learning activities.

Thank you.

48. Because computer-mediated communication technology like e-mail and the world-wide web are easy to use, it is easy for me to become an effective instructor using these tools.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

49. Computer-mediated communication technology (e.g., e-mail and the world-wide web) is effective in supporting my department's instructional goals.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

50. Computer-mediated communication technology (e.g., e-mail and the world-wide web) provides capabilities that are of only minor importance to this department's teaching performance.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

IF YOU DO NOT USE CMC TECHNOLOGY TO SUPPORT YOUR TEACHING, PLEASE SKIP TO QUESTION 55.

Impact on Educational Outcomes

How has your use of computer-mediated communication technology (e.g., e-mail or the world-wide web) impacted the following...

51. Student Performance

STRONGLY NEGATIVE 1 2 3 4 5 STRONGLY POSITIVE

52. Student Class Preparedness

STRONGLY NEGATIVE 1 2 3 4 5 STRONGLY POSITIVE

53. Student Ability to Pose Class-Related Questions

STRONGLY NEGATIVE 1 2 3 4 5 STRONGLY POSITIVE

54. Student Ability to Keep Up with Class Work

STRONGLY NEGATIVE 1 2 3 4 5 STRONGLY POSITIVE

55. What else is important to know about faculty use of computer-mediated communication technology to support teaching?

❊ Thank you for your cooperation! ❊

Please return this survey via campus mail in the enclosed envelope. Our campus address is:

Instructional Technology Survey
Psychology Department
State Uni Box XXXX

SURVEY #

Survey of faculty use of information technolgy for teaching

Introduction

This survey measures faculty use of information technology to support teaching activities. In order to accurately reflect faculty attitudes, it is important that all recipients—from computer neophytes to passionate computer advocates—respond to this survey. Please spend 10 minutes to help this university learn how and why (or why not) information technology is used. Note that **all responses will remain completely anonymous**—each survey is numbered in order to track response rates and send follow-up notices.

Computer-Mediated Communication Technology and Teaching

This survey asks about a specific type of information technology: computer-mediated communication technology like web pages posted on the Internet and electronic mail. While you may use the Internet and electronic mail for a variety of activities (e.g., professional research or correspondence with colleagues), this survey refers to your use of computer-mediated communication technology **to support your teaching activities**. These activities may include the use of the world-wide web to research course-related information, the use of a class web page, correspondence with students via electronic mail, or using other web-based distance learning technologies to support your teaching.

FOR EACH QUESTION, PLEASE MARK (✘) ON THE RESPONSE THAT BEST DESCRIBES YOUR OPINION.

Computer Expertise

The first few questions ask about your personal experience using computer-mediated communication tools like the Internet and electronic mail.

1. From a technical perspective, I have sufficient knowledge to utilize computer-mediated communication technology for teaching (e.g., how to create html pages, how to put my course pages on the web, how to set up an e-mail discussion list).

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

2. Which of the following computer-related abbreviations can you define? (**For this question only, please mark as many responses as apply.**)

- ❍ RAM
- ❍ SQL
- ❍ ROM
- ❍ DRE
- ❍ HTML
- ❍ VPN
- ❍ CGI
- ❍ PBX

NOTE: SURVEY FORMAT AND NUMBERING REFLECTS BOOKLET LAYOUT USED.

3. All totaled, how much **formal** computer training did you have during the last academic year related to teaching with computer-mediated communication technology? Note: this type of training may include: face-to-face classroom instruction, formal web-based training, and short "brown bag" courses.

NONE — INTENSIVE
1 2 3 4 5

4. How much self instruction and one-on-one support have you had during the last academic year related to teaching with computer-mediated communication technology (e.g., how to create and post hypertext pages on the Internet, how to search the Internet for information, how to use electronic mail to support instruction)?

NONE — INTENSIVE
1 2 3 4 5

5. If more training related to teaching with computer-mediated communication technology were available, I would participate. ("Training" may include: department- or university-wide classes, one-on-one training, or tutorials).

STRONGLY DISAGREE — STRONGLY AGREE
1 2 3 4 5

6. What training topics or resources would be most helpful to you in using computer-mediated communication technology like the world-wide web and e-mail to support your teaching?

____
____
____
____
____
____

How frequently have you felt...

7. Distracted by the mechanics of using the world-wide web?

NEVER — ALWAYS
1 2 3 4 5

8. Distracted by the mechanics of using e-mail?

NEVER — ALWAYS
1 2 3 4 5

9. Frustrated in your ability to express your views using e-mail (provides text-only communication)?

NEVER — ALWAYS
1 2 3 4 5

Expectations

If you have used the web or e-mail to support your teaching activities, please complete the following questions with your initial expectations of these technologies in mind. If this is the first time you've considered the idea of using these technologies to support teaching, keep your current expectations in mind as you complete these questions.

When I first became aware that computer mediated communication technology (e.g., class web pages and e-mail) could be used to support instruction,...

10. I expected that these technologies would give me less control over my teaching responsibilities.

STRONGLY DISAGREE — STRONGLY AGREE
1 2 3 4 5

39. Approximately how many individual **students** do you correspond with during the typical work week using electronic mail? (Note: many message to one student would still be ONE student. However, the next question asks about the total number of correspondences).

___ __ __STUDENTS PER WEEK

40. Approximately how many **correspondences** with students do you typically send during the typical work week using electronic mail?

__ __ __ E-MAIL CORRESPONDENCES PER WEEK

41. When possible, I try to avoid using computer-mediated communication technology to support my teaching (e.g., e-mail or the world-wide web).

STRONGLY DISAGREE — STRONGLY AGREE
1 2 3 4 5

42. Even when I can support my teaching using computer-mediated communication technology, I still use the old way of doing things instead.

STRONGLY DISAGREE — STRONGLY AGREE
1 2 3 4 5

43. Computer-mediated communication technology (e.g., e-mail or world-wide web) is a viable way to share information with any student attending one of my courses.

STRONGLY DISAGREE — STRONGLY AGREE
1 2 3 4 5

44. What percentage of faculty members in your department actively use computer-mediated communication technology (e.g., e-mail or the world-wide web)?

__ __ __%

45. What percentage of students taking your courses actively use computer-mediated communication technology (e.g., e-mail or the world-wide web)?

__ __ __%

46. What prevents you from using computer-mediated communication tools in your instructional activities more than you already do?

____
____
____
____
____
____
____
____
____
____

Satisfaction & Usefulness

47. Learning to apply computer-mediated communication technology like e-mail and the world-wide web to my teaching needs is difficult.

STRONGLY DISAGREE — STRONGLY AGREE
1 2 3 4 5

survey continues on back—>

21. Our department's current efforts in implementing computer-mediated communication technology continue this department's history of using computer technology effectively.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

❍ DON'T KNOW (NEW TO DEPARTMENT)

22. This department shows that it values new communication capabilities by creating supportive policies related to computer-mediated information technology.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

23. Our department has procedures in place that help us learn how to use new computer-mediated information technologies.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

Training & Support

24. This university's top management—the chancellor and most deans— is strongly committed to the use of computer-mediated communication technology to support teaching.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

25. Judging from the training opportunities provided, this department sees training related to web- or e-mail supported teaching as a waste of time.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

26. This department provides the resources necessary to insure that faculty members learn how to use computer-mediated information technology to support teaching.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

27. The use of computer-mediated communication tools to support instruction is important to my department head.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

28. When it comes to teaching with computer-mediated communication technology, my department head does not take an active interest in our teaching problems and successes.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

29. Judging from the practices and procedures active in this department, faculty members are not expected to utilize the capabilities that computer-mediated communication technology provides to achieve the department's instructional goals.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

30. Specifically, what could your department do to help you use information technology to support your teaching? (e.g., provide rewards or recognition for integrating new communication technology into teaching, providing training time to learn new technologies, etc.)

____
____
____
____
____
____
____

31. Members of my department expect me to use computer-mediated communication technology to support my teaching activities (e.g., use of e-mail and the world-wide web).

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

32. For me and my fellow faculty members in this department, using computer-mediated communication technologies (e.g., e-mail and the world-wide web) is a part of teaching.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

33. Using computer-mediated communication technologies (e.g., e-mail and the world-wide web) is important to the smooth operation of this department because this technology supports critical teaching tasks.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

34. The tasks addressed by computer-mediated communication technologies like e-mail and the world-wide web help people in this department provide better instruction.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

35. Compared with other tasks that compete for our time, the teaching tasks for which faculty members in this department use computer-mediated communication technologies are trivial.

STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

Use and Satisfaction

The next few questions focus on how often you currently use computer-mediated communication technology. "Use" includes: sending electronic mail, browsing the world-wide web, using web-based collaboration tools, or other programming/content creation activities (e.g., creating web pages, manipulating graphics, or other programming activities).
"Use," then, may mean different things to different users: some faculty members may use many different computer-mediated communication technologies while others use just one. These questions are aimed at measuring how **you** use CMC technology.

36. How do you use web-based information technology to support your teaching activities? (**For this question only, please mark as many responses as apply.**)
- ❍ I LOOK AT COURSE-RELATED SITES ON THE WORLD WIDE WEB (I.E., "SURFING") FOR PLANNING AND PREPARING COURSES
- ❍ I RECOMMEND COURSE-RELATED WEB SITES TO STUDENTS AND PROVIDE THEM WITH THE PROPER WEB ADDRESSES TO THESE SITES
- ❍ I PROVIDE AN INSTRUCTOR HOME PAGE (TYPICALLY CONTAINING CONTACT INFORMATION, LIST OF COURSES TAUGHT, OFFICE LOCATION, ETC.)
- ❍ I PROVIDE A COURSE HOME PAGE (RELATED TO A SPECIFIC COURSE THAT YOU TEACH)
- ❍ I POST LECTURE NOTES AND/OR COURSE SYLLABUS ON THE COURSE HOME PAGE
- ❍ I POST STUDENT-PRODUCED WEB PAGES
- ❍ I CREATE STUDENT LEARNING ACTIVITIES THAT ARE AVAILABLE ONLY ON THE CLASS WEB PAGE
- ❍ OTHER (PLEASE DESCRIBE): _______ ___________________________

37. How would you describe your use of the world-wide web as a research tool to support your teaching activities?
- ❍ NONEXISTENT. I DO NOT USE THE WEB TO GATHER COURSE-RELATED INFORMATION.
- ❍ ONCE OR TWICE A SEMESTER I GATHER COURSE-RELATED INFORMATION VIA THE WEB.
- ❍ THREE TIMES TO SIX TIMES PER SEMESTER I GATHER COURSE-RELATED INFORMATION VIA THE WEB.
- ❍ ABOUT EVERY OTHER WEEK I LOOK AT COURSE-RELATED SITES ON THE WORLD WIDE WEB FOR PLANNING AND PREPARING COURSES.

choices continue on next column—>

- ❍ ONCE A WEEK I LOOK AT COURSE-RELATED SITES ON THE WORLD WIDE WEB FOR PLANNING AND PREPARING COURSES.
- ❍ TWICE TO FOUR TIMES A WEEK I LOOK AT COURSE-RELATED SITES ON THE WORLD WIDE WEB FOR PLANNING AND PREPARING COURSES.
- ❍ DAILY: I LOOK AT COURSE-RELATED SITES ON THE WORLD WIDE WEB FOR PLANNING AND PREPARING COURSES EVERY WORK DAY.

38. How do you use e-mail to support your teaching activities? (**For this question only, please mark as many responses as apply**.)
- ❍ I DO NOT USE E-MAIL. (IF CHECKED, PLEASE SKIP TO QUESTION 41).

- ❍ I READ MY E-MAIL. SOMETIMES THESE MESSAGES CONTAIN INFORMATION RELATING TO TEACHING (E.G., DEPARTMENT MEMOS OR ANNOUNCEMENTS).
- ❍ I CORRESPOND WITH MY PROFESSIONAL PEERS VIA E-MAIL. THESE CORRESPONDENCES MAY DIRECTLY OR INDIRECTLY IMPACT MY TEACHING.
- ❍ I COLLECT E-MAIL ADDRESSES OF THE STUDENTS TAKING MY CLASSES AND DISTRIBUTE THEM BACK TO THE STUDENT TAKING THE CLASS.
- ❍ I RESPOND TO E-MAIL MESSAGES THAT STUDENTS SEND TO ME.
- ❍ I WRITE E-MAIL MESSAGES TO STUDENTS (INDIVIDUALLY).
- ❍ I CREATE AND USE A CLASS E-MAIL MAILING LIST.
- ❍ I CREATE STUDENT LEARNING ACTIVITIES THAT ARE AVAILABLE ONLY ON VIA E-MAIL.
- ❍ OTHER (PLEASE DESCRIBE): _________ ________________________________

11. I had low expectations regarding how much these technologies would help students learn.
STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

12. I felt that using these technologies would require major adjustments in the way I communicate with students.
STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

13. I felt that using these technologies in my teaching would be a major change.
STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

14. I felt that it was important to communicate with students using these technologies.
STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

15. I felt that it was important to use these technologies to support my teaching.
STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

Climate

The following questions refer to your peers within your department and how they view computer-mediated communication technology in general and how it supports teaching.

16. Faculty members in this department have low expectations of the instructional capabilities provided by computer-mediated communication technology.
STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

17. Faculty members in this department feel that computer-mediated information technology (e.g., use of e-mail or the world-wide web) is a helpful teaching tool.
STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

18. In this department, faculty members support each other's efforts in adopting and using unfamiliar new computer-mediated information technologies.
STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

19. If I ever have a problem using computer-mediated information technology (hardware or software), I have someone in my department that can help me.
STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

20. I'm sometimes concerned about "looking dumb" when I ask someone else in my department for help with a problem related to computer-mediated information technology.
STRONGLY DISAGREE 1 2 3 4 5 STRONGLY AGREE

Appendix G

Summary of Items and Factor Loads for Varimax Orthogonal Five-Factor Solution for the Dependent Variables

Item	Factor loading 1	2	3	4	5	Communality
52/ EDPR_DV2. Student Class Preparedness	**.80**	.18	.13	-.02	.08	.69
54/ EDPR_DV4. Student Ability to Keep Up with Class Work	**.77**	.19	-.02	.06	.10	.64
E53/ DPR_DV3. Student Ability to Pose Class-Related Questions	**.75**	.15	.11	.02	.02	.59
51/ EDPR_DV1. Student Performance	**.68**	.22	.24	.13	-.06	.59
41/ USE_DV6 . (R) When possible I try to avoid using CMC to support my teaching	.26	**.64**	.25	.09	-.05	.55
49/ USEFL_D1. CMC is effective in supporting my department's instructional goals	.28	**.58**	-.14	.21	.44	.67
43/ UNVR_DV1. Computer-mediated communication technology —e.g., e-mail or world-wide web— is a viable way to share information with any student attending one of my courses	.21	**.55**	.16	.10	-.02	.39
50/ USEFL_D2. (R) CMC provides capabilities that are of only minor importance to this department's teaching performance	.16	**.54**	-.13	-.01	.51	.60
42/USE_DV7 . (R) Even when I can use CMC to support teaching, I still use the old way of doing things	.32	**.53**	.08	.26	.06	.45
37/USE_DV2. How frequently do you use WWW as research tool to support teaching (1=nonexistent…5=daily)	.03	**.50**	.45	.07	.02	.45
39/ NUBMEX. # individual correspondences sent to students each week using e-mail	.10	-.12	**.69**	-.01	-.04	.50
38/EMAILFUN . Number of e-mail functions used (Choose all core features that apply, e.g., correspond with student, use class e-mail list)	.11	.22	**.65**	.07	.07	.49
36/WEBFUN . Number of different web functions used to support teaching (Choose all core features that apply, e.g., provide course home page, recommend course-related URL's…)	.31	.25	**.52**	.31	-.03	.52
40/NUBSTUX. # of students corresponded with during typical work week	.04	.22	**.45**	-.20	.34	.41

(Appendix G continues)

(Appendix G continued)

Item	Factor loading 1	2	3	4	5	Communality
47 EAS_DV1. / (R) Learning to apply CMC to my teaching needs is difficult	-.03	.06	.13	**.88**	.09	.79
48 EAS_DV2. / Because CMC technologies are easy to use, it is easy for me to become an effective instructor using these tools	.16	.35	-.08	**.71**	.07	.67
44/ PERCFAC. What percentage of faculty members in your department actively use CMC technology —e.g., e-mail or world-wide web	-.11	.08	.03	.02	**.74**	.56
45/ PERCSTUD. What percentage of students taking your courses actively use CMC technology like e-mail or world-wide web?	.28	-.27	.20	.27	**.64**	.67
Eigenvalues	4.8	1.6	1.4	1.3	1.1	
% variance	26.8	9.0	7.9	7.0	6.2	

Note. Items in italics eliminated during reliability analysis. Boldface indicates highest factor loadings.

Appendix H

Intercorrelations Between Dependent Variable Scales and All Eliminated Items (Note. *p < .05, **p < .01 (2-tailed).

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1 GOAL1 (R) Expect less control over teaching	--																		
2 GOAL2 (R) Low expect re. CMC help studs	.363**	--																	
3 TRN_IND2 Hours formal training	-.049	.179**	--																
4 TRN_IND3 How much self instruction	.158**	.254**	.354**	--															
5 TRN_IND4 I would participate in training	0	.213**	.292**	.155**	--														
6 GOAL_CL3 (R)Compared other tasks,trivial	.134**	.190**	.041	.138**	.033	--													
7 HIST_CL1 current CMC imp=dept's history	.171**	.154**	.015	.095	-.104*	.257**	--												
8 HIST_CL2 Depart values CMC= policies re. CMC	.086	.089	.003	.07	-.081	.240**	.647**	--											
9 HIST_CL3 Depart procedures for learning	.038	.015	.110*	.044	-.108*	.223**	.387**	.535**	--										
10 TRN_CL3(R) I don't look dumb w others	.310**	.113*	-.053	.101*	-.114*	.014	-.007	-.034	.016	--									
11 EAS_DV1(R) Learning CMC difficult	.175**	.170**	-.009	.063	-.156**	.097	.153**	.170**	.149**	.306**	--								
12 EAS_DV2 CMC ez 2 use ez 2B effective	.209**	.321**	.123*	.083	.021	.077	.204**	.184**	.110*	.077	.439**	--							
13 NUBSTUD # students emailed/week	.134*	.132*	.109*	.211**	.071	.081	.113*	.09	.077	.013	.065	.114*	--						
14 NUMBMESS # correspondences/week	.088	.137*	.101	.236**	-.016	.062	.051	-.047	-.033	.086	.066	.019	.305**	--					
15 UNVR_DV1 CMC viable share w/any stud.	.290**	.331**	.163**	.267**	.163**	.153**	.044	.031	.008	.198**	.110*	.288**	.149**	.113*	--				
16 PERCFAC % faculty in dept. using CMC	.108	-.017	-.085	.007	-.058	.121*	.277**	.287**	.127*	.031	.133*	.039	.118*	-.04	.154**	--			
17 PERCSTUD % students using CMC	.140*	.165**	.045	.029	-.181**	.069	.187**	.161**	.108*	.093	.200**	.095	.115*	.083	.04	.273**	--		
18 USE SCALE	.338**	.453**	.191**	.347**	.063	.184**	.119*	.022	.001	.230**	.274**	.335**	.240**	.234**	.439**	.150*	.181**	--	
19 SATISFACTION SCALE	.241**	.387**	.085	.181**	.127*	.439**	.346**	.362**	.236**	.024	.183**	.385**	.179**	.047	.358**	.154**	.207**	.381**	--
20 EDPROCES SCALE	.243**	.425**	.215**	.310**	.043	.188**	.117*	.058	-.055	.094	.134*	.324**	.210**	.182**	.334**	-.003	.214**	.537**	.419**

Appendix I

Intercorrelations Between Dependent Variable Scales and Eliminated Individual-Level Items

Item	1	2	3	4	5	6	7	8
1. GOAL1 (R). I expected that these technologies would give me less control over my teaching	--							
2. GOAL2. (R) I had low expectations regarding how much these technologies would help students learn.	.363**	--						
3. TRN_IND2. How much formal computer training did youy have during the last year	-.049	.179**	--					
4. TRN_IND3. How much self instruction and one-on-one support have you had during last year	.158**	.254**	.354**	--				
5. TRN_IND4. If more training related to teaching with CMC were availible, I would participate	.00	.213**	.292**	.155**	--			
6. Use Scale	.338**	.453**	.191**	.347**	.063	--		
7. Satisfaction Scale	.241**	.387**	.085*	.181**	.127**	.381**	--	
8. Impact on Ed. Processes Scale	.243**	.425**	.215**	.310**	.043	.537**	.419**	--

Note. *p < .05, **p < .01 (1-tailed).